Inferring Underwriter Intervention on First Day IPO Market
-- A Comparison of Two Methods of Gauging Price Support

By
Emilio Venezian and Xiaoli Wang[1]
Department of Finance and Economics
Rutgers Business School, Newark and New Brunswick

[1] Both of the authors are from Department of Finance and Economics, Rutgers University. Emilio Venezian can be reached at emilio_venezian@yahoo.com and Xiaoli Wang can be reached at xiaoliw@andromeda.rutgers.edu.

Inferring Underwriter Intervention on First Day IPO Market -- A Comparison of Two Methods of Gauging Price Support

By
Emilio Venezian and Xiaoli Wang
Department of Finance and Economics
Rutgers Business School, Newark and New Brunswick

Abstract

Abnormal first days returns for initial public offerings (IPOs) have been well documented in literature. One of the explanations offered for this observation is intervention of the underwriters to “support” or “stabilize” prices in the after market. Such researches focus on the activities and motives of underwriters exercising the right to intervene in the market. Basically speaking, in literature there are two competing methodologies of estimating intervention in IPOs. Benveniste, Erdal and Wilhelm (1998) identify the price intervention in IPOs based on a microstructure data on individual issues whereas Asquith, Jones and Kieschnick (1998) estimate the probability of price support from the whole distribution of IPO initial returns. No research has investigated the relationship between these two methodologies. This paper fulfills the gap by assessing the relationship between them. The results are mixed. The two methods differ substantially on the percentage of issues that are price supported, but when the procedures are applied to individual IPOs, the misclassification errors are not large. The estimated means and standard deviations of the IPOs with and without intervention determined from the two methods differ significantly from each other, but the results show that the BEW method confirms the hypothesis underlying the AJK method that returns for “supported” IPOs are lower than those for “unsupported” IPOs. These results suggest that what we have is two imperfect methods of identifying intervention, but that there is some truth underlying the notion that intervention affects the distribution of first day returns in IPOs.

Inferring Underwriter Intervention on First Day IPO Market -- A Comparison of Two Methods of Gauging Price Support

By
Emilio Venezian and Xiaoli Wang
Department of Finance and Economics
Rutgers Business School, Newark and New Brunswick

1. Introduction

The pattern of initial returns to initial public offerings (IPO) has been one of the most striking phenomena in finance area. For example, as documented by Loughran and Ritter (2001), the average first-day return on IPOs was 7% in the 1980s, and then doubled to almost 15% during 1990 –1998, before jumping to 65% during the Internet bubble years of 1999-2000. Two main categories of explanations are offered for these observations on early IPO returns: one is based on underpricing of the issues by the underwriters, the other is based on underwriters' price support or price stabilization activities in the aftermarket.

Most of the underpricing theories concentrate on why underwriters might choose to deliberately underprice IPO offers while studies on "price support" or "price stabilization[2]" focus on the activities and motives of underwriters exercising the right to intervene in the market. Although IPO underpricing argument has been widely accepted in the literature, the underwriters' price support/ price stabilization activities (such as motivation, effectiveness, practice, etc) have not been well understood in the market. One of the reasons is that the lack of transparency in industry practice prevents exerts

[2] These terms are used interchangeably in the literature. For example Asquith, Jones and Kieschnick (1998) discuss "supported and unsupported issues" in their model but the paper is entitled "Evidence of Price Stabilization and Underpricing in Early IPO Returns)". As discussed below we will attach more specific meaning to these two terms.

difficulties to clearly identify of the price supported IPO targets. Various methodologies have been proposed trying to assess the price supported or price stabilized IPOs. However, none of them has achieved universal acceptance. In this paper, we provide a systematic and comparative analysis between two main methodologies of inferring IPO price support / stabilization activities and thus provides insight to the understanding of underwriter price support / price stabilization activities.

One of the two methodologies we studied is provided by Benveniste, Erdal and Wilhelm (1998), who rely on microstructure data and use the relationship between the price of trades in a given issue and the bid–ask prices in effect at the time of the trade as a basis to distinguish "price supported" issues from others. We refer to this as the "micro" or "BEW" method. Another methodology is documented by Asquith, Jones and Kieschnick (1998). They argue that the distribution of the IPO initial returns gives rise to a mixture of two normal distributions, corresponding to "underpricing" and "price-support" respectively. We refer it as the "macro" or "AJK" method. In the rest of this paper we will use the terms "support" and "supported" to refer specifically to interventions as inferred from the macro method and the terms "stabilization" and "stabilized" to refer to interventions as inferred from the micro method.

There has been no systematic study of the relationship between these two methodologies. Our study attempts to fill the gap by assessing this relationship using data from year 1996 through 2002. Our primary interest in this paper is to investigate whether these two methodologies are measuring the same phenomenon, regardless of the rationale adduced for the intervention. Specifically we are interested in determining whether the probabilities of intervention (support or stabilization) obtained from the two methodologies are the same, whether the means and standard deviations of the returns of the groups (with and without intervention), as estimated from the two methodologies, are consistent, and whether "stabilized" firms and "supported" firms are largely overlapping sets or not.

Our empirical findings are of interest. We find that the two methods lead to different estimates of the fraction of issues subject to intervention, and different parameter for the moments of the distributions of return to IPOs with and without intervention. On the other hand, the cross-classification of issues deemed price supported by the two decisions shows reasonable agreement.

To our knowledge, our research is the first that provide a systematic analysis about the methodologies of inferring IPO price support / stabilization. It will contribute to the IPO price support literature as it provides insight about inferring the underwriter price support / stabilization activities. The identification of the price supported / price stabilized IPOs will also help to explain questions like "what types of IPOs are more likely to be price supported / stabilized", "the effectiveness of the IPO price support / stabilization" etc.

The rest of the paper is organized as follows: section 2 reviews the relevant literature; section 3 discusses the data. Section 4 and section 5 describe the Macro and Micro methodologies respectively. Empirical results are documented in section 6 and section 7 concludes.

2. Literature Review

IPO underpricing and price support / stabilization are the two compelling explanations for the IPO first day abnormal returns. Most of the underpricing theories focus on why underwriters might choose to deliberately underprice IPO offers. Ljungqvist (2005) has pointed out that the theories of underpricing can be grouped under four broad headings: asymmetric information, institutional reasons, control consideration and behavioral approaches.

1. Asymmetric information models assume that one of the key IPO parties (issuing firm, underwriter, and investors) knows more than the others; these models include:
    a) information asymmetry between issuers and investment bankers (Baron (1982)[3]);
    b) information asymmetry between uninformed investors and informed investors (Rock (1986)[4]); and
    c) asymmetric information between issuer and investors (Allen and Faulhaber (1989), Welch (1989) and Grinblatt and Hawang (1989)).
2. Institutional theories focus on the features of the market place such as litigation and taxes considerations. For example, Tinic (1988), and Hensler (1995) argue that intentional underpricing may act like insurance against securities litigation.
3. Ownership and control arguments explain the underpricing within the context of an agency cost approach (Brennan and Franks (1997), Stoughton and Zechner (1998),

[3] Baron (1982) argues that because of informational asymmetry concerning the quality of the IPO issues and the observability problem regarding the effort of the investment bankers, IPO issuers have to underprice their offer in order to deal with the adverse selection as well as moral hazard problems of underwriters.

[4] Rock (1996) holds that IPO issuers deliberately underprice their offers in order to attract uninformed investors, because uninformed investors face unfavorable condition or so called winner curse compared with informed investors in), bidding IPOs.

4. Finally, behavior theories assume either that:

   a) "irrational" investors bid up the price IPO shares beyond true values (Ritter (1991)), or

   b) issuers are subject to behavior biases and therefore fail to put pressure on the underwriting banks to have underpricing reduced (Welch (1992), Loughran and Ritter (2002))

As a counterpoint to underpricing theories, there are studies on "price support" or "price stabilization[5]." These studies focus on the activities and motives of underwriters exercising the right to intervene in the market. The literature also offers several different rationales for price support. First, price support is viewed as a reward to investors or a bonding mechanism between underwriter and investors. These interventions can be viewed as either fulfilling an obligation to the issuer to maintain an orderly market or as ways of rewarding investors that supplied valuable information for the ultimate pricing of the issue. For example, Benveniste, Busaba and Wilhelm (1996) claim that the price stabilization is used to effectively bond the underwriter against overstatement of pre-offer interest and subsequent overpricing of issue, while Chowdhry and Wikram (1996) argue that price support is used to compensate uninformed investors ex post for the adverse selection cost. Alternatively, literature also views the price stabilization as a means of price manipulation. Hanley et al (1993) argue that price stabilization temporarily inflates the stocks' price and thus allows underwriters to disguise overpriced IPO offers. Schultz and Zaman (1994) suggest that price support permanently increases the aftermarket stock

[5] These terms are used interchangeably in the literature. For example Asquith, Jones and Kieschnick (1998) discuss "supported and unsupported issues" in their model but the paper is entitled "Evidence of Price Stabilization and Underpricing in Early IPO Returns)". As discussed below we will attach more specific meaning to these two terms.

price by reducing the supply of shares and thus helps to distribute overpriced offerings. Fishe (2001), on the other hand, argues that underwriters choose the offer price, the over-allotment and the degree of price support to maximize their profits from the offerings, including the profits from the aftermarket trading. Lewellen (2003) provides an alternative argument for price stabilization, arguing that underwriters choose, ex post to support weak IPOs to protect their reputations with investors.

Stabilization of the IPO's secondary market price usually involved one or more of the following practices: pure stabilization bid, penalty bids and underwriter's short position. Legitimate concern about current practices rests on price stabilization being a relative opaque mechanism (Wilhelm Jr. 1999). Among the three stabilization tools, only the pure stabilization bid are made transparent to market makers and in principle to investors at large. According to Aggarwal (2000), SEC only regulates pure stabilization in a direct way. In pure stabilization, underwriters are allowed to post a stabilizing bid to purchase shares at a price not to exceed the offer price. However these stabilizing bids are required to have a flag identifying them as stabilization bids and such a flag would send a clear signal to the market that the offering is weak and stabilization is required.

In contrast to stabilization bids, penalty bids are designed to control flipping or reselling of shares. Even though managing underwriters are required to disclose the presence of penalty bids to the regulatory body of the market in which the stock will trade, the public disclosure of penalty bids is not currently required. Moreover, regulation does not exclude the possibility that underwriters can use both the explicit penalties (penalty bids) and the implicit penalties such as threat of exclusion from future transaction to create similar incentive and this creates another difficulty to make the price support/ stabilization activities through penalty bids transparent to investors.

