An Empirical Analysis of the Effects of Options and Futures Listing on the Underlying Stocks' Return Volatility: the Portuguese Case

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Abstract

The volatility implications of options and futures listing are not yet clearly understood. The theoretical analyses of the effect of the start of trade of derivative contracts on the volatility of the underlying asset led to conflicting conclusions, depending upon what assumptions were made. The empirical evidence on this subject is also mixed. This paper attempts to analyse the volatility effect of the initial exchange-listing of options and futures on the Portuguese capital market. The conclusions of this paper are mixed. We can not reject the hypothesis that, on average, the listing of derivatives has no effect on the total and systematic risk of the underlying stocks. However, on an individual basis, we can reject the idea that the derivatives have no effect on the total and systematic risk of the underlying stocks.

Keywords: Option listing, future listing, derivatives, stock volatility, stock betas
JEL classification: G13; G14; G15

An Empirical Analysis of the Effects of Options and Futures Listing on the Underlying Stocks' Return Volatility: the Portuguese Case

I. Introduction

The volatility implications of options and futures listing are not yet clearly understood. As Harris (1989) notices, theoretical analyses of the effect of the start of trade of derivative contracts on the volatility of the underlying asset led to conflicting conclusions, depending upon what assumptions were made. The empirical evidence on this subject is also mixed. This paper attempts to analyse the volatility effect of the initial exchange-listing of options and futures on the Portuguese capital market. The remainder of this paper is organised as follows. Section II presents the literature review. Section III describes the sample data, the hypotheses tested and the empirical methods employed to test the hypotheses. Empirical results are presented in Section IV. Finally, Section IV provides some concluding remarks.

II. Literature Review

The debate over the effect of trade in derivative contracts on the volatility of underlying stock returns have increased, especially since the October 19, 1987 stock market crash[1]. Some suggest that derivative markets caused an increase in speculative activity that in turn destabilised cash markets, causing higher volatility. For example, Harris (1989), indicates that volume in index futures and index options increased dramatically since their introductions in 1982 and 1983. Hence, large speculative trading in the derivative markets makes the suggestion plausible.

However, as Harris also remarks, theoretical analyses of whether speculative trade destabilises cash markets originate different conclusions, depending on what hypotheses are considered. In fact, an increase in well informed speculative trade has two opposite effects on measured volatility: it decreases volatility due to order flow imbalances caused by uninformed traders because informed traders provide liquidity in such events; and it increases volatility due to new fundamental information since the information is impounded into prices more quickly. On the other hand, an increase in uninformed speculative trade may increase price volatility by interjecting noise into a market with limited liquidity or it may decrease volatility by increasing the rewards to being well informed, so that their numbers increase, increasing market liquidity and thereby, decreasing volatility.

Stein (1987) suggest that both risk sharing considerations and potentially adverse informational externalities must be taken into account when attempting to weigh the pros and cons of opening futures or options markets or of other measures designed to facilitate speculative behaviour. In his paper, Stein (1987) discusses increased speculation in the context of a particular example: the opening of a futures market for a perfectly storable commodity.

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[1] Becketti and Sellon (1989) examine the claim that financial volatility has increased in the 1980s. They find that financial market volatility has indeed increased, yet the nature of the volatility, its magnitude, and its persistence are very different across markets.

Conrad (1989) presents several reasons to test the assumption that options are redundant assets and can therefore be valued with a no-arbitrage relation as considered in Black and Scholes (1973) pricing model. First, the use of the option may allow the investor to take positions in the underlying security which were not possible prior to option introduction. One example of an institutional feature that could have made a position costly or even prohibitive is a short sale restriction. Second, options may affect the opportunity sets of investors, as discussed by Ross (1976), by permitting an expansion of the contingencies that are covered by the market. Third, trading in options and in derivative securities in general, may be driving down the value of stocks and other securities, presumably by increasing volatility in the underlying markets.

In the former two reasons, the introduction of the options may improve the welfare of previously restricted traders and be associated with a price effect. Figlewsky and Webb (1993) present empirical evidence that trading in options contributes to both transactional and informational efficiency of the stock market by reducing the effect of constraints on short sales. The later reason, in opposition, gives support for the notion that derivatives may instead be detrimental to investors.

