The impact of stock spams on volatility

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Abstract

This paper is dedicated to study the impact of stock spams through the analysis of the variations of volatility. We use the methodology of event studies on a sample of hundred ten firms quoted on emerging market, namely the penny stock market.

The results show positive and significant changes in volatility during 12 days of the event window; a widening of the variation [lowest price - highest price] was noticed following the consignment of messages by the spammers. The sending of stock spams affected the behaviour of investors, indicating thus that the spamming activity is a lucrative business.

Keywords: stock spam; event studies; volatility; penny stock; emerging market
JEL classification: G14, D84, C12

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I. Introduction

Spam is not only a means used to send massively unsolicited advertising messages. Hackers, now, use this practice to influence stock prices and push up the values of certain securities. The spammer launches a campaign to promote the stocks of a society by sending e-mails massively: he purchases stocks of a society for which the price is low, sends spams to artificially increase the stock value and then resells them with profit. The stock spam targets securities whose share price is relatively low; the targeted society generally is not conscious of the abusive use of its mark or its social denomination in the spams for speculative purpose.

Stock spams are increasing on Internet. So, it's interesting to wonder whether this phenomenon affect really the volatility of prices. To do this, we are going to use the event studies methodology. It is a method which allows analysing the reactions of market to a given event. Since Fama et al. (1969), event studies have become a reference method in finance. Today, this methodology is fluently applied to test the informational impact of different events, notably the announcements of alliances or mergers and acquisitions (Hubler and Meschi, 2000; Guards, 2003; Woolridge and Snow, 1990), announcements of annual earnings (Mignon and Lardic, 2003), stock repurchases (Mai and Tchemeni, 2000), etc…

In this work, the event is stock spams. To our knowledge, only four studies are available on this topic: Bohme and Holz (2006), Frieder and Zitterain (2007), Hanke and Hauser (2008) and Bouraoui (2009, 2010). Bohme and Holz (2006), Frieder and Zitterain (2007) and Bouraoui (2009, 2010) were interested in studying the impact on volumes and returns. Whereas, in the study of Hanke and Hauser (2008), the authors highlight the impact on volatility, but by using a panel regression.

Our main contribution in this paper is threefold. Firstly, we study the impact on volatility while using the event studies methodology. Secondly, we take into account the assumptions associated with the implementation of the method of event studies which are not always verified empirically, such as normality, independence and homogeneity of variances between securities, and stability of variance over time. Thirdly, we employ an updated database which contains firms recently targeted by the campaigns of spam in order to know if spammers always succeed in affecting the behaviour of investors.

The impact of the occurrence of new information on the price of financial assets has already been the subject of considerable attention for more than forty years. However, the effect of financial informations on the second moment of the conditional distribution of returns (volatility) is very little approached.

The purpose of this paper is to provide an answer to the following question: does stock spam have a significant effect on volatility? If so, does it increase the volatility or decreases it? To this end, this article unfolds as follows. Section II examines the origin as well as the working of stock spams. In section III, we present the methodology of event studies. In the fourth section, we set our data. Empirical results are reported and discussed in section V. Finally, section VI concludes.

II. Stock Spams

Since the existence of Word Wide Web, resources are democratized and the flow of information circulating on the networks has been increasing. However, the content of information didn't always evolve in the right sense and various people understood quickly how to use these resources abusively.

The spams, called as spamming or mail-rubbish, are used to designate the non-solicited electronic mails having an advertising character. This expression comes from a Monty Python's sketch (name of troop of English comedies) in which the word spam

(contraction of "spice ham", English brand of sausage) is repeated constantly in order to incite the listeners to become consumers. The first goal of spam is to make advertisement at low cost by massive dispatches of electronic messages. Frieder and Zittrain (2007) note that this curse represents more than 65% of e-mail traffic.

