2007

Seasonal Affective Disorder and the Pricing of IPOs

Steven D. Dolvin
Butler University, sdolvin@butler.edu

Mark K. Pyles

Seasonal affective disorder and the pricing of IPOs

Steven D. Dolvin
Butler University, Indianapolis, Illinois, USA, and
Mark K. Pyles
College of Charleston, Charleston, South Carolina, USA

Abstract

Purpose – It has been found that stock market returns vary seasonally with the amount of daylight, and they attribute this effect to seasonal affective disorder (SAD), which is a psychological condition that causes depression and heightened risk aversion during the fall and winter months. The goal of this study is to examine whether this effect also manifests itself in the pricing of initial public offerings (IPOs).

Design/methodology/approach – The authors conduct an empirical analysis on IPO data collected over the period 1986-2000. Specifically, we examine potential pricing differences between IPO that go public during the fall and winter months, relative to other issues. The paper begins by exploring differences on a univariate basis (i.e. testing via *t*-statistics), subsequently extending the analysis by controlling for firm and offer characteristics in a multiple regression framework.

Findings – The paper finds that IPOs experience higher levels of underpricing in both the fall and winter months and that offer price revisions are higher during the winter months. Both of these results are consistent with SAD influencing the IPO pricing process.

Originality/value – The results suggest that behavioral issues (i.e. the emotions of buyers) may have as much of an effect on the pricing of IPOs as more traditional characteristics. Further, the results imply that firms with flexible issuance schedules should avoid going public during months affected by SAD, thereby potentially reducing the cost of issuance.

Keywords Behaviour, Stock markets, Risk analysis, Assets management

Paper type Research paper

1. Introduction

The underpricing of initial public offerings (IPOs), which is defined as the percentage change from the offer price to the closing market price on the first trading day, has garnered increased attention over the last two decades. Particularly during the "internet bubble" period of 1999-2000, these first day returns have been economically and statistically large. For example, specific to this period, underpricing averaged over 65 per cent, which implies that a firm that went public with an offer price of $10 had a first day closing price above $16.50.

Traditional thought suggests that underpricing represents an opportunity cost to the pre-existing owners of the firm. Specifically, underpricing implies that shares are sold at a discount to market value, thereby diluting the worth of pre-existing equity. Given this effect, IPO researchers have primarily focused on finding the determinants of underpricing. Although many studies have identified possible contributing factors, such as information asymmetry (e.g. Rock, 1986), issuer incentives (e.g. Loughran and Ritter, 2004), and issuing mechanisms (e.g. Derrian and Womack, 2003), the results are generally mixed.

We examine underpricing from a somewhat different point of view than most previous studies. Rather than concentrating on firm and issue characteristics, we address the demand side influence of IPO issuance by analysing the potential impact of the emotions of buyers on the pricing of IPOs. Specifically, we examine the possible effects of seasonal affective disorder (SAD), which is a medical condition that causes depression and heightened risk aversion during the fall and winter months when the amount of daylight is the lowest, on the IPO pricing process.

Our approach implicitly assumes a direct connection between investor emotions and issuer pricing. Specifically, we suggest that investors influenced by SAD will be more risk averse and, therefore, less willing to invest. Issuers, recognizing this, will adjust the offer price accordingly, resulting in issues going public at a lower price than during non-SAD months. This reduction, based on the standard definition, will entail higher underpricing. Thus, our basic approach assumes that some characteristics of the offer are dictated, at least in part, by the demands of investors.

We find that underpricing is higher during SAD months (i.e. fall and winter), even after controlling for various firm and issue characteristics. We attribute this result to increased risk aversion, which necessitates lower offer prices during these months. We also find that offer price revisions are higher, particularly during the winter months, which is consistent with added pricing volatility, as well as with an asymmetric effect documented in previous studies. We conclude that these results are consistent with SAD influencing the pricing of IPOs.

The remainder of the paper proceeds as follows: section 2 examines background research on IPO underpricing, section 3 takes a closer look at SAD, section 4 presents our hypotheses, section 5 provides data sources and summary statistics, section 6 presents the results, and Section 7 concludes.

2. IPO underpricing

The amount of underpricing in an IPO directly reflects the difference between the IPO's offering price and the market's determination of the stock's value. Exactly why this phenomenon exists (i.e. why issuers are willing to accept a lower price) has garnered much attention in both academic and professional arenas, particularly given that the level of underpricing is not constant over time or across issuers.

Loughran and Ritter (2004) document that underpricing rose from the mid-1980s through the internet bubble period of 1999-2000. Many potential explanations have been proposed for this trend. For example, Ljungqvist and Wilhelm (2003) study the bubble period of 1999-2000, finding that the large increase in underpricing is associated with changes in ownership structure and insider selling behavior. They contend that reduced CEO ownership and increased share retention by pre-existing shareholders reduces the incentive to control underpricing.

