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The effect of CBOE option listing on the volatility of NYSE traded stocks: a time-varying variance approach ☆

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Abstract

This paper employs the standard General Auto-regressive Conditional Heteroskedasticity (GARCH(1,1)) process to examine the impact of option listing on volatility the underlying stocks. It takes into consideration the time variation in the individual stock's variance and explicitly tests whether option listing causes any permanent volatility change. It also investigates the impact of option listing on the speed at which information is incorporated into the stock price. The study uses clean samples to avoid sample selection biases and control samples to account for the change in the volatility and/or information flows that may be caused by factors other than option listing.

Keywords: CBOE; NYSE; Time-varying variance approach

1. Introduction

In a complete market, with no transaction costs and trading constraints, a stock option is regarded as a redundant security, as its payoffs can be synthesised by combining a position in the underlying stock with risk-free lending and borrowing. However, in the real world, where dynamic trading strategies replicating option payoffs are infinitely costly introducing options may have an impact on the underlying stock prices and their variances. Theoretically, the impact of option listing is still controversial. Researchers provide several

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theoretical arguments supporting both the view that option listing decreases the volatility of the underlying stocks, and the opposite view that option listing has a destabilising effect on the volatility of the underlying stocks.

On one hand, Grossman (1988) claims that a new option contract generally increases the liquidity of the underlying stocks, and that the information released by new traders may have a stabilising effect on the stock market. Grossman's argument is based on the possibility that the price of traded options conveys the demand for securities and removes the uncertainty regarding the cost of obtaining an option-like payoff. In addition, options provide an opportunity for market makers to hedge their exposure, allowing them to lower the bid–ask spread. The bid–ask spread may also be lowered as a result of the migration of informed traders from stock markets to option markets. The migration of informed traders could be explained by the inherent leverage and lower transaction costs associated with options and the ability of options to avoid the restrictions imposed on selling stocks short. Furthermore, it is logical to argue that the availability of options as hedging vehicles makes investment in riskier stocks more attractive and this leads to an increased demand for the underlying stocks (Figlewski, 1987). Figlewski further argues that the trading volume in the underlying stocks may increase as a result of market makers in futures and option markets trading the underlying securities to hedge their positions. Consequently, with their ability to improve liquidity, options should stabilise the underlying stock markets.

On the other hand, the increased liquidity in the underlying stock should not only be regarded from one angle. The information released by new traders may have a destabilising impact and its effect may be strong enough to more than offset the effect of the increased liquidity, and the ultimate result would be on the increased bid–ask spread (Stein, 1987). Stein argues that the information released by new traders inflicts a negative externality on those people already in the market and their ability to make inferences from prices is impaired. In addition, Gorton and Pennacchi (1993) argue that the derivatives introduction may lure uninformed traders away from the underlying market. The essential elements in the Gorton and Pennacchi argument are probably hedging and transaction costs. Lower transaction costs in the option market can lead investors to hedge their positions by trading in the options in preference to making equivalent stock transaction. The migration of uninformed traders would act in the opposite direction to the migration of informed traders. This would, therefore, lead to the increase in the information asymmetry component of the bid–ask spread. This increased spread would increase the bid–ask spread bounce in the stock price and thereby increase the volatility of the underlying stock returns. Moreover, the introduction of derivatives may increase both price pressure and the volatility of the underlying market, as they allow institutional investors to make large volume transactions in both markets in order to take advantage of price discrepancies (Kumar et al., 1998).

The above summarised theoretical analysis, to date, shows that the impact of option listing on the volatility of the underlying stocks is ambiguous. As a result of this ambiguity, the problem is probably best addressed empirically. Several empirical studies have investigated the issue. Using data from the US market, some studies suggest that option listing decreases the volatility of the market for the underlying assets (see Bansal et al. (1989), Conrad (1989), Skinner (1989), Damodaran and Lim (1991), Fendenia and Grammatikos (1992), and Kumar et al. (1998)) whereas others (see Klemkosky and Maness (1980), Bollen (1998), and Mayhew and Mihov (2000)) suggest that there is no volatility impact associated with option listing. Since the previous literature is largely inconclusive, it is worth re-examining the issue using different data set and alternatives measures of the possible volatility impact associated with option listing.

