NBER WORKING PAPER SERIES

DOTCOM MANIA:
THE RISE AND FALL OF INTERNET STOCK PRICES

Eli Ofek
Matthew Richardson

Working Paper 8630
http://www.nber.org/papers/w8630

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2001

Stern School of Business, New York University. We would like to thank an anonymous referee, Ken French (the NBER discussant), Stewart Myers, Jay Ritter, Jeremy Stein, Robert Whitelaw and participants at MIT, NYU and the NBER summer institute for helpful comments and suggestions. The views expressed herein are those of the authors and not necessarily those of the National Bureau of Economic Research.

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ABSTRACT

This paper provides one potential explanation for the rise, persistence and eventual fall of internet stock prices. Specifically, we appeal to a model of heterogenous agents with varying degrees of beliefs about asset payoffs who are subject to short sales constraints. In this framework, it is possible that "optimistic" investors overwhelm "pessimistic" ones, leading to prices not reflecting fundamental values about cash flows summarized by aggregate beliefs. Empirical support for this explanation is provided by exploring the behavior of internet stock prices during the period January 1998 to November 2000. In particular, we document four important elements to our story: (i) the high level of internet stock prices given their underlying fundamentals, (ii) responses of stock prices to a shift towards potentially optimistic investors, (iii) empirical results consistent with shorting being at its maximum possible level for internet stocks, and (iv) the eventual fall, or bubble bursting, of internet stocks being tied to the increase in the number of sellers to the market via expiration of lockup agreements.

Eli Ofek
Stern School of Business
New York University
44 West 4th Street
New York, NY 10012
and NBER

Matthew Richardson
Stern School of Business
New York University
44 West 4th Street
New York, NY 10012
and NBER
mrichardson@stern.nyu.edu

I. Introduction

By February 2000, the internet sector equaled 6% of the market capitalization of all U.S. public companies and 20% of all publicly trade equity volume. Moreover, in just a two-year period of time, the entire sector earned over 1000% returns on their public equity. This paper provides a new look at the behavior of stock prices in this sector. In particular, we develop a cohesive explanation of the rise, persistence and then subsequent fall of internet stock prices.

Of particular interest is the question of how the mispricing of internet stocks could persist in the presence of well-funded, rational investors. We provide an analysis based on Lintner's (1969) model of asset prices with investors having heterogenous beliefs and facing short sale restrictions. For Lintner's model to produce "bubble-like" behavior in asset prices, two conditions are necessary: (i) heterogeneity in beliefs, and (ii) short sale restrictions for the pessimistic investors. In his framework, asset prices are a weighted average of beliefs about asset payoffs with the weights being determined by the investor's risk aversion and beliefs about asset price covariances. While the asset prices are equilibrium-determined to the extent that they reflect the underlying beliefs about payoffs, short sale restrictions force the pessimistic investors out of the market, leaving only optimistic investors left and thus inflated asset price levels.[1]

There are four elements required to give empirical support for this explanation: (i) were internet firms overvalued?, (ii) if so, were the marginal investors of these stocks overly optimistic?, (iii) why did pessimistic investors not push internet prices back to fundamental levels?, and (iv) within this framework, what type of conditions could eventually lead to the eventual collapse of internet prices? This paper posits an answer to each of these questions and provides corresponding empirical support.

First, we investigate whether internet stock prices were too high relative to traditional valuation metrics. Specifically, we use an implied price/earnings measure to generate the necessary excess returns on capital or growth rates in earnings to justify the internet stock

[1] There is a long history in the finance literature of developing the equilibrium implications of short sales restrictions, e.g., see Lintner (1969), Miller (1977), Jarrow (1981), Detemple and Murthy (1997), and, more recently, Basak and Croitoru (2000) , Chen, Hong and Stein (2000), and Jones and Lamont (2001), among others.

price levels. In general, across entire sectors of the internet economy, these returns/growth rates are far in excess of any values previously documented (even for the *ex post* most successful firms in other industries).

Second, we explore two examples of shifts in the heterogeneity of investors. The first example documents the holders of internet stocks and shows that, by in large, a much greater fraction are retail investors relative to holders of non-internet stocks. The second example explores what happens to internet stock prices when there is a shift in the distribution of investors, i.e., optimistic ones entering the market. To gather evidence on this latter topic, we look at a far-reaching event, which affect all firms, related to the IPO: (i) the first day, and (ii) the quiet period. Using these events illustratively, we argue here that there is a link between asset price behavior and the beliefs of these agents being overly optimistic.

Third, why didn't "realistic" investors come into the market and drive prices back down to fundamental levels? One particular explanation is that even though there might have been plenty of capital available for rational trading, the market had limited ability to short internet stocks. We show evidence via (i) short interest, and (ii) the rebate rate on shorts, that there were significant short positions in internet stocks relative to "old economy" stocks with indirect evidence of it being difficult to accumulate additional short positions. That is, pessimistic traders were trying to bring markets back to reasonable price levels, but they were being overrun by the size and volume of optimistic trading.

Fourth, what caused the so-called internet bubble to burst? We offer a potential explanation consistent with the Lintner model that does not require a shift in the beliefs (at least initially) of the optimistic investor. During the Spring and latter half of 2000, an extraordinary number of lock-ups expired. Though there is evidence that the constraint against shorting these stocks was binding, these lock-up expirations added a significant number of new investors to the market. If a fraction of these investors were either agnostic or pessimistic, then these "realistic" beliefs would get incorporated into asset prices. We present evidence consistent with this explanation.

II. The Story

Figure 1 graphs the index of an equally-weighted portfolio of the internet stocks over the sample period January 1998 to December 2000 versus the S&P500 and NASDAQ indices over this same period. While this graph is not evidence of mispricing per se, there was a substantial divergence between the relative pricing of internet stocks and the broad market as a whole.

There are three interesting questions related to the level of internet stock prices: (i) why did the prices get high in the first place?, (ii) why did they continue to be high in the presence of rational, well-funded investors?, and (iii) why did the stock prices of these firms eventually fall? Unfortunately, these are questions that we are not going to be able to answer definitively. Nevertheless, in this and later sections, we provide one potential theoretical explanation for (i) – (iii), and then derive and empirically analyze implications of the model. In particular, we appeal to Lintner's (1969) model of asset price formation. Two important features of the model are necessary to generate the appropriate story. First, investors must have significant heterogeneity of their beliefs about asset price payoffs, so that prices (without trading restrictions) reflect a weighted combination of these diverse views. Second, the more pessimistic investors are restricted from selling (i.e., shorting) the stocks so that their beliefs do not get impounded in prices.

Note that Lintner's (1969) paper also addressed the issue of short sales constraints and our results mirror his. Similar papers working off the Lintner framework which provide similar (albeit more detailed) results include Miller (1977), Jarrow (1980) and Figlewski (1981), among others. Recently, Chen, Hong and Stein (2000) also develop a model in which rational investors cannot short stocks such that they can only decide to not participate in the market. With enough irrational traders, stocks can be overpriced, which will be similar to our model's results below (see also Jones and Lamont (2001)). Their results are applied from the perspective of short sales restrictions on mutual funds. Also, Lamont and Thaler (2000) and Mitchell, Pulvino and Stafford (2001) make a similar point in the context of looking at mispricing and arbitrage with respect to equity carve-outs. Dynamic general equilibrium models have been developed by Detemple and Murthy (1997) and Basak and and Croitoru (2000) who show that with heterogenous investors prices of redundant assets can deviate in equilibrium under portfolio constraints.

Suppose there are M investors, each with constant absolute risk aversion utility indexed by parameter α_j and different beliefs about the distribution of asset payoffs. The beliefs about the payoff of the N assets are the normal distribution with mean μ_j and variance-covariance matrix Ω_j. We assume that there exists a riskless asset available for holding or borrowing at a fixed, exogenously determined rate r_0 with numeraire price, P_0=1. Assume further that the risky assets exist in fixed quantity, one each, which are spread across the endowments of the M investors.

This model is a convenient way to approximate the overall framework that many academics and practitioners feel appropriate for the internet sector. That is, the model allows for investors who have "optimistic" beliefs about the payoffs of internet stocks (i.e., high μ_j) as well as unwise beliefs about the level of risk (i.e., low $|\Omega_j|$).[2] Similarly, on the other side, the model allows for pessimistic investors in terms of both means and variances of asset payoffs. Why would investors have optimistic beliefs about internet stock prices? The internet-related industries in general were very new with little or no past history to guide investors. One possible reason for optimism might be that individual investors believed the hype about the internet and transferred those beliefs into asset prices, ignoring fundamental information about cash flows. While we have no concrete evidence for this point, below we will show evidence of heterogeneity amongst investors and seemingly optimistic behavior on at least some of these investors' part.

The behavior may not be strictly irrational since the optimism could fit the theory of rational bubbles (e.g., Blanchard and Watson (1982) and Froot and Obstfeld (1991)). Rational bubbles occur when investors satisfy their first order conditions from their consumption and investment decision, yet asset prices do not reflect their fundamental values, i.e., the discounted value of expected future cash flows. This is because today's price also reflects the discounted value of the future price (possibly way in the distant future) which may not equal its fundamental value. The intuition is that, even though asset prices lie above their fundamental values, investors still value the asset highly because of the possibility of even higher prices in the future. Of course, through iteration,

[2] By "optimistic", we generally mean unrealistic beliefs about future payoffs of the assets. The static nature of the here model aside, we ignore for the moment the question of whether the "optimistic" beliefs are about future prices independent of cash flows (i.e., a bubble), or about the prospect of future cash flows (i.e., fundamentals).

this implies some possibility of an infinite price in the future. This and other reasons has led many researchers to question the theoretical viability of rational bubbles (e.g., Diba and Grossman (1988), Santos and Woodford (1997) and Cochrane (2001)). Nevertheless, by making the bubbles somewhat less than fully rational (e.g., Brunnermeier (2001)), the high internet prices are consistent with the idea of high future internet stock prices not tied to fundamental values. Unfortunately, because this future price is by nature never observed in our sample, the empirical content is vacuous.

This point aside, in this paper, we do not distinguish between high prices due to over-optimistic beliefs about future cash flows (i.e., fundamentals) versus a "bubble" belief about even higher future prices. While it is clear that once a bubble is in place, rational investors may find it worthwhile to purchase stocks (i.e., the "greater fools" theory), our analysis focuses on investors who may not have held these beliefs. In particular, why, in a heterogenous world, did pessimistic (or ex post smart) investors not help deflate internet prices?[3] The Lintner model is a convenient way to investigate this question.

Working through Lintner's model, each investor's demand for the risky assets can be written as

$$\underline{q_j} = \frac{1}{\alpha_j}\Omega_j^{-1}(\underline{\mu_j} - r_0\underline{P}) \qquad (1)$$

where the underbar represents a vector, q is the demand and P the prices of the assets. Summing over all the individual demands, and equating demand and supply of the risky assets, yields the equilibrium prices of the assets:

$$\underline{P} = \frac{1}{r_0}\left(\sum_{j=1}^{M}\tfrac{1}{\alpha_j}\Omega_j^{-1}\right)^{-1}\left(\sum_{j=1}^{M}\tfrac{1}{\alpha_j}\Omega_j^{-1}\underline{\mu_j} - \underline{1}\right) \qquad (2)$$

In this model, prices are a weighted average of the beliefs about asset payoffs, the weights being determined by the investor's individual risk aversion and beliefs about the variance-covariance matrix of the payoffs. Intuitively, the more risk averse an individual is (i.e., high α) or stronger believer in risk either through the variance or correlation pattern of asset payoffs (i.e., high $|\Omega|$), then the less weight his/her beliefs about the

[3] There is an even deeper question about whether irrational investors can persist in equilibrium, that is, whether natural selection takes place. The debate continues and is beyond the scope of this paper (e.g., see the different conclusions in DeLong, Shleifer, Summers and Waldmann (1990) versus Sandroni (2000)).

payoffs has on asset prices. Moreover, the more significant a representation one has in the investor pool (i.e., large fraction of *M*), then one's beliefs are more imposed on prices.

