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On measuring speculative and hedging activities in futures markets from volume and open interest data

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On measuring speculative and hedging activities in futures markets from volume and open interest data

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Abstract

This paper provides a critical assessment of the line of research that measures speculative and hedging activities in futures markets from volume and open interest data. It makes several contributions. First, a detailed theoretical analysis of the measures proposed in the previous literature as proxies for speculative activity clarifies the circumstances in which they fail, as well as the assumptions that have to be made, when they are used as intended. Second, we propose a new way of combining the volume and the open interest figures, which provides additional information regarding the type of trading activity that takes place in the market on a given date. Finally, we analyse empirically the basic statistical properties of all the ratios when they are applied to real data for some of the stock index futures contracts most actively traded in the world. This empirical analysis shows the diverse behaviour of the ratios when they are applied to a common sample of real data, which confirms our previous theoretical findings. Our contributions should be taken into account when any of the measures is used as a proxy for the relative importance of speculative demand in empirical analyses.

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1. Introduction

In the literature of derivative markets, market participants are traditionally classified as either hedgers or speculators. In conventional terms, hedgers engage in derivative trading so as to manage a risk exposure. Thus, a necessary condition to be a hedger is to have a spot (or forward) commitment that involves a risk exposure. On the contrary, speculators trade derivatives without such risk exposure and thus they are outright position-takers (this group of traders includes the so-called day traders, who hold their positions for less than one trading day). The understanding of the trading purposes that underlie the trading behaviour of market participants may shed some light on a variety of important theoretical discussions and practical issues.[1]

This paper contributes to the line of research that tries to identify who trades futures from objective market activity data that is readily available in every derivative market in the world, namely, the volume of trading and the open interest.[2] The daily trading volume simply accounts for the amount of trading activity that has taken place in a specific contract on a trading date. On the contrary, the daily open interest figure determines the number of outstanding contracts at the end of a trading day; i.e. the number of contracts that have been entered into but not yet liquidated. Since the seminal papers by Rutledge (1979), Leuthold (1983) and Bessembinder and Seguin (1993), there is a convention that the daily trading volume primarily proxies movements in speculative activity, whereas the daily open interest variable captures hedging activities in futures and options markets, since open interest excludes by definition all intraday positions

[1] For instance, the distinction between hedging and speculation lies at the core of the long-lasting controversy regarding the Keynes' "normal backwardation hypothesis" in futures markets. Also, in practice, it is widely accepted that both hedgers and speculators are needed for a contract to reach a true success.

[2] Another way of approaching this issue has been the elaboration of surveys aimed at clarifying the type of use (if any) made by a target group of potential users of derivatives. Finally, another source of information that has been used by a number of researchers of the US futures markets is the CFCT Commitments of Traders reports. This approach has been put into question many times from diverse perspectives (for instance, see Peck, 1982, and Ederington and Lee, 2002).

For Peer Review

taken by day traders, most of whom are inspired by speculative motives. In essence, the distinction between speculative and hedging positions is assumed to lie in the length of the holding period. Interestingly, there is compelling empirical evidence available that seems to confirm that hedgers tend to hold their futures market positions longer than speculators.[3]

Based on these general ideas, García *et al.* (1986) and ap Gwilym *et al.* (2002) proposed to combine both series of data into specific ratios, which were claimed to reflect more accurately the relative importance of the speculative behaviour in the market. Since then, other authors have used the proposed ratios as a proxy of the relative importance of the speculative demand in derivatives markets for empirical analyses with diverse objectives (see Hagelin (2000), Corkish, Holland and Vila (1997) and Kim (2005), among others).[4] Additionally, the ratios facilitate the comparisons across different contracts (defined by both their underlying assets and their time-to-maturity periods).

This paper is aimed at providing a critical assessment of this approach. It makes several contributions. First, a detailed theoretical analysis of the measures proposed in the previous literature as proxies for speculative activity clarifies the circumstances in which they fail, as well as the assumptions that have to be made, when they are used as intended. Second, we propose a new way of combining the volume and open interest figures, which not only helps to understand the drawbacks of the usual ratios as measures of speculation activity, but also provides additional information regarding the type of trading activity that takes place in the market on a given date. Finally, we analyse empirically the basic statistical properties of all the ratios when they are applied to real data for some of the stock index futures contracts most actively traded in the world. This empirical analysis shows the diverse behaviour of the ratios when they are applied to

