

Anything Wrong with Breaking a Buck? An Empirical Evaluation of NASDAQ \$1 Minimum Price Maintenance Criterion

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Abstract

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JEL Classification: G10; G14; and G18

Keywords: Exchange Listing Standards, Low-priced Securities, Extreme Downside Price Movements, Maximum Likelihood Estimation, Generalized Extreme Value Distribution

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Major stock exchanges are exclusive “clubs” -- each has its own maintenance criteria. The reputation and viability of an exchange rest on the listed companies. The listing requirements have been evolving throughout the history of stock exchanges, and acting as a beacon for market changes. In the past two decades, the most hotly debated practice is setting a hard-and-fast minimum trading price for listed companies. Major US exchanges adopt minimum price rules. The New York Stock Exchange (NYSE) has a \$1 average closing price criterion in its continued listing standards.¹ On the National Association of Securities Dealers Automated Quotations (NASDAQ), trading with a closing bid price under \$1 for thirty consecutive business days will trigger a delisting warning. A grace period will be initiated to afford the issuers a buffer time to “catch up”. The stock will be delisted if higher-than-\$1 bids cannot be regained during the grace period.² This policy (the one-dollar rule) is applicable throughout NASDAQ’s three market tiers -- the Global Select Market, the Global Market, and the Capital Market. Appendix A summarizes the maintenance criteria for listed securities on these component markets. On the NASDAQ, security delistings due to non-compliance with the minimum price criterion take a portion of over 42% in all the regulatory delistings after the introduction of the one-dollar rule in the early 1990s.³ This makes minimum price the most influential requirement in all maintenance standards.

In sharp contrast to these two leading exchanges, most equity markets outside the US do not assign a minimum price as one of the quantitative continued listing criteria.⁴ An extreme non-US case may be the aborted penny stock delisting in Hong Kong in 2002. On July 25, 2002, Hong Kong Exchanges and Clearing Limited (HKEx) issued a consultation paper which proposed to delist securities from the Main Board if the moving average of the daily

¹ Listed Company Manual of NYSE, Section 802.00, from www.nyse.com.

² The minimum price criterion is more common in the *initial* listing standards of US exchanges such as the NYSE, the NASDAQ, the American Stock Exchange, the Boston Stock Exchange, the Philadelphia Stock Exchange (in its alternative listing criteria -- tier I), and the NYSE Arca (which also has minimum bid price rule in its continued listing standards).

³ The sample period is from September 1991 to December 2006. Refer to Table II Panel A for detail.

⁴ Among the stock exchanges outside the US, only the Neuer Markt in Frankfurt, Germany has minimum price (Euro 1) in the continued listing standards. The young Neuer Markt established in 1997, however, is mainly a micro cap stock exchange.

volume-weighted share price over thirty consecutive trading days was less than HK\$0.5 (about US \$0.065).⁵ The following day, the market capitalization of penny stocks collapsed by approximately HK\$10 billion (about US\$1.3 billion), with daily price drop by as much as 88%. This forced HKEx to withdraw the proposal two days later (July 28, 2002). On November 12, 2002, HKEx released a revised version of the consultation paper to eliminate the minimum price criterion. In this revision, HKEx announced that it “would like the views of a wider audience on whether there should be any minimum standards for continuing listing”, and if minimum standards should prove necessary, it “would like to seek market views on what should these minimum standards be”.⁶

HKEx obviously is not the only one who has the above concerns. In the US, the debates on the minimum price standard have lasted for nearly two decades since the NASDAQ first introduced the one-dollar rule. One battle group consists of market regulators and self-regulatory organizations such as the Securities and Exchange Commission (SEC), the Financial Industry Regulatory Authority (FINRA) (former National Association of Securities Dealers (NASD)), and the NASDAQ, which continuously support the one-dollar rule. The other group includes some law firms or lawyers, most issuers, and almost all securities industry related firms, which generally deny the rationale of the rule. The regulators claim that the NASDAQ minimum price standard “generally serve(s) to increase investor confidence and the credibility of (the) market”.⁷ The opponents, on the contrary, harshly criticize the minimum price policy. Arguments such as “the \$1 rule doesn’t really make any sense”,⁸ “it is a dubious measure even in the best of times”,⁹ “I always thought the rule was a strange rule”¹⁰ are not uncommon in the media and among the practitioners.

Despite the widespread application of minimum price listing requirements in the US stock exchanges and the long-lasting disputes between market participants and regulators, the

⁵ Hong Kong Exchanges and Clearing Limited, 2002, “Consultation paper on proposed amendments to the listing rules relating to initial listing and continuing listing eligibility and cancellation of listing procedures”, from <http://www.hkex.com.hk/news/hkexnews/020725news.htm>.

⁶ Hong Kong Exchanges and Clearing Limited, 2002, “HKEx today released its revised consultation paper on Continuing Listing Criteria and Related Issues”, from <http://www.hkex.com.hk/news/hkexnews/021115news.htm>.

⁷ 62 *Federal Register*, 17269.

⁸ Kennedy, Siobhan, 2001, Nasdaq mulls waiver of \$1 delisting rule, from <http://us.rediff.com/money/2001/sep/26nasdaq.htm>.

⁹ Glassman, James K., 2003, Nothing wrong with breaking a buck, *Jewish World Review*, February 3, 2003, from <http://www.jewishworldreview.com/cols/glassman020303.asp>.

¹⁰ Krantz, Matt, 2001, Nasdaq suspends \$1 listing rule: techs may benefit, from <http://www.usatoday.com/tech/techinvestor/2001/09/28/nasdaq-listing-rule.htm>.

academics have been surprisingly silent on this issue. “This academic silence on the role of quantitative listing standards is puzzling, considering the important role such standards play in determining the set of securities to which qualitative exchange regulation will apply” [Harris (2006)]. According to Bottazzi and Da Rin (2005), “there is an obvious need to evaluate how existing rules perform, in terms of selecting valuable companies”. To our best knowledge, however, no rigorous academic research has been done to examine this influential and controversial listing standard. The evidences are all anecdotal. As Seguin and Smoller (1997) point out, “exchange and regulatory officials admit that the share price cutoff incorporated in these regulations is based primarily on popular perception rather than on theoretical or empirical evidence”. So using share price as a discriminatory variable for listing administration thirstily needs a convincing justification.

This paper provides a direct evaluation of the minimum price maintenance rule on the NASDAQ. We focus on the price collapses and catastrophic losses of individual stocks since they can swiftly wipe off enormous market values and severely damage public confidence in the stock market. Low-priced securities are more susceptible to extreme price movements due to their small capitalization, illiquidity, and informational asymmetry. If prices are substantially low, stocks may also be more likely to be subject to speculative activities.¹¹ We employ an extreme value approach to demonstrate the vulnerability of low-priced securities to the extreme downside price movements. Since sharp price plummets take place around the far left tail of the return distribution, we use the left tail index of the Generalized Extreme Value (GEV) distribution to measure extreme plunges and examine the unusual price behaviors of low-price securities. Specifically, we compare the tail indexes across stocks of different price levels before and after the one-dollar rule was implemented. Since larger tail index consistently implies a higher probability of price collapses, the tail comparisons deliver reliable assessment of the efficacy of the minimum price requirement on the NASDAQ.

Empirical evidence compiled in this study suggests that a minimum price benchmark is justified. On the NASDAQ, before the implementation of the one-dollar rule, the average tail index associated with stocks frequently trading below \$1 is more than five times larger than

¹¹ According the estimation made in September 1989 by the North American Securities Administrators Association, Americans lose at least \$2 billion each year as a result of schemes involving penny stocks. See 56 *Federal Register*, 44109.

that of other stocks trading above \$1. After the one-dollar rule was adopted, the average left tail of more-likely-to-break-\$1 stocks is reduced by almost 93%. The phenomenon is also prevalent across different industries. The huge tail decline suggests that the magnitude and frequency of dramatic price collapses in low-priced securities are substantially reduced after the adoption of the minimum price standard. Moreover, only the “breaking \$1” stocks exhibit extraordinarily large tails in the pre-rule period and dramatic tail reductions in the post-rule period. Stocks with prices falling into any higher-than-\$1 ranges do not have similar tail characteristics. This implies that the \$1 benchmark is an appropriate cutoff point in screening stocks listed on the exchange.

Although low-priced stocks generally suffer from lack of liquidity, the tail dynamics does not change after illiquidity is controlled for. Similar tail patterns are observed even after the market, size, and book-to-market effects are factored out. Furthermore, the 1987 market break and the dotcom crash in the early 2000s show no significant impact on the tail behaviors. The discriminative role played by share price cannot be subsumed by other firm and industry characteristics. In addition, for low-priced stocks, most of the traditional risk measures such as Beta and standard deviation do not share similar dynamics with the tail, which reinforces our belief that the GEV-based tail index is a desirable tool for detecting extreme price movements.

The remainder of this paper is organized as follows: Section I provides the institutional background and review of literature related to exchange listing and share price; Section II introduces the research design, the GEV model, and the data; Section III explores the tail performances of different price-based portfolios across different periods; Section IV presents more robustness checks for the tail comparisons; Section V describes the cross-period changes of standard risk measures and highlights the uniqueness of tail index in measuring extreme downside risks; the functions of other financial or industrial variables as indicators of low-priced securities are checked in Section VI; Section VII concludes.

I. Institutional Background and Related Literature

A. The Making of the Over-the-Counter Market System for Low-priced Securities and the Evolution of the One-dollar Rule

The NASDAQ minimum bid price listing requirement originated from a series of

broad-based programs initiated and supervised by the SEC. The reforms targeted at the low-priced securities largely trading in Over-the-Counter (OTC) markets. In 1988 and 1989, the SEC approved Schedule H of the NASD Bylaws and adopted Rule 15c2-6 under the Securities Exchange Act of 1934, requiring broker-dealers to report daily transaction volume and dispense with penny stock warnings to investors.¹² In 1990, the SEC, the North American Securities Administrators Association (NASAA), and some state regulators prompted further regulatory reform that led to the Securities Enforcement Remedies and Penny Stock Reform Act of 1990 (PSRA), which requires broker-dealers selling certain low-priced securities obtain a written sales agreement from any purchaser who is not a regular customer.¹³

However, provisions of the above rules or act are not applicable to NASDAQ securities. This created an incentive for low-priced securities to circumvent the compliance by seeking NASDAQ authorization. In January 1990, the SEC wrote to the NASD urging it to carefully scrutinize NASDAQ listing applications to ensure that low-priced securities fully complied with all applicable standards.¹⁴ The NASDAQ responded with a proposal on April 9, 1990 to raise its listing standards by, among other things, adopting for the first time a requirement that an issuer maintain a minimum bid price. The proposal was officially approved by the SEC on August 30, 1991.

The PSRA also mandated the establishment of an automated quotation system for penny stocks and certain other unlisted equity securities, which led to initiation of the operation of the OTC Bulletin Board (OTCBB) on June 1, 1990.¹⁵ One important purpose of the OTCBB is to aid small companies that do not qualify to have their shares listed on the NASDAQ due to the more stringent maintenance criteria.

NASDAQ's original bid price rule allowed a perpetual exemption from the \$1 minimum if certain public float and capital and surplus requirements were met.¹⁶ This alternative compliance option was abandoned in 1997 when the NASDAQ inclined to a firm

¹² Refer to 53 *Federal Register*, 16488 and 54 *Federal Register*, 35468 respectively.

¹³ *Pub. L.* 101-429, 104 *Stat.* 931 (October 15, 1990).

¹⁴ 56 *Federal Register*, 44111.

¹⁵ Before the OTCBB, a large part of non-NASDAQ OTC securities traded on the Pink Sheets market maintained by the National Quotation Bureau (NQB). Unlike the Pink Sheets, the OTCBB is a regulated quotation service to provide more transparency on the OTC equity markets.

¹⁶ For the SmallCap Market (currently known as the Capital Market), an issuer could use the exemption if the market value of its public float was at least \$1 million and it had capital and surplus of at least \$2 million. For the National Market (currently known as the Global Market), an issuer could use the exemption if the market value of its public float was at least \$3 million and it had capital and surplus of at least \$4 million. See 69 *Federal Register*, 6709.

maintenance of the \$1 bid price rule. Such a policy lasted until September 20, 2001 when the NASDAQ suspended the one-dollar rule until January 2002 under the pressure of economic slump after the 9/11 attacks. Immediately after the moratorium, the NASDAQ initiated a three-year-long (from January 2002 to the end of 2004) pilot program aiming at revising the length of the grace period. Before the 9/11 shocks, the grace period was ninety calendar days for both the NASDAQ National Market (currently known as the Global Market) and SmallCap Market (currently known as the Capital Market). During the pilot program, the NASDAQ proposed a couple of amendments to extend the grace period, with the longest one reaching a maximum of two years for SmallCap issuers. The two-year maximum grace period for the SmallCap Market, however, was cut half to three hundred and sixty calendar days following the end of the pilot program. Moreover, non-Canadian foreign issuers are also subject to the same minimum \$1 price requirement, effective from May 29, 2006.¹⁷ Notably, the NASDAQ makes efforts to have the rule consistently and more universally applied, and in the meantime, provides more measurement period flexibility to issuers engaged in continuing difficult or extraordinary climate. Appendix B provides a chronological list of events related to the reforms of OTC markets and the minimum price maintenance criteria.

The NASDAQ claims that it “continues to believe that the bid price requirements are a valuable measure of compliance”.¹⁸ However, all the justifications for the rule (including the level of the price benchmark) that the regulators could provide are exclusively from experience-based perceptions. Interestingly, in Rule 15c2-6, the SEC sets \$5, rather than \$1, as the benchmark price for the definition of penny stocks. It claims that the \$5 figure “is consistent with the Uniform Limited Offering Registration project developed by the State Regulation of Securities Committee of the American Bar Association to provide a short term registration procedure for small business private offerings”.¹⁹ Obviously, this is more of a legitimate concern than of a market concern, and says nothing about the \$1 benchmark. Similarly, the NASDAQ originally seemed not very sure about the exact level of the

¹⁷ For detailed information, refer to SEC Release No. 34-47482; File No. SR-NASD 2003-34, SEC Release No. 34-48991A; File No. SR-NASD 2003-44, SEC Release No. 34-50541; File No. SR-NASD 2004-147, SEC Release No. 34-50753; File No. SR-NASD 2004-147, <http://www.nasdaq.com/about/ForeignListingStandards021105.pdf>, and www.perkinscoie.com/content/ren/updates/corp/delisting.htm.