The National Commission of Computer science and Freedom of France performed a study in which it tried to classify spams according to two different classifications: the first one according to the target: it found that 85 % of spams aim at individuals, while 15 % only are intended for firms. The second classification is according to the language in which spams are written: 84.8% of spams are written in English against only 8% in Asian and 7% in French origin. The proportion of spams in other languages is negligible. Later, spams written in English were classified according to several themes; and it proved that messages advertising stock exchange and financial products occupy the second place with a percentage of 40% behind messages with pornographic character or proposing formulas of meeting that reach 42%. In the same context, Sophos, a specialist in protection of corporations against spams, established a classification of twelve main issuing countries of spams between July 2006 and October 2006. The table 1 reveals the important place occupied by USA with a percentage of 21.6%, practically twice of China which follows with only 13.4%. The complete list of the twelve countries is the following:

Table 1: The main issuing countries of spasm

Rank	Country	Percentage
1	USA	21.6 %
2	China (& Hong Kong)	13.4 %
3	France	6.3 %
3	South Korea	6.3 %
5	Spain	5.8 %
6	Poland	4.8 %
7	Brazil	4.7 %
8	Italy	4.3 %
9	Germany	3.0 %
10	Taiwan	2.0 %
11	Israël	1.8 %
12	Japan	1.7 %
	Other countries	24.3 %

Source : Sophos[1]

The spread of wrong information about stock exchange is an efficient means to act on the value of securities for dishonest aims of speculation, and with the development of Internet, it becomes simple and easy to reach a big number of investors.

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[1] http://www.sophos.fr/pressoffice/news/articles/2006/11/dirtydozq306.html

Stock spams are based on a simple principle; the spammer starts by buying gradually a big number of stocks. Then, he sends false information about the share prices by mail in order to encourage potential investors on a bad way. Unfortunately, investors believe in such information and buy securities with significant amounts. As a result, brutal increases in share prices take place. Finally, the dishonest speculator, the originator of all these activities, sells stocks at higher prices. The following figure illustrates an example of a stock spam encouraging investors to buy securities of Diamond Film, a company specializing in environmental protection in Canada.

Figure 1: Example of stock spam

Source[2]

Bohme and Holz (2006) studied the impact of stock spams on financial market between November 2004 and February 2006. On the basis of 7606 messages, 111 stocks have been targeted. They used a multiple regression model and found that the volume on a stock exchange security mentioned in a spam increased 215.2% on average. This number falls to 154.1% when the message is transmitted before the opening hours of the market. The impact on returns was also studied; by implementing the methodology of event studies, they note that prices climb of +1.7% the first day of the campaign. Frieder and Zittrain (2007) led the same type of survey for the period of January 2004 until July 2005; they showed that a spammer makes in two days a medium benefit of 4.9 % of the share value, while the investor sees his investment, in two days, falling of 8 %. They also noted an increase of volumes and positive returns of the stocks touched by spams. Similarly, Hanke and Hauser (2008) were also interested in studying the effect of stock spams on return, volatility and turnover. They constituted a sample of 235 firms that were the subject of spam during 2005. Besides the presence of significant and positive impact on all the three variables during the first day of the

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[2] http://www.infos-du-net.com/image/Spam-image,0101-5735-712----jpg-.html#

event, the authors emphasize two results. Firstly, they show that lack of liquidity has a strong link with the presence of impact; more the stock is illiquid, more the impact observed is important. Secondly, they find that repeated spamming on successive days generates an additional demand on behalf of investors for targeted securities. Finally, Bouraoui (2009, 2010) studied the reaction of volumes and returns further the sending of stock spams. The author finds positive and significant variations of volumes throughout the event window, while returns reacted positively the first day and negatively the following days.

This leads us to conclude that spams can affect and mark the presence of an abnormal activity on market. In order to study the impact on volatility, we implement the event studies methodology.

III. Methodology of event studies

Event studies enable to measure the informative relevance of an event, notably the analysis of the behaviour of share prices at the arrival of information. They are based on the idea according to which financial markets react immediately to new information susceptible to affect the future profitability of the society (Hubler and Meschi, 2000). Empirically, an event study consists in determining an abnormal volatility at the date of announcement of the event. This abnormal volatility is interpreted as the measurement of the impact of the event on share prices.

Mackinlay (1997) identifies seven stages for the implementation of this methodology.