Underwriter's short position maybe the most opaque mechanism among the three stabilization tools. Underwriters can create buying power to offset selling pressure by overselling or taking short position during the allocation of the offerings. Underwriters can then cover the short position through exercising "green shoe" or overallotment options. Since that regulation imposes the same disclosure requirements as those imposed on penalty bids, investors need not be informed that an offering is or will be stabilized by way of a syndicate short position.

Most importantly, Aggargel (2000)'s finding that pure stabilization, in which an identified stabilizing bid is posted is never done, and that aftermarket short covering is the principal form of stabilization, suggests that price stabilization efforts generally may not be highly transparent to secondary market investors.

The lack of transparency in industry practices stabilization activities impose difficulties to studying underwriters' price support / price activities. This motives researchers to inferring underwriters' market intervention behaviors in various indirect ways, such as from IPO return or IPO trading behaviors etc. In general, two very different ways of assessing price support or price stabilization have been reported in literature. Benveniste, Erdal and Wilhelm (1998) rely on microstructure data and use the relationship between the price of trades in a given issue and the bid–ask prices in effect at the time of the trade as a basis to distinguish "price supported" issues from others. We refer to this as the "micro" or "BEW" method. BEW find that, of their final sample of

504 IPOs between January 1 1993 and September 30 1994, 22.0 percent (111 issues) were stabilized and 78 percent (403 issues) were not accordingly to their definition.

The other methodology relies on analysis of the distribution of the post IPO returns. For example, Rudd (1993) argues that underwriter price support amounts to a left handed truncation of the return distribution and manifests itself as positive skewness. Instead of forming a symmetric curve centered over a positive mean, the distribution of observations is peaking steeply around zero and includes very few observations in the negative tail. Asquith, Jones and Kieschnick (1998) argue that the distribution of the IPO initial returns gives rise to a mixture of two normal distributions, corresponding to "underpricing" and "price-support" respectively. In both cases, statistical methods are used to infer the fraction of IPOs that are "supported" and the other parameters of the postulated distributions. Using data on 560 IPOs in 1982-1983, AJK estimate that 49.0% of the IPOs are price supported based on one-day returns, whereas on a one-week basis this declined to 38.0%.

In this paper, we focus specifically on the method of Asquith, Jones, and Kieschnick (1998) to which we refer as the "macro" or "AJK" method. In the rest of this paper we will use the terms "support" and "supported" to refer specifically to interventions as inferred from the macro method and the terms "stabilization" and "stabilized" to refer to interventions as inferred from the micro method.

The differences between the two methodologies are marked. The micro method permits us to identify whether a specific IPO is price stabilized using only data of that particular issue. Data on other issues are irrelevant, and the decision is on an issue-by-issue basis. The macro method, on the other hand, assesses parameters based on a group of issues (typically all issues that came to market over a period of time) and does not lead directly to the decisions about individual issues.[6] It should be evident that the group of issues used in the analysis must be homogeneous enough so that the economic factors that affect the rate of return apply equally to all; otherwise the heterogeneity will by itself impose a "mixture of distributions" on the data even if there is no price support[7]. Unfortunately the methodology requires a large number of issues in order to provide reliable parameters, so compromises between numerosity and homogeneity of data are unavoidable.

In our analysis, we focus on IPO first day returns, for two primary reasons. One is that the discrimination in the macro model is more powerful in the shorter interval. The second is that extending the period to five days or one week inevitably risks the introduction of heterogeneity if the location of the weekend is important for dissemination and interpretation of information. We find that the two methods lead to different estimates of about the IPO price support / price stabilization probability, but on the other hand, the cross-classification of issues deemed price supported by the two decisions shows reasonable agreement.

3. Data

The sample of IPOs in this study was identified from www.hoovers.com.[8] We also obtained the offer price and the first day close price information from it. The data

[6] We will show that a simple application of Bayes' theorem can be used to infer the posterior probability that any issue is in the price supported group from the data usually recovered by the macro method.

[7] Sopranzetti, Venezian and Wang (2005) , The market for new issues: impact of offering price on price support and underpricing, working paper of Rutgers university, have shown that over the period 1985-1993, the issue price has a bearing on the inferred parameters.

[8] The data was obtained from the Hoovers.com, IPO central, IPO performance in June 2003. It includes all the IPO issues from April 1996 to Dec. 2002 that are still available in the market till June 2003. This

spans the period from April 1996 to December 2002. We then excluded the IPOs of real estate investment trusts, close-end funds and IPO issues in the financial industry. The remaining IPOs formed a sample of 1332 issues.

The microstructure data (the trade and quotation data) were obtained from NYSE TAQ database. Of the total 1332 issues, the microstructure data for 176 issues (about 13%) were not available[9]. Those IPOs were deleted from the sample and resulted in a final sample of 1156 issues. We identified the Internet IPOs by matching our data with Ritters's Internet IPO sample. Another 178 IPO issues will be excluded if we restrict our sample to non-internet IPO issues. Panel A of Table 1 provides the detailed data information.

(Insert Table 1 here)

Panel B of table 1 shows the summary statistics for the IPO initial returns of our sample firms over the period of 1996 to 2002. Two interesting observations can be drawn. First, the means and medians of the initial return in individual years over period 1996 to 2002 follow a reverse "U" shape with the highest mean return of 46.9% in year 1999. Second, the distributions of returns are positively skewed, which is consistent with the finding of AJK. Figure 1 shows the histogram of the IPO initial return over years with a plot of the normal density using the sample mean and sample variance for each corresponding period. Panel A shows the graph for the samples including internet companies while Panel B provides the graph for samples excluding internet companies. The number of Internet companies in some years is too small to give reliable results, thus

---

may cause a survival bias of the data sample, however, since that the objective of this paper is to compare the two methods for identifying price supported issues, we think the survival bias effect will be small.

[9] The main reason is that these issues were not listed in the exchanges covered by the TAQ database. The other reason is that some of the issues do not have the micro information from the IPO day but include such information only at a later date.

we did not he report the distribution of the Internet companies. The graph is consistent with the descriptive statistics.

(Insert Figure 1 here)

To assess the sensitivity of the results to various assumptions we used two measures of returns: the linear return $r_{Lin} = \frac{P_C - P_O}{P_O}$ and the logarithmic return $r_{Log} = \ell n \frac{P_C}{P_O} - 1$, where P_C and P_O represent the end of period closing price and offer price respectively. As Kon (1984) pointed out and also noted by AJK, limiting arguments imply that only the logarithmic returns are normally distributed. We also ran analyses based using all IPOs in our sample and only non-internet IPOs[10].

4. Inferring Price Support from Micro Information

Introduction

BEW apply a microstructure methodology to identify the price stabilized IPO issues. They first recognize each transaction as either buyer-initiated or seller-initiated using Lee and Ready's (1991) algorithm for inferring trade direction. They then infer whether a specific issue is price supported on a given day from information on the relationship between the trades that took place on that day and the bid – ask prices in effect at the time of the trade.

Methodology

We follow BEW's method to identify the price stabilized IPO issues. The procedure involves three steps. Firstly, for each IPO issue, we calculate the national best

[10] The number of internet IPOs is, unfortunately, not sufficient to get reliable estimates of the parameters for this subpopulation in most of the years. Given the heterogeneity among years it did not appear fruitful to conduct an analysis of all years combined for this subgroup.

bid and offer prices (NBBO) for each quotation on the fist day. We then infer the trade direction by matching the trades and NBBOs. At last we distinguish between stabilized and non-stabilized issues following BEW criteria,

1. Calculate NBBO

NBBOs were calculated for each IPO issue on the first day of trading[11] based on the quote information. To minimize the effect of the extreme bid or ask prices, we exclude the quotes that have ask price higher than two times the maximum trade price on that day or bid price lower than 0.5 times the minimum trade price. Quotes with a negative NBBO spread (National Best Offer price (NBO) smaller than National Best Bid (NBB)) are also excluded from the analysis.

2. Distinguish between buyer initiated and seller-initiated trades

Like BEW, we also use the method of Lee and Ready (1991) to infer the trade direction. The only difference is that we do not locate the transaction price relative to the most recently quoted bid and ask prices. Instead, we match each transaction price with the NBBO, which happens at least five seconds earlier than the transaction. Lee and Ready (1991) claim and show that this five-second spread could greatly mitigate the misclassification of the trade direction.

Then the buyer initiated or seller-initiated transaction is identified as follows:

A If a trade price is equal to or closer to the NBB (NBO) price than to NBO (NBB) price, it is recognized as a sell (buy) order.

[11] We calculate the NBBO for all the IPO issues except the ones from Jan. 2000 to March 2001, for which we use WRDs NBBO and trade match tools.

B For trades occurring exactly at the midpoint of the spread, we identified the issues by the tick test (Lee and Ready, 1991), which is based on the classification of the preceding trade.

i. Trades that are preceded by a trade classified as a buy order and executed at a lower price than the previous transaction were classified as sell orders.

ii. Similarly, trades preceded by a trade classified as a sell order and executed at a higher price than the previous transaction were identified as buy orders

iii. If current trade price was equal to the previous transaction price, the current transaction received the same classification as the preceding transaction.

Lee and Ready (1991) state that this tick test achieves 85% accuracy in their sample of NYSE-listed stocks. Unclassified transactions are then thrown out of the sample. We also excluded the transactions that have trade price lower than NBB or higher than NBO to insure the consistency.

3. Distinguish between stabilized and non-stabilized issues

This step begins by defining a " stabilization range." The upper bound of this range is the NBO. The rationale, as BEW indicated, is that the initial stabilizing bid does not exceed the offer price or the bid of the highest independent dealer (Hanley et al (1993)). The lower bound of the stabilization range is first set to be $0.25 below the upper bound. We refer to the difference between the upper and lower bounds as the stabilization interval[12].

After that, we used BEW's criteria to identify the stabilized IPO issues[13]. An issue is classified as a stabilized one if it satisfies:

A. At least 50% of the sell orders on that day were executed at prices less than or equal to the offer price[14].

B. At least 80% of these sell orders were executed within the stabilization range[15].

Once the issues were identified as having been stabilized or not we estimated the fraction of issues that had been stabilized and first two moments of the return distributions so that these could be compared with the parameters obtained from the macro analysis.

