Option Introductions and the Skewness of Stock Returns

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The decision to introduce options for stocks is made by exchanges with the intention of selecting stocks that will generate the most option trading activity. This study hypothesizes that exchanges will introduce options for stocks with positive skewness. The motivation for our tests is based on the idea that some investors have preferences for skewness and the payoff structure of options is conducive to these types of preferences. Results show that the likelihood of introducing options is increasing in the level of return skewness. We also find that stocks with the most pre-introduction skewness generate the most post-listing option volume. © 2017 Wiley Periodicals, Inc. Jrl Fut Mark 37:892–912, 2017

1. INTRODUCTION

In contrast to the exchange-listing decision, which is made at the firm level, the decision to introduce options is made at the exchange level. In theory, exchanges will choose to introduce options for stocks that generate the most option trading volume in order to maximize long-term profits of the exchange (Mayhew & Mihov, 2004). Various factors have been shown to influence this decision to introduce options for a specific security. For example, Mayhew and Mihov (2004) find that trading volume, volatility, and market capitalization are related to the decision. Additionally, Danielsen, Van Ness, and Warr (2007) find that liquidity improvements increase the probability of option introductions. In this study, we attempt to extend this growing body of research by identifying additional characteristics that motivate exchanges to initiate options for stocks.

The tests in this study are important for at least two reasons. First, a general understanding of the dynamics of options markets is important as the development of options markets has increased both in the United States and globally. For instance, in 1974, 5.7 million U.S. equity option contracts were traded. In 2015, approximately 3.73 billion equity and 416 million non-equity contracts were traded in the United States.[1] While the growth in option trading volume has dramatically increased over the last

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40 years, we have also seen growth in the number of exchanges that list options. Mayhew and Mihov (2004) report that, at the time of their research, five exchanges listed options. As of 2015, that number has grown to 13. The growth and development of derivative markets is not isolated to the United States. In fact, in the last 20 years, these types of markets have also expanded to places such as Greece, Hungary, India, Israel, Korea, Malaysia, and Mexico.

The second reason that our tests are important is based on a theoretical debate that has spanned more than three decades. Theory in Stein (1987) suggests that introducing options, and the subsequent speculation into financial markets, can lead to destabilized stock prices under certain conditions. Similar conclusions about the adverse effects of speculative trading are reached in Hart and Kreps (1986). In contrast, Ross (1976) argues that introducing options can increase the opportunity sets of investors, resulting in greater risk-sharing in markets.[2] In addition to greater risk-sharing opportunities, Black (1975), Biais and Hillion (1994), Easley, O'Hara, and Srinivas (1998), and Faff and Hillier (2005) illustrate how option markets provide an important venue for informed traders. Figlewski and Webb (1993), Danielsen and Sorescu (2001), and Johnson and So (2012) argue that introducing options might mitigate short-sale constraints and allow informed investors who might be otherwise constrained to synthetically short stocks by using some combination of options. Given the breadth of research that shows that short-sale constraints lead to inefficient stock prices (Bris, Goetzmann, & Zhu, 2007; Chang, Cheng, & Yu, 2007; Diamond & Verrecchia, 1987; Miller, 1977; Ross, 1976 among others), any relaxation of short-sale constraints should improve the quality of financial markets. Therefore, to the extent that the introduction of options improves the informational efficiency of underlying stock prices, identifying stocks that are likely candidates for option listing becomes important.

In this study, we develop and test the hypothesis that exchanges will choose to introduce options for stocks with return distributions that are positively skewed. If exchanges strategically introduce options for stocks that will generate the most option trading activity, then why might the skewness of the return distribution influence this decision? The answer to this question is based on a growing body of literature that shows that investors have strong preferences for positive skewness. For instance, Barberis and Huang (2008) show that investors tend to overweight the tails of return distributions, which leads to preferences for positive skewness that can impact asset prices. Empirically, Mitton and Vorkink (2007) find that some investors intentionally underdiversify their portfolios and sacrifice mean-variance efficiency in order to attain higher portfolio skewness. Additionally, other studies show that preferences for positive skewness and/or other lottery characteristics leads to price premiums and subsequent underperformance (Bali, Caciki, & Whitelaw, 2011; Boyer, Mitton, & Vorkink, 2010; Boyer & Vorkink, 2014; Kumar, 2009; Kumar & Page, 2014; Kumar, Page, & Spalt, 2011; Zhang, 2005).

We propose that while investors tend to have preferences for stocks with positive skewness, these preferences can lead investors to trade in the options market. The implicit leverage and the nonlinear payoff structures (i.e., the limited downside risk and the unlimited

[2]Although the literature that conducts a variety of event studies surrounding option introductions finds that stock returns (share prices) increase (decrease) surrounding the introduction of options (Branch & Finnerty, 1981; Conrad, 1989; Danielsen & Sorescu, 2001; Detemple & Jorion, 1990), another group of studies examines the variance of returns surrounding option introductions. These studies generally show that the introduction of options decreases the volatility of stock prices (Bansal et al., 1989; Damadoran & Lim, 1991; Skinner, 1989; Trennepohl & Dukes, 1979). In our some of our tests, we examine the skewness of returns surrounding the option introduction and can indirectly contribute to this line of research by showing whether the option introduction affects the skewness of returns.

upside potential) found in option contracts provide features that might be popular among investors with penchants for positive skewness. For instance, a call option on a stock with a small probability of observing an extremely large return has the possibility to be extremely profitable while limiting potential losses. This idea is consistent with the contention in Stein (1987), who suggests that the presence of options will induce greater speculative trading activity. Consistent with this argument, Blau, Bowles, and Whitby (2016) show that stocks with equity return distributions that are the most positively skewed exhibit the greatest amount of call-option trading activity.[3,4] In the framework of our study, we posit that because stocks with the most return skewness will attract the most option trading activity, these types of stocks will be attractive candidates for option introductions.

To explore this hypothesis, we examine the association between the skewness of returns in underlying stocks and the likelihood of an option being introduced in a variety of univariate and multivariate tests. We begin by conducting a simple event study of return skewness surrounding the first introduction of options. Consistent with our hypothesis, we find that the level of return skewness is increasing, and is abnormally high, during the period when the decisions of exchanges are generally made.[5] In the months prior to the option introduction, the return skewness for stocks that introduce options is between 20% and 45% higher than the skewness of stocks that do not introduce options.

Following Mayhew and Mihov (2004) and Danielsen et al. (2007), we use a variety of limited dependent variable techniques to determine whether the likelihood of an option being introduced for the first time is related to the level of pre-introduction return skewness. Both our logistic regressions and Hazard models show that volatility, volume, market cap, and liquidity are important determinants in the decision to introduce options, which confirms the results of prior research. However, after we control for these factors, we find that the level of return skewness during the pre-introduction period also increases the likelihood of options being introduced. Depending on the econometric specification, our multivariate results indicate that a one unit increase in skewness increases the likelihood of option introduction by about 3%.

As a measure or robustness, we replicate our multivariate analysis using, what we define as abnormal skewness, which is the difference between skewness of those stocks that introduce options in month *t* and the skewness of non-listed stocks. We are able to draw similar conclusions to earlier tests as pre-introduction abnormal skewness is directly related to the likelihood of an option introduction. This is true in both our logistic regressions and Hazard models and whether or not we examine the raw difference or the percentage difference between the skewness of stocks that introduce options and those that do not. Combined with earlier findings, these results tend to support our hypothesis that the return skewness in the underlying stock is an important determinant in the decision to introduce options.

In our second set of tests, we attempt to determine whether the high pre-introduction skewness indeed leads to higher post-introduction option volume. After calculating average

[3]We recognize that there are other motives to trade options. For example, in their seminal work Black and Scholes (1973) argued that options provide investors an opportunity to properly hedge other equity positions. Similar arguments are made in Ross (1976). In a different stream of literature, researchers have argued that investors with information will be motivated to use options (Biais & Hillion, 1994; Black, 1975; Easley et al., 1998).