Also, Detemple and Selden (1991) demonstrate that when the market is incomplete primary and derivative asset markets, generically, interact, that is, the valuation of derivative and primary securities is a simultaneous pricing problem and primary security prices depend on the contractual characteristics of the derivative assets available. Furthermore, they have shown that the value of the underlying stock increases when an option is introduced in a version of the Mossin mean-variance economy where investors have diverse beliefs.

Bessembinder and Seguin (1992). refer that, as consequence of the widely held belief that trading activity in equity futures markets can lead to excess volatility in spot equity markets, asset market volatility and the role of futures trading has been the focus of substantial recent attention. In addition, and despite the lack of reliable statistical evidence that equity futures trading is associated with increases volatility, increased regulation of futures trading has been implemented.

Considering these conflicting views as to the effect of derivative securities on primary markets, it is an important empirical question whether the introduction of an option or of a future in fact has a price effect in the underlying security. The table 1 synthesises the results of several empirical studies.

Some studies of volatility related with derivatives markets

Study	Derivatives market	Key results
Basal, Pruitt and Wei (1989)	Options market	Option listing leads to decreases in the total, but not systematic, risk of optioned firms. This offer support for the theoretical research by Ross (1976) which suggests that option trading should actually improve the overall pricing efficiency of the equities markets through the “noise reduction” permitted by an expansion of the contingencies that are covered by these markets.

Study	Derivatives market	Key results
Becketti and Roberts (1990)	Futures market	Stock index futures have not increased stock market volatility whether measured by the frequency or the size of large swings in stock prices.
Bessembinder and Seguin (1992)	Futures market	Active futures markets are associated with decreased volatility.
Chamberlain, Cheung and Kwan. (1993)	Options market	The listing of options on Canadian stock exchanges appears to have had little impact on the price behaviour, trading volume or liquidity of the underlying stocks.
Chaudhury and Elfakhani1(1997)	Options market	The evidence shows a decrease in the beta risk following the listing of put option and a decrease in the variance following earlier put option listings.
Conrad (1989)	Options market	Introduction of options on individual securities causes a permanent price increase accompanied by a decline in volatility. The systematic risk of securities does not appear to be affected by option introduction.
Fedenia and Grammatikos (1992)	Options market	Options listing significantly affects the spread on the underlying stock: the empirical findings show an average decline (increase) in spreads of NYSE (OTC) traded stocks associated with options trading.
Harris (1989)	Options market	No significant difference in volatility is observed before the start of trade in index futures and index options between S&P 500 stocks and a matched set of stocks. Since then, S&P 500 stocks have been relatively more volatile and the difference is statistically, although not economically, significant
Jennings and Starks (1986)	Options market	The sample of non option firms require substantially more time to adjust to the release of quarterly earnings than the sample of firms with listed options, which supports the argument that the existence of the option market is useful in disseminating earnings news.
Kabir (1999)	Options market	A significant decline in stock price is observed with the introduction of option trading, but no significant effect takes place on the volatility of underlying stocks.

Study	Derivatives market	Key results
Ma and Rao (1988)	Options market	Options trading does not have a uniform impact on the volatility of underlying stocks: stocks that were originally volatile, that is, traded primarily by uninformed traders, will be stabilised by the introduction of options; stocks that were more stable become destabilised by options trading.
Mayhew and Mihov (2000)	Options market	Volatility increases with options listing which is consistency with the hypothesis that forward-looking exchanges list options in anticipation of increasing volatility.
Poon (1994)	Options market	A structural shift in the relation between stock return volatility and stock trading volume associated with option listing is documented
Trennepohl and Dukes (1979)	Options market	No adverse effect of options on stock volatility is detected: instead of increasing in volatility, the optioned stocks decreases in volatility, even more so than the sample of nonoptioned securities.

Table 1

III. Data and Methodology

1. Sample selection

Options and futures trading on Portuguese exchange is coordinated by BVLP[2]. The BVLP provided us with information about 14 options and futures contracts, 2 of which about indices and 12 of which about stocks, the later listed from June 20, 1997 through January, 12, 2001. These constitute the underlying stock of an option contract, of a future contract or of either an option and a future contract introduced in the same date. In this last case there are three stocks, which means that we reduced our sample to 9 stocks. Additionally, we further drop all events on either side of which there are less than 150 daily returns. Only one stock registered this problem. These securities are mostly large and well known on the BVLP. Therefore, thin trading problems are minimal.