III.1 Stage 1: Definition of the event

The first stage of an event study consists in defining the event and identifying the period during which this event will be studied, called « event window » or « period of test ». In this paper, as mentioned in the introduction, the event is stock spams. Regarding the event window, and unlike others papers which take a period of test centred around the date of event (Hubler and Meschi, 2000), we choose a period of test of length 15 days which starts at the date of sending spam and spreads until the fourteenth day. Indeed, the stock spam is an advertising message which brings a private and little known information. So, we cannot fear flight of information of the type of those that can precede the official announcement of merger and acquisitions or earnings. Bohme and Holz (2006) led the same type of reasoning on an event study by returns; they chose an event window which begins at the date of announcement and extends until the fourth day.

III.2 Stage 2: Selection criterion

Once the event is defined, it is necessary to determine a selection criterion, *i.e.* a criterion on which the event study will be based. The majority of works on this topic have used either the volumes or the returns. In this paper, we chose volatility as criterion.

The volatility of a stock exchange security indicates in which amplitude the price of this security can vary, to the rise as to the fall, relative to its average price, over a period of time. The volatility of assets is all the stronger as the market prices are unstable. This is in particular observed following an event concerning the security in question. However, assuming that volatility is constant over time amounts to suppose that the event specific to the firm does not affect the risk of its security.

Volatility must be estimated because it is not directly observable. For that, several methods can be used whose principal ones are:

- Squared return (Harris, 1987 ; Dravid, 1987) :

$$VT_{it} = R_{it}^2 \qquad (1)$$

- Absolute value of return (Crouch, 1970; Teiletche and Lespagnol, 2005) :

$$VT_{it} = |R_{it}| \qquad (2)$$

- The difference between the highest price and the lowest price (Parkinson, 1980; Alizadeh et al., 2002) :

$$VT_{it} = Ln(\frac{H_{it}}{B_{it}}) = Ln(H_{it}) - Ln(B_{it}) \qquad (3)$$

Where H_{it} and B_{it} are respectively the highest and the lowest prices of security i on date t.

The first two measurements are rather adapted for high frequency data (intra-day data), which is not the case for our study[3]. In addition, Parkinson (1980) and Alizadeh et al. (2002) show that the use of the highest and the lowest prices of the same day, in comparison with the first two measurements, gives a better estimation of the true volatility. For these reasons, we adopt the third method to measure volatility.

### III.3 Stage 3: Normal volatility – Abnormal volatility

To assess the impact of an event, it is necessary to calculate an abnormal volatility or an excess of volatility due to the event. The abnormal volatility is the difference between the observed volatility and the normal or theoretical volatility. The last one is the volatility that we would normally have observed in the absence of event; it must be modelled over a period preceding the period of test called "the estimation window".

III.4 Stage 4: Estimation window

The estimation window precedes the event window. It is much longer than the period of test; generally it has a length equal at least three times the length of event window in order to have enough number of observations for estimation. In our survey, we choose 146 observations[4] preceding the date of event. We must in particular ensure that the two windows do not overlap to prevent that the impact of the event is not found in the estimator and to avoid, thus, that the study is skewed.

The estimation window (L_1) and the event window (L_2) can be schematized as follows:

Figure 2: Estimation window and event window

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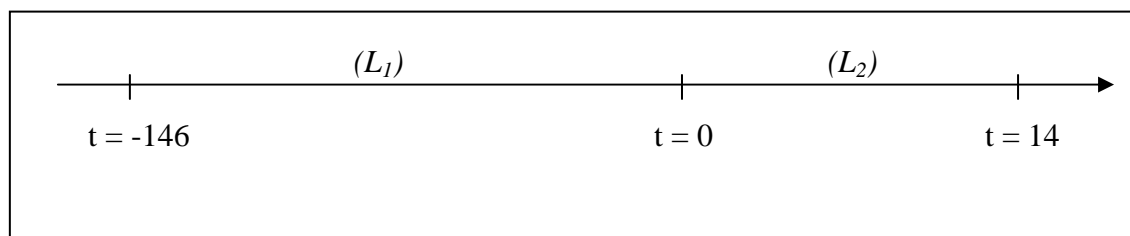
[3] We have daily data. These will be presented in the section IV.
[4] It is the maximum number of observations that we retained following the unavailability of historical stock quotes for some securities.

III.5 Stage 5: Test of hypothesis

After having identified the estimation window, the abnormal volatility can be calculated. At this stage, we set up a test of hypothesis, *i.e.* a null hypothesis H_0 against an alternate hypothesis H_1, in order to see if stock spams have an effect or not on volatility.