Loughran and Ritter (2004) test the above proposal, which they refer to as the "realignment of incentives" hypothesis; however, they find little empirical support. Loughran and Ritter also examine two additional explanations for the evolution of underpricing. Following Ritter (1984), the "changing risk composition" hypothesis contends that riskier IPOs will be more underpriced than their less risky counterparts. The basic idea is that firms going public in the 1990s were inherently more risky than those in the 1980s, due in part to the emergence of the technology boom. Loughran and Ritter (2004) conclude that, while part of the increase in underpricing can be attributed to a change in the type of firms going public, the effect does not appear to explain the overall change in underpricing over time.

The last hypothesis of Loughran and Ritter (2004) is the "changing issuer objective function" hypothesis, which contends that during the bubble period issuers were less focused on maximizing proceeds due to an increased emphasis on research coverage and other services provided by certain underwriters. Loughran and Ritter (2004) suggest two reasons for this shift:

(1) the increased importance of analyst coverage ("analyst lust" hypothesis);

(2) the co-opting of decision makers through side payments (i.e. "spinning"). Subsequent studies (e.g. Dolvin and Jordan, 2005), however, cast doubt on the overall effectiveness of this explanation.

Another possible explanation for the level of underpricing is given by Derrian and Womack (2003). Using the French stock market, they find that market returns prior to the selection of the offer price have some impact on IPO underpricing. Specifically, they find the auction mechanism used to go public is associated with less underpricing, a result they attribute to the additional information incorporated from recent market conditions.

Also, recent studies, such as Cheng and Firth (2000), Firth (1998), and Jog and McConomy (2003), have examined the degree of information disclosure at the time of issuance. The idea is that little information is available about issuing firms; therefore, the firms have an incentive to disclose information in order to ensure a successful subscription and to receive the offer price they desire. One of the most prevalent of these disclosures is managers' estimates of current year profits. Firth (1998) finds that profit forecasts are critical in an investor's decision to invest in the issue. Cheng and Firth (2000), following Chan *et al.* (1996) and Jaggi (1997), examine the accuracy of these profit forecasts using IPO prospectuses in Hong Kong. Their study reveals that the mean forecast error is positive, indicating that actual profits are higher than forecasts.

Obviously, the above studies are not all inclusive of the potential explanations of IPO underpricing; however, they do exhibit the general nature of the majority of IPO research. Specifically, existing research generally concentrates on firm and issue. We address an alternative explanation to this notion by considering behavioral issues that affect the demand side of the IPO market, specifically focusing on the effect of SAD on the pricing of IPOs.

We are not the first to consider a behavioral explanation to underpricing. For example, Ljungqvist, *et al.* (2004b) model an issuer's optimal response to sentiment investors. Further, Mohan and Chen (2004) take a more direct behavioral approach by examining underpricing in relation to the gender of the leader (i.e. CEO) of the issue and find no evidence of gender bias in IPO pricing. These existing studies, however, do not evaluate investor demand as a possible influence on IPO underpricing; therefore, we feel that our work adds significantly to the area of behavioral IPO research.

3. Seasonal affective disorder

Seasonal affective disorder or SAD is an extensively documented medical condition that has been linked to depression and, in turn, to a decreased willingness to accept risk (i.e. increased risk aversion). According to Rosenthal (1998), approximately 10 million Americans are reportedly afflicted with SAD, with another 15 million suffering from a milder form of "winter blues". In addition, Molin *et al.* (1996) and Young *et al.* (1997) find that seasonal depression is explicitly linked to the number of hours of daylight.

With at least 25 million Americans potentially being affected by SAD, the possibility exists that the stock market, which is driven by the actions of individual investors, may, in turn, be influenced by this disorder. Kamstra *et al.* (2003) investigate the role of SAD in the seasonal time-variation of stock market returns. They find that returns are, in fact, significantly affected by the level of daylight through the fall and winter months.

More specifically, Kamstra *et al.* (2003) find that general market returns are, on average, lower in the fall and winter, but they also find that the effect of SAD is not symmetric. Returns tend to be lowest in the fall months when the amount of daylight is declining, and, although winter returns are generally lower than those in spring or summer, winter returns tend to be higher than those in the fall, which is attributable to a reversal of emotions as days begin to lengthen. In addition, Kamstra *et al.* find that their results are robust to markets across the globe, including different hemispheres.

4. Hypotheses

Given the medical documentation and the empirical results above, we base our hypotheses on the notion that during the fall and winter months (i.e. when the amount of daylight is lowest) investors affected by SAD are more depressed and, therefore, are also more risk averse. As such, investors may be more reluctant to participate in financial markets, or, if they do participate, they may do so with an increased level of skepticism. Issuers tend to react to the perceived demand for the stock and are, therefore, more likely to adjust the pricing accordingly.

4.1 SAD and underpricing

As discussed above, previous studies find that SAD influences overall market returns; however, we hypothesize that this effect may be even more pronounced in a particular segment of the market, i.e. IPOs. Firms going public are typically small and not well-known, and, therefore, they exhibit higher risk than a comparable firm being actively traded in the equity market. Thus, we hypothesize that IPOs taking place during the fall and winter (i.e. SAD) months must be priced differently so as to induce investors to participate in the offering.