5. Inferring Price Support from Macro Information

5.1 Introduction

In order to compare the macro method with the micro method it is necessary to obtain estimates of the relevant parameters from the data and two infer from the results whether individual issues are price supported or not. The following subsections describe the methods used to achieve these ends.

5.2 Estimation of the parameters

[12] To determine sensitivity we used stabilization intervals of $0.125 and $0.50 in addition to the $).25 used by BEW.

[13] BEW use the first five trading day information and identify an issue as price supported if its data satisfied the two criteria for at least three out of five days, while we only use the first day trading information and identify an issue as price supported if it's first day transaction data satisfies the two criteria.

[14] To assess sensitivity we used the alternate value of 0.6 for this criterion.

[15] To assess sensitivity we used the alternate value of 0.9 for this criterion.

Two models that relate macro information to price support have been published. Ruud (1993) presents a model in which “price supported” issues have zero return at the end of the period and “underpriced” issues have a normally distributed return with a positive mean. Asquith, Jones and Kieschnick (1998) (AJK) develop a model in which the return distribution at the end of a period is described as the mixture of two populations, both normally distributed. They identify the population with the lowest expected return as price supported issues and the other with underpricing issues. In this paper we focus on the AJK method.

AJK assume that the IPO initial returns follow a mixture of two normal distributions, i.e.

$$f(r) = \frac{p_S}{\sigma_1\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r-\mu_1}{\sigma_1}\right)^2} + \frac{1-p_S}{\sigma_2\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r-\mu_2}{\sigma_2}\right)^2}$$

Where p_S is the probability that the issue is price supported,
μ_1 is the expected value of the return to price supported issues,
σ_1 is the standard deviation of the return to price supported issues,
μ_2 is the expected value of the return to underpriced issues, and
σ_2 is the standard deviation of the return to underpriced issues.

They then estimate the parameter using the maximum likelihood method. We followed the same procedure to estimate the parameters. Since that the AJK model requires that both the two distributions are Gaussian, the measure of return implemented is important.

Following AJK, the Newton-Raphson algorithm is applied to obtain maximum likelihood estimates. The distribution with the lower mean is identified as corresponding to the “supported” group. The other distribution is then referred as the “non- supported” group. In one year (2001) we found the best fit to include only one population: in this case the model provides no way of determining whether the population refers to “supported” or” not supported” except that the underlying rationale would demand that if the mean is “close to zero” it would refer to the “supported” group.

Once the parameters values, $\hat{p}_S$, $\hat{\mu}_1$, $\hat{\sigma}_1$, $\hat{\mu}_2$, and $\hat{\sigma}_2$, were recovered from the macro data, we used Bayes’ theorem to estimate the probability of price support for any issue given its rate of return for the period.

$$\Pi(r) = p\{\text{price support} \mid r) = \frac{\text{Prob. of price support and } r \text{ given the data}}{\text{Prob. of } r \text{ given the data}}$$

$$= \frac{p(r \mid \hat{\mu}_1, \hat{\sigma}_1)\,\hat{p}_S}{p(r \mid \hat{\mu}_1, \hat{\sigma}_1)\,\hat{p}_S + p(r \mid \hat{\mu}_2, \hat{\sigma}_2)(1-\hat{p}_S)}$$

$$= \frac{\dfrac{\hat{p}_S}{\hat{\sigma}_1} e^{-\frac{1}{2}\left(\frac{r-\hat{\mu}_1}{\hat{\sigma}_1}\right)^2}}{\dfrac{\hat{p}_S}{\hat{\sigma}_1} e^{-\frac{1}{2}\left(\frac{r-\hat{\mu}_1}{\hat{\sigma}_1}\right)^2} + \dfrac{1-\hat{p}_S}{\hat{\sigma}_2} e^{-\frac{1}{2}\left(\frac{r-\hat{\mu}_2}{\hat{\sigma}_2}\right)^2}}$$

This measure can then be used directly to measure the probability that a particular issue is price supported. It can also be used as the basis of a dichotomy to divide IPO issues. IPO issues with $\Pi(r) > \Pi_0$ are considered as price supported and issues with $\Pi(r) \le \Pi_0$ are regarded as not price supported, where Π_0 is the cutting off point of probability to differentiate price support IPOs.

5.3 Determining the best value of the rate of return to dichotomize the data

Based on the AJK model, if we classify all IPO's with a rate of return of $r \le r_C$ as being price supported and those with $r > r_C$ as being underpriced, then the fraction of all IPOs incorrectly classified as supported will be given by:

$$P(\mathrm{U}\,|\,\mathrm{S}) = \int_{-\infty}^{r_C} \frac{p_S}{\sigma_1\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r-\mu_1}{\sigma_1}\right)^2} \mathrm{d}r$$

Similarly, the fraction of all IPOs incorrectly classified as underpriced will be:

$$P(\mathrm{S}\,|\,\mathrm{U}) = \int_{r_C}^{\infty} \frac{1-p_S}{\sigma_2\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r-\mu_2}{\sigma_2}\right)^2} \mathrm{d}r$$

The misclassified IPOs as a fraction of all IPOs will, accordingly, be:

$$P(\mathrm{M}) = \int_{-\infty}^{r_C} \frac{p_S}{\sigma_1\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r-\mu_1}{\sigma_1}\right)^2} \mathrm{d}r + \int_{r_C}^{\infty} \frac{1-p_S}{\sigma_2\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r-\mu_2}{\sigma_2}\right)^2} \mathrm{d}r$$

The value of the rate of return that minimizes the misclassification error is given by:

$$\frac{\mathrm{d}P(\mathrm{M})}{\mathrm{d}r_C} = \frac{p_S}{\sigma_1\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r_C-\mu_1}{\sigma_1}\right)^2} - \frac{1-p_S}{\sigma_2\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r_C-\mu_2}{\sigma_2}\right)^2} = 0$$

Or, equivalently,

$$\frac{p_S}{\sigma_1\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r_C-\mu_1}{\sigma_1}\right)^2} = \frac{1-p_S}{\sigma_2\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{r_C-\mu_2}{\sigma_2}\right)^2}$$

The solution of this quadratic gives the cutting value at which the classification error is minimized if the AJK model is correct. For each data set we used this relation, together with the estimated parameters for that data set, to determine the value at which the data should be dichotomized.

6. Results

6.1 Results of the BEW Method

The results from the micro-analyses are given in Table 2. The probability of the price stabilization (the proportion of the IPO issues being stabilized) is significantly different from either 0 or 1 for individual years and for all years combined. In addition, it appears clear that the frequency of price support changes from year to year. A chi-squared test for homogeneity rejects the hypothesis of constant probability of stabilization at all conventional probability levels (see Panel C of Table 2), confirming the casual observation. The frequency of price stabilization (P) seems to decrease over the period. This is confirmed by an analysis including a linear trend, which yields a negative and significant trend coefficient and a chi-squared for departures from trend that is not significant at the 10 percent level.

(Insert Table 2 here)

Since the micro method identifies specific issues as either stabilized or not, it is a simple matter to obtain estimators of the mean and variance of the stabilized and non-stabilized IPOs in any time interval.

The mean returns for the price-stabilized group (μ_1) are positive except year 1998 and are significantly different from zero only in 1997 and 2000, when the significance levels are 1 and 5 percent, respectively. Regression of the return μ_1 on time (Panel E of Table 2) shows a positive slope but is not significant.

In contrast, the mean returns of non price-stabilized issues (μ_2) are positive are significantly different from zero, both statistically and economically, in all sample periods and for all years combined. The mean return to stabilized issues is significantly different from that to non-stabilized issues from a statistical point of view. The Welch-Satterthwaite t tests based on the logarithmic return and using Bonferroni probability levels are significant at 1% level for all years individually and all years combined. The minimum difference in return to stabilized and non-stabilized IPOs is 1.65% in 1996, so the difference appears to be economically, as well as statistically, significant. The results for the sample excluding Internet companies are consistent with the above observations. Robustness tests based on the linear return or using stabilization intervals of $0.125 and $0.50 lead to the same conclusions and thus are not reported here.

F test also shows that the price stabilized IPOs and the non-price stabilized IPOs have different variance. The P values are all significant at 5% level.

The BEW method is supposed to give a clean separation between issues subject to intervention and those without intervention. Hence it is of interest to determine whether the distributions of returns in the two groups are both normal. We applied the Lilienfors normality test to the two groups for each of the years in our sample period and for all years combined. The results are shown in Table 3. The data shows departures from normality more often than would be indicated by the number of comparisons. This implies that if the hypothesis underlying the AJK method is correct then the BEW method does not provide a clean separation. If, on the other hand, the BEW procedure leads to a clean separation, then the AJK method is based on an assumption that is probably flawed.

(Insert Table 3 here)

6.2 Results of the AJK Method

The analysis is performed based on the data of each individual year and for all the data pooled together. The results are shown in Table 4.

(Insert Table 4 here)

The results suggest that the parameters vary from year to year. The log likelihood test (See Panel C of Table 4) supports the conclusion of two distributions for each year except for year 2001, which fails to reach the significance of 10% level. Akaike's Information Criterion (AIC) leads to the same conclusions.

From Panel B, it is clear that the probability of price support (P) is significantly different from 0 or 1 except for year 2002, in which the probability of price support is not significantly different from 1 at 5% level (but still significant at 10% level). Combined with the log likelihood test, it seems that year 2001 and year 2002 are more likely to have just one distribution. Further analysis provides more supporting evidence. In year 2001, the mean return for the price- supported group is not significantly different from 0 and the variance for price support group and non-price support group are basically the same. For the year 2002, the mean returns for the two groups are not significantly different, supporting the evidence that P is not significantly different from 1. The regression of probability being stabilized on the time trend result in a positive coefficient but it is not significantly different at 10%.

The mean returns of price-supported group obtained by macro method (the distribution with the lower return μ_1) are significantly different from 0 for all years except for year 2001. They are also significantly different from those of the second group (non price-supported group μ_2) except year 2002. Robustness tests based on the linear return show the similar results. The regression of the μ_1 on a time trend results in a positive coefficient, but is not significant.

6.3 Comparison of the Results from the two methods

The results obtained from the two methods can be compared in two main ways. One is to compare the parameters inferred from the analyses; the other is to determine how the two methods would classify individual issues. We discuss these in turn.