III.6 Stage 6: Empirical results

It is the stage of analysis of abnormal volatilities by implementing the appropriate statistical tests.

III.7 Stage 7: Interpretations and conclusions

At this stage, we conclude if stock spams affected or not the volatility of targeted securities.

If the event studies methodology has the advantage of being validated and tested on various works, it supposes, however, some statistical properties which, unfortunately, are not always checked empirically. Theoretically, the method supposes that:
- The data are distributed according to a normal law.
- The volatilities of securities are independent and identically distributed (*iid*).
- The variance is constant over time.

In this paper, we consider each of these three hypotheses in applying the methodology on our data.

IV. Data

The data used to lead our empirical study are extracted from the website *<http://www.spamnation.info/stocks/>*. This website lists all firms targeted by stock spams since 1999. But, to have the history of daily volumes for each stock, we used the *Datastream* database. In the beginning, we constituted a sample of 180 firms. However, the unavailability of historical prices for some companies, considering the majority of them have just been created, led us to remove them from the sample. Moreover, other securities had missing quotations on several days. These securities were also excluded from the sample. Finally, we kept only 110 firms. These firms fulfill the following criteria:
- They were targeted by spams after January 2006 in order to obtain the largest possible number of data for the estimation window.
- The availability of at least 100 historical prices starting from the date of sending the first spam.
- The number of missing quotations should not exceed 10.

The sample thus formed contains firms which were targeted by stock spams during the period from February 2006 to October 2008. For each firm, we have 161 daily volatility measurements (event window (15) + estimation window (146)). These firms belong to varied sectors of activity; so we find companies specialized in multimedia, energy, biology, international distribution, telecommunications… Also, they are not all American; they come from different countries (Canada, China…). Nevertheless, the common point between these companies is that they are known under the name of penny stocks companies.

The penny stock term designates the stocks whose share price is extremely low. Generally, the share price is below 5 dollars, and firms which are targeted are very small and not commonly known. Another common point between these firms is that their securities are traded in emerging OTC markets, notably the Over-The-Counter Bulletin Board (OTCBB) and the Pink Sheets, which are less controlled than the main stock exchanges. These markets do not have a physical place as the NYSE or the AMEX; they are only represented by a computer network that displays in real time the share prices. Firms quoted on these markets are speculative and highly illiquid; it is the reason for which they are targeted by advertising campaigns.

The abnormal volatility of stock i on day t is given by:

$$AVT_{i,t} = VT_{i,t} - KT_{i,t} \qquad (4)$$

Where,

AVT_{it}: the abnormal volatility of stock i on day t.

VT_{it}: the real or observed volatility of stock i on day t.

KT_{it}: the theoretical volatility of stock i on day t.

To estimate the theoretical volatility, we use the stock's average volatility over the estimation window ($KT_{i,t} = \frac{1}{146} \sum_{t=1}^{146} VT_{i,t}$). The choice of this method is justified by its simplicity of implementation. Moreover, Mai and Tchemeni (1996), in a simulation study, underline that the use of the historical average of a variable gives better specified and more appropriate results than the use of the market model or the standardized model.

With this method, the calculation of abnormal volatility obeys the following expression:

$$AVT_{i,t} = VT_{i,t} - \frac{1}{146} \sum_{t=1}^{146} VT_{i,t} \qquad ; t = 0,....,14 \qquad (5)$$

In order to appraise the informative content of the stock spam in terms of volatility, we test the null hypothesis H_0 against the alternative hypothesis H_1 at the 5% level:

$$\left\{ \begin{array}{l} H_O\text{: Absence of abnormal volatilities} \\ H_1\text{: Presence of abnormal volatilities} \end{array} \right.$$

We consider the following variables:

- $MAVT_t$: The mean abnormal volatility of all stocks for every date of the event window:

$$MAVT_t = \frac{1}{110} \sum_{i=1}^{110} AVT_{i,t} \qquad (6)$$

- $\sigma_t(MAVT)$: standard deviation of mean abnormal volatilities. It is calculated for every date of the event window:

$$\sigma_t(MAVT) = \frac{\sqrt{\frac{1}{110-1} \sum_{i=1}^{110} (AVT_{i,t} - MAVT_t)^2}}{\sqrt{110}} \qquad (7)$$