Indeed, several authors have questioned the reliability of the results documented by those studies that use unconditional volatility measures when investigating the potential impact of option listing on the volatility of the underlying stocks. Unconditional volatility measures are based on the explicit assumption that price changes in the spot markets are serially uncorrelated and homoskedastic. This assumption is questionable in both criteria. It is inconsistent with Black (1976) and Christie (1982) who both argue that variance changes systematically over time for individual firms as their leverage, investment opportunities, and other characteristics change. It is also inconsistent with Mandelbrot (1963), Fama (1965) and Bollerslev et al. (1992) who find that stock returns are heteroskedastic. Thus, failure to distinguish between the volatility change that may be caused by the event of option listing, and that caused by return dependences may bring about a serious bias to the empirical results.

The conditional volatility measure, namely General Auto-regressive Conditional Heteroskedasticity (GARCH(1,1)) is not entirely new in the literature. Antoniou and Holmes (1995) examine the effect of the introduction of index futures on the volatility of FT100 index using a General ARCH (GARCH) process. An exponential GARCH (EGARCH) model is used by Dennis and Sim (1999) to examine the impact of individual share futures on Sydney Futures Exchange. Hernandez-Trillo (1999) also uses ARCH and GARCH models to examine the volatility effect associated with listing warrants on the individual stocks in the Mexican market.

However, the innovation in this paper is the joint use of the conditional volatility measures and the control sample methodology to account for both systematic time variation in the individual stock variance and the possible volatility changes, across pre- and post-option listing, resulting from changes in market-wide and/or industry-wide conditions or from the endogenous nature of the option listing decision (i.e., listing decisions are made by option exchanges based on a number of requirements, such as trading activity and underlying stock's volatility, which are changing over time[1]). We claim that failure to discriminate between the direct volatility effect of option listing and the volatility changes caused by other factors may produce a significant bias in the empirical results.

The rest of the paper is divided into four sections. Section 2 discusses our empirical procedures. Section 3 presents our data. Section 4 reports the empirical results and Section 5 summarises the paper.

2. Empirical procedures

2.1. Option listing and unconditional volatility

For comparison purposes, we begin our analysis by measuring the impact of option listing on the volatility of the underlying stocks using Merton (1980) variance approxi-

[1] See Mayhew and Mihov (2000) for more detail on the endogenous nature of the option listing decision.

mation. Merton (1980) argues that var(R_t) approximately equals $E(R_t^2)$ for short measurement intervals. Using this argument, we examine the impact of option listing on the volatility of individual stocks by applying the following equation to each stock:

$$E(y_{it}^2) = \rho_{ib} + \rho_{ic}\mathrm{DUM} + \psi \qquad (1)$$

where $E(y_i^2)$ is the squared daily returns[2] of the stock i in the 400-day window. DUM is a dummy coefficient, which takes a value of zero before the option listing date and a value of unity otherwise. ρ_{ic} indicates the direction of the change in the return variance of security i (positive sign on the coefficient ρ_{ic} suggests an increase and a negative sign of on ρ_{ic} suggests a decrease in the volatility of the underlying stock i). A t test can then determine the significance of the change. In Eq. (1), the coefficient ρ_{ib} refers to the pre-listing volatility of the stock i, and ρ_{ib} plus ρ_{ic} refers to the post-options listing volatility of the underlying stock i.