[3] Ederington and Lee (2002), for instance, in their study of the energy market show that while floor traders were the most active, turning over 19% of their positions each day, the refiners' turnover was only 9%. Also, Wiley and Daigler (1998, pp. 99-100) show that, at least for financial futures, on average, commercials keep their positions significantly longer than do the non-commercials (under the classification of the CFCT Commitment of Traders).
[4] Several authors have combined the volume and open interest figures in empirical analyses with other purposes. For example, Black (1986) applied both variables in order to measure the success or failure of futures contracts. The volume to open interest ratio has also been used as measure of liquidity by Holland and Vila (1997).

a common sample of real data. This result should be taken into account when any of them is used as a proxy for the relative importance of speculative demand in empirical analyses.

2. Speculative-Hedging Demand Ratios

2.1. Definitions and basic relationships

All the ratios defined below are based on two observable variables: the volume of trading and the open interest. The (daily) trading volume counts the number of contracts that have been traded *in* a trading day. However, the open interest counts the number of contracts outstanding *at the end of* a trading day. The open interest thus equals the number of outstanding long positions (or equivalently, short positions) at the end of a day. The open interest in a given contract increases whenever neither of the two traders involved in a contract trade is closing out a position. It decreases whenever both parties are closing out a position. Finally, it remains the same provided that only one of the two traders is closing out a position (i.e. one trader replaces another, or takes his position).

To be precise, the volume of trading, denoted V_t, is thus a flow variable measured *over* period t, whereas the open interest, OI_t, is a stock variable measured *at the end of* period t. The change in the open interest *over* period t can be written: $\Delta OI_t = OI_t - OI_{t-1}$ (by convention, $\Delta OI_1 = OI_1$, with $t = 1$ being the first trading day). Thus, ΔOI_t is a difference of two stock variables and it is defined over period t.

In this section, every observational period t (with $t = 1, 2,\ldots,T$) is considered to be a trading day (i.e. a day when the market is open for trading in a given futures contract). This implies that $V_t \geq 0$ and $OI_t \geq 0$, for every t. Also, notice that $\Delta OI_t \in [-V_t, V_t]$. In words, the maximum value of the change in the open interest over a period is given by the value of the

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volume of trading over the same period (this happens when the parties involved in every contract traded over the period have all taken new positions in those contracts). Also, the minimum value of the change in the open interest is minus the trading volume (this happens when all the parties involved in every contract traded over the period have closed out positions that had been taken in previous periods).

García *et al.* (1986) suggested that the total volume of contracts traded in a period relative to the size of open positions at the end of the period reflects (the relative importance of) the speculative behaviour in a given contract. The volume-to-open-interest ratio ($R1_t$, henceforth) is defined as:

$$R1_t \equiv \frac{V_t}{OI_t}.$$

If it is multiplied by 100 it is interpreted as a percentage per period (one trading day). $R1_t$ can take any positive real number, including zero, and takes the value plus infinity whenever the open interest equals zero. The ratio is undetermined when $V_t = OI_t = 0$.

ap Gwilym *et al.* (2002) modified the relative measure mentioned above. They considered that the daily change in open interest reflects more accurately the activity of hedgers than the level of open interest, because the daily change informs of net positions being opened and/or closed each day and held overnight. For this reason, they proposed calculating a new speculative ratio as the volume divided by the absolute value of the change in the open interest. To be precise, the ratio of volume to absolute change in open interest (denoted $R2_t$) is defined as:

$$R2_t \equiv \frac{V_t}{\left|\Delta OI_t\right|}.$$

It is dimensionless, and if it is multiplied by 100 it is interpreted as a percentage. It can take any strictly positive real number (it takes the value plus infinity whenever the change in the open interest equals zero). The ratio is undetermined when $V_t = \Delta OI_t = 0$.

For Peer Review

Finally, we define the ratio of the change in open interest to volume (or $R3_t$, henceforth), which will help us to clarify the drawbacks of using the above-mentioned ratios as speculation-hedging measures. It is defined by the following formula:

$$R3_t \equiv \frac{\Delta OI_t}{V_t}.$$

This ratio has no dimension, and can take any value ranging from –1 to +1, $R3_t \in [-1,+1]$. To see why this must be the case, recall that the change in the open interest over period t is bounded below by $-V_t$ and above by V_t. A positive number indicates that the number of opened positions is greater than the number of liquidated positions. A negative number indicates just the opposite. The ratio is undetermined when $V_t = \Delta OI_t = 0$.