Plugging equation (2) back into equation (1) gives the optimal holdings of each investor:

$$\underline{q_j} = \frac{1}{\alpha_j}\Omega_j^{-1}(\underline{\mu_j} - \left(\sum_{j=1}^{M}\tfrac{1}{\alpha_j}\Omega_j^{-1}\right)^{-1}\left(\sum_{j=1}^{M}\tfrac{1}{\alpha_j}\Omega_j^{-1}\underline{\mu_j} - \underline{1}\right) \qquad (3)$$

Several observations about this model are in order. First, if one views usual circumstances as one in which investors have homogenous beliefs, or at least the ones that matter for trading (i.e., high fraction of *M*), then equation (3) reduces to the well-known two-fund separation result of the CAPM. That is,

$$\underline{q_j} = \frac{1}{\alpha_j}\left(\sum_{j=1}^{M}\tfrac{1}{\alpha_j}\right)^{-1}\underline{1}$$

That is, each investor holds a linear share of the market portfolio, the share depending on his/her aversion to risk. The other holding is in the risk free asset. One might argue that this is the norm when investors were not subject to the "optimism" of the internet market. Second, when beliefs diverge, this result no longer holds as each individual investor holds some combination of his/her own beliefs about payoffs adjusted for the market's aggregate beliefs. If μ_j is low enough for asset *n*, it is clear from equation (3) that the investor will short asset *n*, with the other investors holding more long positions in the asset in equilibrium.[4] In terms of the internet setting, one could loosely view equation (3) in terms of "pessimistic" investors shorting internet stocks, with "optimistic" investors simultaneously going aggressively long in these same stocks. Third, this model can be used to discuss the implications of short sale restrictions. In particular, one could impose the restriction that q_j must be greater than $-q^*$, where q^* is the maximum level of short positions across the n assets for any individual j. Of course, the extreme restriction would be that $q^*=0$, i.e., no short sales allowed. One could imagine that some investors might face tougher restrictions than others, so that q^* might vary across investors.

[4] Equilibrium here is defined in a fairly antiquated way as the model is static and agents do not have rational expectations. That is, their beliefs are set and all other information (such as current prices) is ignored.

As pessimistic investors wish to short the stock more than q*, the constraint is binding and investors either stay at q* or even short less, depending on the variance-covariance matrix Ω. In either case, their beliefs will have less of an impact on asset prices, as the market clearing price no longer reflects the optimal short position, and puts more weight on the optimistic view of payoffs. Consider the extreme case in which the pessimistic investors actually leave the market and hold no stocks. In this case, asset prices will reflect only the beliefs of the optimistic investors and therefore increase as a result. The pessimistic investors would like to short the stocks at these inflated prices, thus bringing them down in value, but are prevented from doing so due to the short sales restrictions. This is the exact result documented in Miller (1977) and Jarrow (1980), and empirically investigated in Figlewski (1981) and Jones and Lamont (2001).

Within the framework of the model, there are three main sources of uncertainty driving stock prices: (i) shocks to beliefs about asset payoffs (μ_j), (ii) shocks to preferences (α_j), and (iii) shocks to either the relevant fraction of or to the number of investors (M), and/or shocks to the short constraint q^*. This latter source of uncertainty is only relevant in the presence of substantive heterogeneity in beliefs about asset payoffs, and thus may be particularly unique to the internet sector.

We believe this model's intuition conveys a reasonable story for the so-called internet bubble. On the one hand, there were many optimistic investors arriving to the market willing to pay high prices for internet stocks; on the other hand, some pessimistic investors were willing to short these stocks at the high prices. However, because the amount of shorting is limited in practice, the pessimistic investors' beliefs got overwhelmed by the optimistic beliefs, leading to the high valuation of internet stocks.

III. Data

Some version of our basic story for how stocks can be overvalued has been circulating the finance literature for over thirty years in some form or another. It is an empirical question whether this explanation applies to the internet sector. As such, this paper studies various characteristics of internet-related companies over the period January 1, 1998 to February 29, 2000.

There is no strict definition of what constitutes an internet-related firm as a number of firms, especially in the technology sector, could perform both “old economy” and internet-related functions. For the past few years, Morgan Stanley has published a summary of the price and financing characteristics of the various internet sectors – (i) portals, (ii) infrastructure companies, (iii) infrastructure services, (iv) software, (v) commerce, (vi) consulting and applications, (vii) financial services, (viii) multi-sector, (ix) vertical portals, (x) marketing and advertising services, and (xi) B2B commerce.[5] For want of a better definition, we follow this breakdown, which yields a total of 400 companies in pure internet-related sectors. Table 1A gives a further breakdown of these 400 companies by internet sector and “old economy” counterpart industry.[6]

Table 1B provides some descriptive statistics about this sample of internet firms versus the universe of firms. Several observations are of interest. First, the majority of these firms went public during 1999 and the first quarter of 2000. While the short time frame can make it more difficult to conduct inference across certain events, it does make it easier to avoid concerns about stationarity across sample periods and so forth. Second, the price characteristics of this sample of firms suggests that price discreteness – a common source of econometric bias – will not be an issue. The average price is $56, which is in the high range of the overall sample of firms. Third, the average market value of the internet sample relative to the universe of non-internet firms is comparable. Thus, from a casual viewpoint, large differences between these samples are probably not due to one of the usual culprits in finance, i.e., firm equity size.

Fourth, Table 1B provides summary statistics for the mean and volatility of returns during the sample. As can be seen from these numbers, both the ex post mean and volatility were extremely high during the period for the internet versus non-internet sample. For example, the median volatility of internet firm returns is 7.3% on a daily basis (or 115.1% annualized) versus 3.0% for the non-internet sample. Moreover, microstructure explanations of these volatility differences seem less likely as bid-ask

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[5] The criteria for a company to be included is that it must be considered a pure internet company. This means that technology companies like Cisco, Microsoft and telecommunication firms, with extensive internet-related businesses, are excluded.

[6] Note that throughout the paper, the number of firms that qualify for each analysis varies due to such items as minimum days needed, whether the firm was public, etc… Each table identifies the exact number of firms used in each analysis.

spread measures tend to be lower for the internet stocks. That is, explanations based on volatility being driven by private information rather than noise would not find the bid-ask results helpful (e.g., Glosten and Milgrom (1985), Glosten and Harris (1990), and Black (1986)).

Finally, Table 1B reports both the median daily volume and share turnover for these firms. These measures suggest an active, liquid market for the internet stocks during the sample. In fact, relative to the universe of firms, the average volume per stock is three times higher for internet firms. As seen from Figures 2 and 3, while internet firms represent 6% of the public equity market during February 2000, the pure internet sector represents 19% of the daily volume. Figures 2 and 3 provide an analogous graph to Figure 1's stock price history by showing the time-series of volume in the internet sector. The magnitude of this volume is even more surprising given that a significant number of shares were not allowed to trade during the lockup period following these firms' IPOs. In addition, depending on the metric, share turnover is between two to four times higher for internet firms.

These stylized facts about volume have several important implications for the market for internet stocks. First, the traded prices of internet stocks were real. That is, large volume could be, and, in fact, was executed at these prices. Thus, any rational explanation needs to take account of this important fact. Second, the large volume at these price levels suggests that there were many investors in this market. While it is theoretically possible that the volume was driven by just a few investors trading amongst each other, there is anecdotal evidence in the press (regarding the aggregate market) that this period had a greater number of participants than ever before. The large volume is consistent with this evidence. Third, there is evidence to suggest that the internet sector was more prone to retail than institutional investing at least relative to non-internet firms (see Table 4). Using points two and three above, it can be argued, at least circumstantially, that a considerable number of new and less sophisticated (i.e., retail) investors were trading internet stocks. The magnitude of the volume suggests this may have been at unparalleled levels.

IV. Were Internet-Related Stock Prices Too High?

The extraordinary rise in internet values as shown in Figure 1 has generally been called the "internet bubble". The fact that prices fell in March of that year, and continued to fall throughout 2000, gave some credibility to this designation. However, one cannot infer necessarily from this ex post realization that market values did not in fact reflect fundamental values about cash flows. Tautologically, changing expectations about cash flows or discount rates, coupled with realization of various internet fundamentals, could also explain the rise and drop in prices. We, as well as anyone else, will not be able to definitively answer this question here. Instead, we follow a long line of previous academic research (e.g., French and Poterba (1991) and Shiller (2000), among others) to provide the reader with an understanding of what the market had to expect to justify such high valuations.

French and Poterba (1991) use Miller and Modigliani's (1961) model for stock valuation to investigate the level of Japanese equity prices in the 1980s. The model is a convenient way to look at equity prices because it provides the reader with a way to gauge the growth rate required to justify the level and movement in P/E ratios over time. In particular, Miller and Modigliani show, that for a firm with supernormal return opportunities r^* over T periods,

$$P/E = \frac{1}{r}\left\{1 + \frac{k(r^* - r)}{r - kr^*}\left[1 - \left(\frac{1 + kr^*}{1 + r}\right)^T\right]\right\} \qquad (4)$$

where k is the fraction of earnings invested in the supernormal projects and r is the discount rate. Now consider the internet sector and further assume that for the first T periods these firms earn supernormal return r^* with a fraction k=1 invested; after this initial period, these firms act like their "old economy" counterparts and achieve similar P/E ratios. In this case, it is possible to show that equation (4) can be rewritten as

$$P/E = \left(\frac{1 + r^*}{1 + r}\right)^T P/E^{OLD} \qquad (5)$$

A nice property of equation (5) is that, as long as we are willing to make an assumption about these firm's long-run P/E ratios, we can estimate how large the supernormal returns have to be on current investments relative to required returns in order to justify current

P/E levels. In other words, we do not need to know the magnitude of discount rates. Equation (5) will form the basis for our analysis to follow.

We calculate the aggregate earnings of each of the internet sectors using Compustat. Even though these companies are public, many of them are startups and have negative earnings, so that even the aggregate earnings number is negative. This is due to significant costs in building the business, both from a technological point of view and from extensive marketing and sales costs. As a result, we consider a different measure of earnings potential by backing out the implicit earnings of the sector assuming that the companies in the sector have *already* achieved income margins of their industry counterparts.[7] For example, in the ecommerce sector, we ignore the fact that the companies are unprofitable. Instead, given their revenue and the income margins seen in the retailing sector, we assume that the ecommerce sector has already reached the same level of profitability.

Several observations are in order. First, the above assumption about profitability is clearly a "best-case" scenario for the internet sectors. In fact, many of their business models assume that, after some period of time, the scale of their operations will be so large that the added marketing and technological costs of being an internet company are swamped and "old economy" margins will be realized.[8] Second, by accelerating the profitability of the sectors, and essentially assuming that they have reached this stage with probability one, the P/Es will be understated, resulting in a corresponding underestimate of what the necessary supernormal returns must be. Third, we estimate the P/E ratio by taking the particular internet sector's aggregate market value of equity divided by its implicit earnings.[9] These earnings are calculated by multiplying its aggregate revenues by the assumed income margin. The assumed income margin is the weighted average margin of its closest "old economy" counterpart.

[7] One could take the view that this is equivalent to not treating some of the business costs as expenses, but instead capitalizing them. We thank Stew Myers for this observation.
[8] There are clearly some types of internet business models in which the goal is to surpass their old economy counterpart's margins. We ignore these except to point out that earnings move one-to-one with margin increases. The interested reader can, therefore, adjust the P/E ratios according to his/her beliefs.
[9] The market value of equity here most likely underestimates the value of the firm. This is due to the fact that internet companies have considerable amounts of stock options which do not get capitalized until the options are exercised.

Table 2 reports this information for the eleven sectors described in Table 1B. For example, industry code 5, the ecommerce sector, includes 50 companies with an aggregate market capitalization as of February 2000 of 72.675 billion dollars and with aggregate revenues of 4.459 billion and net income of minus 3.565 billion. Using the industry margins of 1.9%, we can back out implied earnings of 85 million, which gives the industry an implied, new economy P/E ratio of 856. Given an assumption about the old economy P/E ratio and the number of years excess returns can be achieved, Equation 5 can then be used to generate how large these returns must be to justify the 856 level.

The results in Table 2 correspond to the eleven internet sectors in aggregate; it is also of interest to document the implied P/Es firm by firm. Figure 4 graphs the distribution of these P/Es across the entire sample of internet-related firms. As seen from the figure, the vast majority of the P/Es seem high relative to the types of P/Es usually represented by firms (e.g., Shiller (2000)). For example, almost 20% of the firms have P/E ratios in excess of 1500, while over 50% exceed 500. This seems especially large given that the implied P/Es are derived from the revenue streams of these firms rather than their earnings.

In order to better understand the implications of these P/E numbers, Table 3A documents the relative size of supernormal returns, $(1+ r^{*})/(1+r)-1$, needed to justify the aggregate P/E ratio of the entire internet sector under various assumptions about long-run P/E ratios and the time period over which firms can achieve supernormal returns. For an historically high P/E ratio of 20, the internet sector would need to generate 40.6% excess returns for a 10-year period to justify its current implied P/E ratio of 605. Under the strong assumption that all earnings get reinvested, and even if these opportunities lasted 30 years, excess returns for the entire internet sector still need to be 12.0%. Given Figure 4, and using the fact that 25% of the firms have P/Es of 1000, this implies that 25% of the firms need 47.9% excess returns on capital over a 10-year period.