One weakness of Eq. (1) is that it assumes that the parameters ρ_{ib} and ρ_{ic} are stationary, i.e., constant over time. However, Black (1976) and Christie (1982) argue that the variance changes systematically over time for individual firms as their leverage, investment opportunities, and other characteristics change. In other words, studies based on unconditional volatility measures implicitly assume that price changes in spot markets are serially uncorrelated and homoskedastic (Antoniou and Holmes, 1995). However, many studies in the literature, such as Mandelbrot (1963) and Fama (1965) find that stock returns are heteroskedastic. Thus, any change in the volatility of returns of the underlying stocks between pre- and post-option listing periods could be caused by option listing, or may simply be the result of return dependence. Furthermore, the empirical investigation of the impact of option listing on the volatility of the underlying stocks fails to explicitly connect between the price adjustment to information and the volatility of the underlying stocks. The connection between price adjustment to information and the volatility of returns is an important one, as the volatility of returns should vary over time, even on a daily basis, as it responds to the information flow to the market. Therefore, instead of examining the impact of option listing on the volatility of returns, using the OLS estimation of Eq. (1), which requires the error term to be homoskedastic, GARCH(1,1) process of Bollerslev (1986) is employed. This process provide us with a natural way to test the following null hypothesis:

H0. Option listing does not affect the volatility of the underlying stock, even when conditional volatility measures are employed.

H1. Option listing has no impact on the rate at which information is incorporated to the stock price.

As we will show later, accepting (or rejecting) any of these hypotheses will also depend on the behaviour, between pre- and post-options listing, of the volatility as well as the speed at which information is incorporated into the price of the control stocks.

[2] Note that daily returns as $\ln(p_t + d_t/p_{t-1})$, where p_t and p_{t-1} are the stock price at time t and $t-1$, respectively, and d_t is the total dividend paid in the period t.

2.2. GARCH(1,1) and the option listing effect

We model the time-varying volatility using the GARCH process of Bollerslev, 1986, which provides a more flexible and parsimonious approximation to conditional variance dynamics. We restrict our attention to GARCH(1,1),[3,4] which is specified in the following manner:

$$\mu_{it} = v_{it}(\sigma^2_{it-j})^{1/2}, \tag{2}$$

where v_{it} is i.i.d. with $E(v_{it})=0$ and $E(v^2_{it})=1$, and

$$\sigma^2_{it} = \omega_{ib} + \omega_{ic}\mathrm{DUM} + \alpha_{i1}\mu^2_{it-1} + \beta_{i1}\sigma^2_{it-1} \tag{3}$$

To ensure a well-defined GARCH(1,1) process (the conditional variance σ^2_{it} must be positive at all time (t)), the sum of the coefficients α_{i1} and β_{i1} of Eq. (3) must be less than unity.

The dummy coefficient ω_{ic} is the determinant of the option listing impact on the volatility of the underlying stocks. A positive (negative) sign of ω_{ic} indicates an increase (a decrease) in the volatility of the underlying stock after option listing. The t statistic is then used to check the significance of the change. If ω_{ic} is positive (negative) and significantly different from zero, then we can say that there is a permanent increase (decrease) in the volatility of the underlying stock i.

2.3. Option listing and price adjustments to information

GARCH(1,1) process provides us with a natural way to test the impact of option listing on the rate at which information is incorporated into the stock price.[5] This can be done by separating the estimation and the analysis of GARCH(1,1) process across pre- and post-option listing periods. In other words, we divide the residual series, generated from Eq. (2), of each stock into pre-listing residuals and post-listing residuals. Then we estimate the simple GARCH(1,1) model in both the pre- and post-option listing periods for each stock, using the following equation:

$$\sigma^2_{it} = \omega_{i0} + \alpha_{i1}\mu^2_{it-1} + \beta_{i1}\sigma^2_{it-1} \tag{4}$$

The GARCH(1,1) specification of the conditional variance (Eq. (4)) is often interpreted in the financial context, where an agent or trader predicts this period's variance by computed a weighted average of a long-term average (the constant, ω_{i0}), the forecasted

[3] In many studies, GARCH(1,1) process is successfully applied to capture volatility clustering in financial data. For a survey of applications of the GARCH model see, e.g., Bollerslev et al. (1992), Pagan (1996) or Plam (1996). The GARCH(1,1) process is also adopted by Hernandez-Trillo (1999) in the context of the warrants listing.

[4] Note that adding a dummy factor into ARCH(p) and GJR-GARCH(1,1) does not provide different results from those reported here. The detail is available upon request.

