An experimental study of trading volume and divergence of expectations around earnings announcement

DINH Thanh Huong, IRG - University Paris XII Val-de-Marne
GAJEWSKI Jean-François, IRG - University Paris XII Val-de-Marne [1]

Abstract

The objective is to study from an experimental point of view investors' reaction at the announcement of the annual earnings in terms of trading volume. Annual net income is seen by shareholders as the most important figure, since it is, for individual accounts, the basis of appropriation of profit by the shareholders' general meeting. In the experiment, it is announced at the end of 8 rounds of exchange. Every two periods, a fraction of the annual income is revealed to all the participants. Thus, they revise periodically their expectations of the annual results. The experiment shows that the divergence of expectations does not lower when the investors have more and more information about the final results. This is the main explanation for transactions in our experimental asset markets. However, too large a divergence prevents the investors from trading. As expected, price changes in absolute value influence trading volume. But this effect is smaller than the impact of heterogeneity of expectations.

JEL Classification: *C91 – D84*

Key-words*: trading volume, heterogeneity of expectations, earnings announcement and experimental asset markets.*

Second version: June 2005

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[1] IRG (Institut de Recherche en Gestion – Université Paris XII Val-de-Marne – 61 avenue du Général de Gaulle - 94010 Créteil cedex – France (Tél. : 33 1 41 78 47 52 – Fax : 33 1 41 78 47 34)). Email: tonamiskh@yahoo.fr and gajewski@univ-paris12.fr. The experiments have been made at CIRANO (Center for Interuniversity Research and Analysis on Organizations). We are indebted to Claude Montmarquette for his precious help and Julie Héroux for technical assistance in conducting this research. Financial support for this research was provided by IRG and CDC Institute for Economic Research (Caisse des Dépôts et Consignations). We especially thank Isabelle Laudier. Finally, we have benefited from helpful comments on a preliminary version at the ISINI conference in Lille (2003), at the Northern Finance Association meeting (2004).

1. Introduction

Under efficient market hypothesis, stock prices instantaneously incorporate the whole set of available information. Thus, they reflect the fundamental stock value. Beyond efficient market theory, the theorem of no trade predicts that if prices immediately adjust to a change of fundamental value after any information revelation, no trade should occur. This theorem refers to the risk-neutral rational expectations model without asymmetric information.

Under these conditions, there are trades only when the investors anticipate a change in asset value or have no common knowledge or have biased expectations. According to the first condition, theoretical and empirical studies show that prices cause trades. From a theoretical point of view, by Kim and Verrecchia (1991) demonstrate that trading volume around earnings announcements is proportional to absolute price changes. According to Karpoff's survey (1987), an increase of absolute prices should be associated with a rise in trades.

According to the second condition, the lack of common knowledge between traders, due to asymmetric information or beliefs' heterogeneity, could explain trades around earnings announcements (Kandel and Pearson, 1995; Bamber, Barron and Stober, 1999). The divergence of interpretations concerns either the difference in sets of information owned by the investors at the time of publication or the heterogeneity of beliefs on the basis of the same set of information. The first situation appears when there is asymmetric information between traders. In this case, trading volume is an increasing function of absolute price changes and the precision of investors' private signals. In a heterogeneous structure of information, it may be possible to infer information from trades not revealed by prices. A large change of trading volume could signal the presence of informed traders on financial markets. Other papers (Kandel and Pearson, 1995) make the assumption of a homogeneous structure of information. All the investors receive the same information (for example the annual results). Thus, trading volume is explained by the dispersion in initial beliefs and the idiosyncratic interpretations of information. Ziebart's (1990) paper characterizes this second component as the mean revision of expectations due to the announcement.

Bamber and *al.* (1997) characterize opinion dispersion, called investors' disagreement, by the three following factors: initial beliefs' dispersion (the variance of expectations preceding the announcement), the change of this dispersion (the difference between the dispersion after and before the announcement) and the jumbling of beliefs (the change of one investor's beliefs relatively to others').

However, empirical studies are unable to directly measure the heterogeneity of investors' beliefs. They are estimated by the dispersion of financial analysts' forecasts around the announcement. This proxy can be put into question as financial analysts represent a small fraction of the whole set of economic agents (Atiase and Bamber, 1994). Moreover, they have positions different from the other agents. They are often more informed and more qualified than the individual investors. Finally, their behaviour strictly depends on their interests and utility functions. This induces specific biases, like overoptimistic bias.

In this context, the experimental method may be of particular interest for this kind of research. The effects can be observed directly in a controlled environment and the variables influencing trading volume can be isolated from other effects, which cannot be done in traditional empirical works.

The objective is thus to study the path of trading volume around earnings announcement by using the experimental method. There are three main contributions. First, traders' heterogeneous expectations are considered instead of being approached by financial analysts' forecasts. Second, the experimental methodology isolates the heterogeneity of expectations from asymmetric information as all the investors own the same set of information. The net income is published after the revelation of 4 quarterly results every two periods. The continuous flow of public information makes it possible to study the path of trades around earnings announcement. Third, this structure of homogeneous information allows us to analyze further the links between trading volume, stock price variation and the heterogeneity of expectations. This relation is checked in a deeper way with different degrees of divergence between analysts' forecasts. Two structures of information are built with different standard deviations. The second structure of higher standard deviation should logically lead to a higher divergence of investors' expectations. Instead of an increasing linear function, we observe a concave relation between trading volume and the divergence of expectations.

In spite of a common structure of information, the experiment shows that there are trades between the participants. These trades are explained by stock price changes and the heterogeneity of expectations. The second element is the main explaining factor of trades, when the divergence is not too high. Above a given threshold, the divergence does not lead to any trade. Conversely, the average change of investors' anticipations does not influence trades. The present study also puts forward an effect of prices on trades, which strengthens some prior works concluding that absolute price changes should entail portfolio reallocation. It also appears that divergent expectations may emerge even in a world of homogeneous information, a result similar to Gillette et al. (1999). According to these results, some investors do not seem to believe in a rational reaction of other agents and submit orders. As a consequence, market uncertainty depends not only on the process of how to determine the fundamental stock value but also on agents' motivations. They warrant liquidity of our experimental asset markets. For example, an optimistic trader willing to buy may not find any counterpart if no other trader wants to sell in the same period.

2. Research hypotheses

Obviously, interim figures are actually perceived as an imprecise indicator of the annual results. The picture becomes more and more detailed as the year's end approaches. According to this logic, as the number of periods increase and the publication of the final results approaches, the earnings expectations should become more and more homogeneous and converge towards the value of the earnings.

Hypothesis 1: *Participants' estimations of the final results converge towards the annual results as the number of periods increase. This convergence is all the faster as interim results are announced.*

The heterogeneity of investors' earnings expectations positively affects trading volume, when it is not too strong. Beyond a given threshold, the probability of two opposite orders to be matched lowers. When the expectations differ too much from one investor to another, the placing orders should be widely different. At the highest, the investors would take into account other agents' behaviour, which makes the orders converge in the same sense and lowers the amount of trades. This suggests that there exists a

threshold of divergence under which the heterogeneity positively affects trading volume. Above it, the impact of divergence on trading volume becomes negative.

Hypothesis 2: *the relation between trading volume and divergence of investors' expectations is concave.*

In the present study, several degrees of dispersion are considered as two different structures of information. The first is built in order to entail less uncertainty than the other. Participants' earnings expectations should be logically less heterogeneous in the first structure than in the second. An increasing and linear relationship between dispersion and trading volume should be observed in the first structure of information. Conversely, this type of relationship should be not valid in the case of the second structure.