[4]Although call options provide the non-linear payoff that might fit with investors' preferences for positive skewness, some investors might still prefer to buy the underlying stock with positive skewness and hedge any down-side risk with buying put options. Therefore, our argument that preferences for skewness and the demand for options is not isolated to call options, but these preferences might also lead to demand for put options as well.

[5]Danielsen et al. (2007) argue that, according to industry sources, listing decisions are generally made the month prior to the actual option listing.

monthly option volume during the post-introduction period, we find a positive and significant association between pre-introduction skewness and post-introduction option volume. This result holds when we look strictly at call option volume and, to a lesser extent, put option volume. Observing stronger results in call option volume in relation to put option volume is consistent with findings in Blau et al. (2016) that show that the skewness of the underlying stock is directly associated with higher call option volume. Our multivariate results are robust to controls for volume, volatility, market capitalization, and bid-ask spreads. In economic terms, we find that a one standard deviation increase in skewness during the pre-introduction period results in a 9% increase in average monthly option volume. This result is primarily driven by call option volume although we still find a significant relationship between pre-listing skewness and post-listing put option volume. Thus, it appears that conditioning the exchange's decision to introduce options on stock return skewness has the desired consequence.

The results of our study contribute to the literature in two important ways. First, we extend the literature by identifying another important determinant in the decision to introduce options. Doing so, however, provides an important contribution to the breadth of research that documents that investors have preferences for positive skewness. Although prior work provides evidence that investors have preferences for positive skewness, the results from our study seem to indicate that exchanges that introduce options recognize these preferences, and, therefore, introduce options for stocks with high return skewness under the expectation that these stocks will lead to greater option trading volume. Second, our results suggest that the dramatic increase in option trading activity over the last few decades is, in part, a result of exchanges' strategic decisions to introduce options as stocks with high equity trading volume, high volatility, and the most positive skewness generate higher post-listing option volume.

2. DATA DESCRIPTION

The data used in this analysis come primarily from two sources. We first obtain daily returns, volume, prices, and market capitalization from the Center for Research on Security Prices (CRSP). Second, we gather option introductions and option trading volume from Bloomberg. The options data from Bloomberg consists of trading volume in all options for each stock across various expirations and strike prices. Given that our research question is interested in the introduction of the first option available for a particular security, we determine the introduction date as the first day that option volume appears in the Bloomberg data set.[6] From CRSP, we obtain data for the universe of stocks and then gather options data for these stocks from Bloomberg. The sample time period is from 1996 to 2011.[7] After merging the CRSP data to the options data, we are left with 968,746 stock-month observations and 4,970 option listings during this 16-year period.

Using the data from CRSP, we estimate the two measures of return skewness. First, we estimate the following equation using daily raw returns from CRSP over a

[6]We are able to cross check the options data and the introduction date from Bloomberg with more familiar datasets, like OptionMetrics. We are able to find identical option volumes for both datasets.

[7]To determine the option introduction month, we obtain the month in which option volume begins to appear in the Bloomberg data. Option volume data are only available from September 1995 so we choose to begin our time period in January 1996. Because our sample time period begins in January 1996, we treat assume that all stocks with option volume in that month had introduced prior to 1996. This assumption ensures that we do not mistakenly treat January 1996 as the option introduction date. Again, this portion of our analysis was cross-checked with OptionMetrics data.

rolling six-month window.

$$Skew = \frac{n}{(n-1)(n-2)} \left(\frac{\sum_{t=1}^{n} (r_t - \bar{r})^3}{\hat{\sigma}^3} \right) \tag{1}$$

Equation (1) is the scaled third moment of the return distribution where n represents the number of days during the rolling six-month window, $\bar{r}$ is the mean raw return during the time period, and $\hat{\sigma}$ is the estimated standard deviation during the same time period. The results from estimating Equation (1) using raw returns results in an estimate of skewness for each stock during each month. We denote this estimate using raw returns as total skewness (*Skew*).

Other research has also partitioned total skewness into two components—coskewness and idiosyncratic skewness—and find that the idiosyncratic portion of skewness exhibits the highest price premiums suggesting that investors have stronger preferences for idiosyncratic skewness (see Boyer et al., 2010; Kumar, 2009; Kumar et al., 2011). Therefore, in a number of unreported tests, we estimate the following equation for each stock in each year and obtain the residual returns.

$$r_{i,t} - r_{f,t} = \alpha + \beta_1 MktRf_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{i,t} \tag{2}$$

The dependent variable is the daily risk premium (or daily raw returns minus the daily risk-free rate) for each stock i on each day t. The independent variables consist of the four common risk factors found in Fama and French (1996) and Carhart (1997). The risk factors are measured at the daily level and obtained from Wharton Data Research Services. After estimating Equation (2) for each stock in each year, we obtain the estimated daily residual returns for each stock $\hat{\varepsilon}_{i,t}$. We then re-estimate Equation (1) using residual returns from this four-factor model. The results from this estimation are denoted as idiosyncratic skewness (*IdioSkew*). We replicate our analysis using *IdioSkew* instead *Skew* and find the results to qualitatively similar. Therefore, we only report our findings when using *Skew*.

Table I reports statistics that describe our sample. Panel A reports the statistics for the sample of stocks that do not have tradable options while Panel B presents the statistics for stocks that do not have listed options. We note that the first sample consists of 11,885 stocks and 775,068 stock-month observations. A few other facts about the data are noteworthy.

Besides presenting summary statistics for our measure of skewness (*Skew*), we also report return volatility, which is the standard deviation of daily raw returns (*Volt*).[8] *Turn* is the ratio of monthly trading volume scaled by shares outstanding while *MktCap* is the market capitalization. *Spread* is the percentage bid-ask spread (or the difference between the ask price and bid price scaled by the spread midpoint), which is calculated using closing bid and ask prices from CRSP.[9] Finally, *Price* is the CRSP closing price on the last day of the month. Panel A reports that the average stock has skewness of 0.4693. Furthermore, the average stock also has volatility of 0.0384, turnover of about 11.4%, market capitalization of $446 million, a bid-ask spread of 3.92%, and a share price of $28.96. Panel B shows that the

[8]We note that *Volt*, like *Skew*, is estimated using daily data for each month during a six-month rolling window.

[9]Roll and Subrahmanyam (2010) and Chung and Zhang (2013) discuss how using daily closing bid-ask spread closely approximates bid-ask spreads obtained using transactions data. While we would like to examine transaction-level data, we do not have access to transaction data for the majority of our time period.

TABLE I
Summary Statistics

	Skew [1]	*Volt* [2]	*Turn* [3]	*MktCap* [4]	*Spread* [5]	*Price* [6]
Panel A. Non-Optionable Stocks						
Mean	0.4693	0.0384	0.1141	446,201,879	3.9223	28.96
Median	0.3205	0.0299	0.0465	83,367,700	1.8002	10.69
Std. Dev	1.2439	0.0328	1.3617	3,337,501,506	7.1372	1,045.43
Min	−10.9883	0.0001	0.0000	3,718	0.0228	0.31
Max	11.2843	0.1513	0.9699	225,748,571,000	33.3333	141,600.00
Panel B. Optionable Stocks						
Mean	0.4866	0.0407	0.4841	1,037,914,493	1.0497	46.98
Median	0.3650	0.0354	0.2030	482,123,200	0.3367	20.19
Std. Dev	1.3530	0.0262	3.1337	3,128,841,466	3.1265	1,366.45
Min	−9.8400	0.0002	0.0003	871,700	0.0000	0.50
Max	10.1641	0.4116	4.7584	107,586,600,030	11.8577	90,000.00

Note. The table reports statistics that describe our sample. *Skew* is monthly total skewness or the scaled third moment calculated using CRSP raw returns. *Volt* is the monthly standard deviation of CRSP raw returns. These variables are calculated using daily returns for a rolling six-month window from the current month. *Turn* is the ratio of the share volume to shares outstanding. *MktCap* is the monthly market capitalization *Spread* is the percent bid-ask spread, or the difference between the ask price and bid price, divided by the spread midpoint. *Price* is the CRSP share price. Panel A reports the results for securities on CRSP that do not have listed options. Panel B reports the summary statistics for the sample of stocks that, at any time during our sample time period (1996–2011) listed options. The total sample consists of 968,746 stock-month observations. We note that there are 4,677 option listings during our sample time period.

average stock has total skewness of 0.4866, volatility of 4.07%, turnover of nearly 49%, market cap of $1.04 billion, a spread of 1.05%, and a share price of $46.98.