[5] This methodology is similar to that adopted by Antoniou and Holmes (1995) in the context of the impact of futures trading on the FT100 index (UK market).

variance from the previous period (the GARCH term, β_{i1}), and the information about the volatility observed in the previous period (the ARCH term, α_{i1}). Thus, the constant ω_{i0} is interpreted as the permanent variance component, the ARCH term, α_i, reflects the impact of recent news (α_i relates the impact of yesterday's news on today's price), and the GARCH term, β_{i1}, is picking up the impact of price changes relating to the news arrived before yesterday (old news). Thus, if α_{i1} is interpreted as the impact of recent news in the stock price, then any increase, after option listing, in α_{i1} will indicate an increase in the speed at which the information is incorporated into the stock price, and vice versa. Similarly, if β_{i1} is interpreted as the impact of old news on the stock price, then if option listing increases the speed at which the price adjusts to information, then we expect option listing to reduce uncertainty concerning old news and, therefore, to reduce the impact of old news on today's price changes.

2.4. Controlling for the effect of factors other than option listing

In a similar fashion to Bollen (1998) and Mayhew and Mihov (2000), we use a control sample to account for possible changes, across option listing periods, in either the volatility and/or the speed at which information is incorporated into the stock price, caused by factors other than option listing. These factors include changes market-wide and/or industry-wide conditions and the endogenous nature of the option listing decision. The control sample is selected by matching each optioned stock with a control stock from the same industry sector, with a similar size and pre-option listing volatility of returns. Then, we apply our empirical procedure to the control sample in order to test whether the change in the volatility and/or the speed at which information is incorporated into the stock price is the same for both the sample of optioned stocks and the control sample. We check the results using t statistic and Mann–Whitney tests, through which we examine whether the changes, across pre- and post-option listing periods, in the volatility and the speed at which information is incorporated into the stock price are the same for both the sample of optioned stocks and the control sample.

3. Data

The Chicago Board Option Exchange (CBOE) provided us with a list of option-listed stocks and their dates of listing. The list includes all the stocks for which options have been introduced, within all the US option exchanges, from April 1973 to March 2001. In order to avoid the problem of trading location,[6] together with the issue of market completeness[7] associated with the sample selection bias, we only include New York Stock Exchange (NYSE)-listed stocks with option contract first introduced on the CBOE and listed nowhere else within a year.

[6] Harris (1989) argues that option listing may have different volatility impact in different market conditions. These market conditions include liquidity, short selling constraints and sophistication of the derivatives users.

[7] If a stock has options listed in more than one market, the first listing may complete the market for that stock and the later listings may cause no volatility effect.

Table 1
The pre-listing characteristics of the samples[a]

	Mean pre-listing (low/high)			
	Samples of optioned stocks		Control sample	
Size[b]	1973.2 (74.9/26,755.2)		2460.5 (30.34/29,521.3)	
Return variance[c]	6.01 (0.632/40.33)		5.82 (0.405/32.31)	
Residual variance[d]	5.43 (0.465/42.20)		4.93 (0.415/37.22)	
	OLS regression[e]		Mann–Whitney test[f]	
	t Statistic	p Value	Z score	p Value
Return variance equality	− 0.30	0.760	− 0.884	0.377
Residual variance equality	1.338	0.182	− 1.075	0.283

[a] The table describes the characteristics of the sample of the optioned stocks and the control sample, which is selected using the ranking approach in the pre-option listing periods.

[b] Size is the market capitalisation of the firm. At any point in time, the firm's size is measured as a number of outstanding shares multiplied by the share price.

[c] Return variance and residual variance are multiplied by 10^4.

[d] Return variance and residual variance are multiplied by 10^4.