Hypothesis 2.1: *in the case of the first structure of information (where expectations are not too divergent), trading volume is an increasing function of the dispersion of investors' earnings expectations.*

Hypothesis 2.2: *In the case of the second structure of information (where expectations are very divergent), the linear increasing relationship between trading volume and dispersion is no longer valid.*

The annual results contain several components, each of which being announced every two periods. The investors get more and more information as the experiment continues and consequently investors' expectations should become more and more homogeneous. All things being equal, if hypothesis 2 is checked, as the number of periods increase, the convergence of expectations lowers investors' incentive to trade.

Corollary: *Trading volume lowers as the experiment approaches to the end.*

Copeland's model (1976), extended by Epps and Epps (1976) and Jennings, Starks and Fellingham (1981) proves theoretically that volume is positively related to the

magnitude of the price change. Under the assumption of sequential arrival of information, the information leads to shifts in investors' demands, which causes trading. This is largely confirmed by empirical studies (Karpoff, 1987 for a survey).

Hypothesis 3: *The magnitude of stock price variation has a positive effect on trading volume.*

In addition, stock price deviations from the efficient price can also affect trading volume as they determine trading gains that the investors may have at the end of the experience. As a consequence, the magnitude of price errors should lead to more incentive to trade.

Hypothesis 4: *The size of previous price errors positively influences positively trading volume*

In the hypothesis above, previous price errors are used instead of contemporaneous ones, because contemporaneous errors are only calculated at the end of the period.

3. Methodology

This section focuses on our experimental methodology. We first describe the experimental markets in which the above research hypotheses will be examined. We then turn our attention to the determination of test parameters.

3.1. The description of experimental markets

Participants and incentive

Overall, the number of participants amounts to 91, divided into 11 markets. Each market counts 7 to 10 unqualified students[2]. Using large markets is easier to characterize the divergence of individual reactions. The participants have no special knowledge in

[2] The present experiment only demands the participants to have reasonable scientific knowledge. No specific knowledge is required, since several experimental studies have shown that a high level of skills is not necessary to make the experiments successful.

finance. They are invited to attend an initial formation and receive detailed written instructions[3].

The participants receive an initial endowment of 200 Units of Experimental Cash (UEC) and 20 shares of the same stock. They react to information they get (earnings announcement, orders, prices and trades). By assumption, their objective is to maximize their final wealth. The total gains of each participant come from their exchange gains and earnings estimates. The final gains are converted into cash ($CAD) and added to 10 $ of initial endowment (showing up fees). The rate of conversion is determined so that on average the participants receive 20 $CAD. To sum up the total gains are calculated as follows:

$$\begin{aligned} & 10\ \$CAD \\ & \pm\ Forecast\ Gains\ (\$CAD) \\ & \pm\ Exchange\ Gains\ (\$CAD) \\ & Total\ retribution \end{aligned}$$

$$\begin{cases} Forecast\ gains = \sum Forecast\ gain\ per\ period \\ Forecast\ gain\ per\ period = Max(0;5 - abs(forecast\ error\ per\ period)) \\ Forecast\ error\ per\ period = \left| \begin{array}{l} Final\ results\ announced\ at\ the\ end\ of\ the\ \exp eriment \\ - \\ Forecast\ at\ the\ beginning\ of\ every\ period \end{array} \right| \end{cases}$$

This premium pushes the participants to improve their forecast of annual earnings. It is all the highest as the individual forecast at the beginning of every period approaches the final annual results.

$$\begin{aligned} Exchange\ gains = & \Sigma\ Capital\ gains \\ & + Number\ of\ shares \times stock\ value\ at\ the\ end\ of\ the\ exp eriment \\ & - 200 \end{aligned}$$

The trading price and the fundamental stock value are measured in experimental currency. In the experiment, all the shares left at participants' disposal are bought back at the end of the session at a price equal to the fundamental stock value. Such a rule prompts the operators to speculate about stock prices.

3 See the detail of instructions in annex.

The structure of information

Conversely to the majority of previous studies, the experience here is built on a structure of information common to all the investors[4] made of a flow of information leading to the final results. This modeling fits reality as there always exists other sources of information before the final earnings announcement. They can be preliminary announcements of results or estimates of the results, or interim publications.

Therefore, the results are announced after revealing 4 components. Every two periods, one component is randomly chosen. Consequently, the investors have more and more information as the experiment continues. As the uncertainty of the results lowers, the investors' earnings estimates should be more and more precise and homogeneous. If the linear relation is valid, trading volume should decrease as the experiment approaches the end.

Two series of information of four components are proposed. They have the same mean but a different standard-deviation in order to generate different degrees of estimates' dispersion. This may help to show the predicted concave relation between trading volume and heterogeneity of expectations which may emerge from great dispersion in expectations.

Every series of four components is inspired by Gillette and al. (1999) in terms of determination of the value of the elements. Some differences are related to the definition of uncertainty and the flow of information. Firstly, in Gillette's studies, the uncertainty about the fundamental value is only explained by the random determination of its components. In the present paper, the uncertainty does not only lie in the determination of the annual results but also in the relation which links the results to the fundamental stock value. For needs of simplification, we suppose that the intrinsic value is equal to the dividend[5]. The latter is equal to the last results if they are positive and zero otherwise.

The second difference concerns the number of components and the set of values of each component. In Gillette and al. (1999), the final value is the sum of five positive elements whereas the final value here is the sum of four elements. This structure of

4 There is no asymmetric information between the investors during the experiment.

5 This hypothesis does not imply that the investors have the same estimation of the firm cost of capital or the dividend growth rate.

information approaches the real situation in which the quarterly results are announced before the annual earnings. Moreover, the series may contain negative values. Introducing negative values is of double interest. First, this means that firms may realize losses as well as profits. Second, it may help us to measure risk preferences.

Both series of information are described as follows. For the first series, the final results are made of 4 elements whose value is 0, 2, 4 or 6 with probabilities 1/4, 1/4, 1/4 and 1/4. These four elements are chosen at random and announced at the end of periods 2, 4, 6 and 8. Being the sum of these four elements, the final results belong to the interval [0; 24]. The dividend is distributed at the end of the experiment. For needs of simplification, the rate of distribution is always equal to 100%. It is stable and preannounced at the beginning of the experiment. The dividend is thus equal to the fundamental value. At the beginning of every exchange round, the students are asked to estimate the value of the results. The structure of information allows a regular estimate of the results between periods 1 and 2, 3 and 4, 5 and 6, 7 and 8. These intervals are called estimation periods. At the end of each estimation period, one element of the series of information is randomly chosen. The mean value of each component is equal to:

$$0 \times 1/4 + 2 \times 1/4 + 4 \times 1/4 + 6 \times 1/4 = 3$$

Before the first period, the expected mean value of the results is 12 and the expected fundamental value is thus 12. After drawing one component of the results, the objective anticipated results become the sum of this value and the estimates of the remaining elements. The drawing lots are executed by the computer.

For the second series of information, the determination of the annual results is similar to the first one. However, the fundamental value is determined in a different way because of one negative value into the set of possible values. As a matter of fact, the 4 elements of the series may take the values –4, 0, 6, 10 with probabilities ¼, ¼, ¼ and ¼. The anticipated mean value is thus:

$$-4 \times 1/4 + 0 \times 1/4 + 6 \times 1/4 + 10 \times 1/4 = 3$$

The annual results may vary from -16 to 40 with the mean value of 12. The rate of dividend distribution is 100% if the results are positive and zero otherwise. In this case, the fundamental value is equal to the dividend if it is positive and 0 otherwise.

The trading mechanism

Here, we use the structure of double-auction markets. This mechanism used in most stock markets seems to be the most efficient in terms of information (Theissen (2000)) as well as in terms of allocation (Gode and Sunder (1993)). The anomalies detected in this type of experimental market strictly correspond to the real ones because they do not heavily depend on market microstructure. They are mainly due to the informational attributes and the participants' characteristics like motivations, preferences, rationality and cognitive ability.