3. EMPIRICAL RESULTS

In this section, we present the results of our empirical tests. We first test our hypothesis that skewness is an important determinant in the decision to introduce options. We note that in the analysis that follows, we are only analyzing the introduction of the first option. We do not examine the introduction of additional options for a particular stock. Here, we are attempting to identify the determinants of the initial introduction of options (Danielsen et al., 2007). To do so, we conduct both univariate and multivariate tests. Second, we test whether stocks with high pre-introduction skewness have high levels of post-introduction option volume. As mentioned above, the idea is that the objective for the exchange to introduce options is to maximize the profit of exchange members, which usually entails listing options for stocks that will generate the most option trading activity.

3.1. Event Study—Return Skewness Surrounding Option Listings

We begin by conducting a very simple event study of return skewness surrounding the introduction of options. The idea is to determine whether skewness increases during the pre-listing period when option listing decisions are being made. Danielsen et al. (2007) state that, according to option exchange personnel, listing decisions are generally made in the month

TABLE II
Event Study—Monthly Skewness Surrounding Option Introductions

	Skew [1]	*Abnormal Skew* [2]	*P-Value (Abnormal Skew)* [3]	*Abnormal Skew(%)* [4]	*P-Value (Abnormal Skew(%))* [5]
$t-6$	0.5795	0.1284***	<0.0001	0.2056***	0.0007
$t-5$	0.6012	0.1498***	<0.0001	0.3759***	<0.0001
$t-4$	0.6059	0.1552***	<0.0001	0.4176***	<0.0001
$t-3$	0.6103	0.1623***	<0.0001	0.4519***	<0.0001
$t-2$	0.6008	0.1470***	<0.0001	0.3906***	<0.0001
$t-1$	0.5730	0.1182***	<0.0001	0.3760***	<0.0001
Introduction	0.4876	0.0361*	0.0787	0.0823	0.2219
$t+1$	0.4952	0.0317*	0.0691	0.0692	0.1740
$t+2$	0.5146	0.0430**	0.0158	0.0871	0.1605
$t+3$	0.5238	0.0496***	0.0074	0.0044	0.9459
$t+4$	0.5375	0.0537***	0.0043	0.0378	0.4439
$t+5$	0.5299	0.0476**	0.0101	0.0820	0.1756
$t+6$	0.4983	0.0273	0.1311	0.0557	0.3496

Note. The table reports the results of an event study surrounding option introductions of monthly skewness and two measures of abnormal skewness, which are used throughout the analysis. Column [1] reports skewness. Column [2] shows the abnormal skewness, where abnormal skewness is the difference between skewness for stocks that list options in month *t* and stocks that do not have listed options during our sample time period. Column [3] shows the *P*-values associated *t*-statistics testing whether abnormal skewness is different than zero. Columns [4] shows the results for abnormal skewness in percent, which is the difference between skewness for stocks that list options in month *t* and stocks that do not have listed options during our sample time period divided by the skewness of stocks that do not have listed options during our sample time period. Column [5] shows the *P*-values associated *t*-statistics testing whether abnormal skewness (%) is different than zero. *, **, and *** denote statistical significant at the 0.10, 0.05, and 0.01 levels, respectively.

prior to the introductions of options. Therefore, if exchanges choose to introduce options for stocks with high skewness, then we would expect to observe high skewness in the few months prior to the option introduction. That is, the return skewness for potential candidates for option introductions might be abnormally high relative to other stocks that do not introduce options. We, therefore, estimate abnormal skewness as the difference between the skewness for a particular stock that introduces an option and the average skewness of non-optionable stocks during the same month in the event window. We denote this first measure as *Abnormal Skew*. For robustness, we also include the percent difference or the difference between the skewness of stocks that introduce options and the skewness of stocks that do not have options, scaled by the skewness of stocks without options. We denote this second measure as *Abnormal Skew*(%). Given that more data are required to accurately estimate higher order moments, our six-month rolling estimation technique tends to smooth out any changes in the time series of skewness. However, in unreported tests we calculate what we call, abnormal time-series skewness, which is the difference between skewness during a particular month and average skewness from month $t-24$ to $t-13$. We replicate much of our analysis using this additional measure of abnormal skewness and the conclusions that we are able to draw are similar to those in this study.[10]

Table II reports the results of this simple event study. Columns [1] shows results that focus on skewness while columns [2] and [3] present the results when examining *Abnormal*

[10]We also note that that these other tests are robust to the use of a number of different benchmarks, such as average skewness from $t-18$ to $t-7$, average skewness from $t-24$ to $t-17$, average skewness from $t-24$ to $t-7$, and average skewness from $t-12$ to $t-7$. The results from these tests are qualitatively similar to those reported in this paper.

Skew. Columns [4] and [5] shows the results when using *Abnormal Skew*(%). In column [1] of Panel A, we find that skewness averages 0.5951 during the 6 months prior to the introduction of the option. Furthermore, skewness peaks in month $t-3$ at 0.6103. We also find that skewness decreases during the month of, and the months shortly after, the introduction of options. This might be explained, in part, by the reduction in the volatility of returns surrounding the introduction of options (Bansal, Pruitt, & Wei, 1989; Damadoran & Lim, 1991; Skinner, 1989; Trennepohl & Dukes, 1979). We find that *Volt* and *Skew* are strongly correlated across our time period (correlation coefficient of 0.39). This finding is not surprising due to the similarities in the *Volt* and *Skew* calculations. Therefore, the reduction in volatility that has been shown to occur at the introduction might explain the reduction in the skewness of returns, which occurs at the same time.[11]

To draw statistical inferences, we next turn to our two measures of abnormal skewness. Columns [2] and [3] show these results. We find that abnormal skewness is unusually high during the 6 months prior to the option. *P*-values that are obtained from standard *t*-statistics show that abnormal skewness is statistically different from zero during the 6 months prior to the option introduction. Furthermore, skewness is still abnormally high, relative to non-listed stocks, during the month when the option is introduced although the magnitude is much smaller than in previous months. We also find that skewness in recently introduced stocks is greater than the skewness in non-listed stocks in the months following the option introduction. Given that the decision to introduce options is made during the few months prior to the option listing (Danielsen et al., 2007), our results are consistent with the idea that skewness is an important determinant in the decision to introduce options.

In the latter two columns, we report the results for *Abnormal Skew*(%). Here, we again find that skewness is abnormally high in the 6 months prior to the option introduction. In fact, during the 6 months prior to the introduction, the skewness of stocks that introduce options in month t is nearly 37% higher than the skewness of stocks without listed options, on average. We also report than the percent difference in skewness between those that introduce options and those that do not is no longer statistically significant in month t to $t+6$. The findings in the latter columns support our findings in the earlier columns and suggest that the skewness of stocks that introduce options are unusually high in the months leading up to the option introduction. In so far as listing decisions are made during this time period, our results support the idea that skewness is an important determinant in the decision to introduce options.

3.2. Skewness and Option Listing Decisions—Multivariate Tests

In this subsection, we examine skewness and the decision to introduce options in a multivariate context. To do so, we follow the main idea of prior research and use a limited dependent variable approach (Danielsen et al., 2007; Mayhew & Mihov, 2004). In particular, we estimate the following equation using pooled stock-month data.

$$\begin{aligned} List_{i,t} = {} & \beta_1 Volt_{i,t-1,t-j} + \beta_2 \ln\left(Turn_{i,t-1,t-j}\right) + \beta_3 Spread_{i,t-1,t-j} \\ & + \beta_4 \ln\left(Cap_{i,t-1}\right) + \beta_5 Price_{i,t-1} + \beta_6 Skew_{i,t-1,t-j} + \varepsilon_{i,t} \end{aligned} \tag{3}$$

[11]Although outside the scope of our study, observing a reduction in the positive skewness of stocks surrounding the introduction of options suggests that not only do option introductions reduce volatility but they also help normalize the distribution of returns. Perhaps a more thorough analysis of the effect of the introduction on return skewness will be a fruitful avenue for future research.