2.2. Comparison of the ratios as speculation-hedging measures

Broadly speaking, when the ratios $R1_t$ and $R2_t$ are used as measures of speculative and hedging activity, it is assumed that an increase (a decrease) in the volume of trading relative to the open interest indicates that there is either an increase (a decrease) in the activity of the speculators or a decrease (an increase) in the activity of hedgers. In other words, in both cases, the distinction between speculative and hedging positions lies in the length of the positions' holding period. This general assumption underlies the analysis of any of the three ratios, when used as relative speculation measures. Additionally, recall that, roughly speaking, the lower the relative importance of the speculative demand is, the lower the value of the $R1_t$ and $R2_t$ ratios and the higher the value of $R3_t$ should be. This would imply a positive correlation between $R1_t$ and $R2_t$ as well as a negative correlation between any of these two ratios and the $R3_t$. Finally, notice that these basic relationships can be blurred by the fact that, since the ratios are computed

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in a different way, they are not expected to respond exactly in the same way to the behaviour of the main component variables (volume and open interest).

Seeing as the three ratios are considered as measures of the relative importance of the speculative activity in a futures contract, a detailed analysis of them is now carried out. A simulated example of the daily trading activity in a fictitious market will help to clarify the main issues of our exposition (see Table I). The example covers the relevant possible cases with respect to the main variables that enter into the ratios' formulas (see the second column).

[TABLE I ABOUT HERE]

For Peer Review

To begin with, consider the circumstances under which the ratios defined above do not provide a value that could be meaningfully used as a proxy for the relative importance of speculation. These include the cases when either the ratios are undetermined or they take an infinite value. Recall that indeterminacies occur when $V_t = OI_t = 0$ for $R1_t$ (this would happen on the third day in the example in Table I, if no contract were traded on this date), and when $V_t = \Delta OI_t = 0$ for both $R2_t$ and $R3_t$ (this happens on the fourth day in the example). These circumstances will mostly occur in reality during the first days of trading of any given contract, and they can be avoided altogether by considering only those days with a strictly positive volume of trading in empirical analyses. Provided that $V_t > 0$, however, the ratio $R1_t$ can provide an infinite value when the open interest becomes zero (day two in the example), while the same happens to $R2_t$ when the daily change in the open interest is zero (days 7 and 8 in the example). The first case is expected to take place mostly during the first days of trading of a contract, whereas the second could occur more frequently much later, however.[5] Again, for empirical purposes, these circumstances must be avoided by restricting the sample of data accordingly.

[5] For a real example of the importance of this second possibility, see Table II in the next section.

Next, we will consider some important specific drawbacks of each ratio, assuming that they are used as intended, i.e. as measures of the relative importance of the speculative activity in a contract. Firstly, consider the $R1_t$ ratio. The main inconvenience of it is that it relates a flow variable that refers to a specific day t, V_t, to a stock variable measured at the end of the same day, OI_t, whose value does not depend exclusively on the behaviour of traders on such a date. Accordingly, the behaviour of the ratio depends not only on the behaviour of traders on the observational day but also on the whole past history of the contract up to the same day. That is why in the example in Table I, for instance, the $R1_t$ ratio takes the same value in four consecutive days (days 5 to 8), regardless of the quite different trading behaviour of traders during those days. Hence, $R1_t$ turns out to be inadequate for following speculation activity of traders over time.

Secondly, consider the $R2_t$ ratio. It avoids the problem mentioned above by replacing the open interest at the end of the day, used by the $R1_t$ ratio, with the change in the open interest during the day. $R2_t$ is able to discriminate between day trades (short-term speculation), which are reflected in the volume of trading but not in the daily change in the open interest, and the newly taken positions that are held overnight, which equally modify the trading volume and the change in the open interest (as an example of this, $R2_t$ takes the value 1 on days 3 and 5 in Table I, because on these days all the traded contracts imply newly taken positions that are held overnight). Additional day trades would clearly imply a larger value for $R2_t$. Again, this is related to the main assumption that underlies the use of the ratio $R2_t$ as a speculative measure, i.e. speculators do not hold open positions overnight. Nevertheless, consider what happens if all the contracts traded in a given day are due to day trades (this is the case on day 7 in the example). Then, as mentioned above, $R2_t$ takes an infinite value, which implies that this day must be excluded from the analysis.