We are left with a final sample of 8 options and futures listing events[3] (table 2).

[2] BVLP - Bolsa de Valores de Lisboa e Porto. Trading in derivatives market started on June 20, 1996, with two listed contracts, a long term interest rate futures contract and a stock index futures contract, at the time managed by BDP – Bolsa de Derivados do Porto (cf. CGD (1999)).

[3] For the EDPOP contract there are only 54 daily returns of the underlying stock before the option listing, so it isn't considered in our sample. Anyway the event date is 09.01.00 and the initial and final dates are 01.26.00 and 04.11.01 respectively.

Sample of options and futures listing events

Derivative contract	Event date	Stock returns period	
		Initial date	Final date
BCPFUT	05.11.98	09.29.97	12.14.98
CIMPORFUT	05.11.98	09.27.97	12.14.98
EDPOP	09.01.00	01.26.00	04.11.01
PTFUT	06.20.97	01.21.97	01.27.98
PTOP	02.15.99	02.29.99	04.26.00
PTMULTIFUTOP	01.12.01	06.05.00	08.21.01
SONAEFUTOP	01.12.01	06.05.00	08.21.01
TELECELFUTOP	01.12.01	06.05.00	08.21.01

Table 2

Naturally the sample size may be small to draw conclusive statistical inferences. Consequently, and conforming with McCloskey and Ziliak (1996), our final conclusions emphasise the substantive significance of the derivative listing event more than their statistical significance. This procedure is also consistent with their argument that large sample size is more likely to lead to statistically significant results, which, on the other hand, may compromise the power of the statistical tests. Hence, we reinforce the importance and implications of derivative listing to policy maker rather than narrowing our focus on statistical significance. We completely adopt the assertion that we should "stop searching for economic findings under the lamppost of statistical significance".

2. Measures of volatility

For each of the 8 stocks, two alternative measures of volatility are estimated: the daily return variance and the market model beta. Since the volatility of the stocks may change in response to contemporaneous changes in market volatility, we adjusted the variance of the each stock by that of the market index. We used, for this purpose, the PSI Geral[4] index. Additionally, for each stock, we estimated two variances for a given sampling interval, one time for the period before the event date, and a second time for the period after the event date. We further obtained a market-adjusted variance ratio or simply the adjusted variance ratio. Hence if the derivative listing increases (reduces) the volatility net of the market wide changes relative to an average stock without derivatives contracts, this ratio would be greater (less) than 1.0.

3. Hypotheses tested

Our main goal in this paper is to examine whether derivative contracts listing by themselves have any impact on the volatility (variance and beta) of the stocks on which they are based. To achieve this we considered four alternatives, the first two considering the variances and the later two considering the betas:

A. There is no effect on the variance of each stock of a derivative listing;
B. On average, there is no effect on the variance of each stock of a derivative listing;
C. There is no effect on the beta of each stock of a derivative listing;
D. On average, there is no effect on the beta of each stock of a derivative listing.

[4] Value-weighted stock index of all BVLP stocks.

4. Methodology

If the alternative A is valid for a stock on which is based a derivative, its true variance ratio would be 1.0. If stock returns are normally distributed, a F test can then be undertaken to find out if the unadjusted or the adjusted variance ratio for a given stock is significantly different from 1.0.

On the other hand, alternative B relates to the average effect of a derivative listing on the variance of the underlying stocks. In this case, we apply the Wilcoxon signed-rank test (two-sided at the five percent level) separately to test the samples of adjusted and unadjusted variance ratios. Under the null hypothesis of no variance effect on average, the variance ratios would have a median value of 1.0 in each sample.

To test both alternatives C and D, the beta estimates for the stocks of our sample are needed. Hence, for each stock, the before-listing beta (b_i, $i = 1,...,9$) and after-listing beta ($d_i = b_i + c_i$, $i = 1,...,9$), and the difference between them (or change in the beta) ($c_i, i = 1,...,9$), are estimated from the following regression equation[5]:

$$R_i(t) = a_i + b_i R_m(t) + c_i\left[R_m(t)D(t)\right] + e_i(t),$$

where $t = -T_1,...,-1,0,1,...,T_2$, with 0 as the listing date, T_1 and T_2 are the last available trading days before and after the listing date within the 150-day sampling interval; $R_i(t)$ and $R_m(t)$ are the natural logarithms of the ratios between stock prices at moment *t* and moment *t-1* and PSI general index value at moment *t* and moment *t-1* respectively[6];. $D(t)$ is a dummy variable that assumes a value of one for $t = 1,...,T_2$ and 0 otherwise; and $e_i(t)$ is na i.i.d. error term.