- θ_t: cross-sectional Student test; it is given by :

$$\theta_t = \frac{MAVT_t}{\sigma_t(MAVT)} \sim T_{N-1} \qquad (8)$$

V. Results

V.1 Cross-sectional Student test

In order to justify the use of this test, we have tested the heteroscedasticity of the series of volatilities. Our results[5] show that 60 securities among 110 are heteroscedastic, *i.e.* their variances vary over time. To have unbiased results, it is necessary to take into account this fact. So, we implement the cross-sectional Student test which enables to calculate a variance for each date of the event window. In order to apprehend better the impact of spams, we represent graphically the evolution of the mean abnormal volatilities during the period of test.

According to table 2, we note that the sending of stock exchange spams generated an increase in the volatility of securities on the entire event window. This increase is significant over the first three days of the event and from $t = 5$ to $t = 13$. Furthermore, we record the biggest abnormal variation of volatility (+8.79 %) in $t = 0$. The evolution of the mean abnormal volatilities (fig. 3) shows clearly this impact on the first day, then its progressive reduction until the fifth day where we note the weakest rise of volatility (+0.8%). Nevertheless, this last increase is not significant, and given that the mean abnormal volatility of the previous day (4th day) is also not significant, it lets us think that the impact has lasted only during the first three days. However, we realize from the 6th day the appearance again of a significant impact which continued until the date $t = 13$. But, this impact on the second interval of the event window [t=5; t=13] is less important than the one observed on the interval [t=0; t=2]; the increase in volatility over the second period varies between +3.77% (14th day) and +4.67% (6th day).

It should be noted that this increase in volatility is associated with a rise of volumes on the one hand, and a rise of returns followed by a fall, on the other hand[6]. Indeed, volumes and volatilities have evolved in the same sense. Increased movements of transaction (purchases and/or sales) on securities targeted by stock spams have led to a widening of the range [lowest price - highest price]. These results corroborate the works of Crouch (1970), Harris (1987) and Jain and Joh (1988) who showed a positive relationship between volume and volatility.

On the other hand, the increase in volatility is put in parallel with as well an increase as a reduction of returns. This can be interpreted as follows:

- If the increase of volatility is accompanied by an increase in returns: the answer of investors to the messages of spammers by purchasing massively securities raises the prices. Consequently, the difference between the highest and the lowest price of the day emphasizes an important variation. In this case, the widening of the range is rather from the side of the highest price. This seems to corroborate the work of Gallant et al. (1992) and Hanke and Hauser (2008) who show a positive relationship between return and volatility.
- If the increase of volatility is accompanied by a decrease in returns: investors, having a very modest budget, cannot invest in shares quoted on known stock exchange as the NYSE or the NASDAQ. When they receive the message from the spammer, they believe in the information contained there in the hope of becoming rich and making fortunes. Hence, they respond positively to the

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[5] Results are not reported here. Nevertheless, they are available by the author upon request.

[6] In previous papers respectively relating to the impact of stock spams on volumes and on returns, we have obtained positive and significant variations in volume over the entire period of test. However, returns were affected positively the first day of the event and negatively the following days.

request of the spammer by buying securities with large quantities. However, when they realize the next days that prices did not climb as that was promised in messages, they try to get rid of securities by selling them at low prices. The movement of sale with significant quantities leads to an increase in the fluctuation in prices. The widening of the difference between the highest and the lowest price, in this case, is generated by a reduction in the lowest price. These results are consistent with those of Pindyck (1984) who attributes the decline in return of the NYSE market index during the period 1965-1981 to an increase in volatility. Similarly, French et al. (1987) find that the volatility of S&P is negatively related to return.

The consignment of stock spams has generated positive and significant mean abnormal volatilities over 12 days. So, we reject the null hypothesis H_0. The appearance of new information, which is in our case the messages of spam, increased uncertainty about the penny stock securities. This uncertainty resulted in a rise of the volatility of share prices following the increase in the movement of transaction.