¹⁸ 68 *Federal Register*, 12731.

¹⁹ 56 *Federal Register*, 17193.

minimum price threshold. Along with the one-dollar rule, it also included a \$3 minimum under Standard 2 of the continued listing requirements for the National Market issuers. This elevated price cutoff was replaced by the \$1 benchmark in March 2003 because the NASDAQ did not believe that any material additional protection was afforded to investors as the result of the \$3 bid price requirement.²⁰ Despite all the claimed statutory bases and rule change practices, how to assess the suitability of the minimum price level, and of the rule itself, has always been an unsolved issue.

B. Literature Related to Exchange Listing and Security Price Level

The economics of exchange listing standards has partially rooted in the adverse selection problem due to information asymmetry. Harris (2006) quotes the “lemons problem” described by Akerlof (1970) to economically justify exchanges’ incentive to enhance their reputations by screening the issuers and accepting only qualified applicants. Without appropriate screening mechanism, the above-average-quality issuers exit the market, leading to decline in the average quality of the remaining, until the market ceases to exist. A good example is the fall of the Emerging Company Marketplace (ECM) launched by the American Stock Exchange (AMEX). In sharp contrast to NASDAQ’s success, the ECM had a short life of only a little bit over three years (from March 18, 1992 to May 11, 1995). Aggarwal and Angel (1999) analyze the reason for the failure of the ECM. They find that successful ECM issuers quickly departed for senior markets, leaving only unsuccessful firms behind. Forsythe, Lundholm, and Rietz (1999) argue that imposing listing standards “leads to an upper bound on the variance of the true value of the firm whose equity is listed, and is consequently desirable for exchanges seeking to control this variance”. In a theoretical model, Chemmanur and Fulghieri (2006) demonstrate that listing standards chosen by exchanges affect their reputations and the competition between exchanges will not necessarily lead to a “race to the bottom” in listing standards. Similar idea has been expressed by Santos and Scheinkman (2001) and Huddart, Hughes, and Brunnermeier (1999). Macey and O’Hara (2002), however, cast much doubt on implementing stringent listing standards. They put forward an extraordinary proposal of dropping the listing requirements altogether. According to their paper, with the diminishing information-conveying functions, the exchanges should expand

²⁰ 68 *Federal Register*, 12732.

the number of companies eligible for listing by lowering the listing threshold.

Fama and French (2004) document a sharp decline in survival rates for new listed stocks in the US markets. They propose that listing requirements play a role in the lower frequencies of tiny new lists in later years. Klein and Mohanram (2006) examine the impact of NASDAQ's revision of initial listing standards in 1997 to illustrate that firms listed under market capitalization standard exhibit poorer performances and greater return volatilities than those listed under profitability standard. In a study of NYSE's listing criteria, Bainbridge (2002) critiques the director independence standard. He argues that the proposals adopt an undesirable one size fits all approach and are not supported by the evidence.

Taking a specific price as a threshold for regulatory purpose does not merely appear in the exchange continued listing standards. There are other cases where similar practices are applied. Seguin and Smoller (1997) check the mortality (delisting) rates and performances for NASDAQ stocks with higher or lower Initial Public Offering (IPO) prices, taking \$3 as the watershed which in 1992 became the minimum price requirement for NASDAQ *initial* listing. They find that low-priced stocks (lower than \$3) have higher rates of attrition and lower risk adjusted returns. They consider this finding as a support for the \$3 minimum price *initial* listing rule of the NASDAQ. Consistently, Fernando, Krishnamurth, and Spindt (2004) also find that firms choosing higher stock price levels experience lower mortality rates. In a similar analysis, Bradley, Cooney, Dolvin, and Jordan (2006) document long-run underperformances and larger gross spreads for penny stock IPOs with prices lower than \$5 on the NASDAQ SmallCap Market. Nevertheless, negative evidences are found in other researches. Beatty and Kadiyala (2003) investigate the PSRA effect on restraining penny stock fraud in the IPO market. They find speculations migrate to the non-penny stocks in post-PRSA time. Similarly, in a study of NASDAQ delisting effect, Harris, Panchapagesan, and Werner (2006) argue that the cost of enforcing the minor criteria overweighs the benefit and the NASDAQ should consider easing non-core listing (including the minimum price) requirements.

Another body of share price related literature focuses on the tactics that companies utilize to avoid breaking the bottom line. Reverse stock split (RSS) is the most commonly adopted way to cosmetically drag the price above \$1, and this practice is allowed by the NASDAQ. However, almost without exemption, all the studies find negative responses to the

announcements of RSS in the US markets [Peterson and Peterson (1992), Han (1995), Desai and Jain (1997), Nelling and Chen (2002), Martell and Webb (2008)]. Koski (2007) also finds the volatility increases after RSS for stocks below \$2, even after controlling for bid-ask bounce. The most broadly accepted explanation is that RSS delivers a signal to the market that the management either loses the confidence in future price increases or has exhausted all the means to maintain listing. RSS is the last straw to catch before being delisted to less liquid and less transparent markets, which is especially apparent after the NASDAQ introduced the one-dollar rule.²¹ In Canada, however, RSS is associated with *positive* market response, as documented by Masse, Hanrahan, and Kushner (1997). This is interesting because Canadian security exchanges do not have minimum price maintenance requirements. So market's awareness of the existence of minimum price criterion largely limits the effectiveness of RSS as a way to circumvent the legislation. This highlights the large and unavoidable impact of the one-dollar rule on issuers with low-priced stocks.

Overall, as Harris (2006) emphasizes, "listing standards appear ... to matter. Analyzing the incentive structure within which listing standards are set presents a novel opportunity to analyze stock exchange regulation more generally". However, academic research on the evaluation of listing standards has been sparse. This paper is the first effort to evaluate the NASDAQ one-dollar rule, which also provides guidance for the regulatory activities on other exchanges which have not adopted or are thinking about adopting similar policies.

II. Research Design, Model Setup, and Data Sampling

A. Research Design and Hypotheses Development

In Schedule 15G under the Security Exchange Act of 1934, the SEC requires the brokers of low-priced securities to warn the clients that "investors in penny stock should be prepared for the possibility that they may lose their whole investment". This reflects the fact that unusual extreme downside price movements are more frequently observed in low-priced stocks, for which a 90% plus drop is not rare. A vivid example is Comparator Systems (a former NASDAQ SmallCap issuer). On May 7, 1996, the share price of Comparator was

²¹ Literatures have provided strong evidence on the sharp drop in price and dramatic reduce of liquidity upon delisting [Sanger and Peterson (1990), Lamba and Khan (1999), Chandy, Sarkar, and Tripathy (2004), Macey, O'Hara, and Pompilio (2005), etc.].

pumped from a few cents to a high of nearly \$2, followed by a swift price decline to 56 cents before the NASDAQ halted the trading in Comparator prior to the market open on May 9, 1996. Comparator was delisted from the NASDAQ five days later on May 14, 1996.²²

Inevitably, deep price collapses result in huge losses for shareholders. If investors frequently witness fast evaporation of their investment, they largely lose their confidence in exchanges, which threatens the legitimate securities industry. If an exchange is flourished with listed securities that are suffering from extensive and sharp price plummets, its reputation will be severely destroyed. Furthermore, if the unusual extreme price drops mostly cluster in stocks valued below a certain low level, then it calls for necessary regulatory actions which should give special treatments to the problematic issues. The examination of the extreme downside price changes is one approach to assess the minimum price criterion. In this sense, the far left end of the return spectrum is of great importance for regulatory purpose, and the tail behavior can provide much insights. Specifically, if stocks with prices lower than the threshold level (lower than \$1 for NASDAQ issues) overwhelmingly exhibit larger extreme price drops (i.e., unusually heavier left tails) than other high-priced stocks, they can be deemed harmful to investors' interest and market's integrity. Moreover, the efficacy of the regulation can be inferred if the left tails of low-priced stocks are significantly reduced to a substantially lower level after the minimum price standard was applied. Finally, if a particular price level (e.g., \$1 as set by the NASDAQ) performs better than any other price thresholds in distinguishing securities with abnormally heavier tails from other stocks, it can be considered as a good cutoff point in the minimum price rule.

We utilize the EVT model to capture the extreme price plummets. Specifically designed to assess the shape of the far end of a random process, the EVT is a well-established statistical discipline with nice asymptotic properties and provides the best estimation of the distribution tail among all existing statistical fat-tail detecting tools. It quantifies the probabilistic nature of unusual large changes and is especially suitable for the study of extreme risk associated with low-priced stocks. By using the quantitative tail indicator estimated from the EVT model,

²² Note that the Comparator case happened after the NASDAQ adopted the one-dollar rule. However, the company was exempted from satisfying the minimum bid price standard by meeting the capital surplus alternative. Actually, in the year following this case (1997), the NASDAQ removed the exemption and enforced the one-dollar rule to all domestic and Canadian issuers. See Section I and Appendix B for detail.

informative and unambiguous conclusions can be drawn.

B. Extreme Value Model Setup and Parameter Estimation

Analogous to the Central Limit Theory describing the asymptotic characteristics of the sample mean, the EVT prescribes the asymptotic distribution of the sample extremes, i.e., the maxima or minima. EVT estimates are robust to the initial distribution of the population, which makes it a very powerful tool to analyze the risk in tails. This study utilizes the GEV model, which is a classical and well established parametric EVT method. The model shows that the standardized extrema of a random series converge to a single GEV distribution.

For an i.i.d. sequence of random variables $\{X_1, X_2, \dots, X_n\}$, let R_n denote the minimum of this sample²³. Suppose there exist $\mu_n, \psi_n > 0$ such that

$$\lim_{n \rightarrow \infty} \Pr \left\{ \frac{R_n - \mu_n}{\psi_n} \leq x \right\} = H(x)$$

For any non-degenerate limit distribution $H(x)$, it must be one of three types [Fisher and Tippett (1928), Gnedenko (1943)]²⁴

$$\text{Gumbel type: } \Lambda(x) = 1 - \exp[-\exp(-x)], -\infty < x < \infty$$

$$\text{Frechet type: } \Phi(x) = \begin{cases} 1 - \exp[(-x)^{-\alpha}], & x < 0 \\ 1, & x \geq 0 \end{cases}$$

$$\text{Weibull type: } \Psi(x) = \begin{cases} 1 - \exp(-x^\alpha), & x > 0 \\ 0, & x \leq 0 \end{cases}$$

The GEV is the generalization of these three types with the distribution

$$H(R) = \begin{cases} 1 - \exp \left\{ - \left[1 - \xi \left(\frac{R - \mu_n}{\psi_n} \right) \right]^{\frac{1}{\xi}} \right\}, & 1 - \xi \left(\frac{R - \mu_n}{\psi_n} \right) > 0, \xi \neq 0 \\ 1 - \exp \left\{ - \exp \left[- \left(\frac{R - \mu_n}{\psi_n} \right) \right] \right\}, & \xi = 0 \end{cases}$$

where μ_n is a location parameter indicating where extremes are located on average, ψ_n is a scale parameter indicating the dispersion of extreme realizations, and $\zeta = 1/\alpha$ is the shape parameter [Jenkinson (1955)]. The shape parameter ζ is also called tail index, measuring the thickness of the extreme outcomes. The larger the tail index, the heavier (fatter) the tail.

²³ For sample maximum, since $\max\{X_1, X_2, \dots, X_n\} = -\min\{-X_1, -X_2, \dots, -X_n\}$, similar results can be derived.

²⁴ Non-degenerate distribution does not put all its mass at a single point.

Obviously, the case $\zeta=0$ corresponds to the Gumbel type, which is thin-tailed; $\zeta<0$ corresponds to the Weibull distribution, which is short-tailed; $\zeta>0$ corresponds to the Frechet type, which is heavy (fat)-tailed process. The parameter of the tail index is of central interest in the EVT, since it contains all the information about the distribution property of the extreme values.

The GEV parameter estimation procedure involves a block extrema sampling. Specifically, for time series data, the full period can be divided into non-overlapping sub-periods, each representing one block. The per-block maxima or minima constitute the extreme sample that follows the GEV distribution asymptotically. Longin (1996) shows that the parameter estimates are not sensitive to the length of the sub-period. Moreover, the i.i.d. assumption of the data can largely be satisfied since block sampling method reduces possible extrema interdependence.²⁵

Maximum Likelihood Estimation (MLE) method can be applied to estimate the tail, location, and scale parameters, which gives unbiased, asymptotically normal estimates with minimum variance, especially for $\zeta>-1/2$. The maximum likelihood function is given as

$$L(R_m, m = 1, 2, \dots, n; \xi, \mu_n, \psi_n) = \prod_{m=1}^n h(R_m) \mathbb{I}_{\{1-\xi \frac{R_m - \mu_n}{\psi_n} > 0\}}(R_m)$$

where $\mathbb{I}_{\{1-\xi \frac{R_m - \mu_n}{\psi_n} > 0\}}(R_m)$ is an indicator function, and $h(R_m)$ is the probability density function with the specification of

$$h(R_m) = \begin{cases} \frac{1}{\psi_n} [1 - \xi (\frac{R_m - \mu_n}{\psi_n})]^{-\frac{1+\xi}{\xi}} \exp\{-[1 - \xi (\frac{R_m - \mu_n}{\psi_n})]^{-\frac{1}{\xi}}\}, & 1 - \xi (\frac{R_m - \mu_n}{\psi_n}) > 0, \xi \neq 0 \\ \frac{1}{\psi_n} \exp\{-\exp[-(\frac{R_m - \mu_n}{\psi_n})]\} \exp[-(\frac{R_m - \mu_n}{\psi_n})], & \xi = 0 \end{cases}$$

In this paper, to indicate the extreme price drops for stocks with different price levels, we estimate the GEV-based left tail indexes for daily proportional price changes, using one month as the block window.²⁶

C. Data Sampling

²⁵ Smith (1985) proves the dependence of the data does not constitute a major obstacle to attaining the limiting distribution.