For Peer Review

Additionally, $R2_t$ fails to properly account for a couple of circumstances that may occur, which limits its application as a speculative measure unless the researcher is willing to accept two additional assumptions. First, due to the absolute value function that accompanies the change in the open interest, $R2_t$ is not able to discriminate between positive changes in the open interest (when the newly taken positions that are held overnight outnumber the liquidation of old positions) and negative changes (when the opposite case takes place). This implies that when $R2_t$ is interpreted as a speculation measure, both cases are assimilated. In other words, it is assumed that all the changes in the open interest, either positive or negative, imply that the opening of new positions outnumber the liquidation of old positions (that is why, in the example in Table I, $R2_t$ takes the same value, one, in days 3 and 5, which are days with all newly taken positions, as well as in day 6, which is a day with all liquidating positions). Notice that this drawback can be circumvented by taking out the absolute value function from the ratio. This is what is done in $R3_t$ (that is why it takes a different value on days 3 and 5, on one side, and on day 6, on the other, in the example in Table I). Thus, when the liquidation of long term positions outnumbers the opening of new positions this is considered as an increase in the speculative activity (a reduction in the relative importance of the hedging activity) by this ratio.

Second, $R2_t$ is unable to discriminate between day trades and those transactions that simply imply that one agent is substituted for another in their old long term position. The same happens to $R3_t$, (that is why each ratio takes the same value on day number 7 and day number 8 in the example).[6] This implies that both ratios assimilate any surrogation to day trades (increasing the importance of the speculation or reducing the importance of long term trading). In other words, when used as speculation measures, both ratios assume that any surrogation is a day trade. Unfortunately, there is no way of discriminating between both circumstances from volume and open interest data only.

[6] Also, notice that $R2_t$ takes an infinite value in purely subrogating days.

3. Empirical analysis of speculation-hedging measures

3.1. Data description

For the empirical analysis, we have selected three of the most actively-traded stock index futures contracts in the world. The stock index futures contracts considered are: the *Standard & Poor´s 500* futures contract (S&P 500), the Nikkei 225 futures contract (Nikkei) and the *Eurex DAX Index* futures contract (DAX). All the contracts considered have several common features: they have well-developed spot markets as well as a remarkable tradition in trading stock index futures contracts; futures prices are quoted in index points, and the value of the contracts is the futures price times a multiple (this is USD 250 for S&P 500, JPY 1,000 for the Nikkei, and EUR 25, for the DAX); finally, all contracts have deliveries in the usual March-June-September-December quarterly cycle, and all of them are settled in cash.

The entire sample of data used in this paper consists of the daily figures of trading volume and open interest for the futures contracts with the three underlying indexes mentioned above and with maturity dates in the months of March, June, September and December between March 2000 and December 2006. Thus, the sample comprises the trading activity data of 84 (3 times 28) futures contracts. Based on this data, the three ratios ($R1_t$, $R2_t$ and $R3_t$) were computed daily for each one of the 84 contracts (to avoid indeterminacies, only those days with a strictly positive volume of trading were considered; in other words, every observational period t refers to an actual trading day). Finally, for homogeneity and liquidity reasons, we decided to concentrate on ratios for the first-to-maturity and the second-to-maturity series of futures contracts. To this aim, we constructed two series of ratios. The first one was made up of the ratios for the nearby futures contract. The second series took the ratios for the next futures contract. In the end, the observational period runs from 10 December 1999 to 15 December 2006, both for the first-to-

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delivery series and for the second-to-delivery series. Table II summarizes the liquidity features of both the nearby and the next futures contract series. It also reports the number of observations (trading days) included in every series.[7]

[TABLE II ABOUT HERE]

3.2. Empirical comparison of speculation-hedging measures

Now, we perform a comparative analysis of two series for each of the three speculative-hedging ratios in order to test if they provide similar information when applied to real data. The mean, median and variation coefficient of the daily ratios are reported independently for the first and second to maturity series in Table III.

[TABLE III ABOUT HERE]

Several comparisons can be carried out based on the summary statistics reported in Table III. To begin with, the mean values of the ratios for the first and the second-to-maturity series can be compared. The contracts with the longest time to maturity show the lowest mean values of $R1_t$ and $R2_t$, as well as the highest mean values of $R3_t$. Both results could be interpreted in the same way: the first-to-maturity contracts seem to attract more speculation activity (i.e. the second-to-maturity contracts seem to be used more for hedging activities than the first-to-maturity contracts).