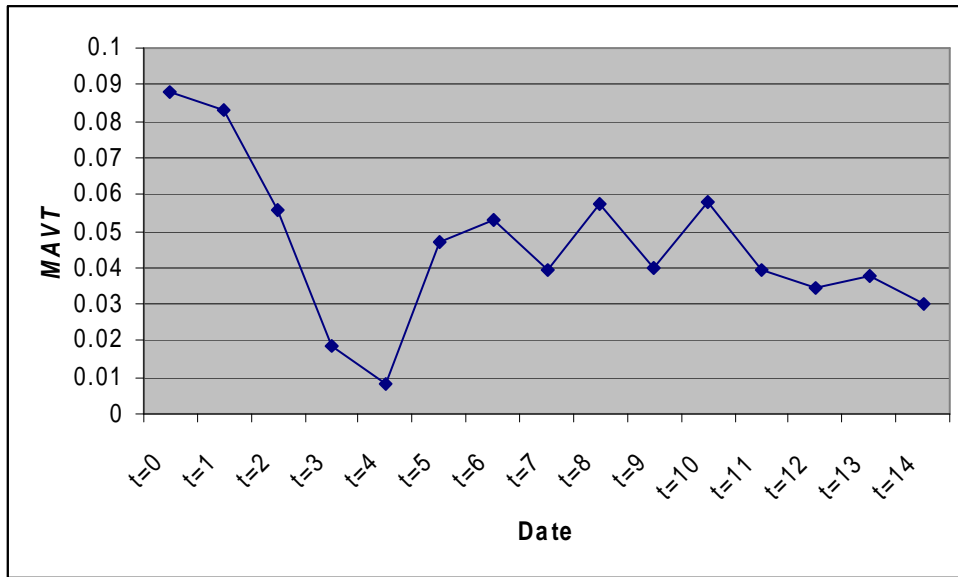Table 2: <u>Mean abnormal volatilities (%) and statistics of Student</u>

Date	$MAVT_t$ (%)	θ_t
0	+8.79	2.980**
1	+8.31	3.764***
2	+5.55	3.012**
3	+1.84	1.249
4	+0.8	0.603
5	+4.67	2.213*
6	+5.28	2.454*
7	+3.92	1.994*
8	+5.73	3.124**
9	+4.01	2.555*
10	+5.79	2.857**
11	+3.94	2.612**
12	+3.43	2.226*
13	+3.77	2.240*
14	+3.01	1.693

* significant at 5%
** significant at 1%
*** significant at 0,1%

Fig. 3: <u>Evolution of mean abnormal volatilities during the event window</u>

The first two limits of the event studies methodology are rather associated with the implementation of the Student test described according to equation (1). This parametric test assumes that the data are distributed according to a normal law, on the one hand, and they are independent and identically distributed *(iid)*, on the other hand. However, these two assumptions are not checked on our data[7], which is a general characteristic of financial series. So, the use of this first test can not reflect the real effect of stock spams on volatility. In order to improve and to give more robustness to our results, we apply now a second statistical test which enables to cure these limits.

V.II Cowan rank test

This second test is used in order to lift completely the hypothesis not checked by the cross-sectional Student test. It is a nonparametric test for which it is not necessary to specify the conditions that the sample has to fill. Nonparametric tests such as the sign test, the generalized sign test or the Wilcoxon signed rank test were already largely used (Berry et al., 1990; Giaccotto and Sfiridis, 1996; Campart and Pfister, 2008). However, the test of Cowan (1992), to our knowledge, has never been applied.

The statistic of the test is given by the following formula:

$$Z_{Cowan} = \sqrt{L_2} \, \frac{\overline{K_D} - E(K)}{\sqrt{\dfrac{1}{L}\sum_{t=1}^{L}\left(\overline{K_t} - E(K)\right)^2}} \sim N(0,1) \tag{9}$$

Where,

L_2: length of the event window.

$\overline{K_D}$: average rank of all stocks on date D ; $D \in [0, 14]$

$E(K)$: expected average rank : $E(K) = \dfrac{L+1}{2}$

L: length of the period of analysis (= estimation window *(L1)* + event window *(L2)*).

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[7] Results are not reported here. Nevertheless, they are available by the author upon request.