The dependent variable is an indicator variable equal to one if stock *i* introduces an option in month *t* for the first time and zero otherwise. We include as independent variables the other known determinants in the listing decision, which are the prior months' volatility ($Volt_{i,t-1,t-j}$), the natural log of share turnover ($\ln(Turn_{i,t-1,t-j})$), the bid-ask spread ($Spread_{i,t-1,t-j}$), the natural log of market capitalization ($\ln(Cap_{i,t-1})$), and share price ($\text{Price}_{i,t-1}$). For instance, Mayhew and Mihov (2004) show that volatility, volume, and market capitalization are all directly related to the likelihood of option introductions. Furthermore, Danielsen et al. (2007) show that liquidity improvements, represented by reductions in bid-ask spreads, are directly related to the introduction of options. Danielsen et al. (2007) also include share prices during the month prior to the option introduction as an additional control variable but only find weak evidence that share prices are directly related to the decision to introduce options. The variable of interest is the skewness for stock *i* from month $t-1$ to $t-\text{j}$. After controlling for the factors described in both Mayhew and Mihov (2004) and Danielsen et al. (2007), positive coefficients on skewness suggests that skewness is an important determinant in the exchanges' decision to introduce options.

Before discussing the results from estimating Equation (3), we need to carefully describe an important issue with our specification. When examining the introduction decision in a limited dependent variable framework, Danielsen et al. (2007) note a potential bias caused by the lack of independence in the dependent variable that is equal to one in each time period after the introduction of the option. If stock *i* introduces an option in month *t*, then the dependent variable is given a value of one. The dependent variable will also be given the value of one in month $t+1$ and the observations in these 2 months are not independent. Danielsen et al. (2007) follow Shumway (2001), who provides a way to overcome this bias by creating what he terms as an event history approach. In an event history approach, once a particular stock introduces an option and the dependent variable receives a value of one (in month *t*), the listing stock will exit the dataset. This subtlety allows for independence across the dependent variable.

Because of the dependence problem, Danielsen et al. (2007) use a Cox proportional hazard model even though Mayhew and Mihov (2004), who are the first to examine listing decisions in this type of context, use a logistic regression. The purpose of using the semi-parametric hazard model instead of the logistic regression is because the hazard model places fewer restrictions regarding the independence of the error term. However, we report the results for both the logistic regression and the proportional hazard model as a measure of robustness. In doing so, we note an important difference in the estimation of these two models.[12]

Table III reports the results from estimating Equation (3). Columns [1] and [2] present the logistic regression estimates while columns [3] and [4] show the results from the hazard model. These results also demonstrate the robustness of our findings. Given that option exchanges have admitted to making decisions about the introduction of options during the month prior to the actual listing, we measure the independent variables of interest in two ways. First, we set $j=1$ so that the independent variables are simply measured in the prior month (i.e., $t-1$). Second, as means of robustness, we set $j=3$. Here, the independent variables are measured as the average from month $t-3$ to $t-1$.[13] We note, however, that the

[12]The intercept in a hazard model is accounted for the unknown baseline hazard, so including an intercept would only affect the magnitude of the baseline hazard function. Although we do not tabulate the intercept from the logistic regression, the intercept is estimated. We choose not report the intercept parameter from the logistic regression to standardize the reported results in our table.

[13]We note that we only average the independent variables volatility, volume, spread, and skewness. We still include market capitalization in month $t-1$ and share prices in month $t-1$ in order to follow Danielsen et al. (2007). These latter variables have less variation than the former variables.

TABLE III
Option Listing Decisions—Multivariate Tests

Panel A. Independent Variables Are Measured During the Prior Month (j = 1)

	Logistic Regression		Cox Proportional Hazard Regression	
	[1]	[2]	[3]	[4]
$Volt_{t-1}$	2.8793***	2.4796***	2.8372***	2.3190***
	(<0.0001)	(<0.0001)	(<0.0001)	(0.0001)
$\ln(Turn_{t-1})$	0.8083***	0.8083***	0.0568***	0.0584***
	(<0.0001)	(<0.0001)	(0.0001)	(0.0001)
$Spread_{t-1}$	−0.0325***	−0.0320***	0.0049	0.0056*
	(<0.0001)	(<0.0001)	(0.1061)	(0.066)
$\ln(Cap_{t-1})$	0.5245***	0.5256***	0.0682***	0.0688***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Price_{t-1}$	−3.4844***	−3.5104***	−0.2985	−0.3107
	(<0.0001)	(<0.0001)	(0.4494)	(0.4308)
$Skew_{t-1}$		0.0225**		0.0236**
		(0.0420)		(0.0454)
McFadden R^2	0.1596	0.1597		
Wald statistic			70.3587	74.0356
			(<0.0001)	(<0.0001)

Panel B. Independent Variables Are Measured During the Prior 3 Months (j = 3)

	[1]	[2]	[3]	[4]
$Volt_{t-3,t-1}$	3.6409***	2.6795***	2.8636***	2.1571***
	(<0.0001)	(<0.0001)	(<0.0001)	(0.0007)
$\ln(vol_{t-3,t-1})$	0.7867***	0.7866***	0.0641***	0.0670***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Spread_{t-3,t-1}$	−0.0311***	−0.0301***	0.0054	0.0063*
	(<0.0001)	(<0.0001)	(0.1020)	(0.0552)
$\ln(Cap_{t-1})$	0.5295***	0.5322***	0.0682***	0.0690***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Price_{t-1}$	−2.9478***	−2.9999***	−0.3308	−0.3398
	(<0.0001)	(<0.0001)	(0.4210)	(0.4068)
$Skew_{t-3,t-1}$		0.0570***		0.0353***
		(<0.0001)		(0.0089)
McFadden R^2	0.1506	0.1509		
Wald statistic			68.9729***	75.6433***
			(<0.0001)	(<0.0001)

Note. The table reports results from limited dependent variable regressions using pooled stock-month data. $List_{i,t} = \beta_1 \ln(Volt_{i,t-1,t-j}) + \beta_2 \ln(Turn_{i,t-1,t-j}) + \beta_3 Spread_{i,t-1,t-j} + \beta_4 \ln(Cap_{i,t-1}) + \beta_5 Price_{i,t-1} + \beta_6 Skew_{i,t-1,t-j} + \varepsilon_{i,t}$ The dependent variable is an indicator variable equal to one if stock *i* lists an option in month *t*—zero otherwise. We include as independent variables the other known determinants in the listing decision, which are the prior months' volatility ($Volt_{i,t-1,t-j}$), the natural log of share turnover ($\ln(Turn_{i,t-1,t-j})$), the bid-ask spread ($Spread_{i,t-1,t-j}$), the natural log of market capitalization ($\ln(Cap_{i,t-1})$), and share price ($Price_{i,t-1}$). The variables of interest is skewness for stock *i* from month $t-1$ to $t-j$ ($Skew_{i,t-1,t-j}$). Columns [1] and [2] show the results when using logistic regressions while columns [3] and [4] present the findings for the semi-parametric Cox proportional hazard model. To avoid dependence in the dependent variables, we follow Shumway and use an event history approach which requires a stock to exit the dataset once an option is listed. Panel A reports the regression results when we set $j = 1$ while Panel B shows the results when we set $j = 3$. *P*-values are reported in parentheses. *, **, and *** denote statistical significant at the 0.10, 0.05, and 0.01 levels, respectively.

results reported in this paper are robust to other values of j, such as 2, 4, 5, and 6. Panel A reports the results when $j = 1$ while Panel B shows the results when $j = 3$.