Tables 2 and 4 suggest that the parameter values obtained from the BEW and AJK methods differ. In particular, that the probability of price support estimated from AJK is very different from the frequency of price-supported issues as identified by BEW procedure. Table 5 formally tests the differences in parameter estimates using Bonferroni limits. The probability of intervention and the mean returns of the group with intervention obtained from the two procedures are statistically different. The standard deviations of the returns to the group with intervention, as given by the BEW and AJK methodologies, are not statistically different, but those of the group with no intervention are different.

(Insert Table 5 here)

The comparison of parameters suggests that there are large differences between the two methodologies. We now turn to examining the way in which the two methods classify individual issues. For this purpose, we used the results of AJK method to dichotomize the issues, as outlined in Section 4.2. We then cross-classified the issues as having been subject to intervention, or not subject to it according to the two methods of assessment.

Table 6 shows the misclassification errors. Panels A and B display the results for logarithmic rates of return, including and excluding internet issues, respectively. Panels C and D give the corresponding results for linear rates of return. The first column of each panel shows the percent of issues that were misclassified. The second column gives the probability level at which the hypothesis of independence is rejected by a chi-squared test. The third column shows the Pearson coefficient of concordance normalized and signed so the perfect agreement gives a value of one and perfect disagreement gives a value of -1.[16] The fourth column gives the value of the misclassification error that would be expected if the AJK method were used to classify issues whose return characteristic are exactly those assumed in the AJK model.

The results show that the two methods agree fairly closely on what issues are classified as having been subject to intervention, and the errors are not too different than what would be expected if the AJK method were applied to sets of data arising from the AJK model. Thus in spite of the failure of the two methods to identify consistent parameters they seem to be consistent in identifying individual issues as having been subject to intervention.

(Insert table 6 here)

6.4 Robustness of the results

To check the robustness of our results we performed all calculations with both log return and linear return, using a value of 0.6 instead of 0.5 for the first BEW criterion, using 0.9 instead of 0.8 for the second BEW criterion, and for stabilization interval of \$0.125 and \$0.5 instead of \$0.25. Table 7 provides the details. In most cases results are generally consistent, the one exception is that for linear returns and including all issues the results differ dramatically from the others. This may be do to more severe non-

[16] The usual Pearson coefficient of contingency gives values of 1 for both perfect agreement and perfect disagreement. We attached a sign, which was positive is most of the entries were on the main diagonal and negative if the entries on the main diagonal were the minority. In all cases we obtained a positive sign.

normality in this case, since non-normality would interfere with the ability of the macro method to reach valid conclusions.

This difference, however, is the only marked one found in our exploration of the robustness of the results.

7. Conclusions

Literature has documented two competing methodologies of dealing with underwriter intervention in the IPO market. One is proposed by BEW (1998), who identify the price stabilized IPOs based on a microstructure method. The other is implemented by AJK (1998), who estimate the probability of price support from the whole distribution of IPOs initial returns. Our comparison of these methodologies indicates that they differ substantially in terms of the parameter measures developed, even when the BEW critical values are changed over a substantial range. On the other hand, the results show that misclassification errors are approximately of the same magnitude as the error in the AJK methodology by itself, suggesting that they identify a consistent set of issues as having been subject of price intervention.

References

1. Allen, Franklin, and Gerald Faulhaber, 1989, "Signaling by underpricing in the IPO market", *Journal of Financial Economics* 23, 303-323.

2. Asquith, Daniel, Jones Jonathan and Kieschnick, Robert, 1998, Evidence on Price Stabilization and Underpricing in Early IPO returns, *The Journal of Finance* 53, 1759-1772.

3. Baron, David, 1982, A model of the demand of investment banking advising and distribution services for new issues, *Journal of Finance* 37, 955-976.

4. Benveniste, Lawrence M, Busaba, Walid Y and Wilhelm, William J. Jr., 1996, Price stabilization as a bonding mechanism in new equity issues, *Journal of Financial Economics*, 223-255.

5. Benveniste, Lawrence M, Erdal, Sina M. and Wilhelm, William J. Jr., 1998, Who benefit from secondary market price stabilization of IPOs? *Journal of Banking & Finance 22,* 741-767.

6. Benveniste, Lawrence M , and Paul Spindt, 1989, How investment bankers determine the offer price and allocation of new issues, *Journal of Financial Economics 24*, 343-361.

7. Betty, Randolph P and Welch Ivo, 1996, Legal liability and issue expenses in initial public offering, *Journal of Law and Economics*, 39-2, 545-603

8. Brennan, M.J., and J. Franks, 1997 Underpricing, Ownership and Control in Initial Public Offerings of Equity Securities in the U.K., Journal of Financial Economics 45, 391-413.

9. Chowdhry, Bhagwan and Nanda, Vikram, 1996, Stabilization, Syndication and Pricing of IPOs, *The Journal of Financial and Quantitative Analysis,* 31, 25-42.

10. Grinblatt, Mark and Hwang, Chuan Yang, 1989, Signaling and the Pricing of New issues, *Jour of Finance* 44, 394-420.

11. Hanley, W.W., Lee, C.M.C., Seguin, P.J., 1993, Price stabilization in the market for new issues, *Journal of Financial Economics 34*, 177-198.

12. Hanley, Weiss Kathleen, A. Arun Kumar, and Paul, J, Seguin, 1993, Price Stabilization in the Market For New Issues, Journal of Financial Economics 34, 177-198.

13. Hansler, D.A., 1995, Litigation Costs and the Underpricinig of Initial Public Offerings, Managerial and Decision Economics 16, 111-128.

14. Kon, Stanley, 1984, Models of stock returns-A comparison, *Journal of Finance 39*, 147-165.

15. Lee, C.M.C., Ready, M.J., 1991, Inferring trade direction from intraday data, *Journal of Finance* 46, 733-746.

16. Ljungqvist, Alexander, "IPO Underpricing: A Survey" in *Handbook In Corporate Finance: Empirical Corporate Finance*, B. Espen Eckbo, ed., Forthcoming http://ssrn.com/abstract=609422

17. Loughran, T. and Rittger, J. R. , 2002 , Why Don’t Issuers Get Upset About Leaving Money on the Table in IPOs? , Review of Financial Studies, 15, 413-443.

18. Rock, Kevin, 1986, “Why new issues are under priced”, *Journal of Financial Economics* 15, 187-212.

19. Rudd, Judith S., 1993, Underwriter price support and the IPO underpricing puzzle, *Journal of Financial Economics* 34, 135-151

20. Schultz, Paul H. and Mir A Zaman, 1994, Aftermarket Support and Underpricing of Initial Public Offerings, Journal of Financial Economics 35, 199-219.

21. Sopranzetti, Ben J. , Emilio Venezian and Xiaoli Wang, 2005, The Market for new issues: impact of offering price on price support and underpricing, *Journal of Quantitative Finance and Accounting, forthcoming* .

22. Stoughton, N. M., and J. Zechner, 1998, IPO Mechanisms, Monitoring and Ownership Structure, Journal of Financial Economics 49, 45-78.

23. Titic, S.M., 1988, Anatomy of Initial Public Offerings of Common Stock, Journal of Finance 43, 789-822.

24. Welch, Ivo, 1989, “Seasoned offering, imitation costs, and the underpricing of initial public offerings, *Journal of Finance* 44, 421-449.

25. Welch, Ivo, 1992, Sequential Sales, Learning and Cascades, Journal of Finance 47, 695-732.

Table 1 Summary Statistics

Panel A: The Number of IPO Issues for Each Period, 1996-2002

Explanations: The IPO issues were obtained from www.hoover.com. IPOs of real estate investment trusts, close-end funds and IPO issues in the financial industry were excluded from the sample.

Year	1996	1997	1998	1999	2000	2001	2002	Total
Total IPO	144	229	173	311	343	72	60	1332
TAQ missing	21	38	32	43	38	4	0	176
TAQ available	123	191	141	268	305	68	60	1156
Internet IPOs	2	7	12	85	68	1	3	178
Non_internet IPOs	121	184	129	183	237	67	57	978

Panel B: Summary Statistics for IPO Initial Returns, 1996-2002

Explanations: All returns are calculated as continuously compounded, or logarithmic returns. Excess Kurtosis is calculated as a sample kurtosis minus 3 (the value of kurtosis for the standard normal distribution is 0)

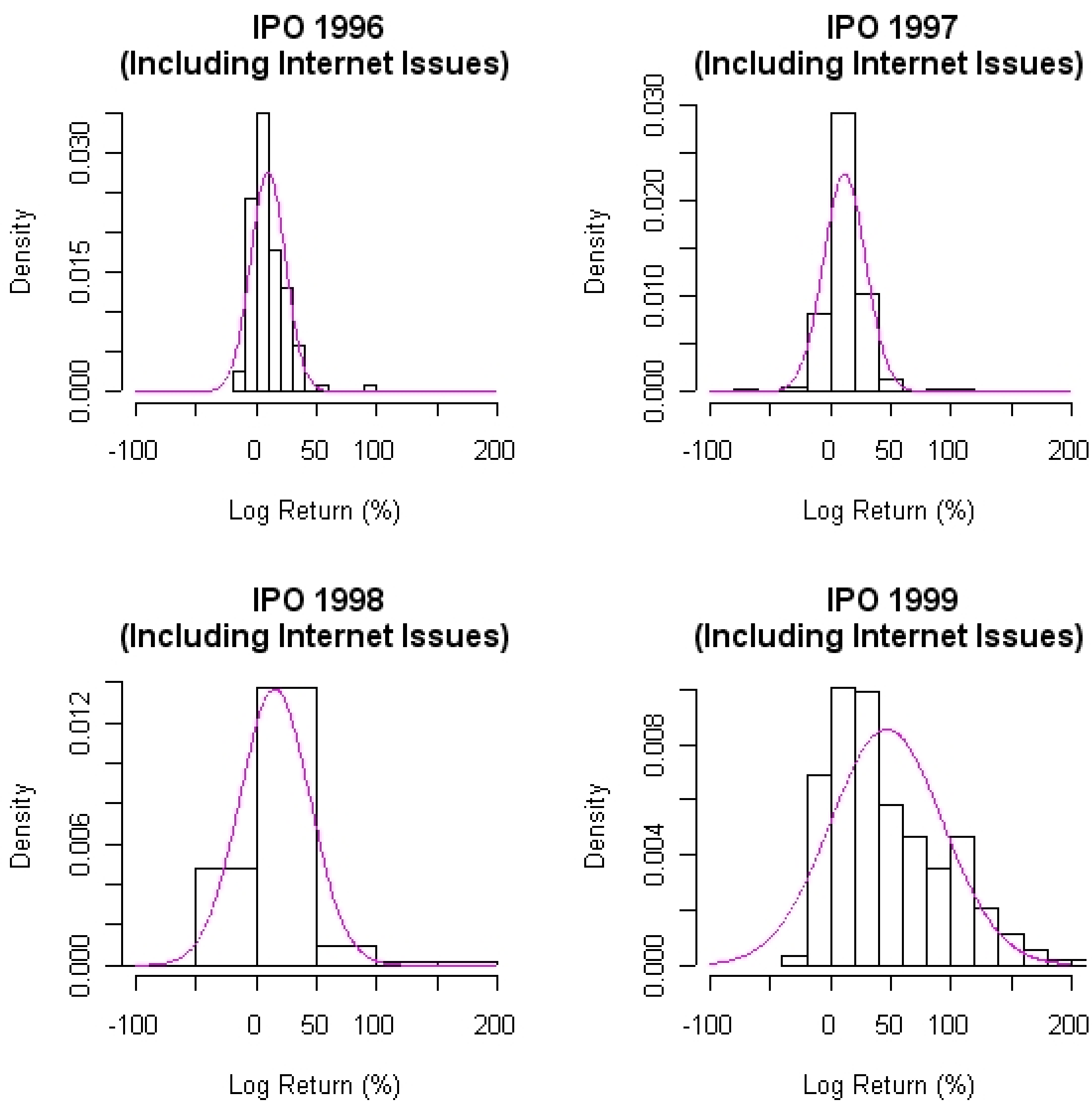
Descriptive Statistics of the First Day IPO return