To provide this added incentive to invest (i.e. to compensate for the higher degree of risk aversion), issuers would need to reduce offer prices, particularly as compared to similar issues that take place during the spring or summer (i.e. non-SAD) months. Given the definition of underpricing, this lower offer price implies that underpricing should be higher for issues that take place in SAD months[1]. This conjecture is the basis for *H1*, which is formally given as follows:

H1. Increased risk aversion brought on by seasonal affective disorder will necessitate higher underpricing during the fall and winter months when the amount of daylight is lowest.

Following Kamstra *et al.* (2003), we also expect a non-linear response around the winter solstice (i.e. December 21). Prior to the winter solstice (i.e. fall months), the amount of daylight hours is systematically declining, which would cause investors to become more reluctant. Conversely, after the winter solstice (i.e. winter months), the amount of daylight hours becomes systematically longer, and investors should see the "light at the end of the tunnel" as spring approaches. In response, we would expect more interest in participating in offerings and, therefore, less underpricing. However, the underpricing in the winter months should still be greater than in non-SAD months, even with this

reversal in emotions. Formalizing these notions provides the following extension to our first hypothesis:

H1a. Seasonal affective disorder is characterized by an asymmetric effect, which should result in higher underpricing in the fall months relative to the winter months.

4.2 SAD and offer price revisions

When a firm begins the process of going public, they, in conjunction with their underwriter, prepare a preliminary prospectus that contains firm and industry information. Within the prospectus, the issuer also provides an estimate of the offer price, including both a high and low end. The middle of this range, referred to as the original midfile price, is the firm's best estimate of the offering price.

Prior to going public, pricing conditions (including investor emotions) may change, leading to an adjustment, or revision, of the estimated offer price. Within the day or two prior to the offering, issuers declare the final offer price, which may be above, below, or equal to their original estimate. The difference between the original midfile price and the actual offer price is the total price revision, which is also referred to as the price adjustment.

We hypothesize that SAD will affect the level of these offer price revisions. Specifically, as risk aversion increases during the fall and winter months, we expect that increased uncertainty associated with investor emotions will result in larger offer price adjustments. Formally, our second hypothesis is given as follows:

H2. Higher risk aversion associated with seasonal affective disorder increases the pricing uncertainty issuers face. Therefore, offer price revisions will be larger in the fall and winter months.

Further, price revisions are also closely related to the general movements of the stock markets, which previous studies (e.g. Kamstra *et al.*, 2003) find to be affected by SAD. These studies, as discussed above, also find an asymmetric effect during SAD months. Thus, we expect that the increased activity and market volatility that occur after the winter solstice will result in larger offer price adjustments during the winter months as compared to the fall months, which gives us the following extension to our second hypothesis:

H2a. Seasonal affective disorder is characterized by an asymmetric effect, which should result in larger offer price adjustments in the winter months relative to the fall months.

5. Methods

Following Kamstra *et al.* (2003), we define the variable SAD for issue t as:

$$\mathrm{SAD}_t = \begin{cases} H_t - 12 & \text{for trading days in the fall and winter} \\ 0 & \text{otherwise,} \end{cases}$$

where H_t is the time from sunset to sunrise for the specific day of issuance. We deduct 12 (the average number of night hours over the entire year) to obtain a measure (i.e. $H_t - 12$) that reflects the length of night relative to an average day. The specification (i.e. modified binary variable) also addresses the medical evidence that suggests SAD

only occurs during fall and winter months[2]. Based on our definition, we expect SAD_t to be positively related to both underpricing and offer price revisions.

More specifically, to calculate the number of hours of night (i.e. H_t), we use standard approximations for spherical trigonometry, which first requires the sun's declination angle at latitude δ as follows:

$$\lambda_t = 0.4102 \cdot \sin\left(\left(\frac{2\pi}{365}\right)(\text{julian}_t - 80.25)\right) \tag{1}$$

where julian_t is a variable representing the number of the day in the calendar year (i.e. ranging from 1 to 365, or 366 in a leap year). We then calculate H_t as follows:

$$H_t = 24 - 7.72 \cdot \arccos\left[-\tan\left(\frac{2\pi\delta}{360}\right)\tan(\lambda_t)\right] \tag{2}$$

where arcos is the arc cosine. Note that equation (2) is specific to the Northern Hemisphere, and the latitude is proxied using New York City. For more specific details see Kamstra *et al.* (2003) or visit http://www.chass.utoronto.ca/~lkramer/, which is Kramer's website.

Given that we are in the Northern Hemisphere, the total fall and winter period is defined as September 21 to March 20. (We assume the autumnal and spring equinoxes are September 21 and March 21, respectively, although it is possible for the actual date to vary slightly.) As discussed above, previous studies also suggest an asymmetric effect across the fall and winter periods. To address this phenomena, as well as to test our hypotheses, we also create a dummy variable, Fall, that equals one if the issue is offered in the September 21 to December 20 period, zero otherwise. This variable is designed to measure the incremental impact associated with the asymmetric effect of SAD.