The experiment is completely computed. First of all, the stocks and the cash at students' disposal are virtually registered into an account. At each round, participants submit buy or sell limit orders. The orders (characterized by the quantity, the price and the time of entry) continuously appear on all computer screens. They are registered in a central computer that allows one to determine the execution price immediately. There is trade between two investors as soon as there are opposite compatible orders. For a buy (sell) order to be executed, any investor may submit a sell (buy) order with a price limit inferior to p (superior to p). When two orders are given the same limit, the priority depends on time. If not, all the orders which are similar in terms of price, quantity and time are proportionally executed. Short-selling is prohibited. During a period, the orders not executed may be modified or eliminated. They are not retained for the following rounds.

The path of the experiment

11 markets of 7 to 10 students are considered. Every market contains 8 rounds of 6 minutes long, 5 of which are for trades. The results become public at the eighth round after the announcement of 4 components. At the beginning of the first round, the participants are invited to estimate the annual results. This estimation stage is over when everyone has made his or her estimate. Thereafter, the participants submit orders and

trade. At the end of the second round, one component of the results is randomly chosen and made public. The objective expected results is calculated as follows:

$$First\ element + 3 \times 4$$

The objective anticipated fundamental value is therefore equal to the annual results if they are positive and zero otherwise.

The other rounds go the same direction. When one component is made public, the objective expected annual results are equal to the sum of the realized components plus the objective estimates of the remaining components. The fundamental value is always determined in the same way: it is equal to the results if they are positive and zero otherwise. The market is completely transparent. Orders and trades are continuously shown on the screens.

At the end of the eighth round, the last component is chosen randomly and the final earnings are announced. This allows the fundamental stock value to be calculated and thus the errors of investors' expectations.

3.2. The determination of test parameters

Abnormal trading volume

Within this kind of studies, the abnormal trading volume is traditionally measured by the difference between the amount of trades during the period under consideration and the one estimated over the normal period on the basis of a standard model such as the market model. In our study, the normal period is set up in a quite normal way (it is completely possible within experimental study framework) in the sense that there are neither released information nor liquidity needs. Under these circumstances, the market would be characterized by the absence of trading activities, or in other words, the abnormal trading volume is equal to zero.

Therefore, the asset exchanges occurring in the period marked by an announcement date can be considered as the abnormal trading volume, which is thus defined as follows:

$$AV = \frac{Number\ of\ traded\ stocks}{total\ stocks} \tag{1}$$

In addition to this measure which seems to be the pure indicator of trading volume, we also consider a second proxy. In this case, the trading volume is equal to the ratio of the total value traded to the market's anticipated value. Here, the value of each transaction is equal to the quantity of assets traded time the corresponding price. Concerning the market anticipated value, it is simply expressed by the total number of stocks in the market time the anticipated value of associated stocks. The final measure of trading volume is derived from the second measure by modifying the denominator element. That is, we use the final value instead of the objectively estimated market value. It equalizes the fundamental value of stock multiplied by the total number of stocks. Being different from the intrinsic value which is only calculated one time at the end of the experience, rational anticipations vary all the periods. Though all three measures mentioned above are usable, all the principal analysis and interpretations of this study is based on the first measure whose results would be the most relevant. In reality, the stock price can be erroneous. Its presence in the empirical tests may bias our results. It is worth noting that the sole object of the use of two other measures is to compare our results to those of previous studies.

Measure of the heterogeneity of expectations

The divergence of expectations is the standard deviation of individual expectations. By contrast, the homogeneity of expectations refers to the mean revision of expectations. Three measures are proposed in our study. The first one amounts to the percentage variation in expectations of a period over another specified period. The next two measures appear like the first one, except the fact that the variation in expectations is differently normalized. We respectively use the objective anticipated value of annual earnings and the final annual income instead of the previous anticipations. The errors of expectations refer to the deviation of expectations from the final income normalized either by the previous expectations, the anticipated value of earnings or by the annual earnings.

Measure of stock price variation and price errors

As the mean revision of expectations, the average variation of stock prices is determined in three ways. It refers to the difference between the current average price and the

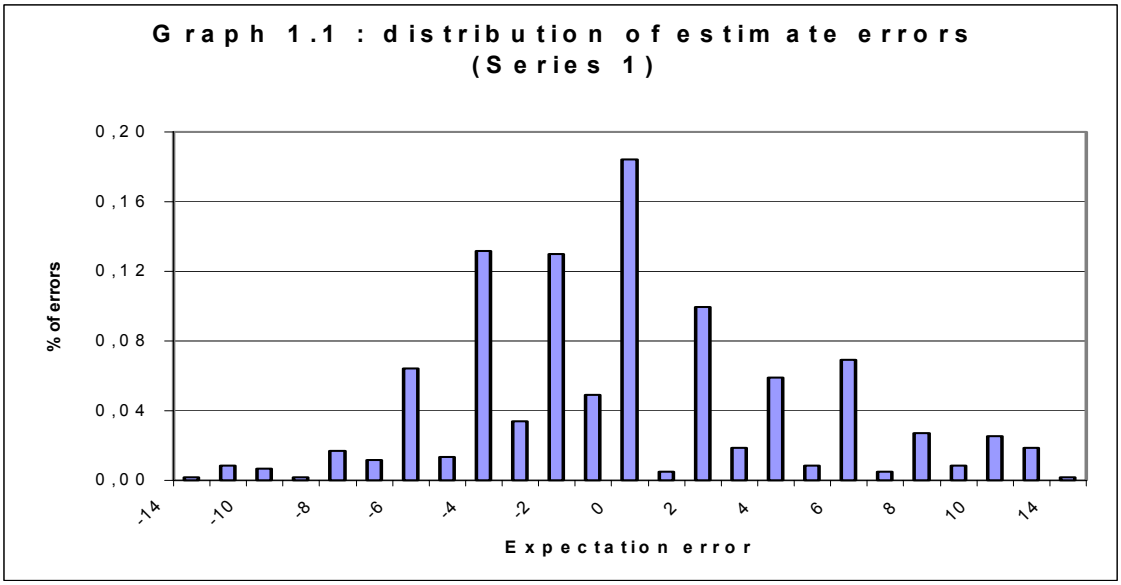
previous one divided respectively by the previous average price, the objective expectations of stock intrinsic value or the final fundamental value of stock. The price error is also calculated on the basis of the fundamental value. It is represented by three ratios whose numerators are the difference between stock price and intrinsic value. As regard to the denominators, they are different each other and correspond respectively to the average price of the previous period, the objective prevision of true stock value or the later.