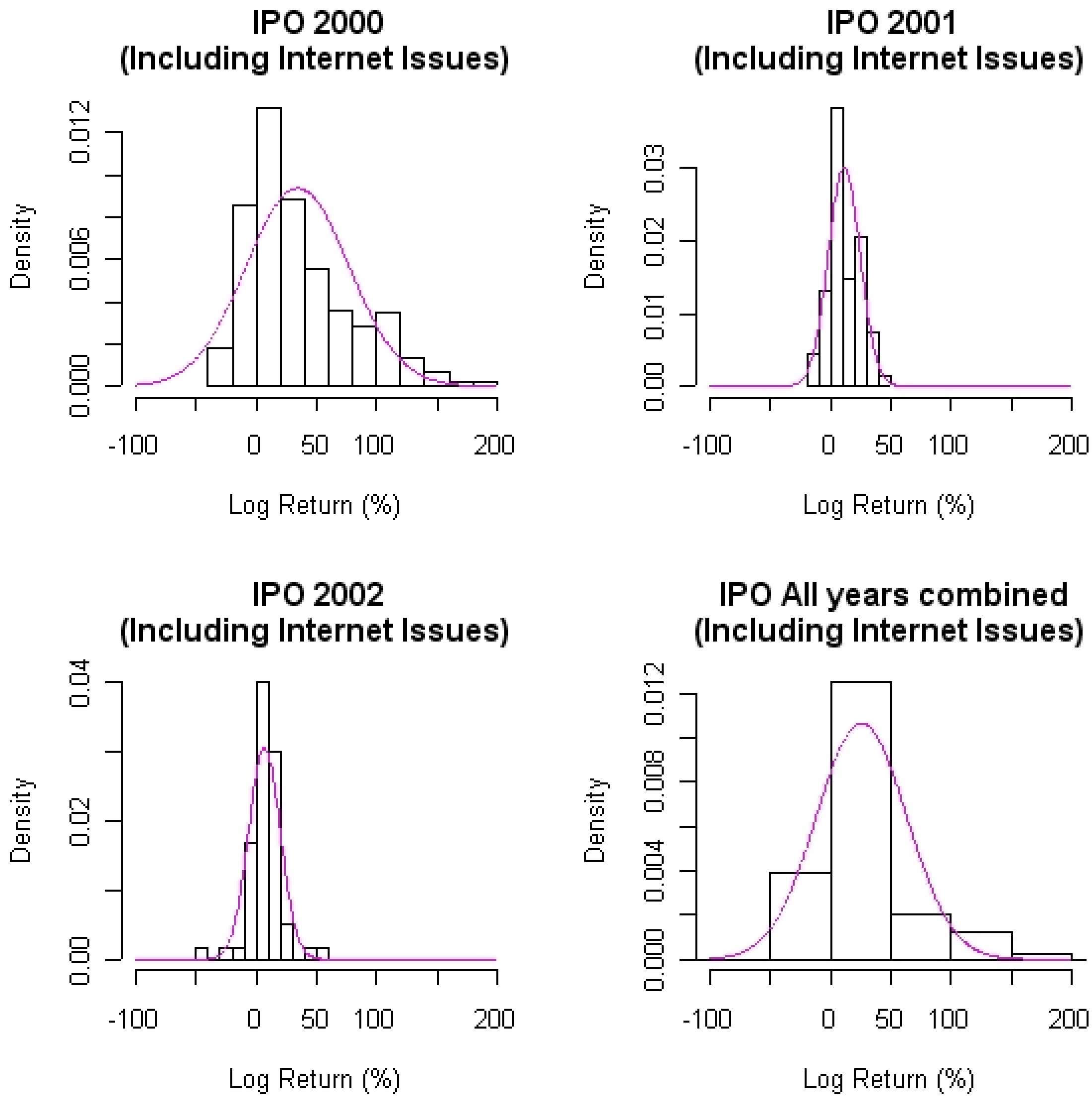
(1) Including Internet Companies								
Period	Obs	Rate of Return						
		Mean	S.D.	Median	Min	Max	Skewness	Excess Kurtosis
1996	123	0.0980	0.1447	0.0682	-0.1823	0.9316	2.0258	8.6045
1997	191	0.1174	0.1755	0.0886	-0.7853	1.1896	1.2412	11.9897
1998	141	0.1555	0.2917	0.1150	-1.6275	1.9538	0.5570	19.6117
1999	268	0.4688	0.4667	0.3507	-0.3378	2.0763	0.8707	0.1149
2000	305	0.3461	0.4262	0.2231	-0.3878	1.8042	0.9761	0.3298
2001	68	0.1146	0.1326	0.0848	-0.1520	0.4527	0.3735	-0.2385
2002	60	0.0682	0.1311	0.0742	-0.4016	0.5108	0.0571	4.3569
All Years	1156	0.2591	0.3747	0.1398	-1.6275	2.0763	1.5432	3.3516
(2) Excluding Internet Companies								
Period	Obs	Rate of Return						
		Mean	S.D.	Median	Min	Max	Skewness	Excess Kurtosis
1996	121	0.0923	0.1238	0.0682	-0.1823	0.5907	0.8596	1.2638
1997	184	0.1160	0.1766	0.0858	-0.7853	1.1896	1.2716	12.1900
1998	129	0.1143	0.2210	0.1001	-1.6275	0.6073	-3.4682	29.5949
1999	183	0.3927	0.4315	0.2803	-0.3378	2.0763	1.1676	1.1309
2000	237	0.3072	0.3892	0.2088	-0.3878	1.6376	1.0330	0.5357
2001	67	0.1151	0.1336	0.0846	-0.1520	0.4527	0.3612	-0.2810
2002	57	0.0698	0.1338	0.0770	-0.4016	0.5108	0.0230	4.1580
All Years	978	0.2082	0.3202	0.1178	-1.6275	2.0763	1.6662	5.4554

Figure 1 Histogram of IPO initial returns over period 1996 to 2002.

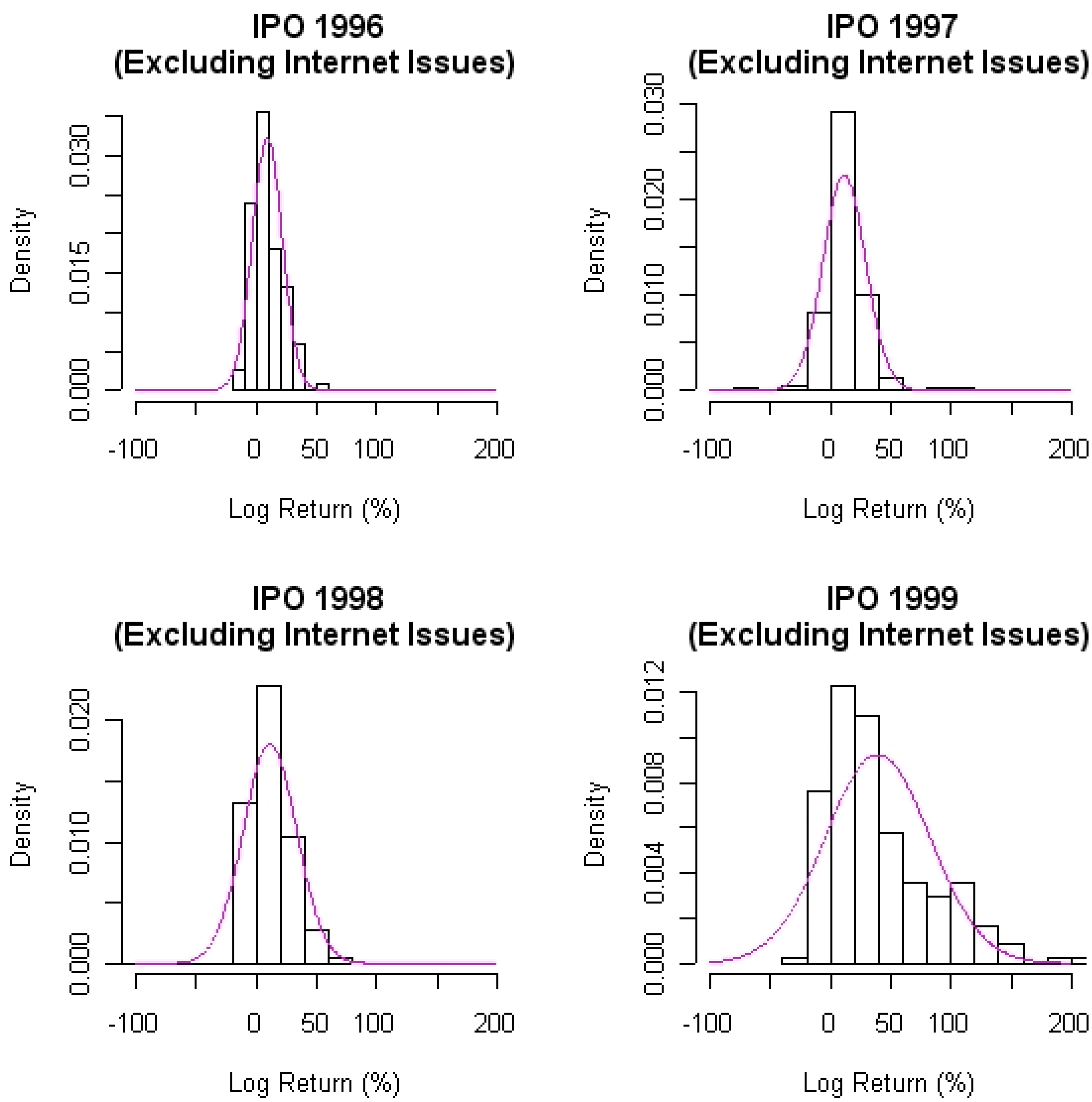
Explanations: These graphs represents histograms of sample returns for the initial IPO returns over period 1996-2002. Superimposed on each histogram is a plot of the normal density function with the sample mean and variance.