6. Data and summary statistics

Our primary data source is Thomson Financial's SDC New Issues database. SDC captures prospectus information on firm commitment IPOs. We also employ the University of Chicago's Center for Research in Security Prices (CRSP) database to provide closing market prices and shares outstanding information on the date of issuance. SDC begins providing several important data items in early 1986; therefore, we begin our sample period January 1, 1986. Also, since there are relatively few issues after the "bubble period" of 1999-2000, we end our sample on December 31, 2000.

We make several corrections to SDC data using information provided by Jay Ritter on a variety of items such as incorrect file ranges and offer type classifications. In addition, we use Loughran and Ritter's (2004) updated underwriter reputation variables (i.e. updates to those originally provided by Carter and Manaster (1990)), firm founding dates, and Internet classification data. Following standard practice, we eliminate closed-end funds, unit issues, American depositary shares, mutual-to-stock conversions, reverse leveraged buyouts, real estate investment trusts, and spin-offs to provide a more homogenous sample. After these eliminations, we are left with a final sample of 4,525 issues, 2,146 of which were issued during the SAD period (1,381 in fall and 765 in winter).

Our hypotheses suggest that SAD will result in higher underpricing (Initial) and larger offer price revisions (Revisions) during the fall and winter months. To address these potential relations, we calculate average values for these variables during the SAD and non-SAD months and report the means, along with p-values from difference tests, in Table I.

	SAD issues (1)	Non-SAD issues (2)	*p*-value
n	2,146	2,379	
Initial	25.94	20.14	0.00
Revision	15.78	14.61	0.03
Proceeds	42.51	43.97	0.62
VC	0.42	0.42	0.94
Age	11.99	11.93	0.91
Integer	0.78	0.75	0.02
HT	0.36	0.37	0.64
Internet	0.09	0.10	0.11
Rank	6.91	6.91	0.97
ShareOver	2.75	2.92	0.01
PartialU	9.47	7.49	0.00
PartialD	−6.31	−7.12	0.01
Bubble	0.16	0.18	0.03

Notes: This table reports descriptive statistics for IPOs from the 1986 to 2000 period. SAD issues are those that went public from September 21 to March 20 in each respective year, and non-SAD issues are all other issues. Columns 1 and 2 report means, and the final column reports *p*-values from difference tests assuming unequal variances. Initial is initial return, or underpricing, in percent defined as the percentage change from the offer price to the closing price on the first trading day. Revision is the absolute value of the percentage change from the original midfile price to the offer price. Proceeds is the gross proceeds of the issue in millions of dollars. VC is a dummy variable equal to one if the issue is backed by a venture capitalist, zero otherwise. Age is the age of the issuing firm in years at the time of the offering. Integer is a dummy variable equal to one if the offer price is an integer, zero otherwise. HT is a dummy variable equal to one if the issue is a high-technology (but non-Internet) firm, zero otherwise. Internet is a dummy variable equal to one if the firm is an Internet firm, zero otherwise. Rank is the quality rank of the lead underwriter as given by Carter and Manaster (1990) and updated by Loughran and Ritter (2004). ShareOver is share overhang, defined as the number of shares retained relative to the total number of shares issued. PartialU is the percentage change from the original midfile price to the offer price if the adjustment is positive, zero otherwise. PartialD is the percentage change from the original midfile price to the offer price if the adjustment is negative, zero otherwise. Bubble is a dummy variable equal to one if the offer takes place in the 1999-2000 period. Data are from the SDC New Issues and CRSP databases

As discussed previously, we define underpricing, or initial return (i.e. Initial), as the percentage change from the offer price to the closing market price on the first trading day. Initial averages 25.94 per cent for SAD issues and 20.14 per cent for non-SAD issues, the difference of which is significantly different at the 1 per cent level. This result is consistent with *H1*.

Next, we address the offer price revision (i.e. Revision), which we define as the absolute value of the percentage change from the original midfile price to the actual offer price. Revision averages 15.78 per cent during SAD months and 14.61 per cent during non-SAD months, and this difference is also significant. This result is consistent with *H2*, and, taken together, these preliminary results suggest that SAD does, in fact, affect the pricing of IPOs.

It is possible that these univariate differences are driven by factors other than SAD. To begin to explore some other potential causes, we also report mean values for some selected firm and offer characteristics in Table I. Although the variables in the table are

representative of those commonly used in IPO research, the list is not intended to be exhaustive. Specifically, we report means and p-values from difference tests for the following:

proceeds, gross proceeds of the issue in millions of dollars;

VC, dummy variable equal to one if the firm is venture capital backed;

age, firm age, measured in years;

integer, dummy variable equal to one if the IPO offer price is an integer;

HT, dummy variable equal to one if the firm is in a "high-tech," but non-Internet-related, industry;

internet, dummy variable equal to one if the firm is Internet-related;

rank, Carter–Manaster (1990) rank of the lead underwriter, as updated by Loughran and Ritter (2004);

shareOver, number of shares retained relative to the total number of shares issued;

partialU, the percentage change (from the original midfile) in the final offer price if the change is positive, zero otherwise;

partialD, the percentage change (from the original midfile) in the final offer price if the change is negative, zero otherwise;

bubble, dummy variable equal to one if the issue takes place in the 1999-2000 period.