Panel A column [1] shows that volatility and the natural logs of turnover and market capitalization consistently produce positive estimates across each of the columns. These results support prior research that indicates that both trading activity, volatility, and size are important determinants of the decision to list options (Jennings & Starks, 1986; Mayhew & Mihov, 2004). We also find that the prior month's bid-ask spread produces estimates that are negative and reliably different from zero in columns [1] and [2]. These results support the idea that liquidity improvements are important in explaining the listing decision (Danielsen et al., 2007). Consistent with prior studies, we also find that the coefficient on share price is not reliably different from zero in columns [3] and [4]. Turning to our variable of interest, column [2] reports that the prior month's skewness produces an estimate that is positive and statistically significant. This finding supports our hypothesis and suggests that after controlling for the other known determinants in the decision to introduce options, stocks with positively skewed return distributions are also more likely to have options introduced than stocks without positive return skewness. To the extent that options provide an important trading mechanism for those investors with preferences for positive skewness, these results suggest that option exchanges recognize that positively skewed stocks might generate higher option trading activity after options become available.

To determine the economic significance of the results in column [2], we take the change in the log odds ratio of a one standard deviation increase in skewness. The change in odds associated with this difference (in exponential form) is 1.031 suggesting that a one standard deviation increase in skewness in month $t-1$ is associated with a 0.031 increase in the probability of introduction. These findings suggest that the results in column [2] are not only statistically significant, but they are also economically meaningful.

Next, we turn our attention to the results from the proportional hazard model. Column [3] shows results that are qualitatively similar to those in column [1] with the exception that the coefficients on the prior month's price and bid-ask spread become statistically insignificant. Furthermore, the coefficient on $Skew_{t-1}$ is again positive and statistically significant in column [4]. The results from the hazard estimates indicate that a unit increase in skewness represents an approximate 2.4% increase in the likelihood of an option introduction. Our findings from Panel A support our hypothesis that option exchanges will choose to introduce options for stocks that have positive skewness. The purpose in doing so is that these types of stocks might generate more option trading activity after options become available.

Panel B reports the results when we set $j=3$. In general, the conclusions that we draw from the estimates in Panel B are similar to those in Panel A. However, a few results are noteworthy. First, the coefficients on $Skew_{t-1,t-3}$ are positive and greater in magnitude than those in the Panel A. This is not surprising given that Table II shows that skewness peaked in month $t-3$. Second, the economic magnitude of the coefficients is substantially larger in columns [2] and [4]. For instance, in column [2], the coefficient on $Skew_{t-1,t-3}$ suggests a one-standard deviation increase in skewness results in nearly an 8% increase in the likelihood of an option introduction. When we examine columns [3] and [4], we find that the mean hazard ratio suggests that a unit increase in skewness represents an approximate 3.5% increase in the likelihood of an option being introduced.

The results from our multivariate analysis in Table III support our hypothesis that skewness is an important determinant in the exchanges' decision to introduce options. The implications of these findings suggests that while prior research discusses the preferences of some investors for lottery-like stock characteristics, such as skewness, options exchanges recognize these preferences and strategically introduce options for stocks with high skewness under the assumption that skewness preferences will generate more option trading volume during the post-introduction period, thus maximizing the profit of exchange members.[14]

3.3. Abnormal Skewness and Option Listing Decisions

In this subsection, we continue our tests of the hypothesis that skewness is an important determinant in an exchanges' decision to introduce options by conducting additional robustness tests. Both Mayhew and Mihov (2004) and Danielsen et al. (2007) use abnormal measures of volatility, volume, and bid-ask spreads when identifying determinants in the decision to initiate options. The reason for doing to so is to determine which variables have an unusual increase during the time period when listing decisions are made. In this subsection, we follow this intuition by estimating the following variant of Equation (3).

$$List_{i,t} = \beta_1 AB\_Volt_{i,t-1,t-j} + \beta_2 AB\_Turn_{i,t-1,t-j} + \beta_3 AB\_Spread_{i,t-1,t-j} + \beta_4 \ln\left(Cap_{i,t-1}\right) + \beta_5 Price_{i,t-1} + \beta_6 AB\_Skew_{i,t-1,t-j} + \varepsilon_{i,t} \quad (4)$$

The dependent variable in Equation (4) is the same as the dependent variable in Equation (3). As before, we use an event history approach to account for the dependence in the dependent variable (Shumway, 2001). The difference between Equations (3) and (4) is that we use our abnormal measures of the independent variables. In particular, we obtain abnormal measures of volatility (*AB_Volt*), turnover (*AB_Turn*), bid-ask spreads (*AB_Spread*), and skewness (*AB_Skew*).[15] We note an important difference between our measures and the abnormal measures of, say, volume in previous research. These studies calculated a time series method for, say, abnormal volume by examining volume for a 20-day period relative to volume during the prior 6 months. Given the large number of observations required for accuracy when estimating the higher moments of the return distribution, we used six-month rolling windows to estimate skewness. Therefore, time-series differences will not capture the same change in skewness. Said differently, the built-in persistence of our measures of skewness does not allow for a distinct change in the amount of skewness over time. Therefore, we attempt to use a different, but equally meaningful way of examining abnormal skewness in the listing decision context. Table IV reports the results from estimating Equation (4) using the abnormal skewness (*AB_Skew*), which is the difference between the skewness of a soon to be introduced stock in the prior month less the skewness of a non-listed stock. *AB_Volt*, *AB_Turn*, and *AB_Spread* are calculated similarly. For example, *AB_volt* is the difference between the volatility of stocks that will introduce options (in the month prior to the introduction) and the volatility of stocks that will not introduce options.

As before, Panel A of Table IV reports the results when $j = 1$ while Panel B of Table IV presents the estimated coefficients when $j = 3$. Columns [1] and [2] contain the estimates from the logistic regressions while columns [3] and [4] show the estimates from the hazard

[14]We recognize, however, the possibility that return skewness is not persistent across time. That is, return skewness in the current time period does not reliably predict skewness in the upcoming time period. To the extent that this is true, exchanges might choose to introduce stocks based not on current skewness, which might not a reliable predictor of future skewness, but instead exchanges might select stocks for options based on expected skewness. In a series of unreported tests, we closely follow Boyer et al. (2010) and include expected skewness and expected idiosyncratic skewness as the independent variable of interest. Results from these unreported tests are qualitatively similar to those reported in Table III.

[15]We note that we do not take the abnormal measures of market capitalization and share prices given that differences between samples are not likely to include a large deal of variation across time.

TABLE IV
Option Listing Decisions—Multivariate Tests

Panel A. Independent Variables Are Measured During the Prior Month ($j = 1$)

	Logistic Regression		Cox Proportional Hazard Regression	
	[1]	[2]	[3]	[4]
AB_Volt_{t-1}	8.0993***	7.3854***	3.4341***	3.0724***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
AB_Turn_{t-1}	0.0157***	0.0158***	0.0045	0.0048
	(<0.0001)	(<0.0001)	(0.3746)	(0.3456)
AB_Spread_{t-1}	−0.0510***	−0.0491***	−0.0016	−0.0013
	(<0.0001)	(<0.0001)	(0.6313)	(0.7147)
$\text{Ln}(cap_{t-1})$	0.5647***	0.5676***	0.0550***	0.0555***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Price_{t-1}$	−0.8090***	−0.8388***	−0.0974	−0.1064
	(0.0033)	(0.0028)	(0.7648)	(0.7442)
AB_Skew_{t-1}		0.0527***		0.0175
		(<0.0001)		(0.1382)
McFadden R^2	0.0847	0.0850		
Wald statistic			52.8748***	53.0013***
			(<0.0001)	(<0.0001)

Panel B. Independent Variables Are Measured During the Prior 3 Months ($j = 3$)

	[1]	[2]	[3]	[4]
$AB\_Volt_{t-3,t-1}$	9.3570***	8.1121***	3.4609***	2.9324***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$AB\_Turn_{t-3,t-1}$	0.0145***	0.0146***	0.0081	0.0086
	(<0.0001)	(<0.0001)	(0.2599)	(0.1960)
$AB\_Sprd_{t-3,t-1}$	−0.0502***	−0.0468***	−0.0022	−0.0017
	(<0.0001)	(<0.0001)	(0.5441)	(0.6492)
$\text{Ln}(cap_{t-1})$	0.5694***	0.5738***	0.0530***	0.0535***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Price_{t-1}$	−0.7968***	−0.8431***	−0.1098	−0.1150
	(0.0034)	(0.0025)	(0.7411)	(0.7272)
$AB\_Skew_{t-3,t-1}$		0.0840***		0.0280**
		(<0.0001)		(0.0379)
McFadden R^2	0.0850	0.0857		
Wald statistic			48.8670***	51.6131***
			(<0.0001)	(<0.0001)