Panel A: Including Internet issues




IPO 2000
(Including Internet Issues)
Density
0.000
0.006
0.012
-100
0
50
100
200
Log Return (%)
IPO 2001
(Including Internet Issues)
Density
0.00
0.01
0.02
0.03
-100
0
50
100
200
Log Return (%)
IPO 2002
(Including Internet Issues)
Density
0.00
0.02
0.04
-100
0
50
100
200
Log Return (%)
IPO All years combined
(Including Internet Issues)
Density
0.000
0.004
0.008
0.012
-100
0
50
100
200
Log Return (%)

Panel B: Excluding Internet issues:



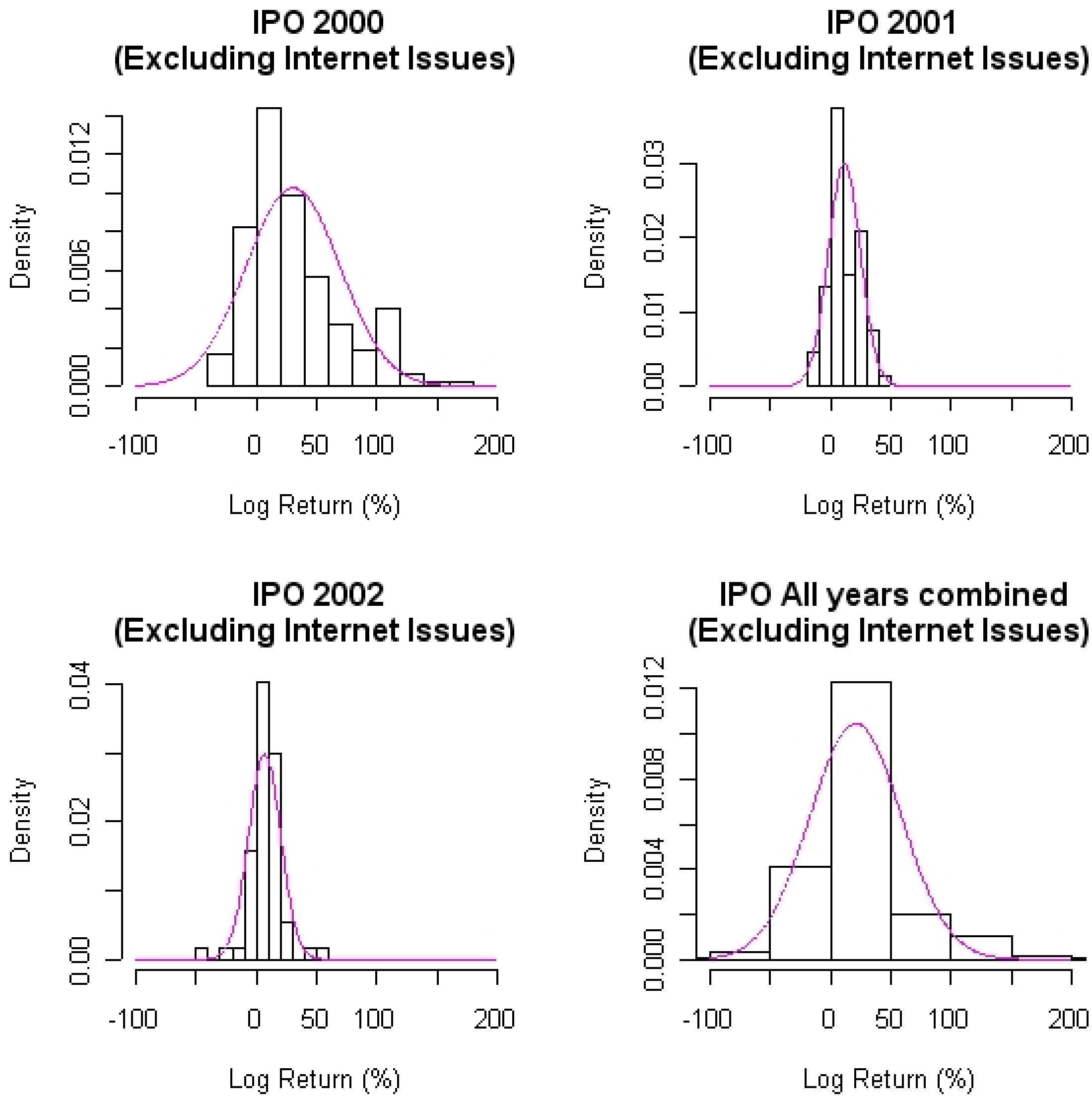

IPO 2000
(Excluding Internet Issues)
Density
0.000
0.006
0.012
-100
0
50
100
200
Log Return (%)
IPO 2001
(Excluding Internet Issues)
Density
0.00
0.01
0.02
0.03
-100
0
50
100
200
Log Return (%)
IPO 2002
(Excluding Internet Issues)
Density
0.00
0.02
0.04
-100
0
50
100
200
Log Return (%)
IPO All years combined
(Excluding Internet Issues)
Density
0.000
0.004
0.008
0.012
-100
0
50
100
200
Log Return (%)

Table 2: Results of the Micro Analysis

Explanation: This table presents the results of the micro analysis based on BEW method.

Panel A: Parameter Estimates

(1) Including Internet issues

	1996	1997	1998	1999	2000	2001	2002	All Years
	0.1309	0.1506	0.128	0.0894	0.0816	0.0461	0.0714	0.1158
P	(0.0244)	(0.0278)	(0.0299)	(0.0182)	(0.0163)	(0.0260)	(0.0344)	(0.01)
	0.0024	0.0067	-0.0117	0.0024	0.0049	0.0018	0.0014	0.0018
μ_1	(0.0055)	(0.0023)	(0.0097)	(0.0022)	(0.0022)	(0.002)	(0.0093)	(0.0019)
	0.0008	0.0001	0.0015	0.0001	0.0001	9.92E-06	3.47E-06	0.0004
σ_1	(0.0064)	(0.0033)	(0.0174)	(0.0023)	(0.0030)	(NA)	(0.0009)	(0.0051)
	0.0722	0.1578	0.2028	0.5607	0.4072	0.1256	0.0786	0.3267
μ_2	(0.0102)	(0.0158)	(0.0303)	(0.0306)	(0.0270)	(0.0170)	(0.0191)	(0.013)
	0.0173	0.0354	0.1001	0.2092	0.1892	0.0179	0.0190	0.1551
σ_2	(0.0184)	(0.0287)	(0.0669)	(0.0216)	(0.0191)	(0.0112)	(0.0228)	(0.0138)
N	123	191	141	268	305	68	60	1156

(2) Excluding Internet issues

	1996	1997	1998	1999	2000	2001	2002	All Years
	0.1359	0.1572	0.1416	0.1296	0.0872	0.0469	0.0755	0.1333
P	(0.0253	(0.0289)	(0.0328)	(0.0264)	(0.0191)	(0.0264)	(0.0363)	(0.0116)
	0.0025	0.0067	-0.0117	0.0023	0.0059	0.0018	0.0014	0.0019
μ_1	(0.0055)	(0.0023)	(0.0097)	(0.002)	(0.0026)	(0.002)	(0.0009)	(0.0020)
	0.0008	0.0001	0.0015	0.0001	0.0001		0.0000	0.0005
σ_1	(0.0064)	(0.0033)	(0.0174)	(0.0024)	(0.0032)	NA	(0.0009)	(0.0053)
	0.0698	0.1581	0.1540	0.5094	0.3653	0.1263	0.0811	0.2719
μ_2	(0.0091)	(0.0165)	(0.0245)	(0.0360)	(0.0283)	(0.0173)	(0.0202)	(0.0125)
	0.0131	0.0363	0.0585	0.1823	0.1594	0.0182	0.0200	0.1167
σ_2	(0.0093)	(0.0298)	(0.0684)	(0.0303)	(0.0207)	(0.0113)	(0.0236)	(0.0157)
N	121	184	129	183	237	67	57	978

Note: NA represents not available and is due to insufficient observations. For example, the standard deviation for σ_1 in 2001 is not available because the number of observations is smaller than 2.

Paned B: Statistical Test Results for the BEW Parameters (include internet companies)

Explanations: The panel gives probability levels at which the hypotheses P=1, or P=0, $\mu_1=0$ and $\mu_2=0$ are rejected. For the test of $\mu_1=\mu_2$, we use t_{test} with Welch Satterthwaite and for the test of $\sigma_1=\sigma_2$, we use F test.