Although we primarily concentrate on offer price revisions in total, several studies (e.g. Bradley and Jordan, 2002) find evidence of asymmetric effects associated with upward and downward price adjustments. Therefore, in the descriptive statistics, we include PartialU and PartialD to examine this "partial adjustment" phenomenon.

In general, there does not appear to be any significant difference with respect to many firm or offer characteristics (e.g. size of the offer, venture capital backing, firm age, or industry), which lends additional support to the significant differences in underpricing and offer price revisions discussed above. However, we do find that SAD issues appear to be more likely to be priced on an integer, as well as more likely to retain fewer shares (i.e. lower overhang), although these differences do not appear to be economically significant.

Those issues that take place in SAD months tend to have higher upward adjustments and those with downward adjustments tend to be smaller. This suggests that although SAD issues tend to have greater offer price revisions, it may be specific to those adjusted upward. We address this issue in our robustness tests in a later section.

Lastly, we find that fewer SAD issues take place in the "internet bubble" period, which we define as the years of 1999 and 2000. Given that underpricing (and offer price revisions) is larger in this period (see Loughran and Ritter, 2004), we would, all else equal, expect the average underpricing in non-SAD months to be higher. Thus, our findings above that SAD issues have higher underpricing (and offer price revisions) may actually understate the true significance of the difference.

Our extended hypotheses state that we expect an asymmetric effect within SAD months. Specifically, we expect underpricing to be higher in the fall, but we expect offer

price revisions to be higher in the winter. To address this conjecture, we split SAD issues into those that take place in the fall and those that take place in the winter. We repeat the above univariate analyses and report the results in Table II.

Contrary to our hypothesis, it appears that underpricing is higher in the winter (29.50 per cent) than in the fall (23.96 per cent). However, this result may be driven by other issue characteristics. For example, a greater percentage of IPOs that take place in the winter months are high-technology firms, which generally have higher underpricing. In addition, these winter issues also have larger upward adjustments, which are also typically associated with greater underpricing. We control for these potentially confounding effects in our subsequent multivariate analyses.

Consistent with our expectation, offer price revisions are significantly higher in the winter (17.69 per cent) than in the fall (14.72 per cent). However, as stated just above, issue characteristics may be driving this relation as well. For example, high-technology companies typically have greater price adjustments. Therefore, the larger percentage of high-technology offers in the winter may explain the difference in the absolute level of the price revisions. We examine these possible underlying relations in the next section.

7. Results

Consistent with the effects of SAD, the univariate analyses above suggest that underpricing and price revisions are higher in the fall and winter months; however, the results also indicate that these relations may be associated with underlying issue characteristics such as the industry of the firm or the period of issuance. Thus, we extend our analysis by controlling for firm and offer characteristics in a multiple regression framework. Therefore, we estimate the parameters of the following model:

	Fall issues (1)	Winter issues (2)	*p*-value
n	1,381	765	
Initial	23.96	29.50	0.03
Revision	14.72	17.69	0.00
Proceeds	42.81	41.95	0.80
VC	0.41	0.45	0.06
Age	12.38	11.30	0.15
Integer	0.77	0.78	0.55
HT	0.35	0.40	0.03
Internet	0.09	0.10	0.34
Rank	6.96	6.82	0.19
ShareOver	2.75	2.74	0.99
PartialU	8.03	12.09	0.00
PartialD	−6.70	−5.61	0.02
Bubble	0.15	0.16	0.60

Notes: This table reports descriptive statistics for IPOs issued in the fall and winter. Fall issues are firms that went public from September 21 to December 20 (i.e. fall) in each respective year. Winter issues are those firms that went public in the winter (i.e. December 21 to March 20). Columns 1 and 2 report means, and the final column reports *t*-statistics from difference tests assuming unequal variances. All other variables are defined in Table I. Data are from the SDC New Issues and CRSP databases for the 1986-2000 period

$$\text{Dep} = \alpha + \beta_1\text{SAD} + \beta_2\text{Fall} + \beta_3\text{LnProceeds} + \beta_4\text{VC} + \beta_5\text{LnAge} + \beta_6\text{Integer} + \beta_7\text{HT} + \beta_8\text{Internet} + \beta_9\text{Rank} + \beta_{10}\text{NasLag} + \beta_{11}\text{Bubble} + \varepsilon_i \quad (3)$$

where Dep is the dependent variable and is either underpricing (i.e. Initial) or the offer price revision (i.e. Revision), LnProceeds is the natural logarithm of the proceeds amount in millions of dollars, LnAge is the natural logarithm of one plus the age of the issuing firm in years, NasLag is the cumulative return on the Nasdaq composite index for the 15 trading days prior to the issue, and all other variables are as previously defined.