An alternative way of writing equation (5), and in the more familiar framework of earnings growth rates, it naturally follows that:

$$P/E \times \left(\frac{1+r}{1+g}\right)^{T} = P/E^{OLD} \qquad (6)$$

where g is the growth rate in earnings (assuming all earnings get reinvested). The intuition of equation (6) is that the drop in P/Es from today to the target P/E must reflect the fact that earnings grow at a much higher rate than expected returns (i.e., the cost of capital).

Assuming a cost of capital of 0%, i.e., zero expected returns over the next few decades, the results previously described in Table 3A correspond to the required growth in earnings. Thus, even if investors required no return on the internet sector, earnings growth would have to range between 12.0% (for 30 years) to 40.6% (for 10 years) at a target P/E of 20. How large is 40.6% for 10 years? Chan, Karceski and Lakonishok (2001) report the distribution of earnings growth over a 10-year period from 1951-1998 for both all firms and the two largest deciles.[10] At the most extreme distribution tail they report (i.e., at 98%), the growth rates are 31.3% and 22.6%, respectively. Thus, our results are extraordinary for several reasons: (i) the required growth rates are between 50-100% higher than the highest 2% of existing firms, (ii) the growth rates reflect an entire sector, not just the ex post performance of the very best firms, and (iii) these growth rates imply a cost of capital of 0%.

At a more reasonable cost of capital, Table 3B provides the various growth rates in equation (6) needed to justify P/Es between 10 and 30 over different time periods. For example, at a weighted average cost of capital of 16%, these excess returns translate to 63.1% growth rate in their implied earnings. This is as much as three times higher than the top 2% earnings performers from the Chan, Karceski and Lakonsihok sample. Even with a long-run P/E ratio of 30, and thirty years of supernormal returns, the growth rate required is still as high as 28.2%.

This analysis is not the first to point out the excessive P/E ratios in the stock market during this period (e.g., Demers and Lev (2000) and Shiller (2000)). Beyond the financial press at large, Shiller (2000), for example, shows that the P/E ratios for the aggregate market were at their highest value of any period in the 20th century, including the infamous market crash of 1929 and the "nifty-fifty" of the late 60's. Moreover, we have focused on the internet sector and shown that these P/E ratios were much higher than the

[10] As Chan, Karceski and Lakonishok (2001) point out, their sample is subject to survivorship bias. In particular, their numbers are biased upwards as their sample reflects the more successful firms.

aggregate markets'. In fact, putting the "best-case" scenario assumptions aside, the results of Table 3 imply that, for a significant period of time, the market would have to expect excess returns on their investments of 30-40% above their cost of capital. That is, in a competitive product market with few barriers to entry, and across over 400 public firms representing 6% of the public market capitalization, expected continual, aggregate profits of this magnitude would appear extraordinary. At the minimum, this represents strong circumstantial evidence of investors being optimistic about the future growth opportunities of this sector.

Aside from optimism, what else can explain these excess returns on capital?

One unique characteristic about internet-related firms during this period is that they tended to go public relatively soon after incorporation. One possibility is that the large implied excess returns on capital for internet firms reflects the firm's age rather than an overvaluation argument. This explanation requires the condition that P/E ratios should decline very rapidly as a firm develops. Since most economist's intuition on what is a reasonable excess return on capital derives from experience with old economy companies, it seems worthwhile exploring the possibility that firm age plays an important role. Table 7B reports cross-sectional correlations of various measures of the sample of internet firms, including the implied P/E of each firm and its age. Though the relation is negative, i.e., younger firms have higher P/Es, it is barely so, yielding a correlation of 0.09. Thus, less than 1% of the cross-sectional variation in P/Es can be explained by the firm's age. Moreover, this correlation estimate is also not significant from a statistical point of view.

The other related possibility is that today's revenues (and implied earnings measures) are not representative of the future potential of these firms. That is, the valuation relation in equation (2) is not a good approximation in practice. In fact, recent work by Schwartz and Moon (2000) argues that internet companies have so many strategic/real options available to them that standard discounted cash flow-based models are no longer appropriate. However, it is important to point out that these options eventually must translate into revenue streams that reflect the growth rates documented above.

V. Heterogeneity and Price Effects

The results of Section 4 are consistent with (though not proof of) overvaluation in the internet sector. The explanation put forward in Section 2 argues that mispricing of this sort could be driven by overoptimism on the part of some investors while simultaneously having pessimistic (arguably rational) investors restricted from selling shares (for whatever reason) in the market. In this section, we try and provide some empirical support for this implication by investigating shifts in the heterogeneity of investors and the corresponding price effects.

While we do not have direct evidence on who was trading, it is possible to document who was holding internet stocks. There is anecdotal evidence that there were many more participants in the internet-related equity markets than previous periods (see Figures 2 and 3). Table 4A documents that, on a relative basis compared to non-internet stocks, these participants were retail investors rather than institutions. For example, in March 2000, the median holding of institutions for internet stocks was only 25.9% versus 40.2% for non-internet stocks. These differences are strongly significant from a statistical point of view. While these differences drop if the sample is restricted solely to IPOs (i.e., from 15.1% to 7.4%), they are still significant statistically. The differences here are most probably understated. An investigation of Morningstar's database for this period shows that a number of internet-based mutual funds started in 1999 and early 2000. Though these are measured as institutional holdings, it is clear that the funds themselves are simply pass-throughs to retail investors. That is, the creation of internet mutual funds was not necessarily due to an institutional view of internet valuations, but more demand driven from retail investors.

If more retail investors were in the market than under normal conditions, then one might reasonably argue that the market was more prone to the types of behavioral biases that lead to overly optimistic beliefs. Recent work supports this view of retail investors (e.g., Barber and Odean (2000, 2001)). As complementary evidence of a typical institution's view of the internet, Table 4B reports the internet versus non-internet holdings of the largest pension funds as of March, 2000. Though the internet weight in the aggregate market is 4.38%, the holdings of pension funds are under-weighted in the internet sector, representing only 2.3%.[11] This is consistent with Chen, Hong and Stein (2000) who argue that overvalued firms will have lower breadth of institutional ownership.

A. The IPO – the first day

The above evidence suggests that there was considerable volume in internet stocks and that this volume was tied to retail investors. Suppose for the moment that retail investors tended to be more optimistic than institutional ones, based on either hard evidence of their holdings or cursory evidence on their behavior (e.g., Barber and Odean (2001)). This point, however, does not necessarily imply that the optimistic retail investors were the marginal investors relevant for pricing securities. In order to investigate this point more closely, we turn to a far-reaching event that all public companies have gone through, namely their initial public offering (IPO). The IPO of an internet company represents the first time the public-at-large can purchase shares in the company. Thus, the first day trading of the IPO represents the first time the price reflects the distribution of the beliefs across investors. If internet stocks are more subject to overoptimistic investors as we have argued, then the IPO process is highly susceptible to a shift in the optimism of beliefs about asset payoffs.

During the 1998-2000 period, the initial public offering (IPO) of an internet firm was arguably the most important event in the firm's history. This interest was not just internally felt, but was also emphasized by the media as well as the individual investor. For example, numerous financial websites were created that carried information relevant for internet IPOs such as IPO.com, IPOtracker.com, IPOlockup.com, and IPOcentral.com, among many others. Moreover, the standard financial websites included detailed analysis of both upcoming and past IPOs. This was perhaps not surprising as there were over 400 IPOs alone from the second quarter of 1999 through the first quarter of 2000. Of these IPOs, over 70% were internet-related with over $33 billion dollars raised.

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[11] On the other hand, not all institutions avoided the internet sector. For example, from the $136 and $222 million held in public equities and reported in 13-F filings by University of Chicago and Yale University,

One of the best known stylized facts in corporate finance is the underpricing of IPOs. For example, Loughran and Ritter (2001) document a 14% first-day return over the 1990-1998 period. The factual nature of this result cannot be questioned as studies in other sample periods and across other markets report similar findings. For example, an update of Loughran, Ritter and Rydqvist (1994) shows that, in all 38 countries looked at, the first-day return is on average positive. A number of explanations have been posited for why underpricing persists. Perhaps, the most respected rational explanation is the winner's curse due to Rock (1986) which argues that underpricing needs to take place to induce uninformed investors into the market. Alternatively, underpricing might result from irrational behavior on the part of investors who tend to overreact to the IPO. Underwriters price the IPO based on its "true" or long-run value – hence, the underpricing phenomenon. Recently, Loughran and Ritter (2001) argue instead that some issuers prefer underpricing the IPO because they care more about the change in wealth than its level, i.e., prospect theory of choice (Kahneman and Tversky (1979)).

Table 5A reports the underpricing of internet and non-internet IPOs over the January 1998 to February 2000 sample period. The most striking result is that the mean first-day return on internet IPOs is 95.5% with consistently high returns irrespective of whether the year was 1998, 1999, or 2000. Moreover, the median is 63.1%, which is relatively high given the aforementioned 14% average return documented in Loughran and Ritter (2001). In fact, from 1975 to 1997, the largest average in any of the years was 21.2% (in 1995). As an example, from the first quarter of 1999 through the first quarter of 2000, 146 IPO issues doubled in price on the first day of trading. In contrast, over the two decades from 1975-1997, this effect occurred for only a handful of the 6,500 or so IPOs. Table 5A also documents the mean and median returns of non-internet IPOs over the 1998 to 2000 period, namely 33.6% and 10.4%, respectively.[12] The difference between the internet and non-internet sample is strongly significant from a statistical viewpoint.

26% and 52% were respectively invested in our sample of internet firms.

[12] The 33.6% mean (though not the median) for non-internet firms is greater in magnitude than previous years. It should be noted that this non-internet sample includes a number of high technology firms that many might consider internet-based. For example, the largest one-day return (e.g., 697%) over the sample is achieved by VA Linux systems, which is the provider of Linux-based computer systems and services. Most analysts would consider their business being driven by internet-based applications; however, in our breakdown based on the criteria for inclusion, VA Linux is part of the non-internet sample.

These large first-day returns are consistent with a sudden shift towards optimistic investors. However, alternatively, perhaps the first day close reflected the “fundamental” value of the stock, and issuers were leaving more money on the table. An anecdotal example suggests this may not be the case. On December 7, 1999 Andover.net completed an IPO at a public offering of $18. This IPO was unique in that it was performed online via WR Hambrecht’s OpenIPO system, which is a uniform price sealed-bid auction conducted over the internet. The auction is open to all investors and resulted in a market clearing price of $24. The company, however, elected to stay within their cited range and priced the deal at $18 (i.e., a 25% underpricing). During the first day of trading, however, Andover.net’s price jumped to $63.38, which represented a 164% premium to the auction clearing price that these investors could have achieved the previous night and a 250% premium to the issuer’s price. What information arrived during the night that would increase Andover.net’s value by 164%, or why investors chose not to participate in the OpenIPO system even though it was highly publicized, brings into question the rationality of the investors who did purchase Andover.net on December 8.[13]

To explore the IPO underpricing explanations in a more formal way, we performed two tests. These test results are reported in Table 5B. The first test looks at the relation between the previous three weeks’ return on the internet index and the IPO underpricing. Consistent with other studies, the relation is positive, which supports the idea that not all public information gets incorporated into the IPO price. While consistent with the prospect theory of Loughran and Ritter (2001), it does not necessarily refute our explanation of the first day return as only a portion of that return is explained by the public information measure. Therefore, the second test examines the relation between the first day return and the cumulative excess return (relative to the internet index) from the close of the IPO’s first day to the end of 2000. Similar to existing studies, a first pass at the data shows little relation, which would tend to contradict our hypothesis or imply that investors were equally “overreacting” to the IPO in December 2000 as on the IPO day.[14]

[13] It is possible that Andover.net was a unique event in that there had been few IPO auctions leading up to this IPO, and most of the previous ones had resulted in small first day run-ups. Even if investors had expected the IPO price to remain flat, however, this does not explain why investors changed their mind and decided to pay significantly more the next day.

[14] DuCharme, Rajgopal, and Sefcik (2001) look at the IPO underpricing phenomenon specific to internet firms and report a similar result. They also explore several hypotheses in more detail, including (i) media

However, as the median estimates show in Table 5A, the first-day returns are skewed. If we truncate the data to look at only the larger first day returns (e.g., 40% of the sample have 100% plus returns) with the motivation that these are the ones with significant shifts, the results change dramatically. In particular, Table 5B shows a strongly negative relation between future excess returns on stocks and their IPO first day return with a coefficient of -.44 and t-statistic of 2.73.[15]

B. The IPO – the quiet period

The above results for the first day of the IPO are simultaneously consistent with (i) inflated internet prices, and (ii) heterogeneity, or, in this case, new investors entering the market. What other IPO-related events can be linked to a shift towards retail investors?