[7] The last trading day for the *S&P 500* and the *Nikkei* futures contracts is earlier than the final settlement date. Therefore, data of volume of trading and open interest are available for every trading day. However, this is not the case for DAX futures contracts. Hence, in the DAX case, the ratios cannot be computed on the last trading day. For that reason, we assumed that all the positions that remained open are closed on the last trading day (i.e. $OI_T = 0$).

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The mean values of the ratios can also be compared across underlying indexes. For the first maturity, both $R1_t$ and $R2_t$ ratios take their lowest values for the *S&P 500* underlying index, while the $R3_t$ ratio takes its highest value for the *DAX* index. Also, for the second maturity, both $R1_t$ and $R2_t$ take their lowest values for the *Nikkei* index, while $R3_t$ takes its highest value for the *S&P 500* index. Thus, according to the $R1_t$ and $R2_t$ ratios, the futures contracts on the *S&P 500* and *Nikkei* index attracted the lowest speculative demand, respectively, for the nearby and the next futures contracts, among all the indexes considered. The $R3_t$ ratio, however, provides different results indicating that the *Nikkei* and the *S&P 500* futures contracts are used more for hedging activities for the first and second to maturity futures contracts, respectively.

Next, we test formally whether the three ratios offer similar information about the evolution of speculation/hedging demand over time. To be precise, for each underlying index, we perform a comparison of the ordering over time that is implied by the daily values taken by each pair of ratios. To this aim, we have calculated the Spearman cross correlation coefficient that takes into consideration the ranks of the values of two series for each trading day. Table IV reports the pair-wise cross-correlation coefficients between the speculation-hedging demand ratios.

[TABLE IV ABOUT HERE]

Firstly, as far as the first maturity is concerned, it is not possible to reach a general conclusion with respect to either the sign or the significance of the cross correlation coefficients. Secondly, the results for the second maturity are somewhat different, however. On one hand, the correlation coefficients $R1_t$-$R2_t$ provide again a diversity of results. On the other hand, the cross correlation coefficients for $R1_t$-$R3_t$ are positive and significant whereas the cross correlations between $R2_t$ and $R3_t$ are all negative and significant.

For Peer Review

Overall, no general comparative conclusion can be reached. Furthermore, the result of the positive cross correlation coefficients for $R1_t$-$R3_t$ is particularly relevant to the aim of this paper since, if both ratios provided similar information on the evolution of the relative importance of speculative activity, a significant and negative cross-correlation between them should be found. These results do not come at a surprise: they are simply the consequence of the disadvantages of using the $R1_t$ and $R2_t$ ratios for discriminating between speculating and hedging that were pointed out in the previous section. Nevertheless, the negative cross correlations between $R2_t$ and $R3_t$ indicate that both ratios provide similar information regarding the evolution of the relative importance of the hedging demand over time in the second-to-maturity contracts, despite the fact that $R2_t$ is not able to discriminate between newly taken positions that are held overnight and the liquidation of old positions. This seemingly contradictory result is due to the fact that the majority of days that comprise the second-to-maturity sample are in fact days with $R3_t$ strictly greater than zero, i.e. days during which the number of newly taken positions that are held overnight is greater than the number of liquidated positions. Indeed, the percentages of such days over the total sample are, respectively, 82%, 63% and 75% for futures on *S&P 500, Nikkei 225* and *DAX*.

In summary, the results in Table IV remind us of the dangers of using the $R1_t$ and $R2_t$ ratios for analysing the evolution of the speculative-hedging demand during the last weeks of the life of a futures contract, since these days are usually characterized by the cancellation of positions, which are mistakenly taken to be newly-taken long-term positions by these ratios. Furthermore, they also suggest that the use of the $R1_t$ ratio for analysing longer to maturity contracts (second maturity) should be avoided. Finally, the high correlation between $R2_t$ and $R3_t$ when applied to longer to maturity contracts indicates that both ratios provide closer results in this case. This conclusion, however, does not take into account that $R2_t$ cannot be calculated when the open interest remains the same as the day before, and this may be an important limitation for empirical analyses. A zero change in the daily open interest happens rarely in the first maturity but, as we can see in Table II, the percentages of occurrence are relevant in the second maturity.[8]

Interestingly, other authors who have previously used the $R1_t$ and $R2_t$ ratios when analyzing speculative-hedging demand have obtained contradictory results as well. For instance, ap Gwilym *et al.* (2002) applied alternatively both ratios to the analysis of the speculative-hedging demand for the FTSE 100, Long Gilt and Short Sterling futures contracts. The comparison of their results for each ratio across underlying assets turned out to be inconclusive (see ap Gwilym *et al.*, 2002, p. 12). This was expected given our previous theoretical analysis and confirms its empirical importance.