The variables SAD and Fall are designed to test our stated hypotheses. Specifically, we expect a positive relation between SAD and both underpricing and offer price revisions. Based on previous studies that find an asymmetric effect associated with SAD, we expect that Fall, which is an incremental effect, will be positively related to underpricing, but negatively related to offer price revisions[3]. The other independent variables serve as controls or have previously been found to be related to IPO pricing.

LnProceeds is a common conditioning variable. Early research (e.g. Megginson and Weiss, 1991) finds that issues with venture capital-backing experience lower underpricing, which is attributed to a certification effect. However, more recent research (e.g. Loughran and Ritter, 2004) suggests that venture capital-backing has no significant effect over the time period we study. To control for potential influences related to venture capital backing, we include the VC dummy variable. The age of the firm may, to some degree, reflect the risk of the offering; therefore, we include LnAge.

Bradley *et al.* (2004) find that issues priced on an integer exhibit greater underpricing, which they attribute to uncertainty surrounding the issue, as well as lack of time available to negotiate an offer price. We include the variable Integer to control for this phenomenon. High-technology firms, and especially Internet firms, generally have greater underpricing, particularly during the bubble period of the late 1990s; therefore, we include the dummy variables HT and Internet.

We include the underwriter reputation variable, Rank, as Dolvin (2005) finds that underwriter certification has a significant effect on IPO pricing, particularly after the level of share retention is controlled for. Without the control for share retention, other studies find an insignificant relation between underwriter prestige and underpricing. The lag variable NasLag proxies for investment sentiment and the existence of a "hot" IPO market. We include Bubble to control for the abnormal levels of underpricing that occurred in the 1999-2000 period.

We report the results of this analysis in Table III (i.e. Initial) and Table IV (i.e. Revision). In each table we provide estimates from two specifications. Each model includes all of the control variables; however, the difference occurs in which seasonal variables are included. The first regression in each table includes only SAD, which tests the general hypotheses that SAD affects IPO pricing. The second regression includes both seasonal variables, which is designed to test for the existence of an asymmetric effect.

We begin by examining the underpricing regression in Table III. The signs of the coefficients on the control variable are generally consistent with previous studies. For example, issues that are larger, venture capital backed, priced on an integer, high-technology or Internet-related, and/or issued in hot markets have higher underpricing. Firms that are younger have lower underpricing, and underwriter reputation is insignificantly related.

	Coefficient (1)	*p*-values	Coefficient (2)	*p*-values
Intercept	−5.57	0.05	−5.62	0.04
SAD	2.11	0.00	1.92	0.01
Fall			0.70	0.72
LnProceeds	3.54	0.00	3.53	0.00
VC	3.80	0.01	3.80	0.01
LnAge	−1.48	0.02	−1.47	0.03
Integer	5.87	0.00	5.87	0.00
HT	8.76	0.00	8.77	0.00
Internet	35.23	0.00	35.23	0.00
Rank	−0.12	0.75	−0.12	0.74
NasLag	1.54	0.00	1.55	0.00
Bubble	27.91	0.00	27.92	0.00
N	4,319		4,319	
Adjacent R^2	0.2695		0.2694	

Notes: This table presents regression results from the estimation of the following model:

$$\text{Initial} = \alpha + \beta_1\text{SAD} + \beta_2\text{Fall} + \beta_3\text{LnProceeds} + \beta_4\text{VC} + \beta_5\text{LnAge} + \beta_6\text{Integer} + \beta_7\text{HT} + \beta_8\text{Internet} + \beta_9\text{Rank} + \beta_{10}\text{NasLag} + \beta_{11}\text{Bubble} + \varepsilon_i$$

where the dependent variable is underpricing (Initial, defined as the percentage change from the offer price to the closing price on the first day of trading). SAD is calculated as $(H-12)$ during fall and winter, zero otherwise, where H is the number of hours of night for the given day of issuance. Fall is a dummy variable equal to one if the issue went public in the fall (i.e. September 21 to December 20). LnProceeds is the natural logarithm of the proceeds amount in millions of dollars. LnAge is the natural logarithm of one plus the age of the firm in years. Naslag is the cumulative return on the Nasdaq composite index for the 15 trading days prior to the issue. All other variables are defined in Table I. Data are from the SDC New Issues and CRSP databases for the 1986-2000 period

We next turn our attention to our primary variables of interest, i.e. SAD and Fall. When included individually SAD is positively related to underpricing, which, consistent with our first hypothesis, suggests that SAD results in higher underpricing, even after controlling for various firm and offer characteristics[4]. When included together, SAD remains positive and significant; however, Fall is insignificant. Consistent with the first regression, these results suggest that underpricing is higher in SAD months, but, in contrast to previous studies, we find that there is no asymmetric effect. Therefore, we find support for our first hypothesis, but not its extension[5].

We next examine the offer price revision regressions in Table IV. Similar to above, the control variables are in line with previous studies. For example, more volatile issues (i.e. high-technology or integer priced) and those offered in more volatile markets (i.e. higher NasLag or in the "bubble") have larger adjustments. Consistent with higher quality underwriters and venture capitalists generating more information in the issuance process, each is associated with larger offer price revisions.