Usually, in the existing literature, the beta effect of derivative listing is tested by comparing the pre-listing to the post-listing betas. This means that if derivative listing increases (reduces) the nondiversifiable risk of the underlying stock, c_i would be positive (negative). When we consider the alternative C of no beta effect at the individual stock level, we conduct a t-test to test determine if the change in beta, c_i, is statistically significant. In what concerns alternative D of no average beta effect, the median value of c_i's is expected to be zero. Therefore, we adopted the Wilcoxon signed-rank test to analyse c_i.

We should note that these tests of beta effect using the c_i's may, nontheless, be misleading in the presence of a regression tendency of the estimated betas toward 1.0, as noticed by Blume (1971). That tendency is described as follows: if the pre-listing estimated stock beta is above (below) 1.0 because of sampling error, the post-listing beta estimate would likely be lower (higher) than the pre-listing estimate. For example, Trennepohl. and Dukes (1979) and Chamberlain, Cheung and Kwan. (1993) show the average pre-listing beta is above 1.0 and betas decreases following afterwards, although they have not account for the problem. Chaudhury and Elfakhani. (1997) adapted

[5] Using the Ordinary Least Squares (OSL) method.
[6] Or simply the natural logarithms of one plus the rate of return on the stock and the market respectively.

Blume's technique to adjust the estimate of the beta change. In order to prevent from a possible regression tendency effect, we also adapted Blume's technique. In this context, we estimated the regression tendency equation by regressing the pre-listings betas on the nonevent betas. Thus, we previously estimated the nonevent betas using the return observations during 150-day period before the pre-listing 150-day interval. Subsequently, the individual beta forecasts for the post-listing period are obtained by using the pre-listing beta as the predictor variable value in the estimated regression equation. Finally, we compare the post-listing betas with the beta forecasts, instead of the pre-listing betas. Naturally that under alternative D of no average beta effect adjusted for the regression tendency, the Wilcoxon signed-rank test is considered to the deviations of the post-listing betas from the beta forecasts.

IV. Empirical Results

1. Sample results concerning variances

Table 3 shows that, although the mean increases 17% and the median decreases 3,5%, derivatives listing did not affect the unadjusted variance ratios on average (the Wilcoxon test it is not significant). So we can not reject the hypotheses that, on average, there is no effect of a derivative listing on the variance of the underlying stock.

Variance Ratios for stocks with derivative contracts

Period	June 20, 1997 to January, 12, 2001
Number of stocks	8
Variance ratios: estimated variance for period after derivative listing divided by estimated variance before	
Mean	1,17133
Median	0,966603
Number (%) of stocks with:	
Variance increase	4 (50%)
Variance decrease	4 (50%)
Two-tailed Wilcoxon signed-rank probability for change in variance	0,889
Number (%) of stocks with significant (at 5 percent level):	F test
Variance increase	2 (25%)
Variance decrease	3 (37,5%)
Adjusted variance ratios: estimated market- adjusted variance for period after derivative listing divided by estimated market- adjusted variance before	
Mean	0,876468
Median	0,748006
Number (%) of stocks with:	
Variance increase	3 (37,5%)
Variance decrease	5 (62,5%)
Two-tailed Wilcoxon signed-rank probability for change in variance	0,161
Number (%) of stocks with significant (at 5 percent level):	F test
Variance increase	0 (0%)
Variance decrease	4 (50%)

Table 3

When we analyse the results of the F test for individual stocks, two stocks experienced a significant increase in the unadjusted variance and three stocks experienced a significant decrease in the unadjusted variance. This results show that takes place a significant change in the unadjusted variance for some of the underlying stocks. So, we can reject the hypothesis that there is no effect of derivatives listing in the variance of the underlying stock.

On average, the adjusted variance decrease 13,4% and the median decrease 25,2%, but this effect is not significant when we look to the Wilcoxon test. So we can not reject the hypotheses that, on average, there is no effect of a derivative listing on the adjust variance of the underlying stock.