At an IPO, there is generally a syndicate of investment banks that underwrite the shares and then sell them to the public. The top tiers of the syndicate, the lead and senior co-managers, tend to provide research on the company to the financial community. According to rules of the SEC, during a 25-day Quiet Period after the IPO, the underwriters and the company must remain silent with respect to the company's financial prospects. This practically means that the underwriters cannot publish research and that the company cannot give forecasts and must maintain a relatively "low" public profile (outside of hard news). The SEC's motivation behind this rule is to prevent "hyping" of the stock during the initial days of the IPO. As a byproduct of this rule, almost invariably at the end of the quiet period, the top tiers of the syndicate release their research reports on the company. Not surprisingly, the research tends to be very favorable since the investment bank originally espoused this opinion during the registration process. The quiet period end is thought to be associated with positive, though not unexpected, research reports from the underwriters (often called "booster shots"). If an overly optimistic investor is characterized by someone who basically ignores public information, then one manifestation of this optimism might be the belief that this news from the

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hype, (ii) desire for follow-on offerings, and (iii) the IPO as a branding event. They find evidence that supports the media hype hypothesis to the extent that underpricing increases with media exposure. This is consistent with overoptimism on the part of investors entering the IPO market.

research report is new. In fact, "wall street folklore" is that retail investors buy these shares from institutional investors on the release of these positive research reports. Because institutions know this will happen, they tend to buy, and therefore bid up the price of the shares, in the preceding days.

Nevertheless, the importance of the research reports is irrelevant for whether prices rationally incorporate the quiet period. The key implication is that because the event date is known, there should be no price response on average around that date. If there is on average a directional move, investors should have incorporated that move into the stock price when it first trades. This is because the event itself is completely anticipated; that is, it is public information that the quiet period lasts 25 days for all companies following an IPO. In fact, during this period, there were IPO-related websites which provided the exact timing.

Table 6 reports average daily and cumulative abnormal returns for the internet IPO sample leading up to the end of the quiet period. The abnormal returns are calculated by taking the firm's return minus the return on the index of internet stocks.[16] The daily returns are all positive for the last ten days of the quiet period, with a cumulative effect of 13% and a corresponding t-statistic of 7.99. This 13% excess return is completely predictable because the end of the quiet period is a known and anticipated event. In contrast, we took a sample of non-internet related firms for the period prior to 1998 from Ofek and Richardson (2000) and still find a positive effect which suggests this anomaly has been persistent and is not purely internet-related. However, the effect is 3.5%, which is about one-fourth the magnitude of our internet sample. As mentioned earlier, there is evidence that the internet has a greater fraction of retail investors. Thus, if one takes the view that retail investors are more optimistic than institutional investors, one might consider the internet sector as being more prone to quiet period trading, thus explaining the 9.5% differential.

Along with providing the CAR for the sample of firms, Figure 5 also graphs the daily volume. The average daily volume around the end of the quiet period (i.e., the prior day,

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[15] A similar truncation for a sample of noninternet firms shows a slightly positive, though insignificant, relation.
[16] The results are robust to other indices and methods such as the Nasdaq composite and market model, respectively.

day of, and next day) is 60% higher, which is consistent with increased buying of the firm's shares on the release of the underwriter's research report. While this fact alone does not mean there is a shift in the heterogeneity of investors during this period, it is consistent with that story. Moreover, the daily average volume is around $25 million which also suggests that a large portion of the 13% is predictable profit, that is, considerable amounts of trading can be completed at the prevailing market prices.

While the 9.5% differential between internet and non-internet stocks, and the higher volume, can be explained by the increased presence of retail investors, it is still a puzzle why the inefficiency exists in the first place. Rational investors should have priced the inefficiency away thereby immediately incorporating the effect into the opening price on the IPO day. The fact this does not happen suggests an even deeper degree of irrationality.

VI. The Limited Ability to Short Internet Stocks

Section 5 above provided some evidence that internet stocks were held by a greater fraction of retail investors, and that, when shifts towards retail investors occurred, the price effects are in the right direction. While these results are consistent with our model, there is the additional requirement that pessimistic, or arguably realistic, investors were prevented from shorting these stocks. If one takes the view that there is considerable amounts of "rational" capital in the marketplace, the question remains why was not the capital deployed against the internet sector. There are two possible reasons why pessimistic investors did not short stocks sufficiently to offset the optimistic investors: either investors could not or were unwilling to short stock (at least up to some point).[17]

Before presenting the empirical work on shorting stocks, it is worthwhile discussing whether capital was limited or not. Who are these pessimistic investors? Obvious potential candidates are institutions, and in particular, mutual funds (aside from pure internet funds or index funds) and hedge funds.

[17] This ignores the earlier point that, in a framework consistent with a rational bubble, pessimistic investors might buy internet stocks to take advantage of other investors' beliefs.

As pointed out by Chen, Hong and Stein (2000), among others, mutual funds are reluctant to short stocks. While this may be more a reflection of previous outdated legislation, such as the Investment Company Act of 1940, than anything real, it is relevant if mutual funds still abide by it. They cite work that shows only a small fraction (2%) of mutual funds short stocks, and provide evidence of greater mispricings when mutual funds are absent from the market. Their argument is that, due to an unwillingness to short, institutions tend to avoid "overvalued" stocks. Thus, lower breadth is consistent with a stock being overvalued. Interestingly, here, as shown in Table 4B, pension funds were very much absent from the internet sector, which is consistent with this explanation.

With respect to hedge funds, Shleifer and Vishny (1997) argue that, in practice, arbitrage is neither capital-free nor riskless. In a model in which arbitrageurs require capital from outside investors and is performance-based, they show that arbitrage may not be successful at forcing asset prices back to their fundamentals. They then hypothesize that fundamental valuation is most flawed in the presence of highly volatile settings. Clearly, as the volatility results in Table 1B show, the prices of internet stocks and their corresponding mispricing occurred in an extraordinarily volatile period. Thus, on some level, the internet sector satisfies the Shleifer and Vishny (1997) conditions. On the other hand, while this arbitrage is risky, a diversified portfolio across all assets would expose the trader to only the systematic risk of internet stocks. If, within a portfolio of assets, the risk of internet stocks represents purely idiosyncratic risk, then why would the capital be considered risky?

Hedge funds often face convex payout schemes. From the hedge fund's point of view, the positive skewness of internet stock returns is a negative characteristic to have in one's portfolio. The positive skewness is transparent from Table 1B which implies an annualized volatility of 115% for internet-related firms. As an illustration of the distribution of returns facing hedge funds during this period, Figure 7 graphs the cross-sectional distribution of the maximum return over any month (i.e., 22-day rolling period return) for internet and non-internet firms over the January 1999 to February 2000 time period. Figure 7 shows that over 90% of the internet firms had a maximum monthly return of 80% plus over this yearly period. Thus, even if investors thought internet stocks were overvalued, there was a large probability over this year that a short position would be down considerably at some point in time. Thus, short positions might produce on average excess profits but with a substantial risk of an extreme loss. These maximum returns did not all occur at the same time, so diversification would somewhat reduce the risk over any given period. However, over this same sample period, an equally-weighted portfolio of the internet stocks had a maximum monthly return of 64%. Thus, even a well-diversified portfolio of short positions would be subject to the same problems.

Even if we assume that there was willing capital, it still does not follow that it was possible to short internet stocks sufficient to bring the prices back down. As discussed below in some detail, the ability to short on infinitum is practically impossible. Empirically, we show below that (i) internet stocks were in fact substantially more short relative to "old economy" stocks, and (ii) internet stocks were at a saturation point in terms of the ability to short more.

A. Short Interest in the Internet Sector

Table7a reports the amount of short interest in internet stocks relative to the universe of stocks in February 2000. Short interest here is defined as the total amount of shares of stock that have been sold short relative to the total amount of shares outstanding. As seen from the table, short interest was considerably higher for internet stocks than their corresponding "old economy" counterparts. For example, the short interest measures are 2.8% versus 1.8% for the mean and 1.6% versus 0.7% for the median respectively. Thus, short interest is double that of the typical company in the non-internet universe. In addition, across the distribution of short interest in the universe of stocks, the 90th and 95th percentiles are considerably larger for the internet sample (i.e., 6.9% and 10.6% versus 4.7% and 7.8%, respectively).

The results from Table 7a probably understate the results to a very large degree. There are two characteristics of the internet firms that are relatively unique. First, internet firms tend to have many insiders, not least because they represent startup businesses. Insiders' shares are usually restricted from sales either directly through the company's prospectus for a set number of years or implicitly through indirect pressure. Second, for a period usually of six months duration, the majority of shares are locked up after a firm's IPO. Since the sample includes a substantial number of firms during their IPO lockup period, the number of shares available for trading is much less. Thus, the number of shares outstanding is dramatically overstated relative to the number of shares floating, which suggests that short interest is of a magnitude higher than implied by Table 7a.

In order to generate some evidence on this latter claim, Table 7a look at short interest in the internet sector pre- and post-lockup. The short interest is approximately three times higher (and statistically significant) in the post-lockup period, which gives support for the internet sector having an even greater amount of short interest relative to non-internet stocks. Moreover, Table 7b provides the correlation between short interest and the age of the internet firm. As predicted, the correlation is positive, i.e., 0.25, and statistically significant at the 1% level.

B. The Limited Ability to Short Stocks

The discussion in (A) above implies restrictions on the amount of shares that can be traded. This immediately limits the amount of shorting that can take place. However, there are a number of other reasons why shorting stocks may be difficult in practice. First, in order to short a stock, the investor must be able to borrow it. As mentioned above, there were only a limited number of shares available for trading in internet stocks, and someone (i.e., institution or individual) would have to be willing to lend the shares. For whatever reason, individuals tend to lend shares less than institutions do. Since many of the investors in internet stocks were individuals (e.g., Table 4A), this reduced on the margin the supply of shares that could be shorted. Second, there is no guarantee that the short position would not get called either through the lenders demanding it back or margin calls. It is not a 100% probability that the investor would be able to re-short the stock.

While there are anecdotal stories about the difficulty in shorting internet stocks, it would be useful to gather some hard evidence of this from the data. In particular, when an investor shorts a stock (i.e., the borrower), he must place a cash deposit equal to the proceeds of the shorted stock. That deposit carries an interest rate referred to as the rebate rate. When there is ample supply of shares to short, the rebate closely reflects the prevailing interest rate. However, when supply is tight, the rebate rate will be lower. This lower rate reflects compensation to the lender of the stock at the expense of the borrower, and thus can provide a mechanism for evening out demand and supply in the market.

A financial institution, and one of the largest dealer-brokers, provided us its proprietary rebate rates for the universe of stocks on a selected number of dates. Table 7a documents the rebate rate across internet stocks versus the entire universe of stocks. The average rebate rate is approximately 1.08% less for internet stocks than other stocks. Moreover, the median difference is 1.45% which is strongly statistically significant. While it is difficult to know what this means precisely about the ability to short on the margin, it is clear evidence that shorting was more difficult for internet stocks.[18] An additional way to make this point is to note that 46% of the internet stocks lie in the 10% tail of all rebate rates. In fact, the mean rebate rate on internet stocks would represent the 8th percentile of the non-internet distribution. Thus, to the extent shorting is limited in practice, and assuming the rebate rate maps one-to-one with this limitation, the majority of internet stocks had reached a limit in their short positions.[19]

Table 7B provides additional evidence on the relation between the rebate rate and the difficulty in short-selling. First, Table 7b documents the correlation between short interest and the rebate rate. As one might expect, the correlation is significant and negative. That is, the higher the short interest, the lower the rebate rate, and presumably the more difficult to find significant number of stocks to short sell. Second, Table 7b provides the cross-sectional correlation between the implied P/E ratios of each stock (e.g., Figure 4) and the rebate rate. If a higher implied P/E signals a more overvalued internet stock, then the rebate rate should be lower as short selling will be at its saturation

[18] For example, along with receiving a lower rate on their cash proceeds, the short investors (i) may also face a higher risk of having their shorts called, and (ii) there is no guarantee one can find a substantial amount of stock to short at these rates. Mitchell, Pulvino and Stafford (2001) look at the minimum rebate rate for subsidiaries resulting from carve-out transactions. Their findings support ours in that they document substantially lower rebate rates. They view their findings, however, somewhat differently and argue that the rates are not low enough to explain the available arbitrages. Our interpretation of the rebate rate is more in terms of what it says about the difficulty in shorting than a literal view. In a comprehensive paper on the equity lending market, Geczy, Musto and Reed (2001) reach a similar conclusion. Though their paper is not about internet stocks per se, their results are consistent with the view advocated here. (See also Jones and Lamont (2001)).

point from the trading of pessimistic investors. As expected, the correlation is significant at the 1% level and economically meaningful, i.e., -0.16.