Of interest to this study, we find that SAD is positively related to offer price revisions, which is consistent with our second hypothesis. Specifically, this result suggests that the uncertainty associated with going public during periods where investors are influenced by SAD forces issuers to make larger adjustments to offer

	Coefficient (1)	p-value	Coefficient (2)	p-value
Intercept	1.44	0.21	1.59	0.17
SAD	'0.70	0.01	1.22	0.00
Fall			−1.91	0.01
LnProceeds	1.14	0.00	1.16	0.00
VC	4.13	0.00	4.11	0.00
LnAge	−0.34	0.21	−0.37	0.18
Integer	1.92	0.00	1.91	0.00
HT	1.92	0.00	1.91	0.00
Internet	9.13	0.00	9.13	0.00
Rank	0.59	0.00	0.60	0.00
NasLag	0.30	0.00	0.28	0.00
Bubble	6.32	0.00	6.31	0.00
N	4,276		4,276	
Adjacent R^2	0.1594		0.1606	

Notes: This table presents regression results from the estimation of the following model:

$$\text{Revision} = \alpha + \beta_1\text{SAD} + \beta_2\text{Fall} + \beta_3\text{LnProceeds} + \beta_4\text{VC} + \beta_5\text{LnAge} + \beta_6\text{Integer} + \beta_7\text{HT} + \beta_8\text{Internet} + \beta_9\text{Rank} + \beta_{10}\text{NasLag} + \beta_{11}\text{Bubble} + \varepsilon_i$$

where the dependent variable is the absolute value of the offer price revision (Revision, defined as the absolute value of the percentage change from the original midfile price to the offer price). All other variables are defined in Tables I and III. Data are from the SDC New Issues and CRSP databases for the 1986-2000 period

prices. Although the effects of SAD are obviously not the sole possible determinant for price revisions, our results do suggest that it is one of the contributing factors.

We also hypothesize that the effect of SAD is stronger in the winter than in the fall, which may be driven by the reversal in emotions that occur after the winter solstice. This implies that we expect a negative and significant coefficient on the variable Fall. The results of regression 2 in Table IV are consistent with our expectations. Specifically, SAD remains positive and significant, but the variable Fall is negative and significant.

In unreported results we examine the regression by including the variable Fall, but not the variable SAD. We find that Fall is insignificantly related to offer price revisions. Thus, the effect of SAD on IPO offer price revisions appears to be concentrated in the winter months when investors begin to get more actively involved and when the market as a whole begins to turn. We also re-examine the data excluding non-SAD offers to more closely examine differences between Fall and Winter pricing and find the results are qualitatively similar to those reported.

As a robustness check, we repeat the offer price revision regressions using either PartialU or PartialD as the dependent variable. This analysis accounts for the possibility that the direction of revision, as well as the level, is important. We find that the reported results are consistent with those found when regressing on PartialU. However, when regressing on PartialD, we do not find any significant effects associated with the primary variables of interest. As discussed earlier, this result is consistent with the general movement of the stock market following the winter solstice. As the stock market increases, revisions are likely to move in the same direction.

8. Summary

SAD is a medically documented condition that causes depression and heightened risk aversion. Consistent with the influence of SAD on individual investors, previous studies find stock market returns are lower in the fall and winter. These studies also find that there is an asymmetric relation associated with SAD, in that the effects appear to be more pronounced in the fall than in the winter.

IPOs represent an interesting segment of the market in which to evaluate the effects of SAD. Specifically, firms going public are generally more risky than their actively traded counterparts; therefore, the increase in risk aversion should be especially pronounced. Thus, we hypothesize that SAD will affect the pricing of IPOs.

We conjecture that issuers going public in the fall and winter must reduce offer prices and, therefore, increase underpricing to induce investment (i.e. offset the higher degree of risk aversion and lower demand by investors). We control for firm and issue characteristics and find that this relation exists. We also conjecture that there will be an asymmetric effect around the winter solstice; however, we find no evidence of this.

We also hypothesize that the increased risk aversion increases the uncertainty that issuers face in coming to market; thus, we expect that SAD will also result in increased offer price revisions, particularly during the winter months when investor emotions begin to revert to more positive levels. We find evidence consistent with these expectations.

Previous studies primarily concentrate on firm and issue characteristics as the drivers of variation in underpricing; however, many of the proposed explanations have only mixed results. We take a somewhat different approach, focusing on the effect of investor demand on the selection of offer prices. Our results suggest that behavioral issues (i.e. the emotions of buyers) may have as much of an effect on the pricing of IPOs as more traditional characteristics.