²⁶ Another major model of the EVT examines the excess beyond a very high threshold, which proves that the limiting distribution is a Generalized Pareto Distribution (GPD). In this paper, GEV is preferred to GPD due to GEV's advantage in sampling and the difficulty of finding an appropriate threshold return level.

To construct statistical estimates and evaluate the minimum bid price maintenance criterion, we include in the sample all NASDAQ-listed common stocks with trading information records in the Center for Research in Security Prices (CRSP) daily data file. We focus on the two periods before and after the introduction of the one-dollar rule, as shown in Figure 1. Since the NASD first proposed the rule to the SEC on April 9, 1990, and the SEC officially proved the rule on August 30, 1991, we define the pre-rule period as the era between January 1, 1975 and March 31, 1990.²⁷ The era from September 1, 1991 to December 31, 2006 is referred to as the post-rule period. We skip the interim between April 1990 and August 1991 to avoid possible noise due to unclear market reactions to the proposed (not yet effective) rule change.

Insert Figure 1 Here

Following Longin (1999) and others, we define daily proportional price change according to

$$R_{i,t} = \log[(P_{i,t} - P_{i,t-1})/P_{i,t-1}]$$

where $P_{i,t}$ is stock i 's closing price at day t , and $R_{i,t}$ represents stock i 's daily price change at day t (proportional to day $t-1$'s closing price). This construction presents a stationary time series that is independent of the unit of measurement and is stable under time-aggregation [Longin (1999)]. Also, the logarithmic function is an efficient way to eliminate possible microstructure biases embedded in daily return data. We exclude dividends in the calculation because our focus is the price change, especially the potential extreme price movement, rather than holding period return.²⁸

To be eligible for the tail estimation, a stock must have at least twenty-four months' daily trading records in either period.²⁹ For each stock in each period, we divide the full time series daily data into a sequence of non-overlapping sub-periods, each representing one month. The minimum daily proportional price change is picked out of each sub-period, and constitutes one observation in the extrema sample. MLE is then applied to the extrema sample to estimate the parameters in the GEV. The asymptotically normal distribution of MLE estimates provides

²⁷ CRSP records NASDAQ data from 1973. Setting the starting date of the pre-rule era as 1975 is to match the period window with the post-rule era. Expanding the sampling time backwards to 1973 produces similar results.

²⁸ Including dividends in the return definition does not change the results in this paper, since low-priced stocks usually do not pay dividends.

²⁹ This requirement is to guarantee enough sampling observations in the MLE process.

a convenient way to conduct statistical analysis when comparing the tail indexes across different groups of stocks.

D. Descriptive Statistics of Stock Price and Delisting on the NASDAQ

Despite the seemingly low level of the \$1 threshold, for a large portion of NASDAQ-listed companies, touching the \$1 bottom line is not a remote possibility as usually perceived. According to the statistics in Table I, during both sampling periods, more than one third of NASDAQ stocks have a history of having closing bid price below \$1 (Panel A). In most of the years between 1975 and 2006, the rate of touching the bottom line is at two-digit percentage level (Panel B). Before the NASDAQ adopted the one-dollar rule, the “touching \$1” portion exhibited an upward trend and peaked in 1990 with a 33.49% rate, implying among every three stocks, there was one that once traded below \$1 bid price in the year.³⁰ Such trend stopped in 1991 when the one-dollar rule was introduced, and the “touching \$1” rate sharply declined afterwards, and reached a less than 10% level in five years (9.88% in 1996). During the dotcom mania, the rate increased again, but a reverse trend quickly followed the bubble burst, reaching a lowest point of 5.25% in 2006.³¹

[Insert Table I Here]

An examination of the delisting rates due to “breaking \$1” provides more direct impression of the impact of the one-dollar rule. Table II presents the relevant delisting statistics after the implementation of the NASDAQ minimum price criterion. Panel A reports the numbers and portions of delistings due to failing to meet different minimum requirements. Besides the \$1 bid price threshold, the NASDAQ also sets minimum levels for other financial indicators such as total assets or equity, the number of market makers or shareholders, as well as the corporate governance standard (see Appendix A). Among all criteria, minimum price is obviously the most influential one, which leads to 744 NASDAQ delistings after 1991, accounting for a dominating portion of 42.11%. The other two largest shares are taken by the total asset and total equity requirements (30.73% and 21.84% respectively), which are also closely related to stock price. In contrast to these standards, the impact of number of market

³⁰ It is understandable that the “touching \$1” rates in Panel A are larger than the corresponding numbers in Panel B. According to the computing method, the longer the sample period, the higher the possibility of having history with price below \$1.

³¹ Obviously, the high “touching-\$1” rate in the post-rule period reflects the fact that a large portion of stocks had prices dropping below \$1 during the NASDAQ bubble burst time.

makers, number of shareholders, and the corporate governance requirements is trivial, only accounting for about 5% of the delistings altogether. The influence of the one-dollar rule is further manifested in Panel B, where the yearly numbers and portions of “breaking \$1” delistings are reported. The numbers are astonishingly high in most years, especially after the late 1990s. In spite of the NASDAQ emergency moratorium which suspended the minimum price standard for more than three months in 2001, the delisting portion due to “breaking \$1” was still as high as 77.42% in that year. The largest number of delistings, however, happened in 1999 (228 cases) and 1998 (203 cases). Although the total number of delistings dropped sharply after the NASDAQ bubble burst, the cases due to violating the one-dollar rule still took a lion’s share.

Insert Table II Here

III. Evaluation of the NASDAQ \$1 Minimum Price Maintenance Criterion

In order to examine the extreme price movements of individual securities with different price characteristics, stocks need to be differentiated by their prices. For the purpose of evaluating the one-dollar rule, the cutoff price should be \$1. One difficulty is that share prices may sometimes wave up and down around \$1 in certain period and with certain frequency, so it is not always obvious whether a particular stock should be allocated into the low-priced or high-priced category (relative to \$1). To circumvent this problem, we label securities with closing bids (or closing prices if bids are not available) falling below \$1 for at least half of all trading days in a certain period as “breaking \$1” stocks. Other stocks are assigned into different control groups based on the price ranges they are falling into.³² The control groups serve as proxies for securities that are less likely to trade below \$1. Following this approach, we can redirect each stock into a specific price-based portfolio according to its price label, and conduct the tail index comparisons between different portfolios or across different periods. This assists us to examine three main aspects of the minimum price criterion: the necessity, the efficacy, and the appropriateness.

A. Is the One-dollar Rule Necessary?

We have hypothesized that low-priced securities are associated with frequent dramatic

³² We also conduct robustness checks by using critical percentile points other than the median to divide stocks into different groups, and reach similar conclusions. The empirical results presented in the paper are fairly representative.

price plummets, which are detrimental to investors' interest and exchange's reputation. In the extreme value approach, this implies the left tails of low-priced stocks are abnormally higher than those of high-priced stocks. If this hypothesis cannot be rejected, using price as the discriminative variable to screen the listed securities should prove to be necessary. The period before the NASD proposed the one-dollar rule provides the most suitable environment for such test. Because there is no minimum price constraint during the pre-rule era, the tail characteristics of low- and high-priced stocks can be compared on a fair basis.

We construct two price-based portfolios using eligible stocks trading in the pre-rule period (January 1971 to March 1990). We assign stocks with history of daily closing bid prices falling below \$1 for at least half of all trading days during the period into the "breaking \$1" portfolio. Other stocks are treated as "non-breaking \$1" issues and assigned into the control group. An important aspect of the minimum price standard is that as long as the price falls below the benchmark level for a certain period (e.g., thirty days under NASDAQ's current rule), the stock will face delisting (after the grace period), regardless any other financial situations of the issuers. In this sense, the one-dollar rule is unconditional. It exclusively concentrates on the bid price. To be consistent with this feature, we focus on the bid price level when creating the "breaking \$1" portfolio and control group.

For each stock in each portfolio, we conduct the per-month minima sampling for the full pre-rule period,³³ and use MLE method to estimate the left tail index for the distribution of the daily proportional price changes. The left tail index acts as the proxy for extreme downside price movements. Average tail indexes for each group are reported in Table III under the "Before" column (i.e., pre-rule period), where "Portfolio 1" represents the "breaking \$1" group, and "Portfolio 2" refers to the control group.

Insert Table III Here

The corresponding statistical estimates clearly show the dramatic difference in estimated tails between the two portfolios. For "breaking \$1" stocks, the average left tail index is as high as 1.2658. For "non-breaking \$1" stocks, the index is merely 0.1991 on average, exhibiting a sharp contrast to Portfolio 1. The average tail index associated with the "breaking \$1" group is more than five times larger than that of the control group, and the difference is

³³ The feature of the EVT requires a large sample size to guarantee the precision and statistical property of the estimates.

statistically significant with a two-digit t -value.³⁴ In the tail comparisons, we trim off stocks with the top and bottom 10% of tail indexes in each portfolio to avoid possible biases caused by the outliers and to improve the statistical property of the estimates.³⁵ Figure 2 (the “Before” row) depicts the average levels of the tail indexes for different portfolios, from which the extraordinarily high tail for “breaking \$1” stocks in pre-rule era is striking.

[Insert Figure 2 Here]

One may argue that the unusually heavier tail associated with low-priced securities is driven by a particular group of stocks, and therefore is not a universally observed phenomenon. For example, some hi-tech stocks may be more vulnerable to extreme price collapses than those in more mature industries. To address this issue, we group the sample stocks by industrial classification, and contrast the left tail indexes across “breaking \$1” and “non-breaking \$1” stocks within each industry. If the heavier tails are primarily associated with “breaking \$1” stocks in only a subset of the industries, the above findings may be only industry-specific and applying the one-dollar rule without discrimination would become dubious.

We assign stocks into six industry groups according to their Standard Industrial Classification (SIC) codes reported in CRSP. The industry names and SIC codes are contained in the first two columns of Table IV. The “Before” column reports the average left tail indexes for different portfolios within each industry in the pre-rule period. Apparently, the tail differences between the “breaking \$1” portfolio and the control portfolio remain vast and significant. In five out of the six industry groups, “breaking \$1” stocks have average tails more than five times larger than those of the control stocks, which is very close to the magnitude of tail difference observed in the full sample case. The smallest difference appears in the electrical equipment group, but the “breaking \$1” portfolio still exceeds the control portfolio by 345.42%. The results from Table IV suggest that although some variation in the tail difference across industries is found, there is no evidence that the general conclusions are driven by, or are specific to, any particular industry.

³⁴ As a treatment of the potential size-mismatch problem, we also conduct non-parametric bootstrapping method to test the significance of the tail difference, and reach same conclusions.

³⁵ For the virtue of consistency, we apply the same approach in the tail comparisons throughout this paper. The tail difference would be even more dramatic in the untrimmed sample.

Insert Table IV Here

The universally and abnormally higher left tails for the “breaking \$1” stocks in the pre-rule period indicate that, before the implementation of the minimum price maintenance criterion, the low-priced (relative to \$1) securities on the NASDAQ do suffer a lot from extreme price plunges. The frequency and severity of steep price drops are far beyond those associated with high-priced stocks. It would be understandable if low-priced stocks only exhibited slightly heavier tails in the return distributions due to illiquidity problem, but the enormous tail gap between low- and high-priced securities as documented here is definitely not normal and deserves a scrutiny. According to our evidence, something indeed seems wrong with breaking a buck, which should catch enough attention from both the regulators and the market participants, especially the low-priced stock investors. The exchange regulators are obliged to take necessary actions to rectify the “tail anomaly”, and what the NASDAQ chooses is to delist the problematic securities. Although this policy looks tough, it is a serious step taken to battle a serious problem. With the supporting OTC market reforms initiated by the SEC, setting a minimum price maintenance criterion is a convenient way to screen the NASDAQ listing and uphold the exchange’s reputation. The necessity of such a listing requirement is confirmed in this paper.

B. Does the One-dollar Rule Work?

Following the justification of the rationale of the one-dollar rule, a nature question is whether the policy can reach and have reached its goal of curbing the extraordinarily severe price collapses for low-priced stocks on the NASDAQ. A checking of the left tails in the post-rule period as compared with those in the pre-rule period will provide meaningful evidence for the efficacy of the rule.

To address this issue, we first assign stocks into “breaking \$1” and control groups using method consistent with the approach used for the pre-rule period, i.e., stocks trading below \$1 for at least half of all trading days in the post-rule period (September 1991 to December 2006) are labeled as “breaking \$1”, and other stocks belong to the control group. We estimate the left tail indexes for all stocks in each portfolio and report the results in Table III under the “After” column. Contrasting the tails across different periods for the “breaking \$1” stocks reveals another striking phenomenon: the left tails of low-priced (relative to \$1) stocks on the

NASDAQ are substantially reduced after the adoption of the one-dollar rule. The average tail drops from a high level of 1.2658 before the rule to a low level of 0.0942 after the rule, resulting in a considerable and significant 92.56% reduction (the magnitude of the t -value is 11.74). Figure 2 presents a more vivid picture for this huge change.

Tail abatement across the sample periods is not observed for high-priced stocks. For “non-breaking \$1” securities, the average tail shows a slight 3.97% *increase* from the pre-rule period to the post-rule period, and the difference is only marginally significant. This exhibits a sharp contrast to the deep tail *decrease* for the “breaking \$1” stocks after the implementation of the one-dollar rule. In Figure 2, the cross-period tail difference for Portfolio 2 stocks is hardly observable. Similar information can be obtained from different industries, as shown in Table IV. Among the six industry groups, almost all show a 90% plus tail reduction for “breaking \$1” stocks after the introduction of the one-dollar rule. On the contrary, in five industry groups, the tail indexes of high-priced stocks do not have significant changes across the periods. The only significant change appears in the electrical equipment industry, but it is an increase instead of decrease.