$\overline{K_t}$: average rank of all stocks on date t ; $t \in$ [-146, 14]

Under the null hypothesis of no abnormal volatilities, the test of Cowan allows to compare the average ranks of each date of the event window with the expected average rank calculated over the complete period of study. To implement it, we have to firstly transform, for each firm, the series of abnormal volatility into their respective ranks. These ranks are defined in ascending order: rank 1 and 161 correspond respectively to the lowest and the highest abnormal volatility in the series.

The results of this test are reported in table 3.

We realize that results are not sensitive to the used statistical test. As we have found previously in the cross-sectional Student test, volatility, here, is also positively and significantly affected during 12 days of the period test (from t = 0 to t = 2 and from t = 5 to t = 13). The most important variation is observed during the first day of the event (100.1) where all securities are assigned by high ranks above the average rank. This reaction consists in a positive response from investors who believed in the information contained in spams. The next two days (t =1 and t =2) show a fall in volatility expressed by a reduction in the value of the average rank. This demonstrates that the effect starts to disappear gradually, especially when this degradation finishes by non significant average ranks; such is the case of days 4 and 5. However, dice the sixth day (t =5), we observe that the increase in volatility comes back to become significant; the average rank of volatilities during this day (6th day) exceeds the expected average rank and amounts to 87.7. This significant impact was continued until the 13th day.

Buyers and sellers of penny stock's securities, by their movements of transaction, contribute to increase volatility. However, the rise of volatility during the second period from t = 5 to t = 13 is less pronounced than the effect observed during the first three days. This can be explained by the fact that change in volatility during the first days is generated by a widening of the gap [lowest price - highest price] from only one side (the side of the highest price) insofar as the investors respond to spams by massive purchases of stocks, which increases the share prices. While in the second period (from t =5 to t =13), the widening of the range is rather done on both sides because the investors who were purchasers during the first period are very quickly transformed into sellers when they realize that the information to which they have responded is a swindle.

Finally, the use of the cross-sectional Student test as well as the Cowan rank test gives us the same result: stock spams have a positive and significant impact on the volatility of penny stock's securities. This finding leads us to record that the business of spamming is flourishing and continues to make money for spammers. Indeed, with the use of data more recent compared to those of the works of Bohme and Holz (2006), Frieder and Zittrain (2007) and Hanke and Hauser (2008), we expected that investors have realized that these campaigns of stock spams are scams, and therefore, no impact will be observed on volatilities. However, we find that investors still continue to believe in such information in the hope to become rich.

Table 3 : <u>Cowan rank test</u>

Date	$\overline{K_D}$	Z_{Cowan}
0	100.1	5.587***
1	99.8	5.518***
2	95.4	4.215***
3	83.7	0.813
4	85.5	1.321
5	87.7	1.962*
6	92.9	3.481***
7	89.7	2.550*
8	90.9	2.906**
9	90.8	2.880**
10	91.4	3.047**
11	92.1	3.249**
12	90.4	2.755**
13	90.5	2.802**
14	87.3	1.858

* significant at 5%
** significant at 1%
*** significant at 0,1%

VI. Conclusion

This paper has focused on the impact of stock spams on the volatility of penny stock's securities. For this purpose, we constituted a sample of 110 companies which were targeted by spams between February 2006 and October 2008. After we calculated the mean abnormal volatilities over the event window of 15 days by using the event studies methodology, we set up two statistical tests: a parametric test (cross-sectional Student test) and a nonparametric test (Cowan rank test).

The results of both tests show that stock spams affect positively and significantly the volatility of prices: a widening of the variation [lowest price - highest price] was noticed following the consignment of messages by the spammers. This seems to corroborate the works of Koski (1998) and Hanke and Hauser (2008) who also found an increase in volatility following respectively the announcement of stock splits and stock spams. We can conclude that the spamming activity is a very lucrative business which continues to affect the behaviour of investors who still believe in wrong information in the hope to accomplish profits. However, if significant increases in volatility are observable, the effect cannot be generalized to all securities in the sample. So, it would be interesting to detail the results by studying the impact on each security. Moreover, the number of spams received per day during the duration of the advertising campaign varies from one security to another. Thus, we record for some stocks 3 or 4 messages received throughout the period of the campaign, whereas we note for other stocks hundreds of messages received during only one day. In this context, it would be also very convenient to study the extent of the impact according to the number of messages received by security.

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