[e] The t statistic and the p value are based on the dummy coefficient of Ordinary Least Square estimation of the following equation: pre-listing variance$_{i,j,t}$ = Intercept + Coef. × Dummy$_{i,j,t}$ + Error where the variable pre-listing variance$_{i,j,t}$ is made up of $2n$ observations, where n is the number of optioned stocks. At each listing date t, the variable pre-listing variance$_{i,j,t}$ has two observations. The first observation is the pre-listing variance of the optioned stock i and the second one is the pre-listing variance of non-optioned stock j. Dummy$_{i,j,t}$ takes on a value of unity of the pre-listing variance observation is taken from the optioned stock i and a value of zero if the pre-listing variance is taken from the non-optioned stock j. The t statistic (p value) of the dummy coefficient, Coef., indicates whether the pre-listing variance of the optioned stocks and those of non-optioned stocks are the same or significantly different.

[f] A non-parametric Mann–Whitney tests whether the pre-listing variance$_{i,t}$ of the optioned stocks and the pre-listing variance$_{j,t}$ of the control stocks are the same or different without assuming any distribution shape.

To be selected, a stock must have complete daily dividend-adjusted price data for 400 observations around the option listing date (200 observations before the option listing and 200 observations after the option listing). This restriction is necessary to avoid thin trading problems.[8] Data is available for 144 stocks.

The potential control stocks are indicated by the first four digits of the SIC code obtained from Compustat. This SIC code provides for each optioned stocks a list of matching stocks within the same trading location and industry sector as this particular optioned stock. In order to avoid any potential biases due to the way the control sample is selected, the potential control stock is rejected if it has an option listed either earlier or less than 1 year later than the date of introducing the option on the optioned stock counterpart. To avoid thin trading problems in our control sample, any control stock with incomplete set of 400 daily price observations (200 observations before the date of listing an option on their optioned stocks counterpart and 200 observations after the option listing date) is

[8] According to Chaudhury and Elfakhani (1997) data availability is an indicator of whether the stock is thinly traded or not. In other words, if a stock has a complete data set around the option listing date than it is unlikely to be thinly traded.

excluded from our analysis. The mean and the median of the pre-listing size, return variance and residual variance for both the sample of optioned stocks and that of the control sample are reported in Table 1.

4. Empirical results

4.1. Unconditional volatility and option listing impact

The coefficient on the dummy variable (ρ_{ic}) in Eq. (1) provide little evidence on the presence of the option listing impact on the volatility of the underlying stocks. The sign of coefficient ρ_{ic} suggests that 82/144 (62/144) of optioned stocks and 68/144 (76/144) of control stocks experience decrease (increase) in their volatility following the events of option listing. However, based on the statistical significance of ρ_{ic}, only 36/144 (24/144) of optioned stocks and 29/144 (20/144) of control stocks experience decrease (increase) in their volatility after the introduction of options. Thus, the majority of stocks in both samples experience no significant volatility change after option listing.

In order compare the volatility change in the two samples, we employ the portfolio approach. This approach, an OLS regression and a non-parametric Mann–Whitney test, tests the null hypothesis that the change in the volatility between pre- and post-options listing periods is the same for the sample of optioned stocks and the control sample. The OLS equation, which compares the sample of optioned stocks and the control sample in terms of the volatility change, is specified as follows:

$$C_{\mathrm{o,n}} = B + D\mathrm{DUM} + E \tag{5}$$

where $C_{\mathrm{o,n}}$ is the volatility change across pre- and post-option listing periods. The dependent variable, $C_{\mathrm{o,n}}$, of Eq. (5) takes on two values, which are: C_{o} if the stock is optioned and C_{n} if the stock is not optioned. $C_{\mathrm{o,n}}$ is the dummy coefficient in Eq. (1), B is a constant coefficient, DUM is a dummy variable taking on a value of unity if a stock has an option listed on it, and zero otherwise, and E is the i.i.d. error term with a zero mean and a constant variance. It is the coefficient D that measures the difference in the volatility change between the sample of optioned stocks and the control sample. If D is positive (negative) and statistically significant, then the change in the volatility of the sample of optioned stocks is higher (lower) than the change in the volatility of the control sample.