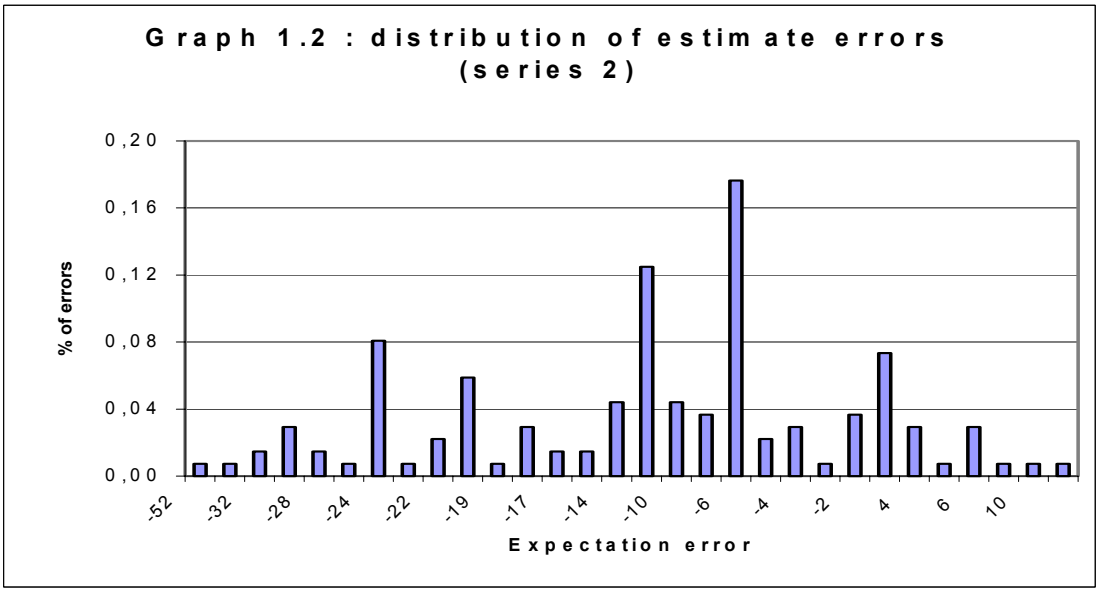
4. Results and interpretations

4.1. Statistic descriptive of earnings estimates and trading volume

4.1.1. The path of the earnings estimates

Graphs 1.1 and 1.2 represent the percentages of expectation errors of the annual results. For series 1 of information, 18% of the expectations are correct, 47% are optimistic and 35% are pessimistic. Conversely, for series 2, only 7% are correct, 9% optimistic and 84% pessimistic.





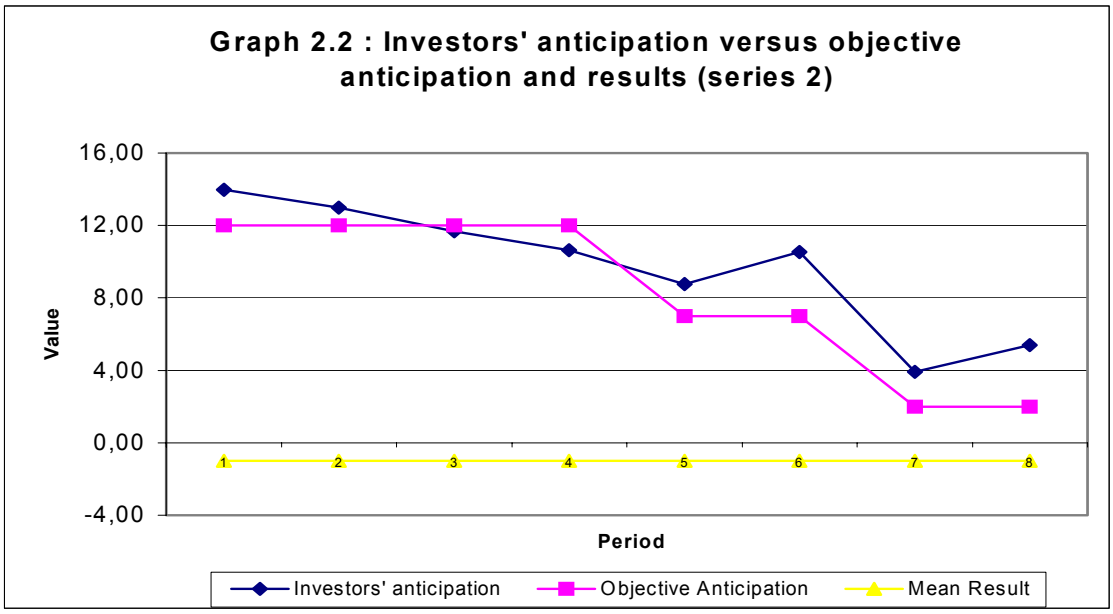
Note: these graphs are made of 728 anticipations from the 11 markets. For series 1 (series 2 respectively), 592 (136 respectively) expectations are taken into account. The unexpected errors, calculated by the difference between each estimate and the annual earnings, are represented in X-plots and the percentage of expectation errors are represented in Y-plots.

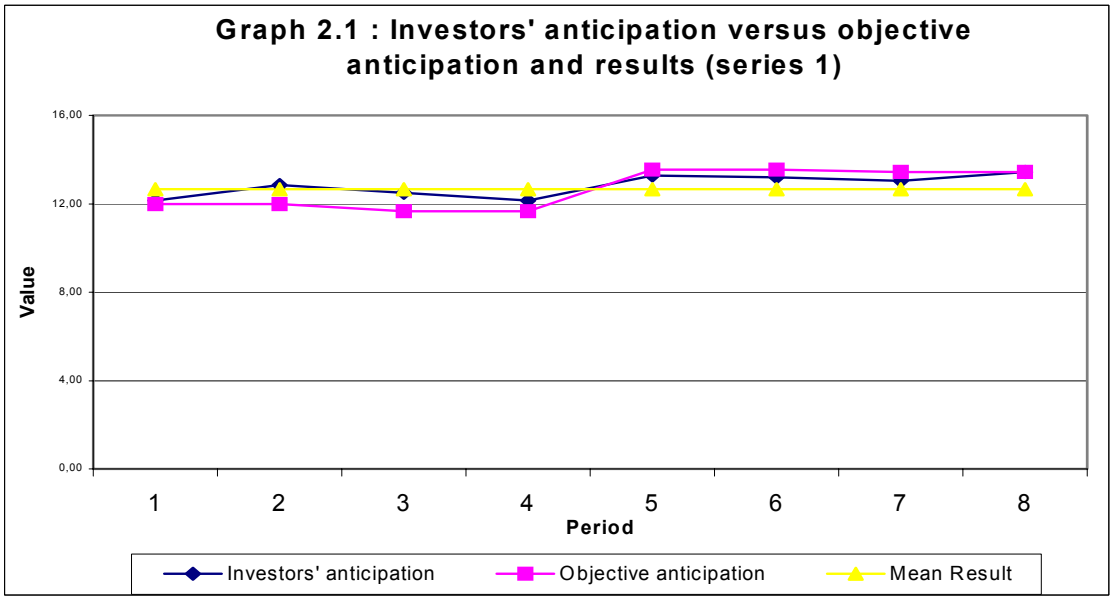
Graphs 1.1 and 1.2 show that, all rounds being equal, the unexpected errors are numerous and much dispersed. This high standard deviation of unexpected errors puts forward that the investors do not have homogeneous anticipations, even if the experiment runs in a structure of common information, i.e., without asymmetric information.

The divergence of estimates can be explained only by implicit factors different from one investor to another. Besides the diverse levels of skills and experience that directly influence the interpretation of information, the risk preferences and cognitive psychology can be the explanatory factors of this divergence. The dissimilar risk preferences can play a major role in the experiment because of the uncertainty during the experiment. This uncertainty participates to the construction of the agents' utility function and makes the preferences different from one agent to another. These preferences are a major determinant of the expectations as the individuals have a great tendency to merge their hopes with the real situation.