If investors are limited by how many shares they can short, however, there are other ways to bet against the stock. For example, one could imagine setting up a synthetic short position using the options market. Figlewski and Webb (1993) and Lamont and Thaler (2000) look at this case empirically. Even if the options market was run by rational traders, we would expect to see violations of put-call parity as arbitrage is violated due to short sale restrictions and the irrational high valuation of stocks. There would be excess demand for put options relative to call options, leaving a significant spread between the prices. Lamont and Thaler (2000) show that, in the Palm/3Com case, the synthetic short for Palm (i.e., its implied value from options) was substantially lower than the traded price of Palm, e.g., approximately 30% less during the first few weeks.

VII. The Bubble Bursts: Effects of the Lock-Up Period

Why did the so-called internet bubble burst? For our model to be consistent with the Internet stock price fall in March 2000, we can think of two possibilities. First, perhaps fundamental news came out about internet stocks that shocked the beliefs of the optimistic investors. While this is possible, we could find no particular single event that could have caused the drop.[20] Second, in spite of the analysis in Section 6, perhaps pessimistic investors could all of a sudden short considerable amounts of internet stocks. At face value, this would not seem to be a credible explanation. Why, for example, in the Spring of 2000 was shorting more easy to do than at other times?

We believe, however, that there is evidence to support this latter explanation once we realize that shorting stocks and selling stocks have the same economic effect. In particular, towards the latter part of 1999 and particularly Spring 2000, there was a large number of investors – insiders, venture capitalists, institutions and sophisticated investors

[19] As evident from Table 7A, this limit applies to firms both pre- and post-lockup because the distribution of rebate rates for both subsamples are similar.

[20] This is not to state that no news came out. For example, on March 27, 2000, CDNow's public accountant expressed "substantial doubt" about CDNow's ability to continue as a going concern. Interestingly, in just the previous month, CDNow had attracted the most buyers of any ecommerce firm, including

– who were free to sell their internet shares (through the unwinding of their lockup agreements). To the extent these investors did not have the same optimism about payoffs that existing investors had, their beliefs would now get incorporated into stock prices. As the amount of potential selling increased, this new class of investors (whether they were pessimistic or agnostic) began to overwhelm the optimistic ones.

To understand this story more fully, note that in an IPO, the existing shareholders rarely sell the entire company. Instead, approximately 15-20% of the shares are issued to the public. Though not a legal requirement, it is a standard arrangement for the underwriters to insist upon the shares of the remaining 80-85% shareholders to be restricted from sale for a certain period of time without the express written consent of the underwriter. This period, the so-called lock-up period, is one way of aligning the incentives of the current owners and new owners, at least during the initial stages of the company being public. There are no rules regarding the length of the lock-up period; however, the majority of lock-up periods last 180 days, or approximately 6 months, and are spelled out in the prospectus. Upon completion of this period, these shareholders are then free to sell their existing shares. Thus, there is a completely observable event which results in (i) a permanent shift in the amount of available shares in the marketplace, (ii) a shift in the class of investors who may have different beliefs than the current marginal investors, and (iii) this new class are potential sellers (as there is no restriction on their buying shares outside of their desire to be diversified).

Figure 8 graphs both the dollar amount of shares being unlocked by month and the cumulative effect over the sample period January 1998 to September 2000.[21] The results are quite striking. By late Spring of 2000, over $300 billion of shares had been unlocked. As these shares become unlocked, and eventually sold, there must be sufficient capital on the other side to support the internet price levels. Because these levels are not justified via their cash flow fundamentals, this new capital must come from a new source of optimistic investors. Thus, to the extent some of the $300 billion in capital was owned by less

Amazon.com. Thus, on one level, this news represented clear evidence that internet success was not necessarily linked to a firm's profits and therefore its value.

[21] The cumulative effect is simply the addition of the dollar value of the shares at lockup expiration; thus, the cumulative effect does not make any adjustments for change in value of the shares after the lockup expiration.

optimistic investors than the marginal investor, prices should drop as this huge amount of capital works its way through the market.[22]

A comparison of Figure 1, the internet stock price history, and Figure 8 is illuminating. From November 1, 1999 to April 30, 2000 the amount of unlocked shares increased from \$70 billion to \$270 billion. What happened to the level of internet stock prices over this same period? As Figure 1 shows, from November 30, 1998 to November 30, 1999, the internet index rose from 200 to 830. If this rise was due to optimism about the future payoffs of the stocks, and, in particular, due to a belief about future prices (absent fundamentals), the rise is consistent with the self-fulfilling properties of a bubble. While the index still rose over the next several months, it did so at a much slower rate. Perhaps, the slowdown in the rise of internet prices may have been due to the beginnings of less optimistic investors selling their unlocked shares. As prices stopped rising, optimistic investors' "bubble-like" beliefs about future prices were also affected, leading to a twofold effect on internet prices. The fall of the index from 1030 to 430 from March 1 to April 30, 2000 coincides with the simultaneous increase in unlocked shares. Once the bubble had burst, there was no longer support as optimistic investors' beliefs had been permanently altered.

Although this explanation is circumstantial, it provides a cohesive explanation of the internet stock price fall in the context of the model of Section 2. Unfortunately, we cannot prove this hypothesis definitively, mostly because the unwinding of lockup agreements is a gradual process. Nevertheless, to support this hypothesis, we turn to evidence of internet stock price performance around both short and long windows of lockup expirations.

Because the end of the lock-up period is a known event, markets should incorporate the economic impact (if any) of either price pressure or permanent shocks to share supply. In other words, the price impact should be built into the IPO traded price long before the end of the lock-up period. From our perspective, the lockup adds a considerable number of potential sellers to the market, some of which may be less optimistic than the current marginal investor. Thus, if there is heterogeneity across

[22] This problem is actually magnified as the firms themselves are issuing (i.e., selling) additional shares. Though not reported in the Tables, from November 1999 to February 2000, an additional \$9.2 and \$16.4

investors and short sale restrictions, then we would expect a drop in internet stock prices around the event.

Table 9 reports average daily and cumulative abnormal returns for the internet IPO sample leading up to the end of the lockup period. The abnormal returns are calculated by taking the firm's return minus the return on the index of internet stocks. The daily returns are mostly negative for the last ten days of the lockup period, with a cumulative effect of 4.5% and corresponding t-statistics around 4.[23] This is larger in magnitude than the range of 1-2% reported in existing studies for non-internet companies. Because the end of the lockup period is a known and anticipated event, however, the 4.5% average excess return is not consistent with market rationality. Nevertheless, the increase in magnitude is consistent with the hypothesis that the price drop is due to less optimistic investors being allowed to sell in the market.[24]

Figure 9 provides a graph of the CAR and the average daily volume around the lockup period. Some additional observations are of interest. First, even prior to the 10-day window and post the lockup end, there tends to be a gradual drift down in the prices of these firms (i.e., approximately 10%). We hypothesize that this may be due to the gradual shift towards pessimistic investors. Conmsistent with this hypothesis is the fact that this continued drop post-lockup is not found in previous studies of lockups for non-internet firms. Second, there is a large jump in volume at the lock-up end, and, though this volume drops thereafter, it remains above the pre-lockup period. While this result is the same for non-internet companies, the magnitude of the volume increase on and after the lockup day is higher than previously reported. This may also be due to the increased number of sellers due to their skepticism about internet prices.

The decline in internet stock prices around the lockup expiration is consistent with the model, i.e., the introduction of sellers to the market causing prices to drop. However, our analysis follows a short event-study window, while our explanation suggests

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billion of capital were issued in IPOs and seasoned offerings, respectively.

[23] Recently, a number of papers have explored the lock-up period (e.g., Bradley, Jordan, Rotan and Yi (1999), Brav and Gompers (2000), Field and Hanka (2000) and Ofek and Richardson (2000).) While the focus of these papers are different, they all report similar price (-1.0-2.0%) and volume effects (35-45%) around the end of the lock-up period over different time periods.

[24] Alternatively, it is also could be due to price pressure from non-diversified investors wishing to sell their stakes for reasons independent of their beliefs. Since the price drop is permanent, however, this explanation is suspect.

continued selling and longer-term effects. Table 9A documents the difference between excess returns on internet stocks over six month periods pre- and post-lockup expiration, excluding the previously documented days –10 to +2. The idea of this analysis is that the six-month post-lockup period is a long enough interval to allow the "pessimistic" investor to sell out of their position, and the comparison to the pre-lockup period controls for the actual inability to sell. The difference is –0.23% on a daily basis (or –28.8% on a six months basis) over the sample period prior to the crash of March 2000. Put together, the 5.5% decline around the lockup period and the 28.8% relative decline post lockup suggests over a one-third reduction in excess returns due to lockup expirations in a period dominated by optimistic investors.

In contrast, post crash, the –0.23% difference disappears and is actually a positive 0.07% though not statistically significant. At first glance, this result might seem counter to the theory. However, if the crash already caused the distribution of investors to change, or, as we argued earlier in the paper, the optimistic investors to lose their "bubble-like" beliefs, then we would not expect any difference. As limited evidence for this explanation, Table 9B shows that the correlations of the relevant internet stocks and the internet index are higher post-crash than pre-crash. That is, irrespective of whether their lockups have expired, stocks tend to move closer together after the internet price fall. This is consistent with greater homogeneity in investors after the crash.

VIII. Concluding Remarks

This paper looks at the behavior of internet stock prices during the extraordinary asset pricing period January 1998 to February 2000. Three immediate facts emerge from a simple cursory analysis: (i) relative to the aggregate market, internet stock prices rose to high levels (Figure 1), (ii) even given these high stock price levels, volume of pure internet stocks was even higher, reaching 20% of the aggregate market (Figure 3), and (iii) there was a greater proportion of retail investors to institutional ones in the internet versus non-internet sector (Table 4). With this backdrop, and at least the conditions for the market being "stormed" by retail investors, we appeal to a model of heterogenous agents with varying degrees of beliefs about asset payoffs who are subject to short sales constraints (e.g., Lintner (1969)).

In this framework, if a set of investors enter the market, or all of a sudden become very optimistic, then stock prices can rise quite dramatically. "Pessimistic" would like to short these "overvalued" stocks but are prevented from doing so. Here, as more and more "optimistic" investors arrive to the market, it becomes a stampede without any initial way of stopping it. We provide circumstantial support for this explanation through the following pieces of evidence: (i) internet stock price levels that are much higher than implied by historical valuation metrics, (ii) price effects consistent with the explanation when there is a shift in the type of investors entering the market (e.g., as with IPO-related anomalies), (iii) empirical results demonstrating that shorting was at its maximum possible level for internet stocks, and (iv) the eventual fall, or bubble bursting, of internet stocks can be tied to the increase in the number of sellers to the market via expiration of lockup agreements.

There are several directions for future research. First, we have provided one potential explanation for the rise, persistence and eventual fall of internet stock prices. While there are clearly explanations for the individual pieces of evidence presented in this paper, we believe it will be a challenge for financial economists to come up with an alternative story that fits all the pieces. Second, our paper has focused on the level of prices and ignored the relative volatility differences between internet and non-internet stocks. Results in Table 1B, for example, show that internet stocks were 5.9 times more variable, yet had 37.5% lower spreads. The magnitude of this volatility needs to be integrated into a full explanation of the internet rise and fall. Third, rational investors had access to derivatives during this period, e.g., index futures and equity options, and could have used these financial assets to bet against internet movements. A full analysis of whether this occurred, and, if not, why not, seems relevant for a complete understanding of the way capital markets behaved during the 1998-2000 period. In any event, this paper provides a first step at generating a complete, cohesive explanation of the internet bubble.

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Table 1A

Internet sub-sectors and "old economy" match

A description of internet sub-industries and their mapping to non-internet industries. For each sub-industry we report the total number firms and the total number of firms with Compustat data for fiscal year 1999.

Industry Code	*Internet Industry Description*	*Number of firms*	*Firms with 12/99 data*	*Industry*
1	Internet Portal Companies	24	15	Media
2	Internet Infrastructure Companies	34	22	Computer Hardware
3	Internet Infrastructure Services	74	47	Computer Software
4	Internet/B2B Software Companies	54	28	Information Services
5	Internet Commerce Companies	50	32	Specialty Retail
6	Internet Consulting/Application Services	50	38	Information Services
7	Internet Financial Services Companies	23	19	Financial Services
8	Multi-Sector Internet Companies	2	2	Information Services
9	Internet Vertical Portal Companies	48	39	Publishing
10	Internet Direct Marketing & Advertising	26	18	Information Services
11	Internet B2B Commerce Companies	15	6	Information Services

Table 1B

Sample description

Descriptive statistic of a sample of 320 internet firms and 3861 non-internet firms as of 2/29/2000. Average daily return is for the period 1/1998-2/2000. The information for internet firms is reported for the whole sub-sample and for 267 internet firms with price > $10 on that date.