Notes

1. Our hypothesis implicitly assumes a degree of irrationality in the market. An alternative notion is issuers, recognizing this irrational lack of demand by investors, would withhold IPO offerings in the fall and winter. However, this biases away from our expectations; therefore, if we find evidence consistent with our hypotheses, our case is made stronger. Also, if the issuing firm is in need of financing, it may not be plausible to put off the offering, and if issuers are unaware of the bias, no behavioral change would occur. We thank an anonymous referee for making this point.
2. For completeness, we examine an alternative specification for SAD, where SAD = (H_t-12) for the entire year rather than just during the fall and winter. The results are qualitatively unchanged.
3. We also examine a specification where we use a dummy variable for Winter; however, the results are qualitatively similar to those reported.
4. It is possible that SAD would only affect investors, resulting in lower market prices. However, this would suggest lower underpricing, all else equal. Thus, our findings suggest that the effect of SAD is primarily revealed in the selection of offer prices.
5. A natural question associated with this finding is whether the effect is big enough to make an abnormal profit. To examine this, we study the association between SAD and IPO long-run returns. We find a positive relation between SAD and five-year buy-and-hold market adjusted returns, indicating that issues going public during the fall and winter months outperform those issuing in the spring and summer. This goes against conventional thinking that high levels of underpricing leads to price reversion and lower long-run returns. However, it is in-line with our hypotheses in that if offer prices are

lower due to investors' reluctance, then the long-run returns should be higher as investors gradually become more optimistic and stock prices rebound. We thank an anonymous referee for suggesting this relation.

References

Bradley, D. and Jordan, B. (2002), "Partial adjustment to public information", *Journal of Financial and Quantitative Analysis*, Vol. 37, pp. 595-616.

Bradley, D., Cooney, J., Jordan, B. and Singh, A. (2004), "Negotiation and the IPO offer price: a comparison of integer versus non-integer IPOs", *Journal of Financial and Quantitative Analysis*, Vol. 39, pp. 517-40.

Carter, R. and Manaster, S. (1990), "Initial public offerings and underwriter reputation", *Journal of Finance*, Vol. 45, pp. 1045-67.

Chan, A.M.Y., Sit, C.L.K., Tong, M.M.L., Wong, D.C.K. and Chan, R.W.Y. (1996), "Possible factors of the accuracy of prospectus earnings forecasts in Hong Kong", *The International Journal of Accounting*, Vol. 31, pp. 381-98.

Cheng, T. and Firth, M. (2000), "An empirical analysis of the bias and rationality of profit forecasts published in new issue prospectuses", *Journal of Business Finance and Accounting*, Vol. 27, pp. 423-46.

Derrian, F. and Womack, K. (2003), "Auctions vs. bookbuilding and the control of underpricing in hot IPO markets", *The Review of Financial Studies*, Vol. 16, pp. 31-61.

Dolvin, S. (2005), "Market structure, changing incentives and underwriter certification", *Journal of Financial Research*, Vol. 28, pp. 403-19.

Dolvin, S. and Jordan, B. (2005), "Overhang and the cost of going public: why IPO underpricing changes over time", working paper.

Firth, M. (1998), "IPO forecasts and their role in signaling firm value and explaining post-listing returns", *Applied Financial Economics*, Vol. 8, pp. 29-39.

Jaggi, B. (1997), "Accuracy of forecast information disclosed in the IPO prospectuses of Hong Kong companies", *The International Journal of Accounting*, Vol. 32, pp. 301-19.

Jog, V. and McConomy, B. (2003), "Voluntary disclosure of management earnings forecasts in IPO prospectuses", *Journal of Business Finance and Accounting*, Vol. 30, pp. 125-67.

Kamstra, M., Kramer, L. and Levi, M. (2003), "Winter blues: seasonal affective disorder [SAD] and stock market returns", *American Economic Review*, Vol. 93, pp. 324-43.

Loughran, T. and Ritter, J. (2004), "Why has underpricing increased over time?", *Financial Management*, Vol. 33, pp. 5-37.

Ljungqvist, A., Nanda, V. and Singh, R. (2006), "Hot markets, investor sentiment, and IPO pricing", *Journal of Business*, Vol. 79.

Ljungqvist, A. and Wilhelm, W. (2003), "IPO pricing in the dot-com bubble", *Journal of Finance*, Vol. 58, pp. 723-52.

Megginson, W. and Weiss, K. (1991), "Venture capitalist certification in initial public offerings", *Journal of Finance*, Vol. 46, pp. 879-903.

Mohan, N. and Chen, C. (2004), "Are IPOs priced differently based upon gender", *Journal of Behavioral Finance*, Vol. 5, pp. 57-65.

Molin, J., Mellerup, E., Bolwig, T., Scheike, T. and Dam, H. (1996), "The influence of climate on development of winter depression", *Journal of Affective Disorders*, Vol. 37, pp. 151-55.

Ritter, J. (1984), "The "Hot Issue" market of 1980", *Journal of Business*, Vol. 57, pp. 215-40.

Rock, K. (1986), "Why new issues are underpriced", *Journal of Financial Economics*, Vol. 15, pp. 187-212.

Rosenthal, N. (1998), *Winter Blues: Seasonal Affective Disorder: What It Is, and How to Overcome It*, 2nd ed., Gilford Press, New York, NY.

Young, M.A., Meaden, P., Fogg, L., Cherin, E. and Eastman, C. (1997), "Which environmental variables are related to the onset of seasonal affective disorder?", *Journal of Abnormal Psychology*, Vol. 106, pp. 554-62.