Another common finding is that after the one-dollar rule is applied, the tail indexes of low-priced stocks are even lower than those of the relatively high-priced stocks. For example, in Table III, the post-rule average tail of “breaking \$1” stocks is 54.49% smaller than that of the control group stocks. Similar observation can be made for each industry group in Table IV. So it seems that the minimum price rule “overshoots” by shrinking the tail thickness of low-priced securities to a “below average” level, and by driving the price change series more normally distributed.³⁶

Overall, the evidence in this sub-section consistently indicates a sharp drop in the tail index for and only for the low-priced stocks on the NASDAQ. This implies that the extreme price plummets are largely eliminated or at least effectively curbed after the early 1990s. The most persuasive explanation for this change is the implementation of the minimum price listing requirement, which delists the “problematic” securities and cleans the atmosphere of the NASDAQ markets. In this sense, the minimum price criterion has proved to be effective.

C. Is One Dollar an Appropriate Benchmark?

³⁶ EVT models prove that a zero tail index in the GEV corresponds to a normal parent distribution.

To comprehensively evaluate the one-dollar rule, there is another issue to address: is one dollar a good watershed to distinguish the abnormally fat-tailed issues from more normally behaved stocks? For example, can a benchmark higher than \$1 but still low enough alternatively act as the cutoff point for the listing regulation because falling below such price level also leads to extraordinarily heavy tails? In previous analyses, the “non-breaking \$1” portfolios have low tail indexes, could it be because that the high tail indexes of near-\$1 stocks (e.g., \$2, \$3) are more than offset by the low indexes of far-beyond-\$1 stocks? These questions are important since they challenge the appropriateness of the specific benchmark of the minimum price rule, although not the rule itself.

The most effective way to answer these questions is directly checking the tail behaviors of stocks with different price levels. We conduct the empirical tests by constructing portfolios according to the percentage of times the daily closing bid prices falling into a certain range, where the median is taken as the critical percentile point to be consistent with previous analyses. In each of the periods (pre-rule or post-rule), we divide the full sample by nine watershed median price levels: \$1, \$2, \$3, \$4, \$5, \$7.5, \$10, \$15, and \$20. Stocks are correspondingly assigned into ten price-based portfolios. Portfolio 1 includes stocks with median closing bids falling below \$1 (this is the “breaking \$1” portfolio in previous sub-sections). Portfolio 2 contains stocks with median closing bids between \$1 and \$2, and so on. The last portfolio consists of stocks with median closing bids higher than \$20. This portfolio construction is based on three concerns: 1, the potential alternative price benchmarks, if there is any, would most probably exist in the price levels close to \$1, at least not so far from \$1. So we conduct a finer price classification for stocks with median bids lower than \$5, setting the price window width as \$1; 2, among the watershed prices, \$5 is the minimum benchmark for penny stock definition set by the SEC, and \$2 is the minimum market price at which stocks can be margined, as required in Regulation T by the Federal Reserve Board. The specific economic implications of these critical price levels may have certain interactions with the minimum price listing standard; 3, each of the ten portfolios contains similar number of stocks (especially for the pre-rule period), which in some way facilitates the statistical treatment and serves as a robustness check of previous results.

Table V reports the average left tail indexes for each portfolio, as well as the percentage

differences among portfolios and cross periods. We label Portfolio 1 through 10 by MP(0, 1], MP(1, 2], ..., MP(20, ∞), where MP stands for median price. Figure 3 depicts the corresponding index level for each portfolio in each period. Both Table V and Figure 3 reveal an interesting fact: in the pre-rule period, stocks in all portfolios except the “breaking \$1” group share very similar magnitude of left tail indexes (Panel A of Table V). Among these portfolios, the highest average tail index is 0.2395 (MP(2, 3]), and the lowest one is 0.1961(MP(1, 2]). The tail differences are generally small and insignificant (Panel B of Table V). Particularly, the MP(1, 2] portfolio, which contains stocks with median price between \$1 and \$2, does not show especially high left tail, even though it is the one that is closest to “breaking \$1”. Actually, it has the lowest average tail index among all the price-based portfolios. Similarly, among other close-to-\$1 portfolios such as MP(2, 3], MP(3, 4], and MP(4, 5], none exhibits significantly heavier tail than those of portfolios with even higher prices. In sharp contrast, the average tail level of “breaking \$1” portfolio (MP(0, 1]) is far above the levels of other portfolios, and is more than four or five times larger in magnitude.

[Insert Table V Here]

[Insert Figure 3 Here]

The similarity of tail behaviors among “non-breaking \$1” portfolios in the pre-rule period suggests that the low tail level of the control group in previous analyses is not due to the “tail dilution effect” in which the large tails of low-priced stocks are offset by the small tails of high-priced stocks. The fact is: low tail level is a common property of all stocks priced higher than \$1 rather than a unique feature of very-high-priced securities. Also, the \$2 margin eligibility benchmark and the \$5 penny stock threshold do not have any observable impact on the tail performances. This casts some doubts on their rationales, much like the NASDAQ does not believe a \$3 price requirement in its Standard 2 before 1997 offers any extra safeguard functions.³⁷ The evidence here confirms the policy makers’ perception of \$1 as the suitable level for the discriminatory price variable to regulate the exchanges.

Consistent with previous findings, cross-period tail changes for “non-breaking \$1” stocks are far less dramatic than “breaking \$1” stocks. Nevertheless, there is no uniform pattern observed for different price-based portfolios. For stocks priced lower than \$5, the average tail

³⁷ See Section I and note 20 *supra*.

indexes significantly decrease in the post-rule period, while for stocks priced higher than \$15, the trend is opposite and the tail indexes increase significantly. For other portfolios, the changes are not statistically significant. This divergent dynamics leads to the variation of tails across different portfolios in the post-rule period, with high-priced stocks generally having larger tails, especially for the very-high-priced stocks (higher than \$15 in median price). This may be due to the early 2000s NASDAQ bubble burst during which a large amount of high-priced stocks are severely and negatively impacted. As Pastor and Veronesi (2006) document, in the late 1990s, the level and volatility of stock prices are positively linked through the firm-specific uncertainty about average future profitability. This does not weaken the supporting basis for \$1 as a good benchmark, however, because the large tails of high-priced stocks in the post-rule period are by no means comparable with the super-high tail indexes of the “breaking \$1” stocks in the pre-rule period.³⁸

IV. Tail Comparisons: Robustness Tests

Much insight has been obtained so far regarding the tail properties of low- and high-priced securities on the NASDAQ. The evidence is derived from the tail estimates for the observed extreme price movements. The low-priced securities, however, also have other particular properties such as illiquidity, which may make their returns more volatile. The tail change might also be driven by the dynamics of underlying economic conditions or common risk factors. In this section, we conduct further tests based on the manifested extraordinary price plummets after controlling for these firm and market characteristics. We also exclude the influence from extreme market downs in order to factor out the unusual periods that may bias the tail estimates. Finally, we examine the tail changes across the sample periods among the same group of stocks. This helps to fix the firm-specific attributes so that the tail behavior can be more clearly depicted.

A. Price, Liquidity, and Extreme Downside Price Movements

Low liquidity is a common concern for low-priced securities. The problem may be more severe for the “breaking \$1” stocks. Illiquidity usually induces significant price changes, which is a potential cause for large tails. If illiquidity and heavy tail are the two sides of the

³⁸ The contrast here is merely for the purpose of demonstrating the extraordinarily high tails of pre-rule “breaking \$1” stocks.

same coin, they should share similar manifestations in different price portfolios and different periods. Following similar approach as in last section, we depict the levels of four commonly used liquidity indicators for the ten price-based portfolios in Figure 4, where Panel A and B are for the pre- and post-rule periods respectively.

[Insert Figure 4 Here]

The four liquidity indicators employed are the quoted percentage bid-ask spread (using daily closing bids and asks), the Roll (1984) effective spread based on the serial autocorrelation in daily returns, the portion of zero return days in the sample period, and volume turnover defined as daily trading volume over shares outstanding.³⁹ Among these measures, quoted spread is a standard trading cost variable, Roll's estimate relies exclusively on price data, and turnover is volume-based. The occurrence of zero returns is an alternative indirect method to indicate liquidity, which is especially useful in reflecting liquidities in low-priced securities due to illiquid trading [Lesmond, Ogden, and Trzeinka (1999)]. In Figure 4, to make the pictures more readable, we rescale the zero return occurrence and the turnover measures by multiplying 1/10 and 50 respectively.

As expected, the quoted percentage spread declines as share prices increase, implying low-priced stocks suffer from low liquidities. This is true for both periods. Roll's spread proxies are generally smaller than the quoted spreads, but exhibit similar price-spread relations. Interestingly, the declining pattern of spread measures from low- to high-priced stocks shows up more clearly in the post-rule period. The magnitude of the spreads, however, does not show obvious cross-period changes except for the very-low-priced stocks whose spreads increase significantly. This is not the same as the cross-period changes of tails as previously documented. Not surprisingly, the zero return occurrence measure also monotonically declines with increasing price levels. The turnover ratio, however, does not show a monotonic trend with share price. Although the "breaking \$1" portfolios normally have the lowest turnover, securities in the highest price category are not associated with the highest turnover in the pre-rule period. The turnover level increases from the pre-rule period to the post-rule period, implying heightened trading volume after the early 1990s.

³⁹ Roll's measure requires a negative autocovariance in the returns. Following Harris(1989) and Lesmond (2005), if the autocovariance is positive, we force it negative and use the Roll estimates as if a negative autocovariance is obtained.

Correspondingly, the occurrence of zero return days also declines in the post-rule period. Generally, “breaking \$1” stocks have the lowest liquidities, but the liquidity difference is not as dramatic as the tail difference between stocks valued below or above \$1. For “breaking \$1” stocks, the liquidity indicators do not consistently exhibit huge cross-period liquidity improvement. This evidence suggests a connection between illiquidity and large tail, but they do not share same patterns. Liquidity factor should not fully subsume the information delivered by tail index.

To further clarify how illiquidity affects the tail behavior, we conduct similar tail comparison analysis using liquidity adjusted return series. We select the zero return occurrence and Roll’s spread to represent the liquidity measures.⁴⁰ Each month in the sample periods, all firms are independently sorted into quintiles according to the occurrence of zero returns and Roll’s measure in the previous month. Within each of these twenty-five liquidity portfolios, stocks are averaged using previous period’s market value as the weight to form a daily return benchmark to be subtracted from each individual stock’s return.⁴¹ We then estimate the left tail indexes for the adjusted return distributions. The particular tail characteristics of low-priced stocks will disappear if liquidity can completely describe the attributes of extreme price changes. Panel A of Table VI reports the results.

Insert Table VI Here

After liquidity influence is excluded, “breaking \$1” stocks’ tails are still more than twice as large as those of “non-breaking \$1” stocks. The cross-period tail reduction effect for the “breaking \$1” portfolio is also very obvious -- the average tail index decreases by 88.47% after the implementation of the one-dollar rule. Although the pre-period tails for liquidity adjusted returns are thinner than those for the raw returns, the reference regarding the cross-portfolio and cross-period tail comparisons does not have substantial changes for “breaking \$1” stocks. Similar to the results from raw returns, “non-breaking \$1” stocks’ tails increase in the post-rule period, but the change is small and insignificant. So liquidity does show some influence in the extreme price behaviors, but the impact is not strong enough to

⁴⁰ These two measures can be estimated using daily return data, which are readily available for the full sample period. The quoted bid-ask spread and turnover require bid, ask, and volume data, which have large missing records in CRSP daily data file, especially for the pre-rule period.

⁴¹ Using equal-weighted benchmark return delivers similar results.

completely eliminate the associated comparative tail characteristics. This suggests that even the liquidity on the NASDAQ can be improved, it is still necessary to keep the minimum price rule, since the extreme risk information indicated by price level is far beyond what liquidity implies.

B. Extreme Downside Price Movements after Controlling for Common Risk Factors

There is another possibility that the tail differences (especially the cross-period changes) documented in last section may be attributed to the evolution of the general market dynamics. The time variations of common risks such as the size effect and value effect may also drive the tail behavior. To control for the influence from standard risk factors and general economic dynamics, we compute the residual proportional price changes for each stock using Fama and French (1993) three-factor model. Specifically, we define the residual daily price change according to

$$ER_{i,t} = \alpha_i + \beta_{i,MKT}MKT_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \varepsilon_{i,t}$$

where $ER_{i,t}$ is stock i 's daily proportional price change in excess of risk free rate (approximated by US one-month Treasury bill rate) at day t , MKT_t is the market excess return at day t , SMB_t and HML_t represent day t 's returns on portfolios formed to capture the size and book-to-market effects respectively, and $\varepsilon_{i,t}$ is the residual proportional price change. The daily values of MKT , SMB , and HML are obtained from Kenneth French's data library.⁴² We report the tail indexes estimated for the residual series in Panel B of Table VI.

Even without the impact of traditional risk factor dynamics, the average left tail of "breaking \$1" stocks still largely exceeds (by 123.97%) that of the relatively high-priced stocks, and the difference is significant. This is consistent with the tail characteristics in the raw price change case. Comparisons across the two periods for both portfolios tell similar stories as in previous analyses. For "breaking \$1" stocks, the average tail index is reduced significantly by 73.52% after the implementation of the one-dollar rule, and for securities in the control group, the index is almost unchanged. So the time variations of traditional risk factors cannot explain the tail changes for "breaking \$1" stocks, and the different tail

⁴² These factor returns include dividends. Since we adjust each individual stock's return consistently using same factor model, the dividend influence on the tail estimation is trivial. Also, to be consistent with asset pricing theory and common practices in the literature, the market return is based on the broad index for stocks trading on the NYSE, the AMEX, and the NASDAQ.

behaviors across the periods are most probably the results of the adoption of the one-dollar rule. This should not be surprising since distribution tails, by nature, capture different risk components other than those reflected by the traditional risk factors. The extreme price movements are much more precisely described by tails.