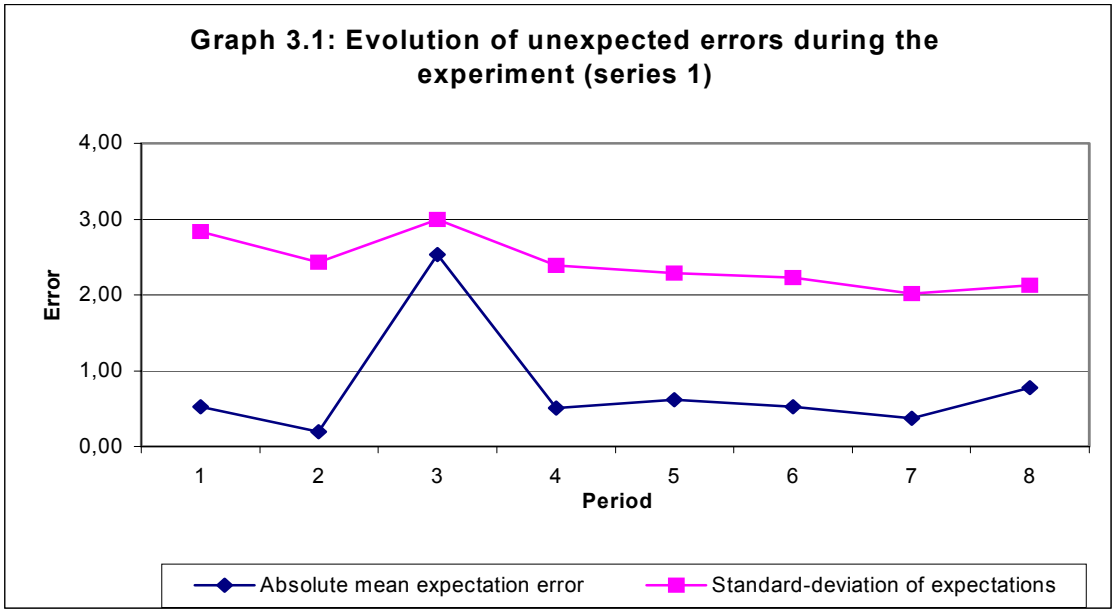
The effect of investors' risk preferences on their earnings expectations would be better defined by comparing expectations obtained from series 1 and those obtained from series 2. Considering series 2 with a negative component of the results, the expectations are more divergent and pessimistic than those of series 1. In average, the investors are not mistaken in the case of series 1, because the mean expectation error is -0.03, significantly different from zero. In the case of series 2, they are rather pessimistic with a mean expectation error of -11.15. Series 1 exhibits a standard-deviation of 4.7, whereas series 2 shows a standard-deviation of 10.78. As a matter of fact, the negative component introduces further uncertainty regarding the final results. In that case, risk preferences influence more investors' behavior. In addition to the factor of risk preference, the psychological and cognitive variables also explain the heterogeneity of expectations. In fact, the overconfident investors may think that they have skills superior to others and that others' expectations are not correct. This leads them to form expectations different from the market. As a result, the divergence of expectations increases. The lack of self-confidence can also entail estimate deviations from the fundamental value. Actually, these no self-confident investors exhibit a tendency to infer information from others' expectations, which leads to mistaken expectations.

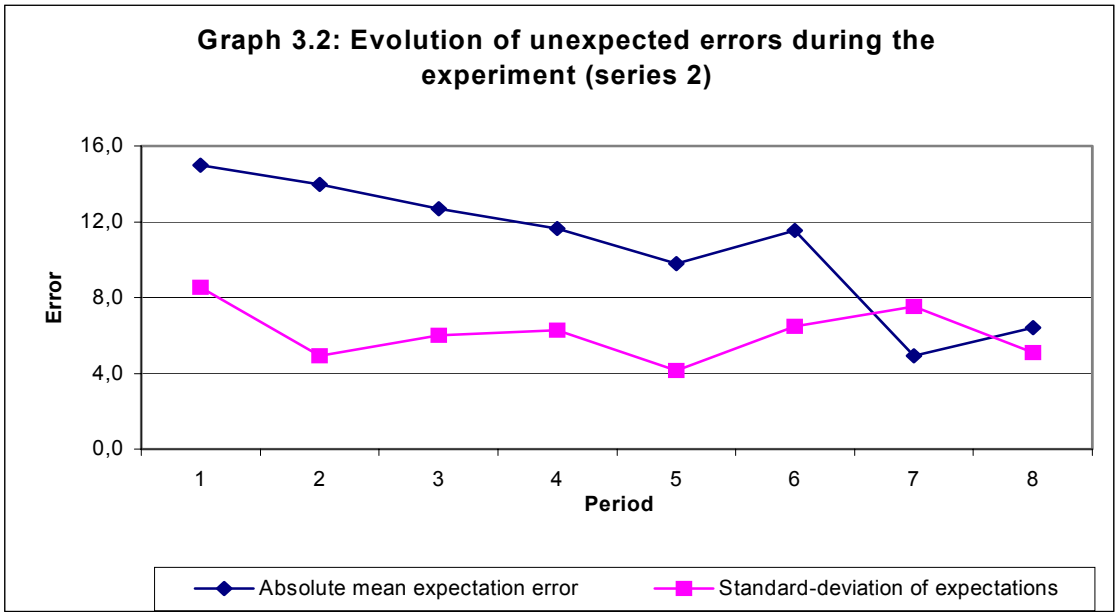
From graphs 2.1 and 2.2, a more detailed analysis of investors' expectations shows that the investors' mean expectation is lower than the objective expectation. This means that the mean expectation does not fit the rational expectations model, i.e. risk neutral and without asymmetric information.





Note: graphs 2.1 and 2.2 are made of all data from all markets. The exchange round is represented in X-plots, the anticipated results, the mean investors' expectation and the mean final results in Y-plots. The objective expectation comes from a rational expectation model without asymmetric information.





Note: Graphs 3.1 and 3.2 are made of all data from all markets. The exchange round is represented in X-plots. The expectation error and the standard deviation of expectations are represented in Y-plots. All the data considered in the above graphs are calculated in average on the basis of each round.

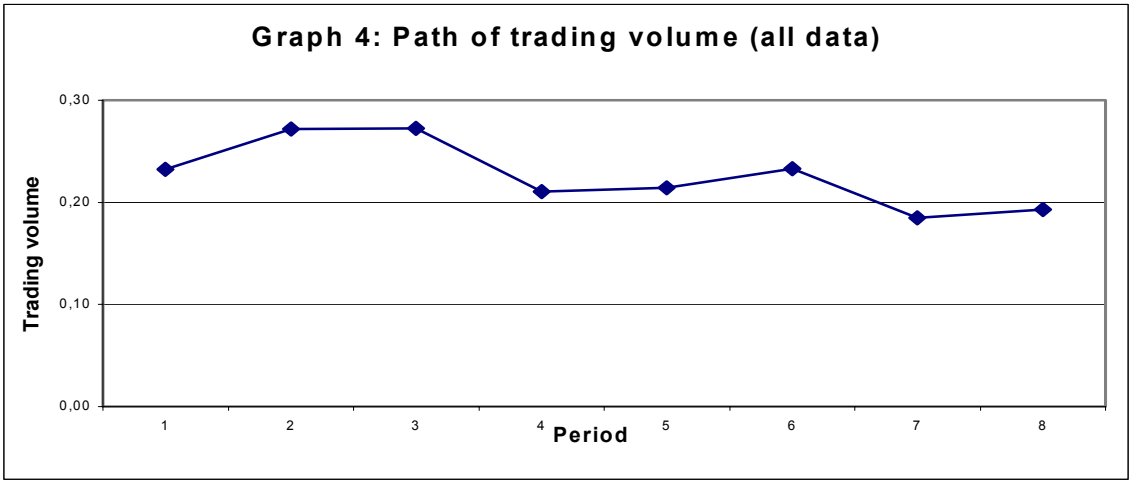
Graphs 3.1 and 3.2 show the evolution of the mean error and the standard deviation of estimates during all rounds. The evidence proves that expectation errors do not immediately converge towards 0 and the standard deviation does not significantly lower. Progressively announcing the results through the revelation of the components does not make investors expectations more homogeneous. Hypothesis H1 is not valid. In other words, the earnings expectation approaches its final value of the results, but with a delay. There are two possible explanations in this case.