Note. The table reports results from limited dependent variable regressions using pooled stock-month data. $List_{i,t} = \beta_1 AB\_Volt_{i,t-1,t-j} + \beta_2 AB\_Turn_{i,t-1,t-j} + \beta_3 AB\_Spread_{i,t-1,t-j} + \beta_4 \ln(cap_{i,t-1}) + \beta_5 price_{i,t-1} + \beta_6 AB\_Skew_{i,t-1,t-j} + \varepsilon_{i,t}$ The dependent variable is an indicator variable equal to one if stock *i* lists an option in month *t*—zero otherwise. Independent variables include abnormal measures of volatility (*AB_Volt*), turnover (*AB_Turn*), bid-ask spreads (*AB_Spread*), and skewness (*AB_Skew*). The abnormal measure of skewness is the difference between skewness for stocks that list options in month *t* and stocks that do not have listed options during our sample time period. We also include the natural log of market capitalization ($\ln(Cap_{i,t-1})$), and share price ($Price_{i,t-1}$), which are measured in the preceding month. Columns [1] and [2] show the results when using logistic regressions while columns [3] and [4] present the findings for the semi-parametric Cox proportional hazard model. To avoid dependence in the dependent variables, we follow Shumway and use an event history approach which requires a stock to exit the dataset once an option is listed. Panel A reports the regression results when we set $j = 1$ while Panel B shows the results when we set $j = 3$. *P*-values are reported in parentheses. *, **, and *** denote statistical significant at the 0.10, 0.05, and 0.01 levels, respectively.

model. Panel A shows that the estimates for *AB_Volt* are positive and significant across each specification suggesting that, relative to non-listing stocks, the higher the volatility, the higher the likelihood of an option introduction. We do not, however, find that *AB_Turn* produces a positive estimate. While *AB_Sprd* produces negative and significant estimates in columns [1] and [2], the results in columns [3] and [4] are insignificant. Similar results are found in when we examine the coefficients on share prices. We do, however, find that the natural log of market cap produces positive coefficients in each of our specifications. After controlling for these factors, we still find that *AB_Skew* produces positive estimates in both columns [2] and [4]. We note, however, that the coefficient in column [4] is not statistically significant at the 0.10 level. In economics terms, the logistic coefficient on *AB_Skew* suggests that a one standard deviation increase is associated with 0.0663 increase in the probability of an option introduction. The hazard coefficient on *AB_Skew* suggests that for every unit increase in *AB_Skew*, the likelihood of an option introduction increases by nearly 2%. These results suggest that, relative to non-listed stocks, abnormally high skewness increases the likelihood of an option introduction. Results in Panel B are qualitatively similar to those in Panel A. We find that the control variables produce estimates that are similar in sign to those in Panel A. Furthermore, the coefficients on *AB_Skew* are slightly larger in Panel B than in Panel A. Furthermore, the coefficients on *AB_Skew* are both statistically significant at, at least, the 0.05 level.

Next, we examine our second measure of abnormal skewness. In particular, we estimate the following equation.

$$List_{\mathrm{i,t}} = \beta_1 AB\_Volt(\%)_{i,t-1,t-j} + \beta_2 AB\_Turn(\%)_{i,t-1,t-j} + \beta_3 AB\_Spread(\%)_{i,t-1,t-j} + \beta_4 \ln\left(Cap_{i,t-1}\right) + \beta_5 Price_{i,t-1} + \beta_6 AB\_Skew(\%)_{i,t-1,t-j} + \varepsilon_{i,t} \quad (5)$$

The dependent variable and independent variables are identical to those in Equation (4) with one exception. Instead of examining the raw difference between, say skewness for those stocks that will soon introduce options and the skewness of non-listed stocks, we examine the percent difference—or we scale the raw difference by the skewness of non-listed stocks. Therefore, *AB_Volt*(%), *AB_Turn*(%), *AB_Spread*(%), and *AB_Skew*(%) are each calculated as the percent difference in a particular variable between stocks that will introduction options and those that will not. As before, we avoid dependence in the dependent variables by following Shumway (2001) and use an event history approach which requires a stock to exit the dataset once an option is listed. Panel A reports the regression results when we set $j = 1$ while Panel B shows the results when we set $j = 3$.

Table V shows the results of these robustness tests. As seen in the table, the coefficients for the control variables are similar in sign and significance to those in the previous table. More importantly, we find that *AB_Skew*(%) produces positive and statistically significant estimates in columns [2] and [4]. We note that coefficient in column [4] is only marginally significant (P-value = 0.0862). However, the magnitude of the coefficients suggests a similar economic significance. For instance, in Panel A column [2], every one standard deviation increase in *AB_Skew*(%) is associated with 2.72% increase in the likelihood of an option introduction. In column [4], a one standard deviation increase in *AB_Skew*(%) is associated with a 2.34% increase in the likelihood of an option introduction. Results are similar both in sign and significance in Panel B when $j = 3$. These findings again support the idea that abnormally high skewness in the period prior to option introductions is an important factor in determining whether options are introduced.

TABLE V
Option Listing Decisions—Multivariate Tests

Panel A. Independent Variables Are Measured During the Prior Month ($j = 1$)

	Logistic Regression		Cox Proportional Hazard Regression	
	[1]	[2]	[3]	[4]
$AB\_Volt(\%)_{t-1}$	0.4257***	0.4142***	0.1328***	0.1187***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$AB\_Turn(\%)_{t-1}$	0.0036***	0.0036***	0.0012	0.0013
	(<0.0001)	(<0.0001)	(0.2089)	(0.1869)
$AB\_Sprd(\%)_{t-1}$	−0.6353***	−0.6334***	0.0127	0.0143
	(<0.0001)	(<0.0001)	(0.3463)	(0.2888)
$Ln(cap_{t-1})$	0.5258***	0.5263***	0.0620***	0.0623***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Price_{t-1}$	−0.7444***	−0.7551***	−0.0781	−0.0834
	(0.0054)	(0.0051)	(0.7979)	(0.7855)
$AB\_Skew(\%)_{t-1}$		0.0071**		0.0062*
		(0.0144)		(0.0862)
McFadden R^2	0.0956	0.0957		
Wald statistic			53.9538***	56.6370***
			(<0.0001)	(<0.0001)

Panel B. Independent Variables Are Measured During the Prior 3 Months ($j = 3$)

	[1]	[2]	[3]	[4]
$AB\_Volt(\%)_{t-3,t-1}$	0.4980***	0.4782***	0.1359***	0.1178***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$AB\_Turn(\%)_{t-3,t-1}$	0.0031***	0.0031***	0.0019	0.0020*
	(<0.0001)	(<0.0001)	(0.1084)	(0.0660)
$AB\_Sprd(\%)_{t-3,t-1}$	−0.6937***	−0.6919***	0.0073	0.0088
	(<0.0001)	(<0.0001)	(0.6324)	(0.5627)
$\mathrm{Ln}(cap_{t-1})$	0.5202***	0.5208***	0.0588***	0.0591***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Price_{t-1}$	−0.7221***	−0.7393***	−0.0904	−0.0900
	(0.0063)	(0.0057)	(0.7750)	(0.7739)
$AB\_Skew(\%)_{t-3,t-1}$		0.0114***		0.0093**
		(<0.0001)		(0.0206)
McFadden R^2	0.0960	0.0962		
Wald statistic			50.2256***	55.8433***
			(<0.0001)	(<0.0001)