C. Individual Tail Behaviors without the Influence of Extreme Market Downs

The major statistical tool used in this paper is the left tail indexes of individual stocks, which measure extraordinary price collapses that are unfairly harmful to investors' interest. Occasionally, steep price drop is a systematic phenomenon, such as the 1987 market break and the dotcom crisis in the early 2000s. These extreme market downs happened in the sample periods and may systematically boost the extreme downside risks. This could cloud the inferences regarding individual tail estimates. To eliminate the impact from market-wide plunges, we drop the data for the month of October 1987 from the pre-rule sample. In the post-rule period, we drop twelve months' data starting from March 2000, since NASDAQ Composite Index experienced a sharp decline from a high of 5048.62 on March 10, 2000 to 1840.26 by the end of March 2001. We obtain the tail estimates for the price change series after excluding these extreme times, and present the results in Panel C of Table VI.

All the tail levels of different portfolios in different periods decline by varying degrees, but the basic story is unchanged. The pre-rule "breaking \$1" stocks have tails 360.95% larger than those of other stocks. After the one-dollar rule, there is a huge tail reduction of 87.24% for low-priced stocks. The extreme market-wide downside price changes have interactions with the individual steep price drops, but cannot significantly change the general comparative tail performances among stocks with different price levels. The results here suggest similar conclusions as those from Panel A and B.

D. Cross-period Tail Changes within the Same Stock Groups

As another robustness check, we present in this sub-section the dependent group tail comparisons across the pre-rule and post-rule periods. We construct the portfolios using panel data sampling approach, and identify the same groups of stocks in the cross-period comparisons. This method controls for the general (and unobserved) firm attributes, and clearly describes the tail dynamics for the same stocks in different time periods. Pane D of Table VI reports the paired comparison results across the sample periods where the stocks'

IDs are matched in each comparison.

Obviously, the substantial tail reducing effect for “breaking \$1” securities is robust under different statistical test mechanisms. For the same groups of stocks, if they are in Portfolio 1 (i.e., labeled as “breaking \$1”), their left tails are much smaller in the post-rule period (the percentage drop is 89.95% on average). If share prices are higher, there is no significant change in tails across the sample periods. These results are consistent with previous findings, and provide further supports for the efficacy of the one-dollar rule.

V. Cross-period Variations of Standard Risk Measures

The analyses in this paper largely depend on left tail index that detects extraordinary price plummets, especially for low-priced stocks. Theoretically, the EVT models provide the best tool in describing the distribution tail behaviors, and tail index is a much reliable proxy for extreme risks than any other traditional mean-centered risk measures. In this section, to demonstrate the uniqueness of tail index as a good proxy for extreme price movements, we explicitly explore the cross-period dynamics of standard mean-centered risk indicators. If no standard risk measures can correctly reflect the dynamics of abnormal price drops as tail index, the statistical foundation of the study can be further strengthened.

To address this issue, we utilize the price-based portfolio approach introduced in sub-section IIIC, i.e., constructing ten portfolios in the pre-rule and post-rule periods according to the percentage of times the closing bids falling into a specific price range. For stocks in each portfolio of each period, we compute the most representative standard risk measures using full sample data: Beta, standard deviation, idiosyncratic volatility, skewness, and kurtosis. Beta represents traditional systematic risk, and is estimated following Fama and French (1992); standard deviation (SD) is the traditional volatility measure; idiosyncratic volatility (IV) is proxied by the standard deviation of Fama and French (1993) three-factor residuals; skewness (Skew) and kurtosis (Kurt) are high moment volatility indicators, and describe the deviations from the normal distribution. All these measures have proved to play important roles in reflecting (different) risk characteristics. The corresponding statistics and cross-period comparisons are reported in Table VII. The last row is the combination of MP(1, 2] through MP(20, ∞).

Insert Table VII Here

We have documented the extraordinarily high tail indexes for the “breaking \$1” securities in the pre-rule period and the sharp tail reductions after the implementation of the one-dollar rule. For the standard risk measures, however, similar dramatic changes can hardly be observed. For the “breaking \$1” group (MP(0, 1]), Beta has no significant change over the periods, there is only a small 2.54% increase, implying the one-dollar rule does not have any material impact on the systematic risk of low-priced stocks. Similarly, none of the portfolios priced below \$5 experiences a significant cross-period change in Beta. Some of the portfolios priced higher than \$5 experience increase in Beta, especially the higher-than-\$20 portfolio which increases by 35.75%. This leads to significant higher Betas in the post-rule period for the overall “non-breaking \$1” stocks. The standard deviation and idiosyncratic volatility unanimously reach significantly higher levels from the pre-rule period to the post-rule period, and the increases are all large in magnitude. This is consistent with the findings from Campbell, Lettau, Malkiel, and Xu (2001), Xu and Malkiel (2003), and Wei and Zhang (2006), who document that individual stocks become more volatile over the second half of the twentieth century. In addition, in the pre-rule period, the “breaking \$1” stocks do not show any materially higher levels in these three risk measures when comparing across the portfolios. Overall, their behaviors are opposite to the left tail performances, and none of them can substitute the role played by tail in reflecting the extreme price movements.

Since the two high moment measures indicate partial information beyond the mean, they can provide some indirect hints on the tail thickness of the distribution. This is comparatively more applicable to kurtosis than skewness. Unlike Beta and the second moment measures, both skewness and kurtosis decline from the pre-rule era to the post-rule era for “breaking \$1” stocks, with percentage decreases of 10.48% and 50.38% respectively. However, the decrease of skewness is not statistically significant, and for kurtosis, although the decrease in lower-than-\$1 portfolio is large and significant, similar trends are observed from the very-high-priced portfolios too. For example, MP(15, 20] and MP(20, ∞) are associated with kurtosis drops of 35.17% and 46.67% respectively. Even though high moment measures such as kurtosis can also signal the heaviness of tails, the information they deliver is much noisier than that expressed by tail index. After all, the third (skewness) and fourth (kurtosis) moments, like the second (standard deviation) moment, are essentially mean-centered measures, which

would not satisfactorily fulfill the task of capturing extreme price movements.

VI. Firm and Industrial Characters of “Breaking \$1” Securities

Besides the minimum bid price criterion, the NASDAQ also adopts several other continued listing standards, and some of them have even longer history. Throughout its three component markets, the NASDAQ imposes financial maintenance criteria including market value of listed securities, number of publicly held shares, and number of market makers, etc. All these requirements are implemented unconditionally, i.e., breaking a particular bottom line will trigger a delisting regardless of any other aspects of the issuer. So it is of interest to check whether these standards have some overlapping functions with the minimum price rule, which, if large enough, would make the one-dollar rule, or any other requirements, inefficient or even redundant.

In this section, we directly check the relation between the probability of a stock falling into the “breaking \$1” group and the relevant financial variables. We also include trading volume and industry indicators in the explanatory variables to represent more market and business characters. If the non-price variables consistently signal the same attributes as reflected by share price, they could also orientate securities to the same directions as price does; otherwise, price would prove to have its irreplaceable role as a discriminative variable for regulatory purpose.

We utilize a probit model to conduct the empirical study, and report the regression coefficients in Table VIII, for both the pre-rule and post-rule periods. We define a limited dependent price indicator variable where a stock is assigned a value of one if it is included in the “breaking \$1” portfolio ($MP(0, 1]$), and zero otherwise. In the explanatory variables, we select market value of listed securities and number of market makers (MM) as the representatives of non-price listing requirements, and use trading volume (VOLUME) and number of trades (TRADE) to reflect the market activities. We compute average values of these variables for each stock in each period. Since market value is the product of share price and number of shares outstanding (SHROUT), in order to factor out the price impact, we take logarithm of the market value and drop the price part.⁴³ To check the influence of business

⁴³ Share price should not be included in the explanatory variable list, since a lower price will for sure lead to a higher probability of “breaking \$1”.

characters, we also include industry indicator variables in the model, where the indicator is assigned a value of one if the stock belongs to a specific industry group represented by mining and manufacturing (MANU), electrical equipments (ELEC), transportation and communication (TRAN), retail and whole sale (RETL), or services (SERV).

[Insert Table VIII Here]

Throughout all the models, a common observation is that none of the firm or industrial factors can significantly and consistently indicate a stock's probability of falling into the "breaking \$1" group. Since a larger number of shares outstanding is in many cases associated with a lower price level (e.g., after stock splits), the coefficients of shares outstanding are positive. However, SHROUT has a large p -value of 0.25 in model 1 of the post-rule period, suggesting an insignificant relation. Similarly, number of trades has consistent negative coefficients, but not always significant (model 4 of Panel A). In the pre-rule period, higher trading volume is associated with a higher likelihood of price falling below \$1 (model 3 and 6 of Panel A), and the evidence is not consistent in the post-rule period (model 3 and 6 of Panel B). Another variable, number of market makers, does not have consistent coefficients either. It is positively related to the dependent variable before the one-dollar rule, but the relation becomes negative in the post-rule period. Moreover, "breaking \$1" stocks do not seem to concentrate in any industries, since the coefficients of industry dummy variables change signs from the pre-rule period to the post-rule period, and in models 6 of both panels, they are mostly insignificant. This is consistent with the findings in the per-industry tail comparisons in Section III.

In summary, share price contains substantially different information about stock attributes, other financial indicators and industry conditions are not able to deliver similar messages. The evidence from Table VIII further strengthens the basis for using price as a discriminatory variable, and also reinforces the importance and unique status of the bid price criterion.

VII. Concluding Remarks

In major US stock exchanges, especially the NASDAQ, delisting an issuer only because of the stock price falling below the \$1 minimum threshold is not uncommon. This paper specifically evaluates this widely influential listing standard. We argue that the "breaking \$1" stocks are usually associated with dramatic price plummets that are devastating to investors'

interest and detrimental to market's integrity. Using an extreme value approach, we proxy the extreme downside price movements using the left tail index from a GEV model, and document significantly and abnormally higher levels of left tail indexes for the "breaking \$1" stocks before the \$1 minimum price threshold was introduced. The minimum price requirement effectively curbs the catastrophic price drops in the "breaking \$1" securities, as evidenced by the sharp declines in the left tail indexes after the one-dollar rule was implemented. The rule does not exhibit substantial impact on the higher-than-\$1 stocks, and the dynamics of tails has similar manifestations in all industries. Liquidity and traditional risks are not able to explain the comparative tail status associated with different price levels. The \$1 threshold has proved to be appropriate and can precisely distinguish stocks with abnormal high tails from the normally behaved securities. Overall, share price acts as a good discriminative variable for the regulatory purpose, and this study largely justifies the necessity, efficacy, and appropriateness of NASDAQ's \$1 minimum bid price listing criterion.

This paper highlights the importance of treating the minimum price listing rule as one step among a comprehensive market reform project for low-priced OTC securities. The PSRA makes non-NASDAQ OTC markets more regulated and the OTCBB constitutes a soft-landing mechanism for delisted stocks. On the NASDAQ, while the one-dollar rule is firmly applied, the regulators also offer great flexibilities to the affected issuers in regaining the compliance with the standard. This is reflected by the practices of modifying the grace period length, especially in the past ten years (including the 2001 emergency moratorium). The grace period modification is essentially based on the overall market conditions over time, and has become an indispensable part of the minimum price regulation. Managing the grace period, however, is more of an art than a science.

A noteworthy fact is most emerging markets do not adopt similar minimum price rule in their listing requirements. Since low-priced stocks may have a broad existence in these trading venues, utilizing price as a discriminative regulating instrument has its potential merits. However, the lessons from HKEx remind regulators to have a clear mind when concerning this issue, and not fix their eyes on the particular minimum price rule *per se*. Also, many emerging markets, especially those in the Asia-Pacific region, have price limit rules to

repress the daily extreme price movements.⁴⁴ The price limit, in some sense, provides buffering functions for potential large price plummets. Nevertheless, setting price limit does not change the particularities imbedded in the low-priced securities. The interaction between price limit rule and minimum price listing standard seems an interesting field to explore.

⁴⁴ US equity markets do not have price limit rules.

Appendix A

NASDAQ Continued Listing Requirements (November 2008)

This table summarizes NASDAQ continued listing requirements as of November 2008. In September 2005, the SmallCap Market was renamed as the Capital Market, and in July 2006, the NASDAQ created the Global Select Market and renamed the National Market as the Global Market. Equities listed on the Global Select Market and the Global Market are subject to the same maintenance criteria, which are shown in Panel A; Panel B presents the maintenance criteria for the Capital Market issuers. For detailed information about NASDAQ listing standards, refer to www.nasdaq.com.