Variable	Internet	Sample	Mean	Median	STD	Low	High
Market value of	No	P>10	5,111	599	22,248	1	461,177
equity ($ mil)	Yes	P>10	4,495	1,323	11,131	48	131,755
	Yes	All	3,801	977	10,294	20	131,755
Stock price	No	P>10	33.97	22.00	39.61	5.38	1100.00
	Yes	P>10	65.96	46.38	62.56	9.56	322.44
	Yes	All	56.23	35.06	61.19	2.50	322.44
Median daily volume	No	P>10	24,988	2,321	128,355	1	3,392,355
previous 100 days ($ mil)	Yes	P>10	78,558	16,419	169,774	1,023	1,204,647
	Yes	All	66,757	12,888	158,250	1	1,204,647
Median shares-turnover	No	P>10	0.0078	0.0034	0.0140	0.0000	0.3554
previous 100 days	Yes	P>10	0.0148	0.0125	0.0097	0.0011	0.0519
	Yes	All	0.0146	0.0125	0.0094	0.0011	0.0519
Average daily return	No	P>10	0.0019	0.0005	0.0046	-0.0291	0.0627
Average daily return	Yes	P>10	0.0067	0.0060	0.0074	-0.0120	0.0375
Daily Standard deviation of return	No		0.0350	0.0300	0.0203	0.0034	0.3952
	Yes		0.0742	0.0728	0.0218	0.0135	0.2078
	Diff		0.0392 [a]	0.0428 [a]			
Bid ask spread $	No	P>10	0.610	0.188	16.250	0.000	1000
	Yes	P>10	0.348	0.188	0.411	0.063	3
	Diff		-0.2613	0.0000			
Bid ask spread/Mid price	No	P>10	0.013	0.008	0.031	0.000	1.645
	Yes	P>10	0.007	0.005	0.007	0.000	0.058
	Diff		-0.0055 [a]	-0.0023 [a]			

[a] - Significant at the 1% level

Table 2

Aggregate financial information and target P/E

A description of aggregate sales, market value of equity, EBITDA and earnings for internet firms with 1999 Financial data available on Compustat. Target earnings are calculated by multiplying the average *Earnings/Sales* ratio for all firms in the matching non-internet industry by aggregate sales for that internet sub-industry. Target P/E is *Aggregate market cap/ target earnings*.

Industry Code	***Aggregate Market cap***	***Aggregate sales***	***Aggregate EBITD***	***Agg.Net Income***	***Industry margins***	***Target earnings***	***Target P/E***
All	942,967	27,429	(5,750)	(9,888)	0.0568	1,557	605
1	284,565	6,090	404	(1,181)	0.0452	275	1035
2	100,910	2,172	23	13	0.0474	103	980
3	139,442	3,354	(1,562)	(2,846)	0.1169	392	356
4	95,617	1,219	(328)	(457)	0.0436	53	1800
5	72,675	4,459	(3,037)	(3,565)	0.0190	85	856
6	62,697	3,038	(123)	(501)	0.0436	132	474
7	30,968	3,658	270	(57)	0.0927	339	91
8	53,620	192	(126)	394	0.0436	8	6400
9	43,264	2,267	(871)	(1,054)	0.0558	127	342
10	31,278	590	(289)	(390)	0.0436	26	1216
11	27,931	390	(110)	(244)	0.0436	17	1643

Table 3

Panel A

Implied excess return on capital

Implied excess return on capital **(1+R*)/(1+R)** for internet firms as of 12/1999, assuming they already have profitability of comparable established industry, (i.e,, P/E of 605)

Years	**Terminal P/E levels**				
	10	**15**	**20**	**25**	**30**
10	50.7%	44.7%	40.6%	37.5%	35.0%
15	31.5%	28.0%	25.5%	23.7%	22.2%
20	22.8%	20.3%	18.6%	17.3%	16.2%
25	17.8%	15.9%	14.6%	13.6%	12.8%
30	14.7%	13.1%	12.0%	11.2%	10.5%

Panel B

Implied excess return on capital

Implied **growth rates *g*** for internet firms as of 12/1999. Assuming they already have profitability of comparable established industry, (i.e., P/E of 605), and that WACC=16% during the growth period.

Years	**Terminal P/E levels**				
	10	**15**	**20**	**25**	**30**
10	74.8%	67.9%	63.1%	59.5%	56.6%
15	52.5%	48.4%	45.6%	43.5%	41.7%
20	42.4%	39.6%	37.6%	36.0%	34.8%
25	36.7%	34.5%	32.9%	31.8%	30.8%
30	33.0%	31.2%	30.0%	29.0%	28.2%

Table 4A

Institutional holdings in internet firms

Comparison of various measures of institutional holdings between 273 internet firms and 3946 non-internet firms with stock price greater than $10. The institutional holdings are from the quarter that ended on March 31 2000.

Variable	**Internet**	**Sample**	**Mean**	**Median**	**STD**	**Low**	**High**
Institutional holdings/shares outstanding	No	P>10	0.4056	0.4024	0.2571	0.0000	0.9987
	Yes	P>10	0.3133	0.2592	0.2141	0.0014	0.9851
	Diff		-0.0923 [a]	-0.1432 [a]			
Number of institutions	No	P>10	110	65	146	1	1219
	Yes	P>10	76	54	78	1	848
	Diff		-35 [a]	-11 [a]			
Institutional holdings/shares outstanding	No	IPOs	0.3542	0.3148	0.2383	0.0019	0.9856
	Yes	IPOs	0.2953	0.2412	0.2024	0.0014	0.9851
	Diff		-0.0589 [a]	-0.0736 [b]			
Number of institutions	No	IPOs	63	50	55	2	376
	Yes	IPOs	65	50	50	6	322
	Diff		2.0	0.0			

[a] - Significant at the 1% level
[b] - Significant at the 5% level

Table 4B

Holdings by large pension funds

Fraction of the largest pension fund holdings in internet and non-internet stock. These pension funds refer to ones identifiable via their 13-F filings and ranked by Pensions and Investments Magazine. The institutional holdings are from the quarter that ended on March 31 2000. Holdings are in millions.

Name	**Internet holdings**	**Non-internet holdings**	**Internet weight**
California Public Employees Retirement Sys	$ 2,858	$ 79,320	3.48%
New York State Common Retirement Fund	$ 1,194	$ 70,141	1.67%
Teacher Retirement System of Texas	$ 863	$ 61,745	1.38%
California State Teachers' Retirement System	$ 2,201	$ 57,159	3.71%
The Regents of the University of California	$ 539	$ 42,678	1.25%
The State Teachers Retirement System of Ohio	$ 528	$ 32,985	1.58%
State Treasurer State of Michigan	$ 646	$ 32,110	1.97%
The Florida State Board of Administration	$ 998	$ 30,871	3.13%
State of Wisconsin Investment Board	$ 167	$ 13,539	1.22%
IBM Retirement Funds Equity	$ 295	$ 12,446	2.32%
Total holdings by pension funds	**$ 10,289**	**$ 432,994**	**2.32%**
Total market capital	**$ 1,107,778**	**$ 24,164,630**	**4.38%**

Table 5

Panel A

First day returns description

First day return for 305 internet IPOs and 746 non-internet IPOs between 1/1998-4/2000.

Internet	**Year**	**Obs**	**Mean**	**STD**	**Median**	**Q1**	**Q3**
Yes	All	305	0.955	1.021	0.631	0.193	1.438
Yes	1998	23	0.860	1.021	0.705	0.162	1.195
Yes	1999	206	0.933	0.979	0.639	0.219	1.417
Yes	2000	76	1.042	1.133	0.613	0.182	1.729
No	All	746	0.336	0.658	0.104	0.000	0.371
No	1998	303	0.135	0.260	0.058	0.000	0.196
No	1999	287	0.463	0.823	0.188	0.000	0.571
No	2000	156	0.495	0.754	0.188	0.002	0.721

Table 5 *continue*

Panel B

Regressions analysis of the first day return of internet firms that went public between 1/1998-4/2000. In the first model the dependent variable is the first day return and the independent variable is the cumulative return of the internet index in the previous 15 trading days. In the second model the dependent variable is the cumulative excess return (relative to the internet index) of the IPO firm from the close of the first day until the end of 2000 the independent variable is the first day return. Student t-statistic is in parenthesis.

Intercept	**Coefficient**	**Obs**	**Adj R sq**
Model 1 - *Day 1 return* =α + β**last 15 day index return*			
Full sample			
0.871 [a]	1.958 [a]	270	0.0956
(14.26)	(5.44)		
Model 2 - *Cumulative excess return* =α+β**day 1 return*			
Full sample			
-0.456 [a]	-0.060	270	0.0000
(4.11)	(0.65)		
Firms with day 1 return > 100%			
0.484	-0.438 [a]	94	0.0641
(1.33)	(2.73)		

[a] - Significant at the 1% level

Table 6

Excess returns around the end of the **quiet period**

The sample includes 305 internet IPOs between 1/1998-4/2000. Window days measure the number of days over which the cumulative excess return is measured. The excess return is the difference between the firm on the stock and the internet index. All window days end on the event day (day 0).

Window days	CAR	t-stat	Event day	Excess return	t-stat
1	-0.007	-1.225	0	-0.0068	-1.225
2	0.005	0.669	-1	0.0122	1.925
3	0.038	3.927	-2	0.0331	5.614
4	0.059	5.425	-3	0.0200	3.615
5	0.072	6.076	-4	0.0136	2.725
6	0.090	6.950	-5	0.0177	3.278
7	0.102	7.284	-6	0.0125	1.912
8	0.109	7.391	-7	0.0070	1.228
9	0.121	7.772	-8	0.0115	2.166
10	0.130	7.999	-9	0.0090	1.640

Table 7
Short Interest and Rebate Rates for Internet Firms
Panel A

Comparison of various measures of short interest between 273 internet firms and 3946 non-internet firms with stock price greater than $10. Short interest data and the rebate rates are as of February 2000.

	Internet	Sample	Mean	Median	STD	p10/p90	p5/p95
Short interest/shares outstanding	No	ALL	0.018	0.007	0.034	0.047	0.078
Short interest/shares outstanding	Yes	ALL	0.028	0.016	0.034	0.069	0.106
	Diff		-0.010 [a]	-0.009 [a]			
Rebate rate on shorts %	No	ALL	5.407	5.660	1.034	5.080	3.590
Rebate rate on shorts %	Yes	ALL	4.328	5.210	1.952	0.870	0.040
	Diff		1.078 [a]	0.450 [a]			
Short interest/shares outstanding	Yes	Pre Lockup	0.015	0.007	0.021	0.042	0.058
Short interest/shares outstanding	Yes	Post Lockup	0.034	0.022	0.037	0.076	0.112
		Diff	-0.019 [a]	-0.016 [a]			
Rebate rate on shorts %	Yes	Pre Lockup	3.929	4.990	2.290	0.110	-0.180
Rebate rate on shorts %	Yes	Post Lockup	4.538	5.250	1.718	1.640	0.210
		Diff	-0.608 [b]	-0.260			

Panel B

Correlation between various measures of short interest and firm characteristics for 273 internet firms as February 2000. Age is the number of months since the IPO until February 2000. Implied P/E is the stock price scaled by steady state earnings (current revenues*profit margins of comparable old economy margins).

	Short interest/shares outstanding	Rebate rate	Age	Implied PE
Short interest/shares outstanding	1.000	-0.431 [a]	0.252 [a]	-0.045
Rebate rate on shorts %	-0.431 [a]	1.000	0.082	-0.161 [a]
Age	0.252 [a]	0.082	1.000	-0.092
Implied PE	-0.045	-0.161 [a]	-0.092	1.000

[a] - Significant at the 1% level

[b] - Significant at the 5% level

Table 8

Excess returns around the end of the **Lockup period**

The sample includes 305 internet IPOs between 1/1998-4/2000. Window days measure the number of days over which the cumulative excess return is measured. The excess return is the difference between the firm on the stock and the internet index. All window days end on the event day (day 0).