Note. The table reports results from limited dependent variable regressions using pooled stock-month data. $List_{i,t} = \beta_1 AB\_Volt(\%)_{i,t-1,t-j} + \beta_2 AB\_Turn(\%)_{i,t-1,t-j} + \beta_3 AB\_Spread(\%)_{i,t-1,t-j} + \beta_4 \ln(Cap_{i,t-1}) + \beta_5 Price_{i,t-1} + \beta_6 AB\_Skew(\%)_{i,t-1,t-j} + \varepsilon_{i,t}$ The dependent variable is an indicator variable equal to one if stock *i* lists an option in month *t*—zero otherwise. Independent variables include abnormal measures of volatility (*AB_Volt*(%)), turnover (*AB_Turn*(%)), bid-ask spreads (*AB_Spread*(%)), and skewness (*AB_Skew*(%)). The abnormal measure of skewness is the difference (in percent) between skewness for stocks that list options in month *t* and stocks that do not have listed options during our sample time period. We also include the natural log of market capitalization ($\ln(Cap_{i,t-1})$), and share price ($Price_{i,t-1}$), which are measured in the preceding month. Columns [1] and [2] show the results when using logistic regressions while columns [3] and [4] present the findings for the semi-parametric Cox proportional hazard model. To avoid dependence in the dependent variables, we follow Shumway and use an event history approach which requires a stock to exit the dataset once an option is listed. Panel A reports the regression results when we set $j = 1$ while Panel B shows the results when we set $j = 3$. *P*-values are reported in parentheses. *, **, and *** denote statistical significant at the 0.10, 0.05, and 0.01 levels, respectively.

3.4. Robustness

The main results of our study, thus far, suggest that the skewness of returns is an important determinant in the exchanges' decision to introduce options. In this section, we describe a number of unreported tests that provide robust support for our findings. First, as mentioned above, we replicate our entire analysis using idiosyncratic skewness instead of total skewness. We should note the high level of correlation (0.98) between these two measures of skewness. Therefore, it does not come as a surprise that our results are robust to tests that use idiosyncratic skewness as our independent variable of interest.

Second, instead of share turnover, we use trading volume in all of our tests. Again, we find robust results using this alternative measure of trading activity. We choose to report the results using share turnover given that shares outstanding as a scaler will account for stock splits. The conclusions that we draw, however, do not depend on the use of share turnover or share volume.

Third, we account for several other control variables. For instance, in separate tests, we account for the amount of time since the firms' initial public offering (IPO). We obtain these data from Compustat and note that not all stocks in our sample report the IPO date. For those that do, we replicate our analysis and find that controlling for the amount of time between IPO and option introduction does not meaningfully influence the results reported in the sections above.[16] We also condition our tests on stocks that do not pay a dividend. Again, the results we report in Tables III and IV hold for this subsample.

Next, we provide specific controls for the decimalization period. Given that Danielsen et al. (2007) show that liquidity improvements are an important determinant in the decision to introduce options, controlling for this period when liquidity has dramatically improved may be important. Results show that when we include an indicator variable capturing the post-decimalization period, if anything, the conclusions that we draw strengthen.

Lastly, we de-trend share turnover and spreads by taking the difference between these variables and the mean of these variables over the last six-month period. We do not de-trend skewness in a similar way since 6 months data are required to accurately estimate skewness. Including the de-trended levels of share turnover and bid-ask spreads as additional control variables does not significantly alter our findings. We again find that skewness remains an important determinant in the decision by exchanges to introduce options.

3.5. Does Return Skewness Generate More Post-Listing Option Volume?

In our final set of tests, we determine whether skewness, in fact, leads to greater option trading volume. If the objective of exchanges is to indeed introduce options for stocks that will generate the most option trading volume, then we expect that the level of pre-introduction skewness will be an important predictor of post-introduction option volume. Table VI reports the results from estimating the following cross-sectional regression.

$$\begin{aligned}\mathrm{Ln}(Option_i) = \alpha + \beta_1 \mathrm{Ln}\left(Volt_{i,t-1,t-j}\right) + \beta_2 \mathrm{Ln}\left(Turn_{i,t-1,t-j}\right) + \beta_3 Spread_{i,t-1,t-j} \\ + \beta_4 \mathrm{Ln}\left(Cap_{i,t1}\right) + \beta_5 Price_{i,t-1} + \beta_6 Skew_{i,t-1,t-j} + \varepsilon_i \qquad (6)\end{aligned}$$

[16]Although we lose a large portion of our data when including this variable, it is interesting to note that for the average stock that does report an IPO date, about 9.2 years pass before options are introduced (standard deviation of 6.56).

TABLE VI
Post-Listing Option Volume—Cross-Sectional Regressions

Panel A. Independent Variables Are Measured During the Prior Month (j = 1)

	Dependent Variable = Ln(OptVol)		Dependent Variable = Ln(CallVol)		Dependent Variable = Ln(PutVol)	
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	3.8142***	3.5612***	3.8369***	3.5701***	1.5527***	1.3039**
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.0106)	(0.0321)
Ln($Volt_{t-1}$)	0.6308***	0.5829***	0.7383***	0.6878***	0.4646***	0.4171***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Ln($Turn_{t-1}$)	0.3285***	0.3324***	0.3087***	0.3128***	0.3813***	0.3852***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Spread_{t-1}$	0.0187***	0.0200***	0.0176***	0.0189***	0.0213***	0.0225***
	(0.0019)	(0.0010)	(0.0028)	(0.0014)	(0.0022)	(0.0012)
Ln(Cap_{t-1})	0.3133***	0.3165***	0.3081***	0.3114***	0.3385***	0.3415***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Price_{t-1}$	1.8632***	1.8042***	1.5487***	1.4864***	2.5521***	2.4934***
	(0.0003)	(0.0003)	(<0.0001)	(<0.0001)	(0.0086)	(0.0087)
$Skew_{t-1}$		0.0638***		0.0672***		0.0631***
		(0.0047)		(0.0030)		(0.0098)
Adj. R^2	0.1286	0.1306	0.1330	0.1351	0.1165	0.1182

Panel B. Independent Variables Are Measured During the Prior Month (j = 3)

	Dependent Variable = Ln(OptVol)		Dependent Variable = Ln(CallVol)		Dependent Variable = Ln(PutVol)	
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	3.6160***	3.3584***	3.6716***	3.3907***	1.2953**	1.0584*
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.0323)	(0.0821)
Ln($Volt_{t-3,t-1}$)	0.6250***	0.5729***	0.7319***	0.6751***	0.4542***	0.4059***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Ln($Vol_{t-3,t-1}$)	0.3990***	0.4041***	0.3773***	0.3828***	0.4541***	0.4589***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Spread_{t-3,t-1}$	0.0255***	0.0269***	0.0233***	0.0248***	0.0302***	0.0315***
	(0.0002)	(<0.0001)	(0.0008)	(0.0005)	(<0.0001)	(<0.0001)
Ln(cap_{t-1})	0.3290***	0.3313***	0.3220***	0.3244***	0.3564***	0.3585***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
$Price_{t-1}$	1.7119***	1.6649***	1.4051***	1.3538***	2.3874***	2.3435***
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.0032)	(0.0031)
$Skew_{t-3,t-1}$		0.0759***		0.0828***		0.0704**
		(0.0043)		(0.0019)		(0.0164)
Adj. R^2	0.1354	0.1375	0.1389	0.1412	0.1222	0.1237

Note. The table reports the cross-sectional regression results using cross-sectional data. $\text{Ln}(Option_i) = \alpha + \beta_1 \text{Ln}(Volt_{i,t-1,t-j}) + \beta_2 \text{Ln}(Turn_{i,t-1,t-j}) + \beta_3 Spread_{i,t-1,t-j} + \beta_4 \text{Ln}(Cap) + \beta_5 Price_{i,t-1} + \beta_6 Skew_{i,t-1,t-j} + \varepsilon_i$ The dependent variable is defined three different ways for each stock *i*: the natural log of the average monthly total option volume, the natural log of the average monthly call option volume, and the natural log of the average monthly put option volume. We measure the average monthly volume for these three measures of option volume from month $t+2$ to month $t+12$. We include as independent variables the natural log of volatility from month $t-1$ to $t-j$ (Ln($Volt_{i,t-1,t-j}$)), the natural log of share turnover from month $t-1$ to $t-j$ (Ln($Turn_{i,t-1,t-j}$)), the bid-ask spread from month $t-1$ to $t-j$ ($Spread_{i,t-1,t-j}$), the natural log of market capitalization during month $t-1$ (Ln($Cap_{i,t-1}$)), and the share price (in \$ thousands) in month $t-1$ ($Price_{i,t-1}$). The independent variable of interest is skewness during month $t-1$ to $t-j$ ($Skew_{i,t-1,t-j}$). We note that in these cross-sectional regressions, each listing has a single observation such that month *t* represents the month in which the option is listed. We control for conditional heteroskedasticity using White (1980) robust standard errors. Panel A shows the results when $j=1$ and Panel B presents the regression coefficients when $j=3$. Furthermore, the results for total option volume are presented in columns [1] and [2] while the results for call option volume and put option volume are reported in columns [3] and [4] and in columns [5] and [6], respectively. *, **, and *** denote statistical significant at the 0.10, 0.05, and 0.01 levels, respectively.