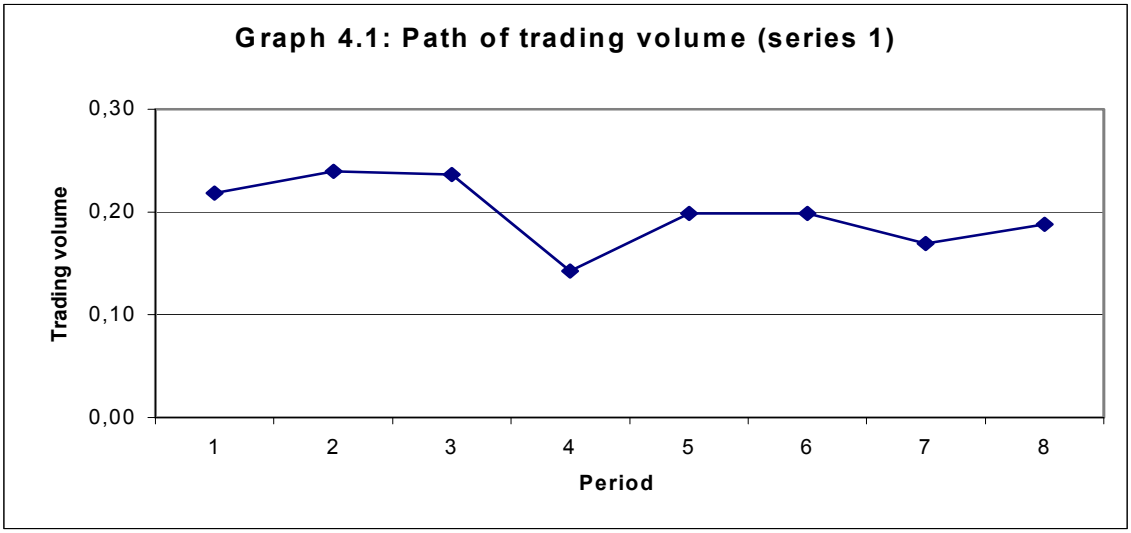
First, the operators do not seem to have a rational and objective reaction in relation with their interpretation of the information. They do not make more and more precise estimations, which is contrary to their interests, as there are expectation gains at the end of the experiment. In other words, the operators' skills in interpreting information are limited.

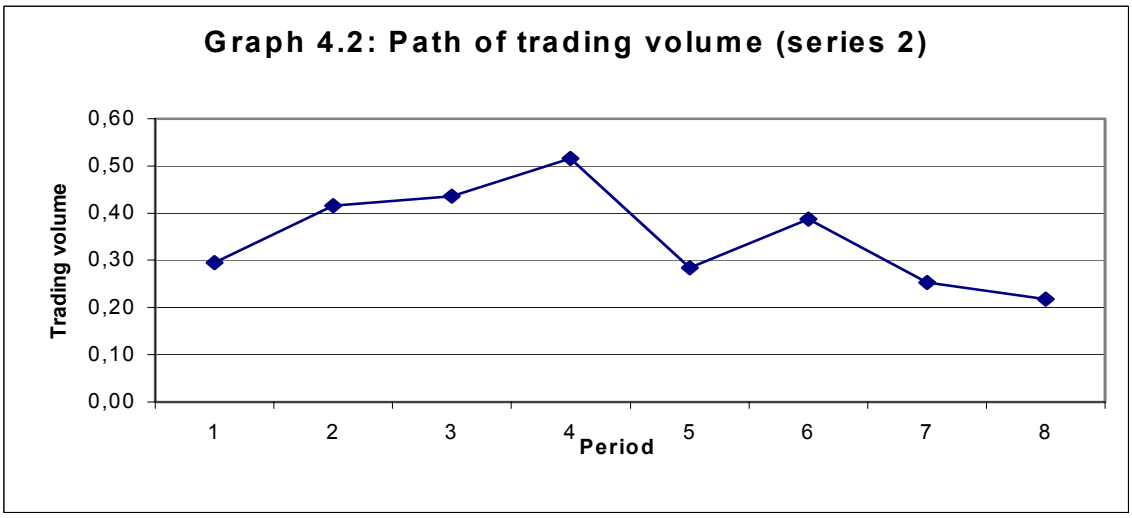
Second, some investors are not self-confident in their ability of interpreting information. Their behaviour consists in minimizing the impact of the others which appear more sophisticated than them. Such a minimization may be inferred from trades on the market. It entails systematic and heterogeneous errors when the "sophisticated" agents react in a divergent and erroneous way. However, the second reason seems less obvious in the present study, because most participants (more than 80%) only revise their expectations at the time of an announcement. During the rounds without any announcement, the estimations are not modified in spite of the information revealed by trades. From graphs 3.1 and 3.2, the mean and the standard deviation of expectation errors do not widely vary inside the estimation periods. This phenomenon allows us to conclude that only the elements randomly chosen can heavily change the formation and the revision of investors' expectations.

4.1.2. The path of trading volume

The participants trade 1 % to 53% of the whole set of shares available with a mean of 20% in the case of series 1, and 12 to 89% with a mean of 35% in the case of series 2. Considering data from all the markets, the trading volume is between 1 and 89% with a mean of 23%. The trading volume of series 1 exhibits a slight downward trend across the successive rounds, which validates hypothesis 4. Nevertheless, this is not true in the case of series 2.


Graph 4: Path of trading volume (all data)
Trading volume
0,30
0,20
0,10
0,00
1
2
3
4
5
6
7
8
Period





Note: All the three graphs show the path of trading volume along the two experiments 1 and 2. The round of exchange is represented in X-plots. Trading volume expressed as the ratio "number of traded stocks/total number of stocks" is represented in Y-plots.

In spite of the correlation between the objective expectations of the results across the exchange rounds, trades are not correlated between the periods even if we consider the periods without any announcement. This means that trades only come from the components that are not announced yet. Also, the dispersion of investors' reactions rather results from the uncertain future in terms of financial stock valuation.

4.2. The determinants of trading volume

4.2.1. Univariate analysis of trading volume

In the present experience, many factors may affect the fluctuations of trading volume. First, we including measures based on earnings estimates such as their heterogeneity, homogeneity and bias. Other determinants are undoubtedly variation and errors of prices. We thus perform a matrix of the correlation between the variables cited in which the amount of trades is also present. All of these variables are expressed in absolute value except trading volume and expectations divergence.

Table1: Correlation between trading volume and its determinants

	Trading volume	*Heterogeneity of expectations*	*Homogeneity of expectations*	*Expectation Error*	*Price variation*	*Price Error*
Trading volume	1	0,420***	0,125	0,125	0,231**	0,326***
Heterogeneity of expectations	0,420***	1	0,345***	0,218*	0,323***	0,524***
Homogeneity of expectations	0,125	0,345***	1	0,611***	0,376***	0,334***
Expectation Error	0,125	0,218*	0,611***	1	0,296***	0,744***
Price variation	0,231***	0,323***	0,376***	0,296***	1	0,394***
Price Error	0,326***	0,524***	0,334***	0,744***	0,394***	1

Note: The table above exhibits the Pearson correlation between the variables mentioned. The tests are made of data from both series 1 and series 2, with 77 observations. (*), (**), (***) denote significance at the 0.1, 0.05 and 0.01 levels respectively.

The evidence does not confirm the significant relation between the homogeneity of expectations; anterior anticipation error and trading volume. This result remains unchanged whatever the measures of expectations' homogeneity and expected errors are included in the model. Among the variables indicated, only the divergence of expectations, price variation and price error have a significant effect on trading volume. Consequently, we perform regression models in which the amount of trades plays the

role of dependent variable and each of significant variables indicated above is independent variable. All the explanatory variables are expressed in absolute value except expectations' divergence.

4.2.2. The impact of expectations' heterogeneity on trading volume

Since we measure the heterogeneity of expectations by dividing the standard-deviation of expectations by the average expectations, all the regressions presented in table 2 show how trading volume is explained by the divergence of expectations.