Window days	CAR	t-stat	Event day	Excess return	t-stat
1	-0.009	-1.586	0	-0.0087	-1.586
2	-0.019	-2.485	-1	-0.0085	-1.709
3	-0.023	-2.845	-2	-0.0049	-0.990
4	-0.031	-3.397	-3	-0.0077	-2.071
5	-0.037	-3.828	-4	-0.0060	-1.470
6	-0.043	-4.256	-5	-0.0057	-1.205
7	-0.046	-4.213	-6	-0.0029	-0.636
8	-0.039	-3.499	-7	0.0063	1.415
9	-0.046	-3.902	-8	-0.0063	-1.376
10	-0.043	-3.523	-9	0.0026	0.545

Table 9
Long horizon comparison of pre-and post-lockup excess returns

Panel A

Comparison of average daily excess returns between the 6 months pre- and 6 months post-lockup expiration periods for internet firms. The excess return is the difference between the firm on the stock and the internet index. (These excess returns exclude days –10 to +2 around the lockup expiration).

	Daily excess return	Observations
Full period 1/1998-12/2000		
Post lockup expiration	0.07%	21291
Pre lockup expiration	0.18%	25188
Difference	-0.11% [c]	
Pre-crash 1/1998-2/2000		
Post lockup expiration	0.01%	10063
Pre lockup expiration	0.22%	19128
Difference	-0.23% [a]	
Post crash 3/2000-12/2000		
Post lockup expiration	0.12%	11228
Pre lockup expiration	0.05%	6060
Difference	0.07%	

Panel B

Comparison of the correlation between the internet firms' stock returns and the return on the internet index, pre- and post-crash. These periods cover 10 months from May 1999 through February 29, 2000 (pre-crash), and 10 months from March 2000 through December 31, 2000 (post-cash). These firms must have at least 100 trading days during this period to be included in the sample.

Period	**means**	**median**	**std**	**low**	**high**
Pre-crash correlations (5/1999-2/2000)	0.3552	0.3684	0.1460	-0.0368	0.6815
Post-crash correlations (3/2000-12/2000)	0.3988	0.4130	0.1761	-0.0240	0.7659
Difference in correlations	-0.0437 [a]	-0.0446 [a]			

[a] - Significant at the 1% level
[c] - Significant at the 10% level

Figure 1
Returns on: equaly weighted internet index, S&P 500, NASDAQ

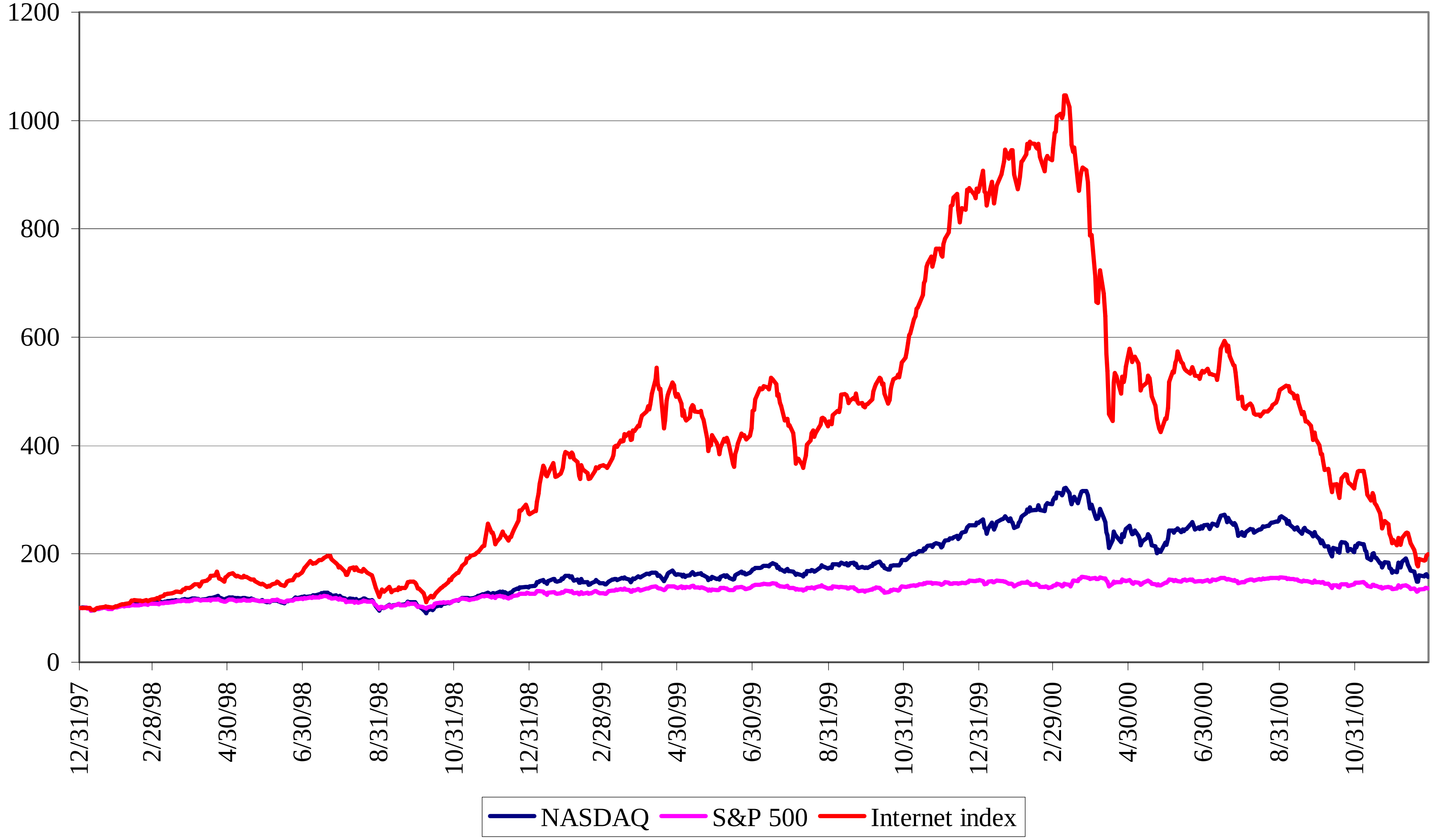

Figure 2
Total daily volume and number of- Internet firms

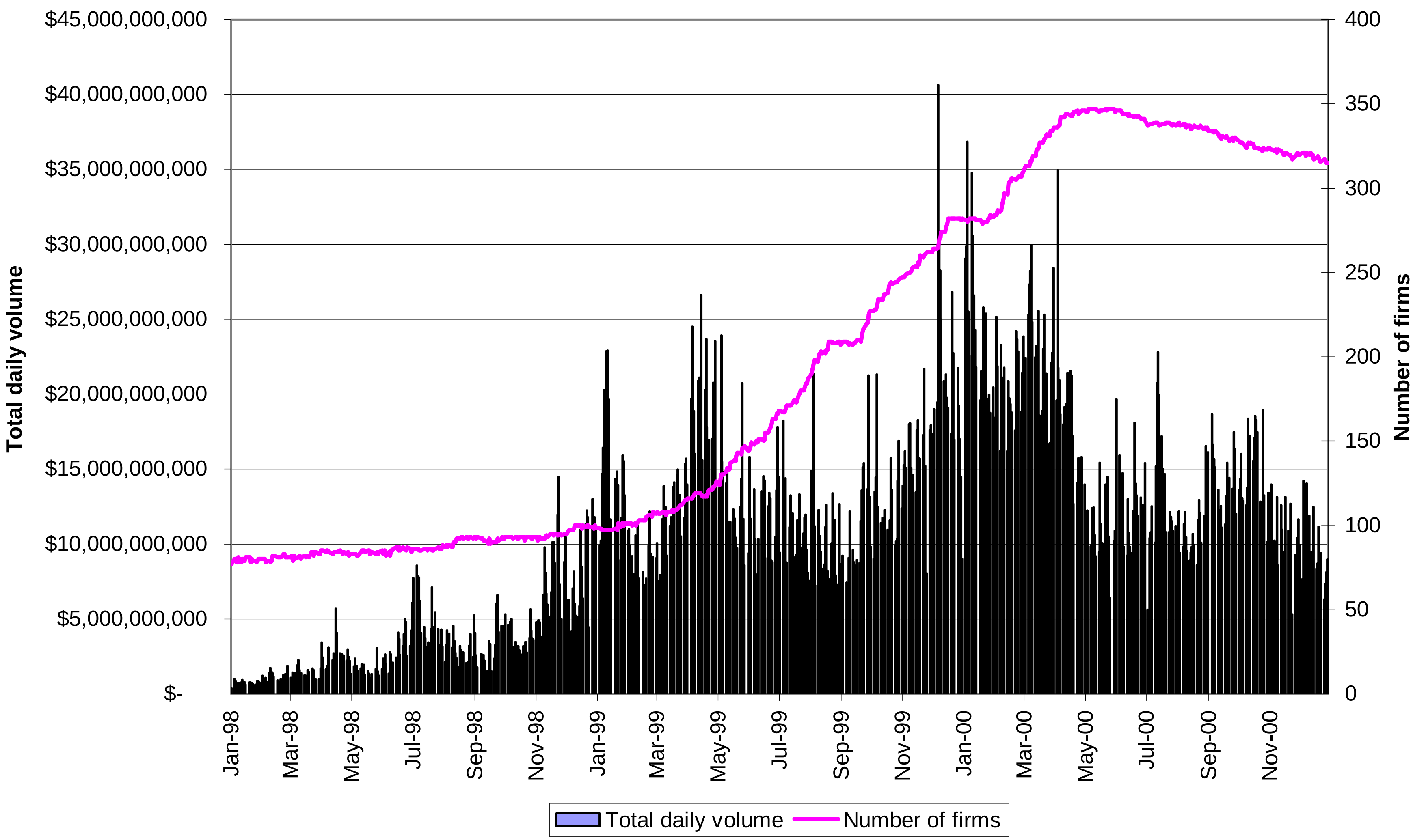

Figure 3
Fraction of internet firms in total market volume and capitalization

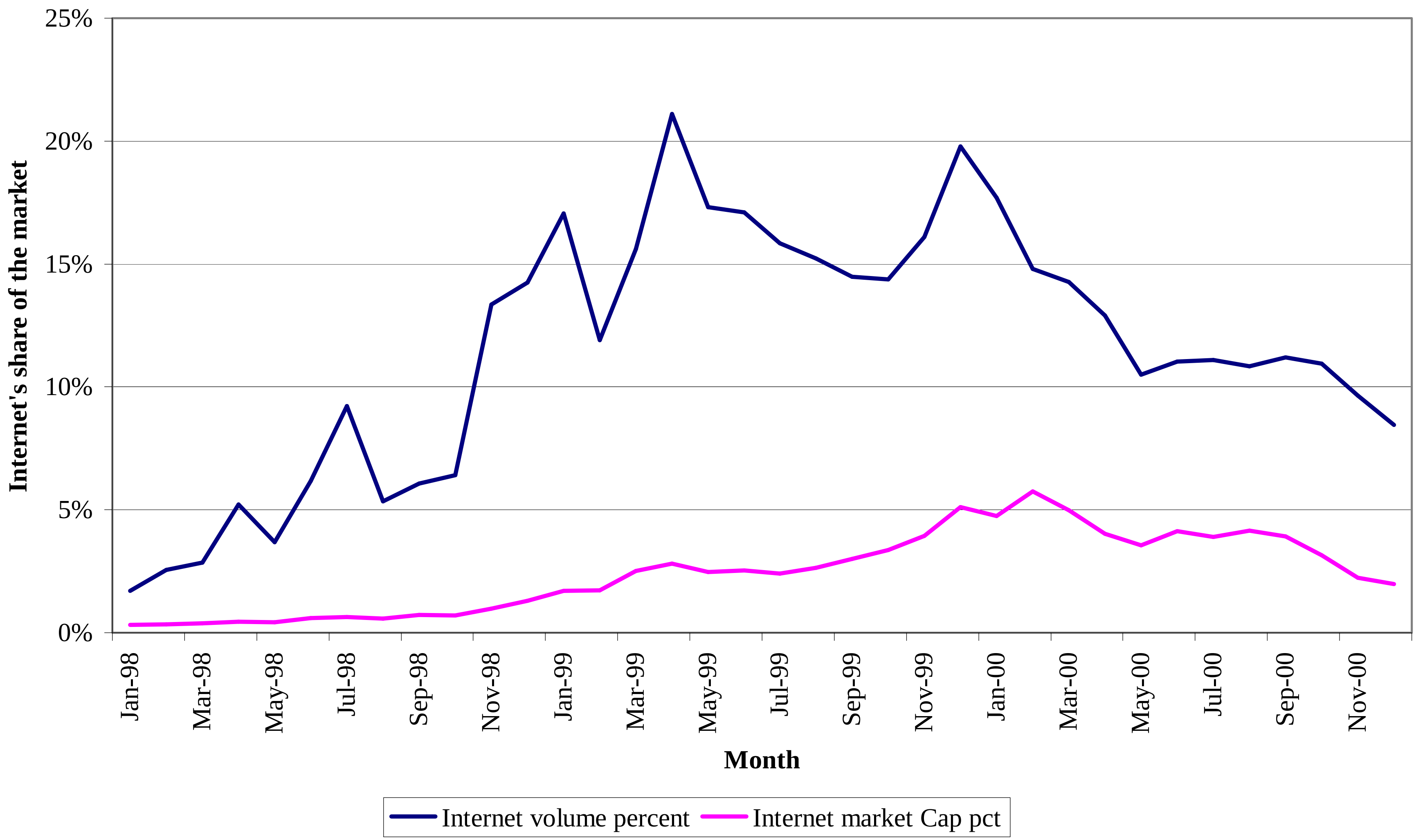

Figure 4
Histogram and cumulative frequency implied PE ratios of internet firms at the end of 1999