The dependent variable is defined three different ways for each stock i: the natural log of the average monthly total option volume, the natural log of the average monthly call option volume, and the natural log of the average monthly put option volume. We examine the post-introduction period from month $t+2$ to $t+12$. The reason for skipping the month after the introduction is based on the results from our event study in Table II. We observe a substantial reduction in skewness in the month after the introduction. Therefore, we would like to isolate the effect of pre-introduction skewness on post-introduction option volume after the initial decrease in skewness during month $t+1$. We note, however, that results are qualitatively similar to those reported below when we examine average monthly option volume from month $t+1$ to $t+12$.[17]

We include as independent variables the natural log of volatility from month $t-1$ to $t-j$ ($\text{Ln}(Volt_{i,t-1,t-j})$), the natural log of share turnover from month $t-1$ to $t-j$ ($\text{Ln}(Turn_{i,t-1,t-j})$), the bid-ask spread from month $t-1$ to $t-j$ ($Spread_{i,t-1,t-j}$), the natural log of market capitalization during month $t-1$ ($\text{Ln}(Cap_{i,t-1})$), and the share price (in \$ thousands) in month $t-1$ ($Price_{i,t-1}$). The independent variable of interest is skewness during month $t-1$ to $t-j$ ($Skew_{i,t-1,t-j}$). In these cross-sectional regressions, each option introduction has a single observation such that month t represents the month in which the option is introduced. We control for conditional heteroskedasticity using White (1980) robust standard errors. Panel A shows the results when $j=1$ and Panel B presents the regression coefficients when $j=3$. Furthermore, the results for total option volume are presented in columns [1] and [2] while the results for call option volume and put option volume are reported in columns [3] and [4] and in columns [5] and [6], respectively.

Although these tests are similar, in nature, to the tests in Blau et al. (2016) that find that call ratios (total call volume divided by total option volume) is higher for stocks with higher return skewness, our tests are different in two important ways. First, we are testing whether option volume is associated with return skewness in the period before options become available while controlling for the other important determinants of the decision to introduce options. Second, we examine the levels of option volume (both call volume and put volume) instead of focusing on call ratios.

In Panel A, column [1] shows that coefficients are volatility, turnover, and market capitalization are positive and reliably different from zero. In economic terms, a 1% increase in volatility is associated with a 0.63% increase in post-introduction monthly option volume. The results also show that a one percent increase in turnover and market capitalization is associated with a 0.33% and a 0.31% increase in average monthly option volume during the post-introduction period. Results also show that less liquid stocks (in the pre-introduction period) have higher post-introduction option volume. We do not find that pre-introduction share prices are reliable predictors of post-introduction option volume. After holding these variables constant, results in column [2] show that the estimate of skewness is also positive and statistically significant. In economic terms, a one standard deviation increase in pre-introduction skewness is associated with a 8.8% increase in option volume.

Next, we focus on columns [3] and [4], where the dependent variable is the natural log of average monthly call volume in the post-introduction period. The control variables produce estimates that are similar in sign and magnitude to the corresponding coefficients in columns [1] and [2]. Again, we find that the variable of interest, *Skew*, produces a positive and reliable coefficient. Furthermore, the economic magnitude is slightly greater than the magnitude of the coefficient in column [2].

[17] We also note that our results (reported below) are robust when we examine option volume from month $t+2$ to $t+6$ and from month $t+2$ to $t+24$.

In columns [5] and [6], we show the results when the dependent variable is the natural log of average monthly put volume. In general, the coefficients are similar in sign to those in the preceding columns. However, slight differences in the coefficients exist. For example, the estimate for share prices becomes positive and marginally significant. At the bottom of column [6], we find that the coefficient on *Skew* is again positive and significant although slightly smaller than the corresponding coefficient in column [4]. Compared to the results in column [4], our findings provide some consistency with prior research that return skewness directly affects the level of call option volume (Blau et al., 2016). However, in Table IV, we also find some evidence that put option volume is also influenced by the level of pre-introduction return skewness.

Panel B reports the results when $j = 3$. The conclusions that we draw from this panel are identical to those in Panel A. We do note, however, that the coefficient on *Skew* becomes significant at the 0.05 level (P-value = 0.0164) in column [6]. Combined with the findings in Panel A, these results suggest that while the other determinants (volatility, turnover, etc.) in the decision to initiate options increase the level of post-introduction option volume, we also document that pre-introduction skewness is an important predictor of post-introduction option trading activity.[18]

4. CONCLUSION

As opposed to the exchange-listing decision, which is made at the firm level, the decision to introduce options is made at the exchange level. In theory, exchanges will choose to introduce options for stocks that generate the most option trading volume in order to maximize long-term profits (Mayhew & Mihov, 2004). While prior research has already identified a few characteristics that are influential in the decision to initiate options, this study develops and tests the hypothesis that exchanges will choose to introduce options for stocks with return distributions that are positively skewed. To the extent that exchanges strategically choose to introduce options for stocks that will generate the most option trading activity, stocks with the most positive skewness might be attractive candidates. This argument is based on a growing stream of literature that shows that investors have strong preferences for positive skewness (Bali et al., 2011; Barberis & Huang, 2008; Boyer et al., 2010; Brunnermeier, Gollier, & Parker, 2007; Kumar, 2009; Kumar & Page, 2014; Kumar et al., 2011; Mitton & Vorkink, 2007; Zhang, 2005). The implicit leverage and the nonlinear payoff structures found in option contracts provide features that are conducive to investors with such preferences.

To explore this hypothesis, we examine the association between the likelihood of an option being introduced for the first time and the return skewness of underlying stocks. Results show that the level of skewness during the period when listing decisions are being made increases the likelihood of an option being introduced. When compared to non-listed stocks, the skewness of stock returns is abnormally high in the months prior to the date when options are first introduced. This abnormally high return skewness during the pre-introduction period is analogous to the identification of other determinants in the decision to initiate options (Danielsen et al., 2007; Mayhew & Mihov, 2004). We also find that after controlling for other known determinants of the exchanges' decisions to introduce options, both a logistic and Cox proportional hazard regressions show that stocks with positively

[18]It might be interesting to examine the post-introduction option volume by the moneyness of the options. For instance, investors with preferences for skewness might prefer call options that are deeper out-of-the-money. Unfortunately, the data is not available historically from Bloomberg. Therefore, the limitations of the data do not allow us to test this conjecture.

skewed return distributions are more likely to have options introduced than stocks without positive return skewness. In economic terms, our tests suggest that a one standard deviation increase in skewness results in an approximate 3% increase in the likelihood of an option being listed.

Although results from our first set of tests are consistent with our hypothesis that exchanges will choose to introduce options for stocks with the most skewness, in our second set of tests, we ask the question: Does the level of pre-introduction return skewness generate higher post-introduction option volume? Tests show that the stocks with the highest return skewness prior to the option introduction have the highest post-introduction option trading volume. This result holds after controlling for other known determinants of the decision to introduce options and is robust to a variety of specifications. In summary, our results suggest that the level of return skewness is not only an important determinant in the decision to introduce options but pre-introduction return skewness is also an important predictor of post-introduction option volume.

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