Panel A: Global Select Market and Global Market			
Requirements	Standard 1	Standard 2	
Stockholders' equity	\$10 million	N/A	
Market value of listed securities	N/A	\$50 million	
Total assets and total revenue	N/A	\$50 million and \$50 million	
Publicly held shares	750,000	1.1 million	
Market value of publicly held shares	\$5 million	\$15 million	
Bid price	\$1	\$1	
Shareholders (round lot holders)	400	400	
Market makers	2	4	
Corporate governance	Yes	Yes	

Panel B: Capital Market			
Requirements	Standard 1	Standard 2	Standard 3
Stockholders' equity	\$2.5 million	N/A	N/A
Market value of listed securities	N/A	\$35 million	N/A
Net income from continuing operations (in the latest fiscal year or in two of the last three fiscal years)	N/A	N/A	\$500,000
Publicly held shares	500,000	500,000	500,000
Market value of publicly held shares	\$1 million	\$1 million	\$1 million
Bid price	\$1	\$1	\$1
Shareholders (round lot holders)	300	300	300
Market makers	2	2	2
Corporate governance	Yes	Yes	Yes

Appendix B

Evolution of US OTC Markets for Low-priced Securities and Minimum Price Continued Listing Standards

October 1913

The National Quotation Bureau (NQB) was organized as a quotation service for Over-the-Counter (OTC) market makers (the NQB changed its name to Pink Sheets LLC in June 2000)

February 8, 1971	The National Association of Securities Dealers Automated Quotation (NASDAQ) system began trading
April 1982	The NASDAQ introduced the National Market System (NMS), predecessor of the NASDAQ National Market (NNM)
May 1988	Schedule H of the National Association of Securities Dealers (NASD) (currently known as the Financial Industry Regulatory Authority (FINRA)) Bylaws was adopted, which requires dealers in non-NASDAQ securities to report daily transaction volume to NASD
January 1, 1990	The Securities and Exchange Commission (SEC) adopted sales practice requirements for certain low-priced, non-NASDAQ securities (Rule 15c2-6)
January 10, 1990	The SEC wrote to the NASD urging it to carefully scrutinize listing standards to ensure that low-priced securities fully complied with all applicable standards
April 9, 1990	The NASD proposed to the SEC to revise the criteria for initial and continued inclusion of securities in the NASDAQ system, introducing for the first time the minimum bid price standards, applicable to all US and Canadian issuers. For continued listing, the minimum bid price was set as \$1*
June 1, 1990	The OTC Bulletin Board (OTCBB) began operation on a pilot basis as part of market structure reforms to provide transparency in the OTC equity markets
October 15, 1990	President George H. W. Bush signed the Securities Law Enforcement Remedies and Penny Stock Reform Act of 1990 into law. The provisions of the Penny Stock Reform Act do not apply to any security listing on the NASDAQ
August 1991	The NASDAQ officially separated its markets into two sectors: the National Market and the SmallCap Market
August 30, 1991	The SEC officially approved NASD's proposal of revising NASDAQ's initial and continued listing criteria, and the minimum bid price listing standards came into effect. The continued listing rules allowed a perpetual exemption from the \$1 bid price minimum if the issuer met heightened requirements for the market value of its public float and for the amount of capital and surplus
April 1997	The NASDAQ eliminated the exemption of minimum \$1 bid price continued listing requirement, and universally applied the standard to all US and Canadian issuers; The SEC approved the operation of the OTCBB on a permanent basis
January 4, 1999	The SEC approved OTCBB Eligibility Rule which requires securities quoted on the OTCBB to report their current financial information to SEC
September 1999	The NQB introduced the Electrical Quotation Service for OTC equities and bonds
April 2000	The New York Stock Exchange (NYSE) implemented the \$1 minimum price continued listing standard**
September 27, 2001	The NASDAQ initiated an emergency moratorium and temporarily suspended the application of the continued inclusion bid price requirement
January 3, 2002	The NASDAQ reinstated the minimum bid price continued listing requirement, and introduced a pilot program which proposed several amendments to extend the grace period for bid price non-compliance
January 1, 2005	The NASDAQ ended the pilot program and reduced the maximum two-year grace period for SmallCap issuers in the pilot program to three hundred and sixty calendar

* For certain NNM issuers, there was maintenance Standard 2 which required a \$3 minimum bid price. In March 2003, the \$3 benchmark was replaced by \$1. At that time, there were only about forty issuers subject to the \$3 requirement.

** On NYSE, a company will be considered to be below compliance standards if the average closing price of a security is less than \$1 over a consecutive thirty trading-day period.

days
May 29, 2006 The NASDAQ implemented the minimum \$1 bid price continued listing requirement to all non-Canadian foreign issuers listed on the Capital Market

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Table I
Descriptive Statistics of “Touching \$1” Stocks on the NASDAQ

This table reports the numbers and proportions of stocks with a history of having closing bid price (or closing price if bid is not available) lower than \$1 (“Touching \$1”) within a specific period. The sample includes all NASDAQ-listed common stocks from January 1975 to December 2006. In Panel A, the statistics are reported for the two periods separated by the introduction of the NASDAQ minimum \$1 bid price continued listing requirement (the one-dollar rule). The one-dollar rule was firstly proposed by the NASD to the SEC on April 9, 1990, and was officially approved by the SEC on August 30, 1991. The era between January 1, 1975 and March 31, 1990 is referred to as “Before ‘\$1 rule’” period, and the era between September 1, 1991 and December 31, 2006 is referred to as “After ‘\$1 rule’” period. The interim during which the proposal was pending is skipped. Panel B reports similar statistics for each year between 1975 through 2006.

Panel A: By Period			
Period	Number of "Touching \$1" Stocks	Number of All Stocks	Rate of "Touching \$1"
Before "\$1 rule" (01/75-03/90)	3221	9010	35.75%
After "\$1 rule" (09/91-12/06)	3871	10337	37.45%

Panel B: By Year			
Year	Number of "Touching \$1" Stocks	Number of All Stocks	Rate of "Touching \$1"
1975	357	2518	14.18%
1976	314	2569	12.22%
1977	280	2584	10.84%
1978	253	2586	9.78%
1979	265	2604	10.18%
1980	326	2814	11.58%
1981	558	3199	17.44%
1982	737	3259	22.61%
1983	679	3848	17.65%
1984	924	4104	22.51%
1985	994	4208	23.62%
1986	956	4605	20.76%
1987	1137	4768	23.85%
1988	1200	4674	25.67%
1989	1178	4425	26.62%
1990	1428	4264	33.49%
1991	1271	4215	30.15%

(continued)

Table I-continued

Year	Number of "Touching \$1" Stocks	Number of All Stocks	Rate of "Touching \$1"
1992	922	4315	21.37%
1993	587	4582	12.81%
1994	608	4900	12.41%
1995	603	5197	11.60%
1996	552	5588	9.88%
1997	660	5632	11.72%
1998	900	5382	16.72%
1999	642	5115	12.55%
2000	838	4815	17.40%
2001	1059	4285	24.71%
2002	905	3711	24.39%
2003	565	3355	16.84%
2004	180	3157	5.70%
2005	189	3086	6.12%
2006	160	3046	5.25%

Table II**Delistings from the NASDAQ after the Implementation of the One-dollar Rule**

This table reports the summary statistics of delistings due to failing to meet NASDAQ continued listing requirements after the minimum \$1 bid price continued listing requirement (the one-dollar rule) was officially approved by the SEC, i.e., for the sample period of September 1991 through December 2006. Panel A reports the numbers and proportions of delistings due to different non-compliance reasons within the whole period; Panel B reports the numbers and proportions of delistings due to not being able to maintain higher-than-\$1 bid price ("Breaking \$1"). The statistics are computed each year between 1992 and 2006.

Panel A: All Types of Delistings			
CRSP Delisting Code	Description	Number of Delistings	Portion
550	Insufficient number of market makers	48	2.72%
551	Insufficient number of shareholders	33	1.87%
552	Price fell below acceptable level	744	42.11%
560	Insufficient capital, surplus, and/or equity	386	21.84%
561	Insufficient (or non-compliance with rules of) float or asset	543	30.73%
587	Corporate governance violation	13	0.74%

Panel B: Delistings Due to "Breaking \$1"			
Year	Total Number of Delisted Stocks	Number of Delistings Due to "Breaking \$1"	Portion
1992	256	59	23.05%
1993	88	21	23.86%
1994	94	40	42.55%
1995	116	44	37.93%
1996	91	29	31.87%
1997	124	39	31.45%
1998	203	65	32.02%
1999	228	102	44.74%
2000	140	61	43.57%
2001	186	144	77.42%
2002	104	72	69.23%
2003	68	41	60.29%
2004	18	1	5.56%
2005	33	15	45.45%
2006	18	11	61.11%

Table III
Left Tail Comparisons

Maximum Likelihood Estimation (MLE) is adopted to estimate the left tail index in the Generalized Extreme Value (GEV) distribution of daily proportional stock price changes. The daily proportional price change is defined according to $R_{i,t} = \log[(P_{i,t} - P_{i,t-1})/P_{i,t-1}]$, where $P_{i,t}$ is stock i 's closing price at day t , and $R_{i,t}$ represents stock i 's daily price change (proportional to day $t-1$'s closing price) at day t . "Before" refers to the period from January 1975 to March 1990, i.e., before the NASDAQ minimum \$1 bid price continued listing requirement (the one-dollar rule) was firstly proposed (on April 9, 1990); "After" refers to the period from September 1991 to December 2006, i.e., after the one-dollar rule was officially approved by the SEC (on August 30, 1991). The sample includes all NASDAQ-listed common stocks with at least twenty-four months' return records in CRSP daily data file within each period, and left tail indexes are estimated using all available daily data for each stock in each period. Portfolio 1 includes stocks trading with closing bid prices falling below \$1 for at least half of all trading days, i.e., with the median closing bid price (MP) less than or equal to \$1. All other stocks are assigned into Portfolio 2. Portfolio 1 is considered as low-priced and acts as a proxy for stocks that are more likely to trade with bid prices less than \$1; portfolio 2 is a control group, representing stocks that are less likely to trade under the minimum bid price benchmark. This table reports the average left tail index of stocks within each portfolio in each period, and the comparisons across different portfolios and periods. "Percentage Change" is computed as "(After-Before)/Before" for the row variables and "(Portfolio 1-Portfolio 2)/Portfolio 2" for the column variables. Stocks with the top and bottom ten percent of tail indexes in each portfolio/period group are trimmed to avoid potential biases caused by outliers. Also reported are the associated t -statistics.

Portfolio	Period		Percentage Change	t -value
	Before	After		
Portfolio 1 (MP≤\$1)	1.2658	0.0942	-92.56%	-11.74
Portfolio 2 (MP>\$1)	0.1991	0.2070	3.97%	2.09
Percentage change	535.76%	-54.49%		
t -value	10.72	-12.38		

Table IV
Left Tail Comparisons by Industry

GEV-based left tail indexes are estimated for the distribution of daily proportional stock price changes. Daily price change is the logarithm of proportional closing price change; “Before” and “After” refer to the periods before (January 1975 – March 1990) and after (September 1991 – December 2006) the implementation of the NASDAQ minimum \$1 bid price continued listing requirement; and portfolio1 and 2 contains stocks with median daily closing bid price below and above \$1 in each period respectively, representing equities with more and less likelihood of trading below \$1. The first two columns indicate the industry names and CRSP SIC codes. Average left tail index of stocks within each portfolio of each period in each industry is reported (stocks with the top and bottom ten percent of tail indexes in each portfolio/period group are trimmed to avoid potential outlier biases). Also reported are the tail comparisons across different portfolios and periods in each industry, as well as the associated *t*-statistics. “Percentage Change” is computed as “(After-Before)/Before” for the row variables and “(Portfolio 1-Portfolio 2)/Portfolio 2” for the column variables.

Industry	CRSP SIC Codes	Portfolio	Period		Percentage Change	<i>t</i> -value
			Before	After		
Mining and manufacturing (except electrical equipment)	90-399	Portfolio 1 (MP≤\$1)	1.2053	0.0870	-92.78%	-7.29
		Portfolio 2 (MP>\$1)	0.2002	0.2011	0.45%	0.10
		Percentage change	502.05%	-56.74%		
		<i>t</i> -value	6.58	-6.6		
Electrical equipment	350-369, 380-389	Portfolio 1 (MP≤\$1)	0.8129	0.0845	-89.61%	-3.82
		Portfolio 2 (MP>\$1)	0.1825	0.2096	14.85%	3.66
		Percentage change	345.42%	-59.69%		
		<i>t</i> -value	3.32	-6.13		
Transportation and communication	400-499	Portfolio 1 (MP≤\$1)	1.4129	0.0987	-93.01%	-2.43
		Portfolio 2 (MP>\$1)	0.1977	0.2189	10.72%	1.64
		Percentage change	614.67%	-54.91%		
		<i>t</i> -value	2.26	-2.31		
Retail and whole sale	500-599	Portfolio 1 (MP≤\$1)	1.5073	0.0860	-94.29%	-4.33
		Portfolio 2 (MP>\$1)	0.2114	0.2159	2.13%	0.36
		Percentage change	613.01%	-60.17%		
		<i>t</i> -value	3.96	-5.41		
Services	600-899	Portfolio 1 (MP≤\$1)	1.4997	0.1098	-92.68%	-6.33
		Portfolio 2 (MP>\$1)	0.2111	0.2040	-3.36%	-1.11
		Percentage change	610.42%	-46.18%		
		<i>t</i> -value	5.88	-6.15		
Other and N/A	above 900 or missing	Portfolio 1 (MP≤\$1)	1.7516	-0.0650	-103.71%	-2.71
		Portfolio 2 (MP>\$1)	0.1693	0.2262	33.61%	0.45
		Percentage change	934.61%	-128.74%		
		<i>t</i> -value	2.36	-3.11		

Table V
Left Tail Comparisons across Different Price-based Portfolios

GEV-based left tail indexes are estimated for the distribution of daily proportional stock price changes. Daily price change is the logarithm of proportional closing price change; “Before” and “After” refer to the periods before (January 1975 – March 1990) and after (September 1991 – December 2006) the implementation of the NASDAQ minimum \$1 bid price continued listing requirement. Ten portfolios are constructed according to the percentage of times the daily closing bid prices falling into a certain range, where the 50th percentile (median) is taken as the critical point. Portfolio 1 includes stocks with median daily closing bid prices falling below \$1 (including) within each period, indicated by MP(0,1]; portfolio 2 contains stocks with median daily closing bid prices between \$1 and \$2 (MP(1,2]), and so on. The last portfolio MP(20,∞) consists of stocks with median daily closing bid prices higher than \$20. Panel A reports the average left tail index of stocks within each portfolio and the comparisons across different periods (stocks with the top and bottom ten percent of tail indexes in each portfolio/period group are trimmed to avoid potential outlier biases). Panel B reports the tail index comparisons across different price-based portfolios within each period. Also reported are the associated *t*-statistics. “Percentage Change” is computed as “(After-Before)/Before” in Panel A and “(Row-Column)/Column” in Panel B.