A t statistic on the dummy coefficient D in Eq. (5) is only -0.834 (p value $=0.404$), suggesting that the volatility change of the sample of optioned stocks is not significantly different from the volatility change of the control sample. This is further supported by Mann–Whitney test, with a Z score of -1.375 and a p value of 0.169, which suggest that the sample of optioned stocks and the control sample experience the same degree of volatility change across pre- and post-option listing periods. However, concluding that option listing does not affect the volatility of the underlying stocks at this stage is premature, as we have not yet allowed for the variance of returns to vary systematically over time. Indeed, as it is shown in Section 4.3, the estimation of the standard GARCH(1,1) process confirms the presence of the ARCH-type heteroskedasticity in the variance series of the majority of stocks included in our analysis.

4.2. GARCH(1,1) and the volatility effect of option listing

Panel A of Table 2 reports a summary of the results of the tests incorporating dummy coefficient of the GARCH(1,1) process (Eq. (3)), applied to both the sample of optioned stocks and the control sample. The dummy coefficient of Eq. (3) suggests that 70 (and 74) of the option listed stocks experience an increase (decrease) in their volatility after option listing. However, based on the statistical significance of the volatility change, only 43 stocks exhibit a significant (permanent) change in their volatility after the introduction of options (23 with a significant increase and the other 20 with a significant decrease) and the majority of the stocks (70.13% (101/144)) experience no permanent volatility change across pre- and post-option listing periods.

Under the GARCH(1,1) specification of the conditional variance equation, the change in volatility of the control sample is close to the volatility change in the sample of the optioned stocks. Taking the sign of the dummy coefficient in Eq. (3), 67/144 (77/144) of the control stocks exhibit a volatility decrease (increase) after option listing. However, basing on the statistical significance of the dummy coefficients, only 46/144 stocks in the control sample with a statistically significant (permanent) change in their volatility after option listing (24/144 of these stocks experience a statistically significant increase and 22/144 of them show a significant decrease). The majority of the control stocks (68.05% or 98

Table 2
GARCH(1,1) and the volatility effect of option listing[a,b]

	Optioned stocks	Control sample	Total
Panel A: individual stocks approach			
No. (%) increases (sign)	70 (48.61%)	77 (53.47%)	147 (51.04%)
No. (%) increases (st.sig)	23 (15.97%)	24 (16.66%)	47 (16.31%)
No. (%) increases (sign)	74 (51.39%)	67 (46.52%)	141 (48.95%)
No. (%) increases (st.sig)	20 (13.88%)	22 (15.27%)	42 (14.83%)
No. (%) no significant change	101 (70.13%)	98 (68.06%)	199 (69.09%)
Panel B: portfolio approach			
(1) OLS regression			
Intercept (p value)	3.73e − 05 (0.342)		
Dummy coefficient (p value)	2.6e − 06 (0.962)		
R^2	0.000		
F (p value)	0.002 (0.962)		
(2) Mann–Whitney test			
Z score	− 0.647		
p Value	0.518		

sign: "+" or "−", st.sig: statistical significance.

[a] The table summarises the results from the individual stock approach, (Eq.(3)) applied to each stock involved in our analysis, and portfolio approach. The portfolio approach includes the OLS regression and the Mann–Whitney test. The OLS regression regresses the volatility change measured by the dummy coefficient in Eq. (3) against a dummy variable taking a value of unity if a stock has an optioned listed on it, and zero otherwise, and the Mann–Whitney test examines whether the volatility changes of the sample of optioned stocks and the control sample is the same or different.

[b] The volatility change is defined as the difference between post- and pre-options, and it is measured by the dummy coefficient of Eq. (3).

in number) exhibit no statistically significant volatility change between pre- and post-option listing periods. Therefore, we conclude this procedure generally supports the null hypothesis of no option listing effect on the volatility of the underlying stocks.

To compare further the volatility change in the two samples, we regress the change in the volatility of both the optioned stocks and the control stocks as measured by the dummy coefficient in Eq. (3) against a dummy variable taking on a value of unity if a stock has an option listed on it and zero otherwise. The results are reported in Panel B of Table 2. The p value of the dummy coefficient is 0.962, suggesting that the volatility change of the sample of optioned stocks is not significantly different from the volatility change of the control sample. This is further supported by Mann–Whitney test, with a Z score of -0.647 and a p value of 0.518, which suggest that the sample of optioned stocks and the control sample experience the same degree of volatility change across pre- and post-option listing periods.