4. Final remarks

In this paper we make a critical assessment on hedging-speculative demand measures obtained from volume and open interest data. The main attraction of these measures, compared to other alternatives, is that they are based on data that is available in every organized derivatives market.

This advantage comes at the expense of several assumptions that are carefully explained for the first time in this paper. Broadly speaking, under this approach for measuring the relative importance of the speculative/hedging activities in a certain futures contract, the distinction between speculative and hedging positions is based on the length of the holding period. Thus, any position held for a long period of time is considered to be a hedging position regardless of its objective and other related aspects such as the existence of a spot commitment. Additionally,

[8] As reported in Yang *et al.* (2004) and Yang *et al.* (2005), the open interest series is typically nonstationary (or integrated of order one), which suggests that only the first difference of open interest would be appropriate. By contrast, the volume series is still stationary while it is highly autocorrelated. Thus, $R3_t$ may also be motivated from the perspective of time series analysis. We thank an anonymous referee for bringing this point to our attention.

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arbitrage positions are considered to be non-speculative positions. Though some available empirical evidence clearly suggests that hedgers tend to hold their positions for longer periods than speculators, which could (at least partially) sustain this approach, the problem lies in the a priori definition of the holding period to discriminate between speculative and hedging activities. To be precise, the main assumption that underlies the use of the ratios previously defined in the literature as speculative measures is that speculators do not hold open positions overnight. In other words, these ratios concentrate on the day-trade speculation.

Additionally, we show that the traditional hedging-speculative measures present some specific theoretical drawbacks (i.e. specific assumptions that are made to use the measures as intended) that make them inappropriate at least under some circumstances. For one thing, the volume-to-open-interest ratio turns out to be inadequate for following the behaviour of traders over time, since its behaviour does not depend solely on the behaviour of traders on the observational day but also on the whole past history of the contract up to that day. The ratio of volume to absolute change in open interest assumes that all the changes in the open interest, regardless of them being positive or negative, imply that the opening of new positions outnumber the liquidation of old positions.

We proposed a new related measure which circumvents some of the drawbacks of the previous measures. In particular, it discriminates between those days when the newly taken positions that are held overnight outnumber the liquidation of old positions and those when the opposite case takes place. A careful examination of this measure, however, reveals that the degree of speculation in derivatives markets cannot be neatly determined, since it is impossible to discriminate between day trades and subrogating trades from volume and open interest data only.

Furthermore, by using data on some of the most important equity index futures traded in the world, we perform a comparative analysis for each of the three speculative-hedging ratios in

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order to test if they provide similar information when applied to real data. In general, our results warn against using traditional measures for analysing either the first or the second-to-delivery contracts.

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For Peer Review

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Table I. Illustrative Trading Activity Example

This table simulates the trading activity for a sequence of consecutive days in a fictitious futures market. In columns 3 to 6, each one of the nine traders involved in the example is represented by a distinctive capital letter, from A to I. In columns 3 and 4, each one of the capital letters indicates a single contract, which is negotiated by a trader as indicated. In columns 5 and 6, each capital letter indicates a position in one contract, held at the end of a day by a trader as indicated. The activity of the final (eleventh) day has been split in two: the first row registers the activity resulting from the trading activity, and the second represents the cancellation of outstanding positions by the clearing house, once the final settlement has taken place. V_t stands for volume of trading (in number of contracts), OI_t is the open interest, ΔOI_t is the change in the open interest, and $R1_t$, $R2_t$ and $R3_t$ are the three ratios defined in the main body of the text.