Panel A: Comparison across Periods					
Portfolio	Period		Percentage Change	<i>t</i> -value	
	Before	After			
MP(0,1]	1.2658	0.0942	-92.56%	-11.74	
MP(1,2]	0.1961	0.1446	-26.26%	-3.63	
MP(2,3]	0.2395	0.1790	-25.26%	-3.98	
MP(3,4]	0.2236	0.1875	-16.14%	-2.57	
MP(4,5]	0.2203	0.2162	-1.86%	-0.13	
MP(5,7.5]	0.2270	0.2067	-8.94%	-1.06	
MP(7.5,10]	0.2098	0.2022	-3.62%	-0.38	
MP(10,15]	0.2032	0.2136	5.12%	0.69	
MP(15,20]	0.2252	0.3170	40.76%	3.44	
MP(20,∞)	0.2095	0.4621	120.57%	8.53	

Panel B: Comparison across Portfolios										
Portfolio		Before								
		MP(0,1]	MP(1,2]	MP(2,3]	MP(3,4]	MP(4,5]	MP(5,7.5]	MP(7.5,10]	MP(10,15]	MP(15,20]
MP(0,1]	Percentage change	545.49%	428.52%	466.10%	474.58%	457.62%	503.34%	522.93%	462.08%	504.20%
	<i>t</i> -value	10.66	10.21	10.39	10.06	10.27	10.42	10.57	10.23	10.39
MP(1,2]	Percentage change		-18.12%	-12.30%	-10.99%	-13.61%	-6.53%	-3.49%	-12.92%	-6.40%
	<i>t</i> -value		-2.19	-1.46	-0.73	-1.34	-0.58	-0.36	-1.15	-0.54
MP(2,3]	Percentage change			7.11%	8.72%	5.51%	14.16%	17.86%	6.35%	14.32%
	<i>t</i> -value			0.81	0.57	0.53	1.22	1.77	0.55	1.17
MP(3,4]	Percentage change				1.50%	-1.50%	6.58%	10.04%	-0.71%	6.73%
	<i>t</i> -value				0.10	-0.15	0.59	1.04	-0.06	0.57
MP(4,5]	Percentage change					-2.95%	5.00%	8.42%	-2.18%	5.16%
	<i>t</i> -value					-0.19	0.29	0.51	-0.13	0.29
MP(5,7.5]	Percentage change						8.20%	11.71%	0.80%	8.35%
	<i>t</i> -value						0.64	1.01	0.06	0.62
MP(7.5,10]	Percentage change							3.25%	-6.84%	0.14%
	<i>t</i> -value							0.28	-0.53	0.01

(continued)

Table V-continued

Portfolio		MP(0,1]	MP(1,2]	MP(2,3]	MP(3,4]	MP(4,5]	MP(5,7.5]	MP(7.5,10]	MP(10,15]	MP(15,20]	MP(20,∞)
MP(10,15]	Percentage change									-9.77%	-3.01%
	<i>t</i> -value									-0.85	-0.25
MP(15,20]	Percentage change										7.49%
	<i>t</i> -value										0.52
MP(20,∞)	Percentage change										
	<i>t</i> -value										
After											
Portfolio		MP(0,1]	MP(1,2]	MP(2,3]	MP(3,4]	MP(4,5]	MP(5,7.5]	MP(7.5,10]	MP(10,15]	MP(15,20]	MP(20,∞)
MP(0,1]	Percentage change		-34.85%	-47.37%	-49.76%	-56.43%	-54.43%	-53.41%	-55.90%	-70.28%	-79.61%
	<i>t</i> -value		-5.75	-9.75	-10.08	-12.20	-12.41	-11.27	-12.19	-12.21	-16.43
MP(1,2]	Percentage change			-19.22%	-22.88%	-33.12%	-30.04%	-28.49%	-32.30%	-54.38%	-68.71%
	<i>t</i> -value			-5.47	-6.37	-9.74	-10.11	-8.69	-11.24	-10.13	-14.84
MP(2,3]	Percentage change				-4.53%	-17.21%	-13.40%	-11.47%	-16.20%	-43.53%	-61.26%
	<i>t</i> -value				-1.26	-5.08	-4.54	-3.51	-5.67	-8.12	-13.24
MP(3,4]	Percentage change					-13.27%	-9.29%	-7.27%	-12.22%	-40.85%	-59.42%
	<i>t</i> -value					-3.74	-2.88	-2.07	-3.98	-7.54	-12.76
MP(4,5]	Percentage change						4.60%	6.92%	1.22%	-31.80%	-53.21%
	<i>t</i> -value						1.33	1.83	0.34	-5.79	-11.32
MP(5,7.5]	Percentage change							2.23%	-3.23%	-34.79%	-55.27%
	<i>t</i> -value							0.70	-1.16	-6.51	-11.97
MP(7.5,10]	Percentage change								-5.34%	-36.21%	-56.24%
	<i>t</i> -value								-1.74	-6.70	-12.09
MP(10,15]	Percentage change									-32.62%	-53.78%
	<i>t</i> -value									-6.10	-11.64
MP(15,20]	Percentage change										-31.40%
	<i>t</i> -value										-5.45
MP(20,∞)	Percentage change										
	<i>t</i> -value										

Table VI
Left Tail Comparisons: Robustness Tests

GEV-based left tail indexes are estimated for different return series. In Panel A, daily proportional stock price changes are adjusted using liquidity-based benchmark returns. Each month, all the sample stocks are sorted into two independent quintile series according to the occurrence of zero return days and a modified Roll measure. Value-weighted returns for each of the twenty-five liquidity portfolios are computed to form benchmarks to be subtracted from each individual stock's return. Tail estimation in Panel B is based on Fama and French (1993) three-factor return residuals. In Panel C, the data of October 1987 and the period from March 2000 to February 2001 are dropped from the return series. Panel D uses raw return series. "Before" and "After" refer to the periods before (January 1975 – March 1990) and after (September 1991 – December 2006) the implementation of the NASDAQ minimum \$1 bid price continued listing requirement; and portfolio 1 and 2 contain stocks with median daily closing bid prices below and above \$1 in each period respectively, representing equities with more and less likelihood of trading below \$1. For each modified return series in Panel A through C, average left tail index of stocks within each portfolio of each period is reported. Also reported are the tail comparisons across different portfolios and periods, as well as the associated *t*-statistics. In Panel D, the cross-period tail comparisons are conducted for the same groups of stocks. In each portfolio/period group of all panels, stocks with the top and bottom ten percent of tail indexes are trimmed to avoid potential outlier biases.

Panel A: Controlling for Liquidity				
Portfolio	Period		Percentage Change	<i>t</i> -value
	Before	After		
Portfolio 1 (MP≤\$1)	0.6257	0.0972	-84.47%	-11.86
Portfolio 2 (MP>\$1)	0.1831	0.1875	2.40%	1.73
Percentage change	241.73%	-48.16%		
<i>t</i> -value	10.09	-10.92		

Panel B: Controlling for Fama and French (1993) Three Factors				
Portfolio	Period		Percentage Change	<i>t</i> -value
	Before	After		
Portfolio 1 (MP≤\$1)	0.4195	0.1111	-73.52%	-12.69
Portfolio 2 (MP>\$1)	0.1873	0.1924	2.72%	1.97
Percentage change	123.97%	-42.26%		
<i>t</i> -value	10.11	-10.10		

Panel C: Excluding Extreme Market Down Periods				
Portfolio	Period		Percentage Change	<i>t</i> -value
	Before	After		
Portfolio 1 (MP≤\$1)	0.6988	0.0892	-87.24%	-8.85
Portfolio 2 (MP>\$1)	0.1516	0.1775	17.08%	10.18
Percentage change	360.95%	-49.75%		
<i>t</i> -value	8.00	-10.67		

Panel D: Paired Comparison				
Portfolio	Period		Percentage Change	<i>t</i> -value
	Before	After		
Portfolio 1 (MP≤\$1)	1.1873	0.1193	-89.95%	-2.03
Portfolio 2 (MP>\$1)	0.1658	0.1699	2.45%	0.72

Table VII
Standard Risk Indicator Comparisons across Different Price-based Portfolios

This table reports the changes in Beta, standard deviation, idiosyncratic volatility, skewness, and kurtosis across different periods for price-based portfolios. “Before” and “After” refer to the periods before (January 1975 – March 1990) and after (September 1991 – December 2006) the implementation of the NASDAQ minimum \$1 bid price continued listing requirement. Ten portfolios are constructed according to the percentage of times the daily closing bid prices falling into a certain range, where the 50th percentile (median) is taken as the critical point. Portfolio 1 includes stocks with median daily closing bid prices falling below \$1 (including) within each period, indicated by MP(0,1]; portfolio 2 contains stocks with median closing bid prices between \$1 and \$2 (MP(1,2]), and so on. The last portfolio (All MP>\$1) represents all stocks with median closing bid prices higher than \$1, i.e., the combination of MP(1,2] through MP(20,∞). The sample includes the stocks with associated left tail indexes in each period (those that have the top and bottom ten percent of tail indexes are trimmed to avoid potential outlier biases). “Beta” is estimated following Fama and French (1992). “SD”, “Skew”, and “Kurt” respectively refer to the standard deviation, skewness, and kurtosis of daily proportional price changes for each stock in each period, “IV” is the standard deviation of Fama and French (1993) three-factor residuals from daily proportional stock price changes. The average values of these standard risk indicators are reported, along with the comparisons across different periods for each portfolio. “Percentage Change” is computed as “(After-Before)/Before”. Also reported are the associated *t*-statistics.

Portfolio	Beta			SD			IV			Skew			Kurt		
	Period		Percentage Change	Period		Percentage Change	Period		Percentage Change	Period		Percentage Change	Period		Percentage Change
	Before	After		Before	After		Before	After		Before	After		Before	After	
MP(0,1]	0.5945	0.6096	2.54%	0.0606	0.1248	105.94%	0.0602	0.1244	106.64%	2.1727	1.9449	-10.48%	39.9330	19.8160	-50.38%
<i>t</i> -value			0.29			25.03			25.04			-1.37			-4.60
MP(1,2]	0.7438	0.7041	-5.34%	0.0546	0.0928	69.96%	0.0539	0.0922	71.06%	1.8546	2.0857	12.46%	29.4340	28.1770	-4.27%
<i>t</i> -value			-1.18			28.80			28.89			1.66			-0.34
MP(2,3]	0.7399	0.7793	5.33%	0.0480	0.0815	69.79%	0.0473	0.0807	70.61%	1.6243	2.1360	31.50%	26.4140	31.0880	17.70%
<i>t</i> -value			1.20			23.59			23.55			3.64			1.42
MP(3,4]	0.7942	0.8576	7.98%	0.0464	0.0693	49.35%	0.0456	0.0684	50.00%	1.6060	1.7450	8.66%	29.2350	29.6150	1.30%
<i>t</i> -value			1.79			20.19			20.24			0.81			0.07
MP(4,5]	0.8388	0.8700	3.72%	0.0440	0.0653	48.41%	0.0431	0.0643	49.19%	1.3303	1.8085	35.95%	20.5240	29.4450	43.47%
<i>t</i> -value			0.86			16.62			16.66			3.14			2.53
MP(5,7.5]	0.8562	0.9349	9.19%	0.0405	0.0556	37.28%	0.0395	0.0545	37.97%	1.2865	1.4167	10.12%	22.5650	25.8490	14.55%
<i>t</i> -value			2.85			18.05			17.89			1.14			1.01

(continued)

Table VII-continued

Portfolio	Beta			SD			IV			Skew			Kurt		
	Period		Percentage Change	Period		Percentage Change	Period		Percentage Change	Period		Percentage Change	Period		Percentage Change
	Before	After		Before	After		Before	After		Before	After		Before	After	
MP(7.5,10]	0.8173	0.9243	13.09%	0.0355	0.0484	36.34%	0.0345	0.0472	36.81%	1.0753	1.1198	4.14%	20.2300	21.1760	4.68%
<i>t</i> -value			3.50			16.33			16.44			0.41			0.39
MP(10,15]	0.8664	0.9125	5.32%	0.0301	0.0417	38.54%	0.0288	0.0403	39.93%	1.1802	0.7773	-34.14%	22.4040	16.6280	-25.78%
<i>t</i> -value			1.75			18.38			18.96			-4.28			-2.62
MP(15,20]	0.8516	0.8281	-2.76%	0.0251	0.0347	38.25%	0.0237	0.0334	40.93%	1.1747	0.6237	-46.91%	24.1760	15.6740	-35.17%
<i>t</i> -value			-0.82			16.17			17.44			-5.21			-3.84
MP(20,∞)	0.7594	1.0309	35.75%	0.0202	0.0328	62.38%	0.0189	0.0308	62.96%	0.9218	0.5310	-42.40%	23.5670	12.5680	-46.67%
<i>t</i> -value			9.96			25.53			26.37			-4.21			-5.08
All MP>\$1	0.8121	0.8992	10.73%	0.0373	0.0560	50.13%	0.0363	0.0547	50.69%	1.3219	1.2714	-3.82%	24.0750	22.4540	-6.73%
<i>t</i> -value			8.43			43.89			43.30			-1.26			-1.62

Table VIII**Probit Regression Coefficients with Price Indicator as Dependent Variable**

This table shows the results of probit models with a limited dependent indicator variable where a stock is assigned a value of one if it is included in the “breaking \$1” portfolio (MP(0, 1]), and zero otherwise. Among the explanatory variables, “SHROUT”, “MM”, “VOLUME”, and “TRADE” represent average shares outstanding (in logarithm), number of market makers, trading volume, and number of trades respectively. CRSP daily data file is used to compute these values. Industry indicator variables are also included in the model specification, where the indicator variable is assigned a value of one if the stock belongs to a specific industry group according to its CRSP SIC codes. “MANU”, “ELEC”, “TRAN”, “RETL”, and “SERV” refer to mining and manufacturing, electrical equipments, transportation and communication, retail and whole sale, and services respectively. Panel A and B report the regression coefficients for the periods before (January 1975 – March 1990) and after (September 1991 – December 2006) the implementation of the NASDAQ minimum \$1 bid price continued listing requirement respectively. The associated *p*-values are reported in brackets.