	P=0	P=1	$\mu_1=0$	$\mu_2=0$	$\mu_1=\mu_2$		$\sigma_1=\sigma_2$
(1) Including Internet issues							
					Equal variance	Diff. variance	
1996	<0.0001	<0.0001	0.6594	<0.0001	<0.0001	<0.0001	0.0015
1997	<0.0001	<0.0001	0.0087	<0.0001	<0.0001	<0.0001	<0.0001
1998	<0.0001	<0.0001	0.2474	<0.0001	<0.0001	<0.0001	0.0018
1999	<0.0001	<0.0001	0.2807	<0.0001	<0.0001	<0.0001	<0.0001
2000	<0.0001	<0.0001	0.0340	<0.0001	<0.0001	<0.0001	<0.0001
2001	0.0808	<0.0001	0.4226	<0.0001	<0.0001	<0.0001	NA
2002	0.04254	<0.0001	0.2232	<0.0001	0.00012	<0.0001	0.0033

All years	<0.0001	<0.0001	0.3444	<0.0001	<0.0001	<0.0001	<0.0001
(2) Excluding Internet issues							
					Equal variance	Diff. variance	
1996	<0.0001	<0.0001	0.65943	<0.0001	<0.0001	<0.0001	0.1391
1997	<0.0001	<0.0001	0.0087	<0.0001	<0.0001	<0.0001	<0.0001
1998	<0.0001	<0.0001	0.2474	<0.0001	<0.0001	<0.0001	0.0016
1999	<0.0001	<0.0001	0.3279	<0.0001	<0.0001	<0.0001	<0.0001
2000	<0.0001	<0.0001	0.0331	<0.0001	<0.0001	<0.0001	<0.0001
2001	0.0808	<0.0001	0.4226	<0.0001	<0.0001	<0.0001	NA
2002	0.0424	<0.0001	0.2232	0.0002	0.0002	<0.0001	0.0031
All years	<0.0001	<0.0001	0.3555	<0.0001	<0.0001	<0.0001	<0.0001

Note: NA represents not available and is due to insufficient observations.

Paned C: Homogeneity test for BEW over time

Explanation: the homogeneity test is to test whether this tests to see if the hypothesis of random departures from a common frequency over time is acceptable, Trend test is to test if the hypothesis of no linear time trend in frequency over time is acceptable. The third one is test whether a random departure from a linear trend is acceptable. The test is based on the sample including internet companies. The results for sample excluding internet companies are similar and thus are not reported here.

Chi-squared test for	df	Value	p-level
Homogeneity	6	23.78	5.70E-04
Trend	1	17.76	2.51E-05
Departures from trend	5	6.03	0.3035

Panel D: Regression of p on Time

Explanation: The test is based on the sample including internet companies. The results for sample excluding internet companies are similar and thus are not reported here.

	Coefficients	S.D.	t Stat	P-value
Intercept	31.06433	7.062215	4.3986	0.0070
Beta	-0.01549	0.003533	-4.384	0.0071

Panel E: Regression of μ_1 on Time

Explanation: The test is based on the sample including internet companies. The results for sample excluding internet companies are similar and thus are not reported here.

	Coefficients	S.D.	t Stat	P-value
Intercept	-0.26558	2.463833	-0.107	0.9183
Beta	0.000133	0.001233	0.108	0.9180

Table 3 Lilienfors Normality Test for IPO Return Distributions based on the BEW decision.

Explanation: The table shows the value of the Lilienfors normality statistic and, in parenthesis, the probability level at which the statistic is significant.

Lilienfors Normality Test for Returns

Year	Stabilized Group	Not Stabilized Group
1996	0.1783 (0.05)	0.1546 (0.01)
1997	0.1850 (0.05)	0.1545 (0.01)
1998	0.3509 (0.01)	0.1868 (0.01)
1999	0.0494 (NS)	0.1551 (0.01)
2000	0.1186 (NS)	0.1506 (0.01)
2001	0.3679 (NA)	0.1097 (0.05)
2002	0.1111 (NA)	0.1233 (0.05)
All Years	0.1776 (0.01)	0.1998 (0.01)

Table 4: Results of the Macro Analysis

Explanation: This table presents the results of the macro analysis based on AJK method.

Panel A: Parameter Estimates

(1) Including Internet Issues

	1996	1997	1998	1999	2000	2001	2002	All Years
	0.2515	0.3335	0.9012	0.522	0.6029	0.6028	0.8536	0.6855
P	(0.0551)	(0.0439)	(0.050)	(0.0672)	(0.0748)	(0.1862)	(0.0849)	(0.0247)
	0.0089	0.0191	0.1218	0.143	0.0911	0.0337	0.067	0.0935
μ1	(0.0035)	(0.0033)	(0.017)	(0.024)	(0.0228)	(0.0282)	(0.0117)	(0.0063)
	0.0138	0.02	0.1431	0.1738	0.1776	0.07838	0.0790	0.128
σ1	(0.0173)	(0.0183)	(0.2141)	(0.0781)	(0.095)	(0.05817)	(0.0086)	(0.0376)
	0.1280	0.1666	0.463	0.8242	0.7333	0.2375	0.075	0.6218
μ2	(0.0038)	(0.0026)	(0.0166)	(0.0183)	(0.0181)	(0.0171)	(0.0983)	(0.006)
	0.1553	0.1962	0.7505	0.4231	0.3993	0.0963	0.2809	0.4688
σ2	(0.0116)	(0.0125)	(0.2038)	(0.039)	(0.0443)	(0.032)	(0.0889)	(0.0186)
N	123	191	141	268	305	68	60	1156

(2) Excluding Internet Issues

	1996	1997	1998	1999	2000	2001	2002	All Years
	0.2401	0.7208	0.0094	0.6091	0.7201	0.5872	0.8443	0.7487
P	(0.0544)	(0.0815)	(0.0093)	(0.0802)	(0.1033)	(0.1789)	(0.0900)	(0.0266)
	0.0084	0.0719	-1.6233	0.1445	0.1184	0.0303	0.0690	0.0955
μ1	(0.0097)	(0.0116)	(0.0102)	(0.0256)	(0.0327)	(0.0274)	(0.0128)	(0.0065)
	0.0128	0.0752	0.1798	0.1736	0.1920	0.0774	0.0799	0.1273
σ1	(0.0033)	(0.0457)	(NA)	(0.1054)	(0.1711)	(0.0551)	(0.0986)	(0.0429)
	0.1188	0.2299	0.1300	0.7795	0.7930	0.2356	0.0738	0.5439
μ2	(0.0146)	(0.0104)	(0.0142)	(0.0202)	(0.0220)	(0.0168)	(0.0098)	(0.0061)
	0.1304	0.2801	0.1603	0.4256	0.3412	0.0965	0.2799	0.4570
σ2	(0.0034)	(0.0405)	(0.1796)	(0.0489)	(0.0848)	(0.0310)	(0.0876)	(0.0226)
N	121	184	129	183	237	67	57	978

Note: the number in the parenthesis is standard deviation.

Paned B: Statistical Test Results for the Parameters

Explanations: For hypothesis P=1, or P=0, μ_1=0 and μ_2=0, use one sample student t test. For hypothesis $\mu_1=\mu_2$, use Welch Satterthwaite t_{test}, for the hypothesis of $\sigma_1=\sigma_2$, use F test

	P=0	P=1	$\mu_1=0$	$\mu_2=0$	$\mu_1=\mu_2$	$\sigma_1=\sigma_2$
(1) Including Internet Issues						
1996	<0.0001	<0.0001	0.0118	<0.0001	<0.0001	<0.0001
1997	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
1998	<0.0001	0.0514	<0.0001	<0.0001	<0.0001	0.0419
1999	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0047
2000	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0358
2001	0.002	0.0367	0.2375	<0.0001	<0.0001	0.7883
2002	<0.0001	0.0901	<0.0001	0.4493	0.9363	0.0276
All years	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

(2) Excluding Internet Issues

1996	<0.0001	<0.0001	0.3901	<0.0001	<0.0001	<0.0001
1997	<0.0001	0.0008	<0.0001	<0.0001	<0.0001	0.001
1998	<0.0001	<0.0001	NA	<0.0001	<0.0001	NA
1999	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0315
2000	<0.0001	0.0073	0.00037	<0.0001	<0.0001	0.4356
2001	0.0017	0.0243	0.273	<0.0001	<0.0001	0.7636
2002	<0.0001	0.0894	<0.0001	<0.0001	0.7674	0.1356
All years	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Paned C: Test of Mixture of two normal distribution vs univariate normal distribution

Explanation: The test is based on the sample including internet companies. The results for sample excluding internet companies are similar and thus are not reported here.

1. Likelihood Ratio tests of first day initial return of IPOs (AJK methods mixture of two distributions *versus* univariate normal distribution)
   The reported likelihood ratios are equal to -2 times the natural logarithm of the ratios of the sample likelihood of the univariate normal density to the sample likelihood of the two-component mixture density. The ratio is asymptotically distributed as a Chi-square distribution with 2 degrees of freedom
2. AIC (Akaike's Information Criterion) of first day return (AJK methods)
   AIC=-2 Lnλ -td where Lnλ represents the log-likelihood function value of the distribution model, t represents the number of estimated parameters and d=2 is the Akaike's information criterion

	Log Likelihood Test					**Akaike's Information Criterion**	
	Log of Likelihood ratio	Ch--Square	df	P-value		Two distribution	One distribution
1996	-20.6894	41.37887	2	<0.0001	**1996**	-178.816	-131.437
1997	-44.6017	89.20338	2	<0.0001	**1997**	-222.905	-127.702
1998	-53.2431	106.4862	2	<0.0001	**1998**	-64.7616	47.72455
1999	-40.0655	80.13092	2	<0.0001	**1999**	260.985	347.1159
2000	-48.8322	97.66435	2	<0.0001	**2000**	236.6741	340.3384
2001	-2.19175	4.383502	2	0.111721	**2001**	-97.1448	-86.7613
2002	-9.1469	18.29379	2	<0.0001	**2002**	-102.879	-78.5857
All years	-369.271	738.5427	2	<0.0001	**All years**	261.3948	1005.938

Panel D: Regression of probability of being stabilized on the time trend

Explanation: The test is based on the sample including internet companies. The results for sample excluding internet companies are similar and thus are not reported here.

	Parameter estimates	S.D.	T statistics	P value
Intercept	-145.548	75.83886	-1.919	0.1130
Beta	0.073101	0.037938	1.9268	0.1119

Panel E: Regression of μ_1 on the time trend

Explanation: The test is based on the sample including internet companies. The results for sample excluding internet companies are similar and thus are not reported here.

	Parameter estimates	S.D.	T statistics	P value
Intercept	-12.2759	20.75146	-0.591	0.5799
Beta	0.006176	0.010381	0.5949	0.5778

Table 5 Comparison of the Parameter Estimates Between AJK and BEW

Explanation: The probability levels quoted are based on Bonferroni limits with 40 paired comparisons (5 parameter values and eight time samples) to correct for the effect of testing multiple hypotheses.