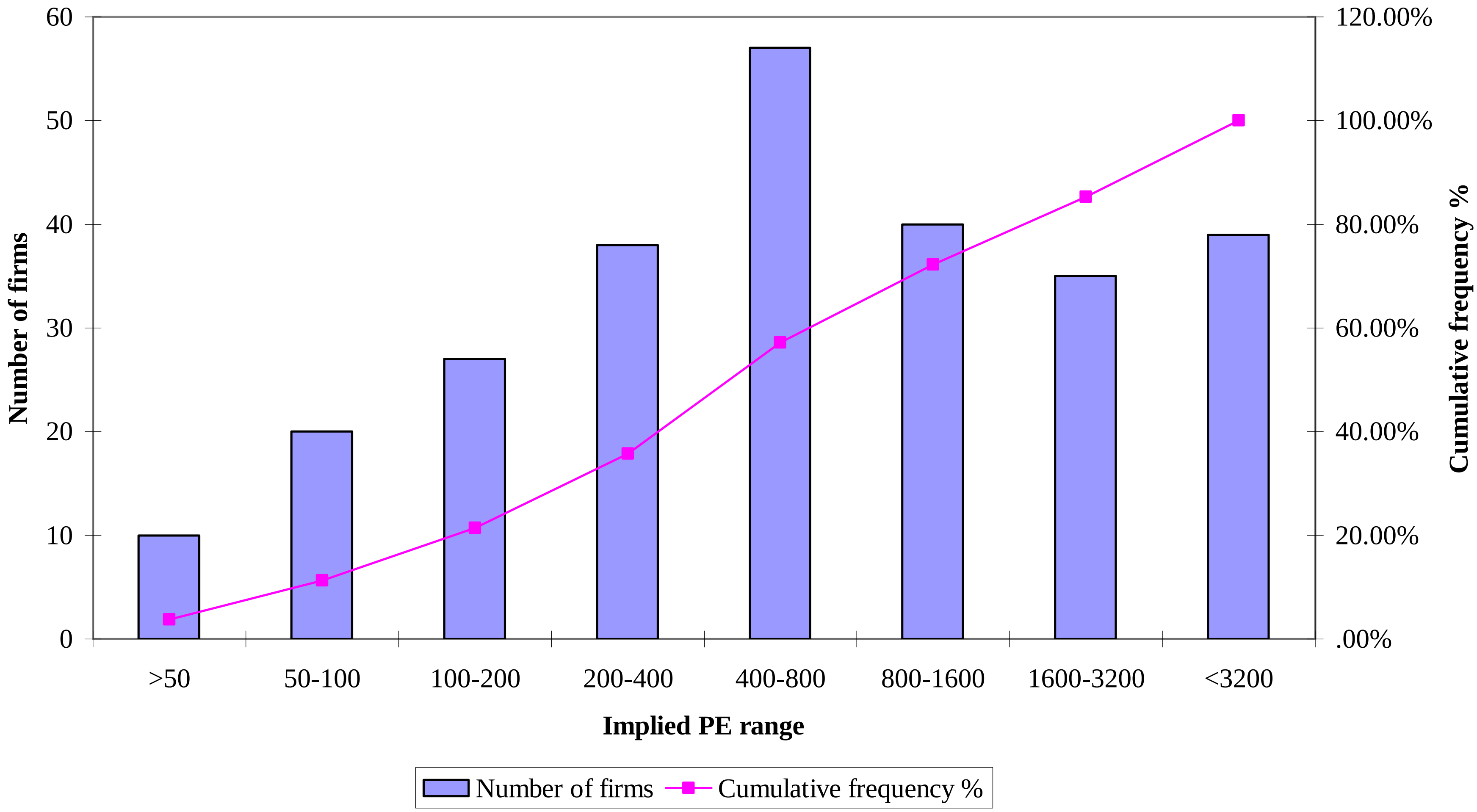

Figure 5

Volume and returns relative to quiet period end

Internet firms 1/1998-2/2000

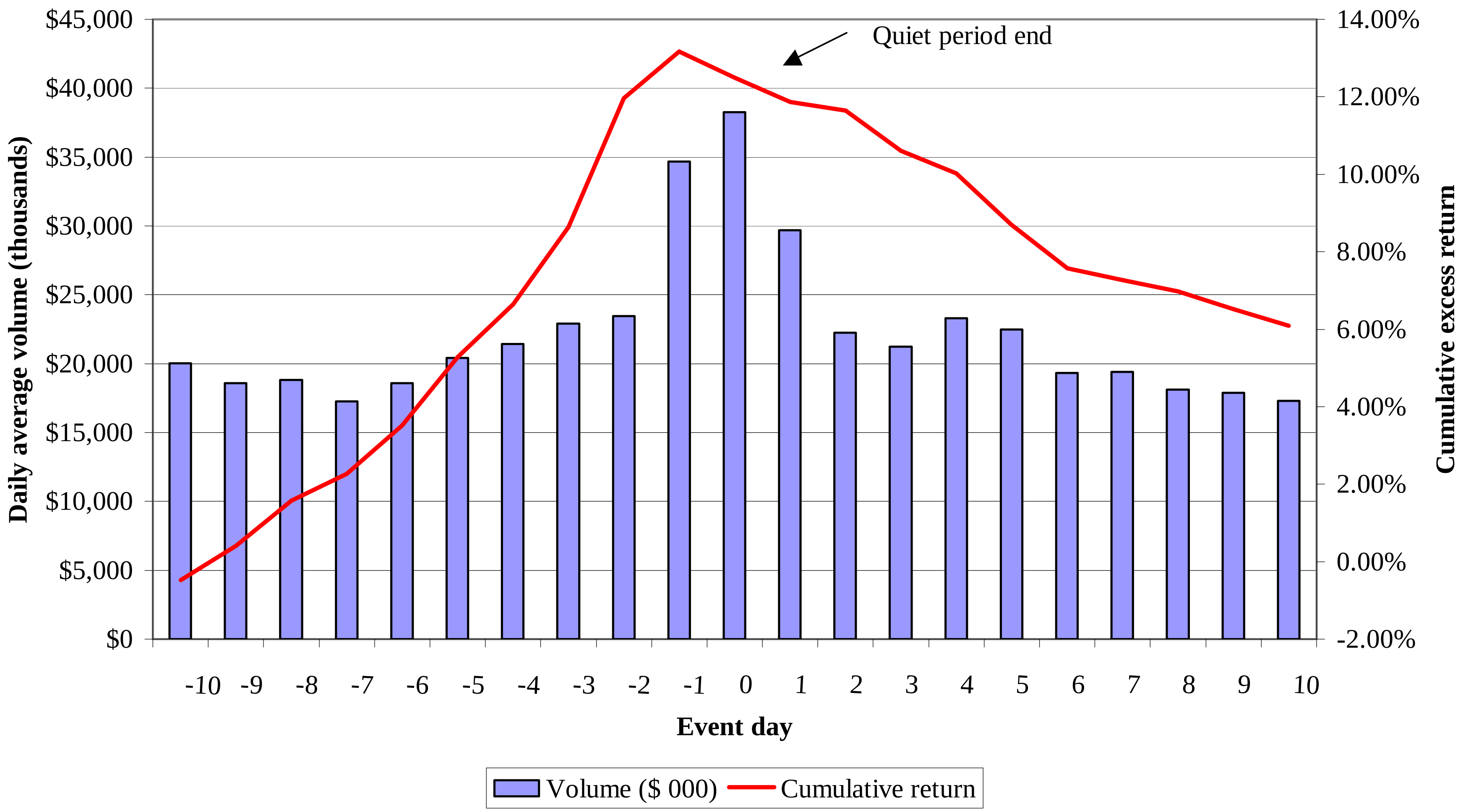

Figure 6
Frequency distribution of maximum 22 day return from 1/1/1999-2/29/2000

Figure 7
Total dollar value of shares that where removed from lockup

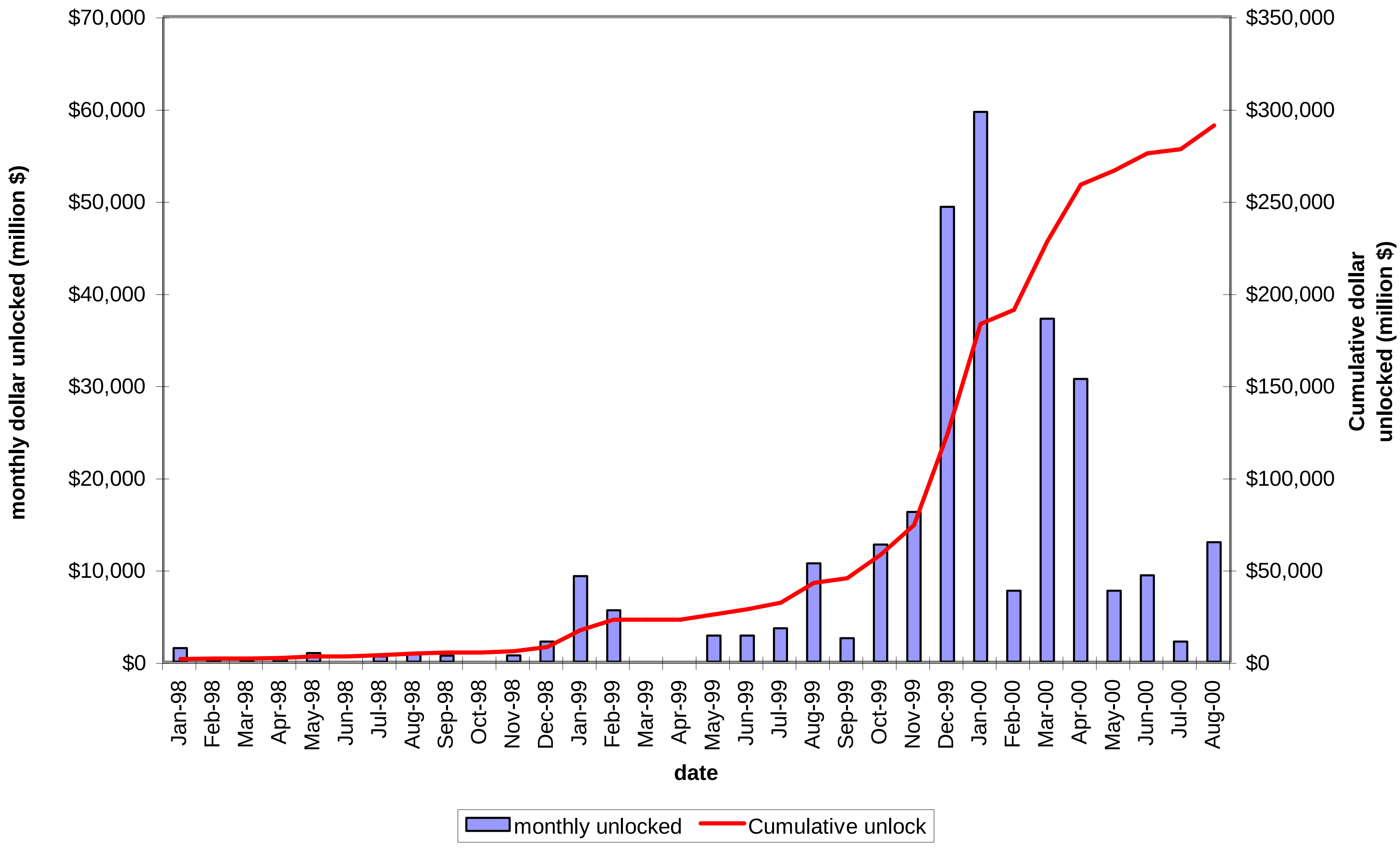

Figure 8
Excess returns relative to Lockup expiration day
Internet firms 1/1998-2/2000