The F test results for adjusted variance are: zero stocks with a significant increase in the adjusted variance and four stocks with a significant decrease in the adjusted variance. So, the derivatives may have some stabilization effect in the adjust volatility of the underlying stock. We can reject the hypothesis that there is no effect of derivatives listing in the adjusted variance of the underlying stock.

2. Sample results concerning betas

As reported in table 4, when we compared the estimated beta after the derivatives listing with the estimated beta before the derivatives listing, there is no effect, on average, in the systematic risk of the underlying stocks (the difference are no significant – Wilcoxon test). So, we can not reject the hypotheses that, on average, there is no effect of a derivative listing on the systematic risk of the underlying stock.

The individual effect, as we look to the t-test results, shows a significant increase in systematic risk for one stock and a significant decrease in the systematic risk for another underlying stock. So, we can reject the hypothesis that there is no effect of derivatives listing in the systematic risk of some of the underlying stocks.

The comparison of post-listing and forecast betas supports the conclusion just presented for the beta of the underlying stocks, and that this effect is not merely a result of a possible regression tendency of the estimated betas.

Betas for stocks with derivative contracts

Change in beta: estimated beta for period after derivative listing minus estimated beta before	
Period	June 20, 1997 to January, 12, 2001
Number of stocks	8
Mean	-0,08906
Median	-0,07645
Number (%) of stocks with:	
Beta increase	3 (37,5%)
Beta decrease	5 (62,5%)
Two-tailed Wilcoxon signed-rank probability for change in variance	0,484
Number (%) of stocks with significant (at 1% percent level):	t- test
Beta increase	1 (12,5%)
Beta decrease	1 (12,5%)
Regression tendency of beta: June 20, 1997 to January, 12, 2001	
Number of stocks	8
Mean pre-listing beta	1,304099
Mean post-listing beta	1,215036
Mean forecast beta	1,233953
Comparing pre-listing beta and forecast, Number (%) of stocks with:	
Beta increase	3 (37,5%)
Beta decrease	5 (62,5%)
Wilcoxon test p-value	0,401
Comparing post-listing beta and forecast beta, Number (%) of stocks with:	
Beta increase	4 (50%)
Beta decrease	4 (50%)
Wilcoxon test p-value	0,779

Table 4

V. Conclusions

The main conclusions of this paper are as follows.

On average we did not find significant differences in the variance (unadjusted and adjusted) for the underlying stocks after derivatives listings. We can not reject the hypothesis that, on average, the listing of derivatives has no effect on the total risk of the underlying stocks.

On average, we did not find significant differences in the beta for the underlying stocks after derivatives listings. We can not reject the hypothesis that, on average, the listing of derivatives has no effect on the systematic risk of the underlying stocks.

Some of the underlying stocks experienced a significant increase or decrease in the variance after the derivative listing. Hence, we can reject the hypothesis that the derivatives have no effect on the total risk of some of the underlying stocks, that is, when we consider the stocks individually, we are not able to reject the hypothesis.

Some of the underlying stocks experienced a significant increase or decrease in the beta after the derivative listing. Consequently, we can reject the hypothesis that the derivatives have no effect on the systematic risk of some of the underlying stocks individual considered.

The results on the beta of the underlying stocks, is not a result of a possible regression tendency of the estimated betas.

Finally, the introduction of the derivatives market, in the Portuguese case, did not has the average stabilization effect on the risk detected in other markets by, for example, Basal, Pruitt and Wei (1989), Bessembinder and Seguin (1992), Chaudhury and Elfakhani1(1997), Conrad (1989), and Trennepohl and Dukes (1979). On the other hand, when we considered the adjusted volatility, the results point to some possible stabilization effect, although not significant on average, but still detectable on an individual basis.

The conflicting conclusions mentioned above seem to persist in our results, which indicates the need for continued study into the subject of stocks and derivatives relationships.

The existence or not of a volatility effect is relevant namely to the Portuguese institutional investors. A decrease in volatility of futures and options listing would benefit stock market participants and would justify and promote the derivatives market. An increase in volatility would constitute a good reason to pressure to further regulate derivatives trading in general. In either case, the issue is of most importance to the growing practice of portfolio insurance during recent years that, in turn has also been criticised for emphasising stock market volatility.

VI. References

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