Panel A: The magnitude difference of parameter estimates between AJK and BEW

Year	P	S.D.(P)	μ_1	S.D.(μ_1)	σ_1	S.D.(σ_1)	μ_2	S.D.(μ_2)	σ_2	S.D.(σ_2)
1996	0.1206	0.0603	0.0064	0.0066	0.013	0.0184	0.0557	0.0109	0.1380	0.0217
1997	0.1829	0.052	0.01241	0.0041	0.0199	0.0186	0.0088	0.0161	0.1608	0.0313
1998	0.7732	0.05847	0.1334	0.0197	0.1416	0.2148	0.2602	0.0346	0.6504	0.2145
1999	0.4325	0.0696	0.1409	0.0241	0.1737	0.0782	0.2636	0.0356	0.2139	0.0446
2000	0.5213	0.0766	0.0862	0.0229	0.1775	0.0953	0.3261	0.0326	0.2100	0.0483
2001	0.5567	0.188	0.0318	0.0283	0.07837	#N/A	0.1119	0.0241	0.0783	0.0339
2002	0.7822	0.0916	0.0656	0.0118	0.079	0.0087	-0.0036	0.1002	0.2619	0.0918
All Years	0.5697	0.0266	0.0917	0.0066	0.1276	0.0379	0.2951	0.0143	0.3137	0.0231

Panel B: The equality test of parameter estimates between AJK and BEW

	P(AJK)=P(BEW)		μ_1(AJK)= μ_1(BEW)		σ_1(AJK)= σ_1(BEW)		μ_2(AJK)= μ_2(BEW)		σ_2(AJK)= σ_2(BEW)	
Year	t-value	p-level	t-value	p-level	t-value	p-level	t-value	p-level	t-value	p-level
1996	2.001	NS	0.979	NS	0.708	NS	5.109	<0.0001	6.348	<0.0001
1997	3.519	0.01	3.052	0.05	1.068	NS	0.545	NS	5.134	<0.0001
1998	13.224	<0.0001	6.785	<0.0001	0.659	NS	7.529	<0.0001	3.032	0.05
1999	6.215	<0.0001	5.852	<0.0001	2.221	NS	7.402	<0.0001	4.800	<0.0001
2000	6.808	<0.0001	3.761	0.005	1.861	NS	10.016	<0.0001	4.350	0.0005
2001	2.961	0.10	1.126	NS	NS	NS	4.642	0.0001	2.312	NS
2002	8.539	<0.0001	5.577	<0.0001	9.096	<0.0001	-0.036	NS	2.854	0.10
All Years	21.405	<0.0001	13.971	<0.0001	3.365	0.025	20.625	<0.0001	13.567	<0.0001

Note: NS indicates the test is not significant at the ten percent level, NA indicates the data are insufficient to perform the test.

Table 6 Misc-Classification Analysis Between AJK and BEW

An issue is counted as misclassified if the AJK method concludes it is supported (as determined by the cutting point of lowest expected misclassification) and the BEW method concludes it is not stabilized, or *vice versa*. The expected misclassification error for AJK is based on the estimated parameters and the assumptions underlying the AJK method.

Panel A: Log Return (Including Internet Issues)

Year	Percent Misclassified	Probability Given Null Hypothesis Of Independence	Modified Pearson Contingency Coefficient	Probability of Misclassification For AJK Method Alone
1996	26.02	<0.0001	0.6228	21.29
1997	22.51	<0.0001	0.6339	20.18
1998	22.70	<0.0001	0.6304	5.50
1999	13.43	<0.0001	0.6994	11.68
2000	21.31	<0.0001	0.5566	11.78
2001	25.00	0.036	0.4466	39.72
2002	35.00	0.0543	0.4264	12.21
All Years	21.28	<0.0001	0.6114	10.53

Panel B: Log Return (Excluding Internet Issues)

Year	Percent Misclassified	Probability Given Null Hypothesis Of Independence	Modified Pearson Contingency Coefficient	Probability of Misclassification For AJK Method Alone
1996	25.62	<0.0001	0.6295	20.01
1997	22.28	<0.0001	0.6422	15.26
1998	24.03	<0.0001	0.6294	NM
1999	13.11	<0.0001	0.7543	11.50
2000	21.52	<0.0001	0.5598	8.24
2001	23.88	0.0307	0.4602	41.28
2002	33.33	0.0462	0.4480	13.14
All Years	21.78	<0.0001	0.6243	10.09

Note: NM denotes that for the sample period the AJK method failed to separate two distributions so it is not possible to dichotomize the issues into “supported” and “not supported”

Panel C: Linear Return (Including Internet Issues)

Year	Percent Misclassified	Probability Given Null Hypothesis Of Independence	Modified Pearson Contingency Coefficient	Probability of Misclassification For AJK Method Alone
1996	76.42	0.9160	0.1360	0.46
1997	84.82	0.9720	0.1133	9.60
1998	78.72	0.3340	0.2359	3.82

1999	50.75	0.0001	0.4842	9.68
2000	59.67	0.0011	0.3912	8.26
2001	94.12	0.0253	0.0525	71.43
2002	91.67	0.0798	0.0695	8.88
All Years	69.55	<0.0001	0.3362	5.95

Panel D: Linear Return (Excluding Internet Issues)

Year	Percent Misclassified	Probability Given Null Hypothesis Of Independence	Modified Pearson Contingency Coefficient	Probability of Misclassification For AJK Method Alone
1996	25.62	<0.0001	0.8902	19.21
1997	24.46	<0.0001	0.8728	9.51
1998	24.81	<0.0001	0.8783	17.83
1999	13.66	<0.0001	1.0555	8.44
2000	21.94	<0.0001	0.7845	6.90
2001	25.37	0.0383	0.6300	73.02
2002	33.33	0.0462	0.6336	9.42
All Years	22.60	<0.0001	0.8692	9.21

Table 7 Sensitivity Analysis of Misclassification Error

Explanation: This table presents misclassification error of the macro and micro methods when applied to logarithmic and linear returns, including and excluding internet companies, and using a range of parameter values for the BEW method. The parameter values used by BEW are in bold face.

Stabilization interval	0.125	0.125	0.125	0.25	0.25	0.25	0.5	0.5	0.5
BEW first criterion	0.5	0.5	0.6	0.5	0.5	0.6	0.5	0.5	0.6
BEW second criterion	0.8	0.9	0.8	0.8	0.9	0.8	0.8	0.9	0.8
Panel A: Log Return (Including Internet Issues)									
1996	30.08%	30.08%	30.89%	26.02%	27.64%	26.83%	21.95%	23.58%	22.76%
1997	23.56%	24.08%	24.08%	22.51%	23.56%	23.04%	19.37%	19.90%	19.90%
1998	24.82%	24.82%	24.82%	22.70%	23.40%	22.70%	14.89%	17.02%	14.89%
1999	14.18%	14.93%	14.55%	13.43%	14.18%	13.81%	10.45%	10.82%	10.82%
2000	21.31%	21.97%	21.97%	21.31%	21.31%	21.97%	20.33%	20.33%	20.98%
2001	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	23.53%	23.53%	23.53%
2002	35.00%	35.00%	35.00%	35.00%	35.00%	35.00%	31.67%	31.67%	31.67%
All years	22.32%	22.75%	22.75%	21.28%	21.89%	21.71%	18.17%	18.77%	18.60%
Panel B: Log return (Excluding internet Issues)									
1996	29.75%	29.75%	30.58%	25.62%	27.27%	26.45%	22.31%	23.97%	23.14%
1997	23.37%	23.91%	23.91%	22.28%	23.37%	22.83%	19.02%	19.57%	19.57%
1998	26.36%	26.36%	26.36%	24.03%	24.81%	24.03%	15.50%	17.83%	15.50%
1999	14.21%	14.75%	14.75%	13.11%	13.66%	13.66%	10.38%	10.38%	10.93%
2000	21.52%	22.36%	21.94%	21.52%	21.52%	21.94%	20.25%	20.25%	20.68%
2001	23.88%	23.88%	23.88%	23.88%	23.88%	23.88%	22.39%	22.39%	22.39%
2002	33.33%	33.33%	33.33%	33.33%	33.33%	33.33%	29.82%	29.82%	29.82%
All years	23.01%	23.42%	23.42%	21.78%	22.39%	22.19%	18.51%	19.12%	18.92%
Panel C: Linear Return (Including Internet Issues)									
1996	80.49%	80.49%	81.30%	76.42%	78.05%	76.42%	72.36%	73.98%	73.17%
1997	85.86%	86.39%	86.39%	84.82%	85.86%	84.82%	81.68%	82.20%	82.20%
1998	80.85%	80.85%	80.85%	78.72%	79.43%	78.72%	70.92%	73.05%	70.92%
1999	51.49%	52.24%	51.87%	50.75%	51.49%	50.75%	47.76%	48.13%	48.13%
2000	59.67%	60.33%	60.98%	59.67%	59.67%	59.67%	58.69%	58.69%	60.00%
2001	94.12%	94.12%	94.12%	94.12%	94.12%	94.12%	92.65%	92.65%	92.65%
2002	91.67%	91.67%	91.67%	91.67%	91.67%	91.67%	88.33%	88.33%	88.33%
All years	70.59%	71.02%	71.19%	69.55%	70.16%	69.55%	66.44%	67.04%	67.04%
Panel D: Linear Return (Excluding Internet Issues)									
1996	29.75%	29.75%	30.58%	25.62%	27.27%	26.45%	22.31%	23.97%	23.14%
1997	25.54%	26.09%	26.09%	24.46%	25.54%	25.00%	21.20%	21.74%	21.74%
1998	27.13%	27.13%	27.13%	24.81%	25.58%	24.81%	16.28%	18.60%	16.28%
1999	14.75%	15.30%	15.30%	13.66%	14.21%	14.21%	10.93%	10.93%	11.48%
2000	21.94%	22.78%	22.36%	21.94%	21.94%	22.36%	20.68%	20.68%	21.10%
2001	25.37%	25.37%	25.37%	25.37%	25.37%	25.37%	23.88%	23.88%	23.88%
2002	33.33%	33.33%	33.33%	33.33%	33.33%	33.33%	29.82%	29.82%	29.82%
All years	23.82%	24.23%	24.23%	22.60%	23.21%	23.01%	19.33%	19.94%	19.73%