Table 2: Impact of investors' expectation divergence on trading volume

Set of observations	*Independent variables*	*Non standardized coefficients*	*Adjusted R-squared*
Series 1	*Constant*	**0.111*****	13.3%
	Divergence of expectations	**0.037*****	
Series 2	*Constant*	**0.255*****	4%
	Divergence of expectations	0.011	
The whole series	*Constant*	**0.135*****	13.7%
	Divergence of expectations	**0.030*****	

Note: As the standard deviation of expectations is almost constant between two announcements, data are aggregated and the regression has been made from trading volume and standard deviation of all rounds. Trading volume is measured in percentage by the number of traded stocks over the number of available stocks. The divergence of expectations is equal to the standard-deviation of expectations. Series 1 (respectively series 2) contains 72 (respectively 16) usable observations. The whole series is made of data from series 1 and series 2. *, **, *** denote significance of the test at the 0.1, 0.05 and 0.01 levels respectively.

In the case of series 1, the divergence of expectations implies a significantly positive impact on trading volume. It explains most of the variation of trades. The degree of quality of adjustment is rather high (14.5%). Hypothesis 2.1 seems to be valid.

The same regression is conducted with data extracted of series 2. The results reveal an increasing relation but non significant between the divergence of expectations and trading volume. This suggests the existence of a threshold above which the heterogeneity of expectations does no longer generate trade. It seems to us that the hypothesis 2.2 can not be rejected. This type of relation, assumed to be concave should be more acute by using higher degrees of divergence. When expectations are too

dispersed, every investor becomes aware of this divergence due to the transparency of the double-auction market. In these conditions, the investors become less self-confident and place fewer orders, which lowers the level of trading volume. Sometimes, the investors do trade without taking care about theirs expectations on the basis of other investors' expectations. In that case, limit orders converge, even if the level of trading is lower.

Table 2 presents results from a regression that includes the square of the divergence of expectations. As expected, trading volume is an increasing function of anticipations' heterogeneity. The significant and negative coefficient associated with the squared divergence of expectations indicates the existence of a concave relation between trading volume and heterogeneity of expectations. In other words, when this divergence becomes too large, trading volume decreases. Hypothesis 2 is entirely confirmed.

Table 3: Impact of expectations' divergence and squared expectations' divergence on trading volume

Independent variables	*Non standardized coefficients*	*Adjusted R-squared*
Constant	0.013	
Divergence of expectations	**0.114*****	20.0%
Squared divergence of expectations	**-0.010*****	

Note: data are aggregated and the regression has been made from trading volume and our measure of the heterogeneity of expectations of all rounds (standard deviation of expectations). The regression is performed with all data from series 1 and 2, i.e. 88 observations. Trading volume is measured by the number of traded stocks in percentage of the total number of available stocks. Considering other measures of trading volume leads to the same results. *, **, *** denote significance of the test at the 0.1, 0.05 and 0.01 levels respectively.

Table 4 confirms empirical results obtained with historical price data. The mean revision of expectations directly moves stock prices. If mean prices are considered as equilibrium prices, the price variations should reflect the homogeneity of opinions in the market. When the investors expect a rise in the results on average, stock prices should rise up and conversely, when they expect a decrease of the results, stock prices should go down.

Table 4: Impact on stock price variation of investors' anticipation homogeneity

Independent variables	*Non standardized coefficients*	*Adjusted R-squared*
Constant	**0.149*****	13.0%
Homogeneity of expectations	**0.243*****	

Note: data are aggregated and the regression has been made from stock price variation and mean variation of the investors' expectations. The homogeneity of expectations at a period is determined by dividing the variation of expectations' average by the previous expectations average. Stock price variation is measured by the mean variation of prices divided by the mean price of the preceding period. This regression is made with all data from series 1 and 2, i.e. 88 observations. *, **, *** denote significance of the test at the 0.1, 0.05 and 0.01 levels respectively.

4.2.3. The impact of stock price variation and price errors on trading volume

We are now trying to explain trades by stock price changes and price errors and the heterogeneity of expectations. Table 5 shows that if separately considered, absolute price variation and previous errors have a significant impact on trading volume, which valid hypothesis 3 and 4.

Table 5: Impact on trading volume of absolute price variation and previous errors

Model	*Independent variables*	*Non standardized coefficients*	*Adjusted R-squared*
Model 1	Constant	0.195***	4.1%
	Absolute variation of price	0.166**	
Model 2	Constant	0.164***	9.4%
	Absolute error of previous price	0.231***	

Note: All data are aggregated and the regression has been made from trading volume and stock price variation. Trading volume is measured by the number of traded stocks divided by the number of available stocks. Stock price variation is measured by the variation of mean prices divided by the mean price of the preceding period. Considering other measures of price variation (variation of mean prices divided by the mean expectation, variation of mean prices divided by the objective expectation, variation of mean prices divided by the annual results) leads to the same results. Excluding data from series 2 does not change the obtained results. This regression is made with 88 usable observations. *, **, *** denote significance of the test at the 0.1, 0.05 and 0.01 levels respectively.

Previous empirical work, summarized by Karpoff (1987) has put forward an increasing relation between the absolute variation of average price and trading volume. This is here confirmed by an experimental study. Therefore, the hypothesis 3 is valid. The investors

also seem to have greater incentive when they detect price errors. Deviations of prices from the efficient price incite investors to reallocate their portfolios in order to make large profits. In other words, operators' motivations for trading are all the stronger as the probability of making gains is high. Moreover, the magnitude of previous price errors is likely to represent a sign of market uncertainty which, at a reasonable level, can be considered as a necessary condition in favour of trading activities.

It should be noted that, in table 5, price errors are normalized by the fundamental value calculated at the end of each estimation period, that is every two exchange periods. In addition, it can also be calculated on the basis of the definitive fundamental value determined at the end of the session. Unlike the first measure which leads to positive effects on trading volume, the second one does not have any impact on the amount of trades. This evidence allows us to conclude that the investors do not refer to the stock value determined in the long term, but to the value coming from the objective expectations, calculated in the short term. This seems to be consistent with standard models in which the fundamental value is the actualized sum of future revenues (or cash-flows).

The asymmetric impacts of stock price variation and errors regarding the same features of investors' expectations would allow to challenge the reliability of empirical studies which consider mean price variation as the average change of market opinions. This asymmetry takes root in many elements. As a matter of fact, participants' expectations rather disclose individual beliefs of each independent subject whereas stock price conveys the interaction between market operators. Therefore, stock price is not only related to the individual variations of each expectation, but also to the average variation of expectations. In addition, it should be noted that stock prices are not only an indicator of investors' previsions, but also reveals the way in which these investors make up their mind in trading. Hence, prices can reflect strategies followed by market operators.

The second reason seems to be relatively specific in case it is concerned by the transparency which we impose on information. In our experimental markets, the individual expectations are not publicly known, but the average prices are made public, which is something like the reality of financial markets. Under these conditions, the investors do not know the expectations of the others, but the average prices. Logically, it seems that investors considerably rely on variations and errors of average prices to trade financial assets, but not on aspects of expectations.

We now put the mean variation and errors of prices as well as the divergence of investors' expectations in the same regression model where trading volume is the dependent variable. The aim of this procedure, as previously mentioned, is to justify the dominance of one variable against the others. However, in such a model, we have to take care of the interaction between independent variables because the existence of strong linear dependences may distort the estimation results of model coefficients.
We calculate the VIF statistic for our regression model where the dependent variable is the trading volume and the independent variables are composed of the divergence of investors' expectations and the variation and errors of prices expressed in absolute value. Table 5 reports the obtained results.

Table 6: Determinants of trading volume

Variables	*Non standardized coefficients*	*VIF*	*Adjusted R-squared*
Constant term	0.112***		15.2%
Absolute variation of price	0.042	1.190	
Absolute errors of previous prices	0.096	1.528	
Divergence of expectations	0.028**	1.385	

Note: All data are aggregated. The regression is made with 88 usable observations. Trading volume is measured by the number of traded stocks in proportion of the quantity of stocks of the whole market. Stock price variation is measured by the relative variation of mean prices. The errors of price refer to the percentage deviation of the average price over the objective expectation of the fundamental value calculated at each estimation period. In case of the second information series, the objectively expected value of the fundamental value can be equal to zero. That's why, all the errors of price which equalize zeros are taken off the regression model. The divergence of investors' expectations is the standard deviation of the errors of price. Altogether, the first information series and both information series totalizes respectively 63 and 77 observations for the model 1, 63 and 73 observations for models 2 and 3. *, ** and *** indicate the signification of coefficients at 10%, 5% and 1%.