		Trading		Outstanding positions						
Day	**Circumstance**	**Buyer**	**Seller**	**Long**	**Short**	V_t	OI_t	$R1_t$	$R2_t$	$R3_t$
1		AA	BB	AA	BB	2	2	1	1	1
2	V=|ΔOI| OI=0	BB	AA			2	0	2/0	1	-1
3	V=|ΔOI| ΔOI>0	AAA	BBB	AAA	BBB	3	3	1	1	1
4	V=0 ΔOI=0			AAA	BBB	0	3	0	0/0	0/0
5	V=|ΔOI| ΔOI>0	CCA	BDB	AAACCA	BBBBDB	3	6	1/2	1	1
6	V=|ΔOI| ΔOI<0	BB	AA	ACCA	BBDB	2	4	1/2	1	-1
7	V>0 ΔOI=0	EF	FE	ACCA	BBDB	2	4	1/2	2/0	0
8	V>0 ΔOI=0	AG	CC	AAAG	BBDB	2	4	1/2	2/0	0
9	V>|ΔOI| ΔOI>0	GGGA	DDDB	AAGGGG	BDBDDD	4	6	2/3	2	2/4
10	V>|ΔOI| ΔOI<0	HDD	IGG	AAGGH	BDBDI	3	5	3/5	3	-1/3
11 Before closing Time		I	H	AAGG	BBDD	1	4			
11 After Closing Time		BBDD	AAGG			4	0			

Table II. Liquidity of the first and second to delivery futures contracts

This table presents the daily average volume and the daily average open interest, both measured in number of contracts. The number of observations appears in parentheses below. The last two columns show the percentage of days in which the open interest is the same in two consecutive days.

	Average Volume per day (Number of observations)		Average OI per day		Days with no change in OI (%)	
	First	**Second**	**First**	**Second**	**First**	**Second**
S&P 500	60,172.43 (1760)	16,305.42 (1755)	518,782.65	82,108.79	0.057	1.254
Nikkei	46,289.12 (1721)	1,518.66 (1440)	230,767.45	26,335.61	0.232	14.028
DAX	9,3023.61 (1747)	6,119.29 (1747)	221,909.33	21,728.89	0.630	2.803

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Table III. Speculation-hedging demand ratios

This table reports the mean, median and variation coefficient (standard deviation divided by the mean value) for the speculation-hedging demand ratios ($R1_t$, $R2_t$ and $R3_t$), for the daily series of the first and second to maturity futures contracts, for each underlying index (S&P500, Nikkei and DAX).

		$R1_t$		$R2_t$		$R3_t$	
		First	**Second**	**First**	**Second**	**First**	**Second**
S&P 500	Mean	0.148	0.104	88.344	5.746	-0.070	0.414
	Median	0.118	0.058	19.291	1.682	-0.025	0.545
	Var. Coef.	0.770	1.106	5.902	3.861	-3.189	1.137
Nikkei	Mean	0.211	0.030	92.171	4.201	-0.007	0.379
	Median	0.198	0.004	20.141	1.720	0.022	0.373
	Var. Coef.	0.327	2.094	8.400	2.176	-29.031	1.372
DAX	Mean	0.453	0.174	125.839	11.552	0.000	0.252
	Median	0.406	0.056	36.239	3.324	0.005	0.210
	Var. Coef.	0.602	10.304	4.714	2.862	240.611	1.653

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Table IV. Pair-wise cross-correlation coefficients for the ratios

This table reports the Spearman's rank-order correlation coefficients between any two speculation-hedging demand ratios ($R1_t$, $R2_t$ and $R3_t$) for the series of the first and second to maturity contracts, for each underlying index (S&P500, Nikkei and DAX). ρ stands for the Spearman's rank cross-correlation coefficient, *p-value* is the critical significance probability level (null hypothesis: correlation equal to zero), and *N.obs.* is the number of observations. * (**) denotes significance at the 5% (1%) level.

		First Maturity			Second Maturity		
		$R1_t$ – $R2_t$	**$R1_t$ – $R3_t$**	**$R2_t$ – $R3_t$**	**$R1_t$ - $R2_t$**	**$R1_t$ – $R3_t$**	**$R2_t$ – $R3_t$**
S&P 500	ρ	-0.233(**)	-0.097(**)	0.431(**)	-0.235(**)	0.418(**)	-0.747(**)
	p-value	0.000	0.000	0.000	0.000	0.000	0.000
	N. obs.	1758	1759	1758	1732	1754	1732
Nikkei	ρ	-0.005	0.052(*)	-0.215(**)	-0.049	0.351(**)	-0.478(**)
	p-value	0.821	0.030	0.000	0.086	0.000	0.000
	N. obs.	1716	1720	1716	1229	1431	1229
DAX	ρ	0.066(**)	-0.184(**)	-0.114(**)	0.029	0.160(**)	-0.397(**)
	p-value	0.007	0.000	0.000	0.226	0.000	0.000
	N. obs.	1710	1721	1710	1692	1741	1692

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