Panel A: Before									
Model	SHROUT	MM	VOLUME	TRADE	MANU	ELEC	TRAN	RETL	SERV
1	0.6565 [0.00]								
2		0.0080 [0.05]							
3			0.0021 [0.00]						
4				-0.0044 [0.22]					
5					0.6347 [0.00]	0.2101 [0.02]	0.0818 [0.49]	0.2165 [0.03]	0.0001 [1.00]
6	0.8119 [0.00]	0.0331 [0.24]	0.0117 [0.00]	-0.0670 [0.00]	4.8895 [1.00]	4.7457 [1.00]	4.9381 [1.00]	4.8572 [1.00]	4.8312 [1.00]
Panel B: After									
Model	SHROUT	MM	VOLUME	TRADE	MANU	ELEC	TRAN	RETL	SERV
1	0.0298 [0.25]								
2		-0.0211 [0.00]							
3			-0.0005 [0.00]						
4				-0.0017 [0.00]					
5					-0.5956 [0.31]	-0.7745 [0.19]	-0.9612 [0.11]	-0.6778 [0.25]	-0.8660 [0.14]
6	0.3874 [0.00]	-0.0277 [0.00]	0.0024 [0.00]	-0.0053 [0.00]	-0.6469 [0.29]	-0.7038 [0.25]	-1.0141 [0.10]	-0.6757 [0.27]	-0.8428 [0.17]

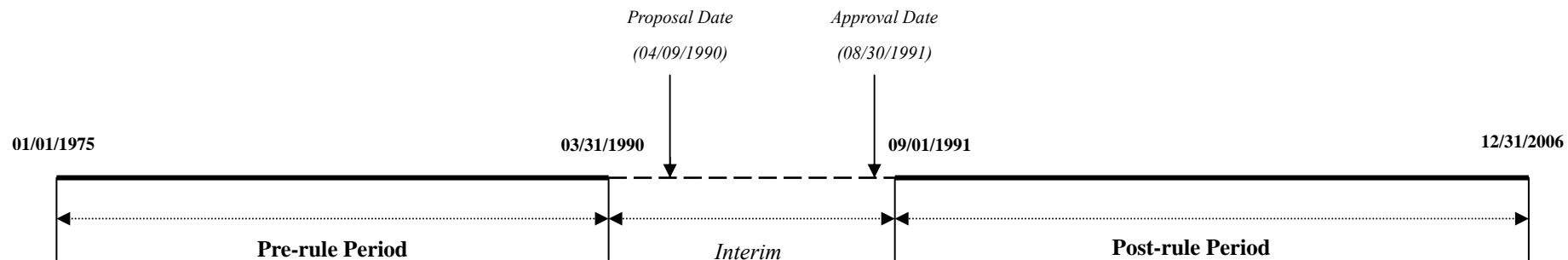


Figure 1. Sample period construction. NASDAQ \$1 minimum price listing standard (the one-dollar rule) was firstly proposed by the NASD to the SEC on April 9, 1990, and was officially approved by the SEC on August 30, 1991. The starting point of the sample period is January 1, 1975 and the ending point is December 31, 2006. The era between January 1, 1975 and March 31, 1990 is referred to as the pre-rule period, and the era between September 1, 1991 and December 31, 2006 is referred to as the post-rule period. The period between April 1, 1990 and August 31, 1991 refers to the interim and is excluded from the sample period.

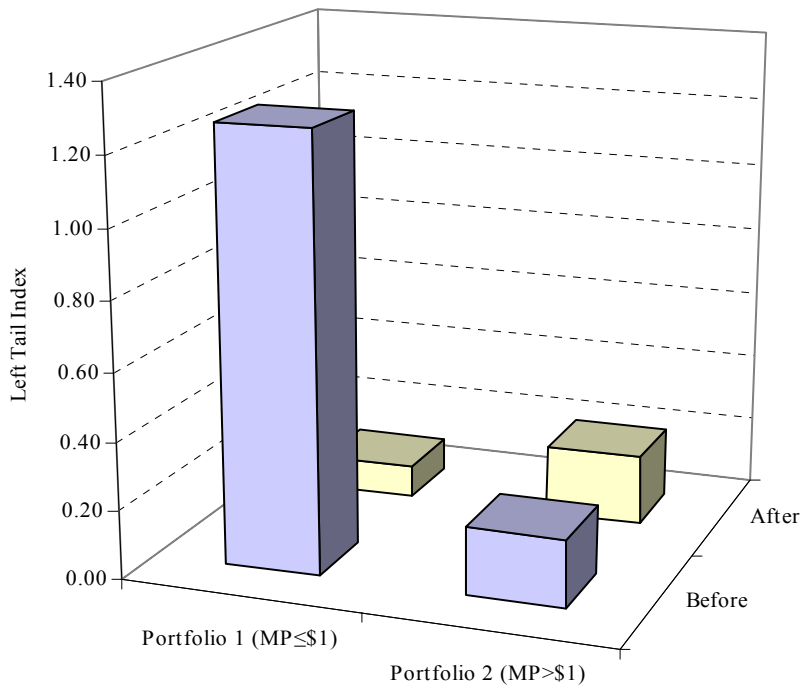


Figure 2. Left tail comparisons. This figure depicts the average left tail index levels for the two price-based portfolios in two periods. Data are obtained from Table III. The vertical line represents GEV-based left tail index for the distribution of daily proportional stock price changes. “Before” and “After” refer to the periods before (January 1975 – March 1990) and after (September 1991 – December 2006) the implementation of the NASDAQ minimum \$1 bid price continued listing requirement. Portfolio 1 and 2 contain stocks with median daily closing bid prices below and above \$1 in each period respectively, representing equities with more and less likelihood of trading below \$1.

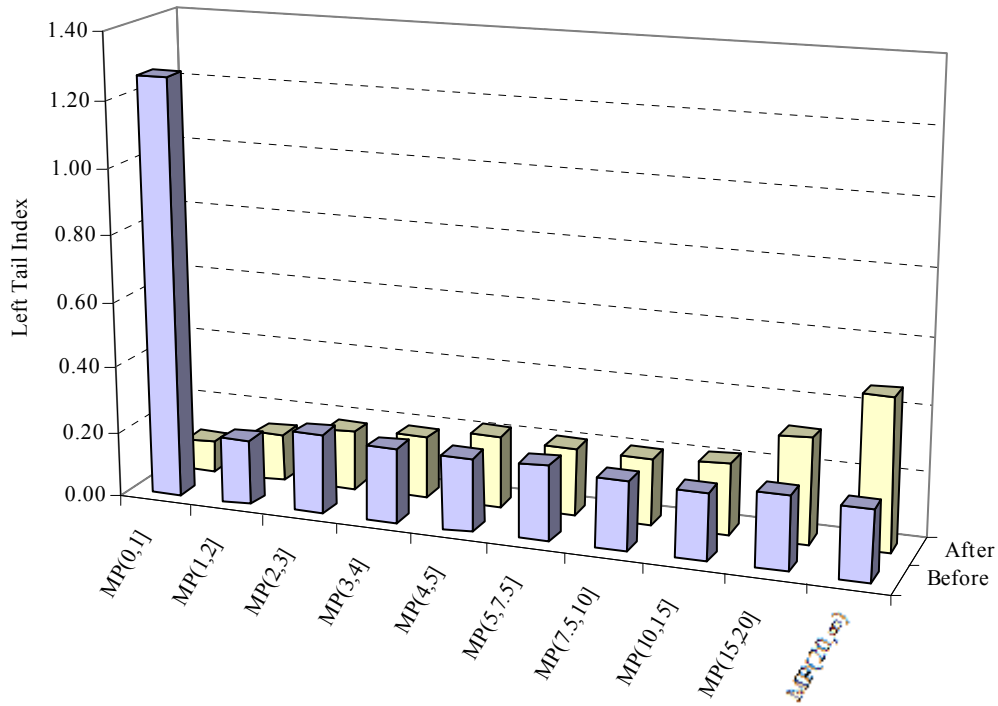
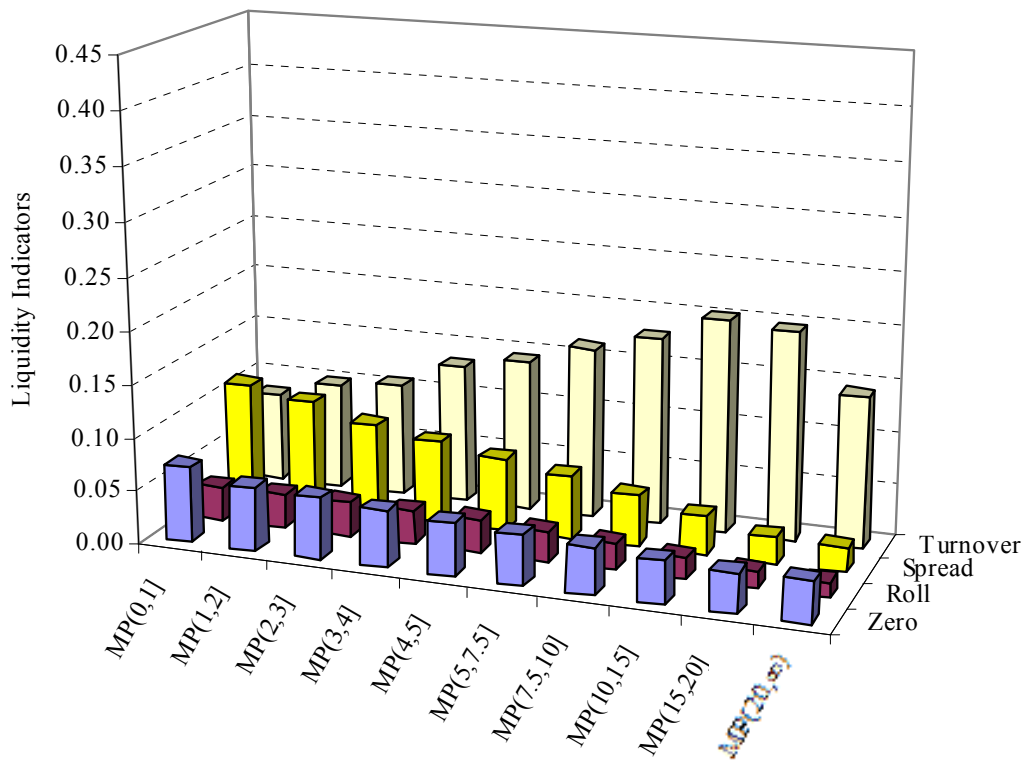


Figure 3. Left tail comparisons across price-based portfolios. This figure depicts the average left tail index levels for the ten price-based portfolios in two periods. Data are obtained from Table V. The vertical line represents GEV-based left tail index for the distribution of daily proportional stock price changes. “Before” and “After” refer to the periods before (January 1975 – March 1990) and after (September 1991 – December 2006) the implementation of the NASDAQ minimum \$1 bid price continued listing requirement. MP(0,1] through MP(20,∞) refer to portfolios containing stocks with median daily closing bid prices falling into a certain range within each period. The two numbers in each portfolio name represent the lower and upper boundaries of the price range.

Figure 4

A: Pre-rule Period



(continued)

Figure 4- continued

B: Post-rule Period

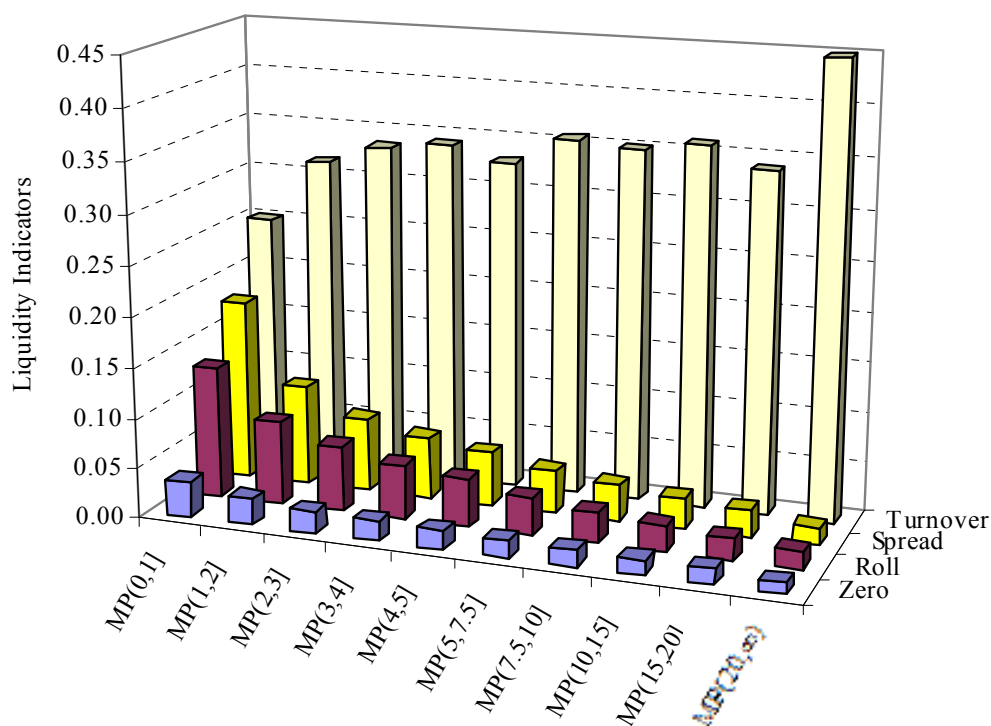


Figure 4. Liquidity indicators for price-based portfolios. This figure depicts the average liquidity proxy values for the ten price-based portfolios in two periods. “Zero” is the portion of zero return days; “Roll” refers to Roll (1984) effective spread indicator modified following Lesmond (2005); “Spread” is the quoted percentage bid-ask spread; and “Turnover” is measured as trading volume over shares outstanding. Liquidity measures are computed using daily data. “Zero” and “Turnover” are rescaled by multiplying 1/10 and 50 respectively. MP(0,1] through MP(20,∞) refer to portfolios containing stocks with median daily closing bid prices falling into a certain range within each period. The two numbers in each portfolio name represent the lower and upper boundaries of the price range. Pre-rule (Panel A) and post-rule (Panel B) periods refer to the eras before (January 1975 – March 1990) and after (September 1991 – December 2006) the implementation of the NASDAQ minimum \$1 bid price continued listing requirement.