Taking into account variables other than stock price variation leads to different results. The absolute price variation, as well as previous price errors, is no more significant in the regression, which contradicts hypothesis 3. However, the divergence of opinions has still a high significant positive impact on trading volume.

In the experiment, prices significantly influence the number of trades. However, the change is rather homogeneous in the sense that the submitted orders are buys (sells) when prices are increasing (decreasing). In every case, the number of opposite orders is too weak to lead to new trades. This phenomenon may be explained by the

characteristics of the experimental markets in the sense that there are no traders entering the market or going out of the market. This should entail that there are no new buying or selling needs matching the existing orders. This is not the case of real markets. The existence of new traders may explain why some empirical studies exhibit a relation between the change in trading volume and the variation of stock prices. Only the divergence of interpretations on the annual results has an impact on trading volume.

An increasing relation between the trading volume of this experimental market and the heterogeneity of expectations is put forward when the divergence is not too high. On the contrary, the divergence does not generate trading volume. A significant link has been detected between the absolute price variation and trading volume, but this factor is a lower determinant of trading volume compared to the divergence of opinions.

To sum-up, trading volume is different from 0 in spite of a structure of common information for all the investors. This means that the theorem of no-trade is violated. Moreover, this absence of no trading volume is not only due to the change in fundamental stock value but also to the investors' different interpretations of public information. The latter is a major determinant of trading volume.

5. Conclusion

This paper mainly allows the role of divergence of investors' earnings interpretations in explaining the path of trades to be analyzed. First, the investors' expectations remain heterogeneous until the final diffusion in spite of successive announcements of results components. Moreover, they do not seem to come from a rational expectations model in absence of asymmetric information.

The heterogeneity of expectations explains a great part of the variation of trades on the market unless it becomes too strong. As expected, trading volume is an increasing function of the heterogeneity of expectations. Moreover, the relation between trading volume and the divergence of opinions is concave. In other words, when the divergence of interpretations becomes too large, trading volume decreases. Conversely, the range of stock price variation has a lower impact on trades. This means that price level is not leading transactions. Only the heterogeneous expectations may imply orders of opposite sense and trades.

The obtained results justify the importance of the trading volume in studies of market reaction, especially when the abnormal returns seem insufficient to explain the anomalies coming from the public information. As a matter of fact, this variable puts forward the heterogeneous character of market reaction and allows to complete the homogeneous aspect of price evolution.

From these results here, it may be wondered why the individual expectations differ from the value that comes from a rational expectations model? Why are trading prices different from the fundamental stock value? The answer to these questions needs the use of the experimental method.

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7. Annex

Instructions for the experiment

You are welcome to participate to our market which allows you to earn money. Your gain depends on your decisions and also on others' decisions. Each participant makes up his/her decisions individually in front of her computer. It is strictly forbidden to communicate with the others. It is a case of exclusion from the experiment and the gains.

You participate to a market in which you can trade stocks in order to win money by using the information contained in the good value. This is a market of eight rounds of exchange with an initial endowment of 20 shares and 200 ECU (Experimental Cash Unit). You can buy stocks to other persons with your cash or sell your stocks. The gain issued from a sell is the difference between the selling price and the stock value. Conversely, the gain issued from a buy is the difference between the stock value and the buying price. The exchange gains are issued from the sum of the gains issued from buys and sells. Therefore, they strictly depend on what you can sell your stocks above or buy goods under the stock value.

How to determine the good value?

The stock value is made of the sum of 4 components with the same probability of arrival. Every two periods of exchange, one component is chosen randomly by the computer. The realized draws are made with delivery, i.e., the drawn number at each time is put back in the urn. Before and after the draws, the drawn number is the same. One element is determined only every two periods. Following each draw of one element, the subjective estimation of the stock value is calculated again. It is equivalent to the value of the preceding realized elements and the value of the elements left to be estimated.

At the end of the eighth period of exchange, the last element is drawn. The stock value is established. The draw of elements and the determination of the stock value are described in the following table.

For the series 1 of information

The draws are made in the sample of 4 numbers, 0, 2, 4 and 6.

Element Value	Probability
0	¼
2	¼
4	¼
6	¼

The value of one element should be between 0 and 6 with a mean of:

$$0 \times 1/4 + 2 \times 1/4 + 4 \times 1/4 + 6 \times 1/4 = 3$$

$$\text{Stock value} = \begin{matrix} 1^{st}\ element + 2^{nd}\ element \\ + 3^{d}\ element + 4^{th}\ element \end{matrix}$$

For the series 2 of information

The draws are made in the sample of 4 numbers, 0, 2, 4 and 6.

Element Value	Probability
-4	¼
0	¼
6	¼
10	¼

The value of one element should be between -4 and 10 with an expected mean of:

$$-4 \times \frac{1}{4} + 0 \times \frac{1}{4} + 6 \times \frac{1}{4} + 10 \times \frac{1}{4} = 3$$

The good value is the sum of 4 elements. Its range goes from -16 (when all the elements are announced to be -4) to 40 (when all the elements are announced to be 10). The stock value is directly extracted from the sum of the four elements in the sense that it is equal to this sum if the latter are positive and 0 otherwise.

Sum of all elements	$S = \begin{matrix} 1^{st}\ element + 2^{nd}\ element \\ + 3^{d}\ element + 4^{th}\ element \end{matrix}$
Stock value	$V = \begin{cases} S\ si\ S \geq 0 \\ 0\ si\ S \lhd 0 \end{cases}$

How to make trades?

The market contains 8 independent rounds of exchange. Each round contains 3 steps:

- First step: all of you have to anticipate the stock value (the sum of 4 elements), not the value of each element.
- Second step: from here you can buy or sell stocks. On your computer, you will see a window indicating “buy” and “sell” propositions. If you want to sell stocks, you should enter the selling price p. This price p designates that your assets are sold only when the price is superior or equal to p.

Conversely, if you want to buy stocks, you have to enter the buying price p. This price p designates that your stocks are bought only when the price is inferior or equal to p. In both cases, the quantity of traded stocks is automatically equal to 1. As a consequence, if you want to trade X stocks (X>1), you have to submit X propositions. Your selling proposition (respectively buying one) is always added to the list of selling propositions (resp. buying ones) appearing on your screen. It is executed as soon as there is one proposition which satisfies your price condition. However, you can also execute directly a sell or a buy by clicking a proposition on the list and button "OK". After its execution, the proposition is withdrawn from the equivalent list. You can make propositions at every time from the round. The not executed propositions can be modified or cancelled in the same period. However, the non executed propositions from one period do not enter the list of trade propositions of the following periods.

- Third step: this is the phase of announcement of the drawn element. A random element is announced at the end of periods 2, 4, 6, 8 and mentioned in box "drawn element". At the other periods without any announcement, the message "no element is drawn at this period" appears in the same box.

How to calculate your gains?

At the end of the eighth period, all your remaining stocks are bought back at a price equal to the stock value. Your final retribution contains three components. Besides an initially fixed sum (part 1), you will receive a premium strictly linked to the accuracy of the expectations of the stock value (part 2) and the gains linked to your trades (part 3). The cash you win is equal to the sum of parts 1, 2 and 3, as follows:

Your retribution = Part 1 + (Part 2 + Part 3)* conversion rate

The rate of conversion is defined so that each of you earns from 10 to 30 Canadian dollars, with a mean of 25 $CA.

Please read carefully the instructions and ask questions about what you do not understand. A great understanding will allow you to play our game in a better way.