Viewed jointly, both the individual stock approach and the portfolio approach strongly support the null hypothesis H_0 of no options listing effect.

4.3. Option listing and price adjustment to information

Panel A of Table 3 summarises the results from estimating Eq. (4) for each optioned stock in both the pre- and post-option listing periods. The panel indicates that the number of stocks with statistically significant ARCH terms is very close in both the periods before and after option listing. More specifically, 63 out of 144 optioned stocks have statistically significant ARCH terms (α_{i1}) before option listing and 65 out of 144 them show statistically significant ARCH elements (α_{i1}) after the introduction of options. Similarly, the number of stocks with significant GARCH terms (old news component or β_{i1}) across pre- and post-option listing periods are quite different (113 exhibiting significant GARCH terms in the pre-listing period and only 88 showing significant GARCH terms in the post-listing period) indicating the possibility that option listing reduce the volatility persistence of the underlying stocks.

To test whether, on average, the introduction of option listing affect the speed at which information is incorporated into the stock price, we use an OLS regression, in which α_{i1} (and then β_{i1}) in Eq. (4) is the dependent variable and a dummy variable taking a value of unity if the α_{i1} (β_{i1}) is generated by the pre-listing residual series of a given stock i, and a value of zero otherwise. We also employ a non-parametric WSRT to check whether the pre-listing and the post-listing α_{i1} (β_{i1}) in Eq. (4) estimated on the optioned stocks are the same. The results of these tests are presented in Panel B of Table 3. It shows that the dummy variable, which measures the average change in the ARCH(1) coefficients (α_{i1} in Eq. (4)) between pre- and post-option listing periods for the sample of optioned stocks, is not significantly different from zero (a t statistic = 0.853 and a p value = 0.394), suggesting a no significant change in the effect of current news in the stock price. The non-parametric WSRT, with a Z score of -0.852 and a p value of 0.394, also indicates that the pre-listing ARCH(1) coefficients and post-listing ARCH(1) coefficients are drawn from the same distribution. Similarly, the coefficient of the dummy variable, which measures the change in the GARCH(1) coefficients (β_{i1} in Eq. (4)) between pre- and post-option listing periods, is also not statistically significant (the t statistic is -1.261 with a p value of 0.206), which implies no significant change in the effect of the old news on the stock price. The non-

Table 3
Option listing and stock price adjustment to information[a]

Panel A: individual stock approach

	Optioned stocks		Control stocks	
	Pre-listing	Post-listing	Pre-listing	Post-listing
No. (%) of significant ARCH coefficients	63 (43.75%)	65 (45.13%)	70 (48.61%)	68 (47.22%)
No. (%) of significant GARCH coefficients	113 (78.5%)	88 (61.11%)	100 (69.4%)	95 (65.97%)

Panel B: portfolio approach

	Optioned stocks		Control stocks	
	ARCH(1)[1a]	GARCH(1)[1b]	ARCH(1)[1c]	GARCH(1)[1d]
(1) OLS regression[b]				
Intercept (p value)	0.134 (0.000)	0.616 (0.000)	0.142 (0.000)	0.638 (0.000)
Dummy coefficient (p value)	0.018 (0.394)	− 0.049 (0.208)	−0.012 (0.518)	− 0.036 (0.352)
F (p value)	0.728 (0.394)	0.509 (0.208)	0.417 (0.518)	0.865 (0.352)
R^2	0.002	0.005	0.001	0.003

	Optioned stocks		Control stocks	
	ARCH(1)	GARCH(1)	ARCH(1)	GARCH(1)
(2) Non-parametric tests				
Wilcoxon Sign Rank test[c]				
Z score (p value)	− 0.852 (0.394)	− 0.989 (0.323)	− 0.396 (0.692)	− 0.961 (0.336)

	Combined analysis	
	Change in ARCH(1)	Change in GARCH(1)
Mann–Whitney test[d]		
Z score (p value)	− 0.530 (0.596)	− 0.060 (0.952)

[a] This table summarises the results of the impact of option listing on the rate at which information incorporate to the stock price.

[b] OLS regression compares the series of pre-listing ARCH(1) (GARCH(1)) coefficients and the post-listing ARCH(1) (GARCH(1)) coefficients for the sample of optioned stock and the control sample, respectively. The series of ARCH(1) and GARCH(1) coefficient for the sample of optioned stocks and control sample are generated from Eq. (4).

[c] WSRT tests whether the pre-listing series and post-listing series of ARCH(1) (GARCH(1)) coefficients of the sample of optioned stocks and those of control sample belong to the same distribution.

[d] Mann–Whitney test examines whether the series of the change (post-listing − pre-listing) in ARCH(1) (GARCH(1)) coefficients is the same for both the sample of optioned stocks and the control sample.

parametric WSRT, with a Z score of -0.989 and a p value of 0.323, also indicates no statistically significant change in the impact of old new on the change in the current stock price. Thus, there is no evidence supporting the hypothesis that option listing increases the speed at which information is incorporated into the stock price.

Although the above-stated results show that option listing has no significant impact on the rate at which information is incorporated into the stock price, we are still interested in examining the possible change, across option listing periods, in the rate which information is incorporated into the price of the control stock for at least one reason. If the control stocks, which have similar pre-listing characteristics to the optioned stocks, experience a statistically significant change in the rate at information incorporate into their prices, then it is possible to argue that option listing has probably prevented the option-listed stocks from following the general trend of their non-optioned stocks counterparts and, therefore, options are not completely redundant.

The results of estimating Eq. (4) in both pre- and post-option listing periods on each control stock are summarised in Panel A of Table 3. In a similar fashion to the sample of optioned stocks, the control sample exhibit only negligible increase in the speed at which information is incorporated to the stock price. The results indicate a negligible change, between pre- and post-options listing, in the number of the control stocks with significant ARCH(1) coefficient (70/144 with a statistically significant ARCH(1) in the pre-options listing and 68/144 exhibiting a significant ARCH(1) term in the post-options listing).

The panel also indicates only a slight decrease in the number of control stocks with a significant GARCH(1) coefficient (100 in the pre-listing period and 95 in the post-listing period). These results are further confirmed by the portfolio approach. Panel B of Table 3 shows that both the OLS regression and WSRT support the null hypothesis of no significant change, between pre- and post-options listing periods, neither in ARCH(1) term nor in GARCH(1) coefficient of control stocks. The non-parametric Mann–Whitney test also confirms that the change in ARCH(1) and GARCH(1) terms across option listing periods is the same for both the sample of optioned stocks and the control sample.

Viewing the results collectively, this study suggests that option listing affects neither the volatility of returns nor the rate at which information is incorporated into the stock price.

5. Summary and conclusion

This paper examines the impact of option listing on the volatility of the underlying stocks. It employs both the GARCH(1,1) process of Bollerslev (1986) in order to allow for the variance of returns to vary systematically through time (Black, 1976; Christie, 1982) and the control sample methodology to control for the volatility changes caused by factors other than option listing. The GARCH(1,1) provides natural ways to examine whether any volatility change associated with option listing is permanent and whether option listing has any direct impact on the speed at which information is incorporated into the stock prices.

Our empirical results imply that even when conditional volatility measures are employed, both the individual stock approach and a portfolio approach support a null hypothesis that option listing has impact neither on the volatility nor on the speed of stock price adjustment to information. These results are further confirmed by the finding that the non-optioned stocks, with similar pre-option listing characteristics as the optioned stocks, do experience changes, across pre- and post-option listing periods, neither in their volatility nor in the rate at which information is incorporated into their prices.

Our results are supportive to the findings of a number of existing studies, such as Edwards (1988), Bollen (1998), Baldauf and Santoni (1991) and Lee and Ohk (1992), which suggest that option listing is volatility-neutral and there is no need for regulatory authorities and other market participant to worry about the possible volatility effect associated with option listing.

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