How Short-termed is the Trading Behavior in German Futures Markets? An Empirical Comparison of Eurex Futures

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Abstract

This paper empirically investigates smoothing-out ratios and average holding periods of different Eurex futures such as the Euro-Bund, the DAX, the DJ Euro STOXX 50 future and others from 1999 to 2002. A methodology that only needs daily volume and open interest data is presented (including an innovative open interest correction algorithm). It can be shown that average holding periods decrease over time in most of the examined futures. Other interesting results are the June contract phenomenon in the DAX future and a 09/11 effect in several Eurex futures.

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1 Introduction

The German options and futures exchange Eurex was founded as "Deutsche Terminbörse" (DTB) in the year 1990. Ever since, it has been growing in trading volume and importance. In 1998 the DTB merged with the Swiss Soffex to form the Eurex.[i] Trading on Eurex is based on an efficient computer trading system, where different options and futures contracts have been and are still traded over time.[ii] Some futures (like e.g. the MDAX future) were not accepted by the market and thus cancelled after a few years. Some futures are among the world's most heavily traded futures. In this paper we want to concentrate on futures that have already existed for a certain time and that have a relevant market impact, like the DAX or the Euro-Bund future (both traded since 1990) and others.[iii]

It is a well-known fact that in futures markets there are different types of market participants. Usually speculators, hedgers and arbitrageurs are mentioned. Each of these participant groups has different motives and time horizons when trading. Many futures market studies are based on high quality data that distinguishes between different trader groups.[iv] In this survey another approach is pursued: We focus on the time horizon aspect and use daily open interest and volume data to calculate the average holding period. Averaging is done over all positions (short and long) held by all market participants. Comparing average holding period data of different contracts, one can draw conclusions about the presence of each of the different trader groups.

The average holding period has already been considered by Canoles et al. (1998) for commodity futures, by Wiley and Daigler (1998) as a side aspect of volume relationships among different trader types and by Bamberg and Dorfleitner (1998), (2002), who were the first to focus on the average holding period in an empirical examination of the DAX futures market. Comparative studies of several futures at the same exchange often consider open interest and volume in relation to the volatility (like e.g. ap Gwilym et al. (2002)). In this survey, for the first time all important futures of one of the most active futures exchanges are compared with respect to the average holding period and the smoothing-out ratio.

The investigation period of this survey starts with the year 1999 where the Euro was introduced in Germany. All of the Eurex futures underwent regulatory changes due to this event, i.e. the contracts were completely redefined.[v] We do not want to explore the time before Euro introduction, but rather focus on recent developments and the present time.

The rest of this paper is organized as follows: In the next section we explain the methodology that was used. Sections 3 and 4 display the data and the general results. Since the 09/11 terror attacks are covered by our examination window and since the Eurex was open during and after the terror attacks, we also explore the question whether there is a 09/11 effect or not. This is done in Section 5. The paper ends with some conclusions.

2 Methodology

In our study we use a method introduced by Bamberg and Dorfleitner (1998) to measure average holding periods and smoothing-out ratios of several (historical) futures contracts. The method, which uses daily volume and open interest data, is modified to allow for regulatory changes at the Eurex, that have taken place since the method first was established. We also present a new error correction algorithm. In the following, we give a short description of the method.

First, let us set up the basic notation. For the futures contract under consideration be

V_t	the trading volume on day t
$\sum_{i=1}^{t} V_i$	the (cumulated) trading volume up to day t
OI_t	the open interest in the future, i.e. the number of open short/long positions at the end of day t.

Time is measured in trading days. Trading starts at day 1 and ends at the settlement day T. We are not interested in an intraday analysis, but rather look upon the market at the end of each day. There is only one exception to this convention: the last trading day.

Peculiarities on the last trading day

On the settlement day the Eurex futures are not traded until the usual end of trading (in the evening hours). The trading stops when the settlement takes place. Thus we cannot count the last day as a full trading day. With t_e we denote the amount of time (still measured in trading days) between the start of the future trading and the settlement. The time t_e is not an integer, but a fractional number somewhere between T-1 and T. The length of the interval $(T\text{-}1; t_e]$ is given by the number of trading hours on the last trading day divided by the number of trading hours on a usual day.

The first thing of interest is the number of positions (short or long) that are closed (or smoothed out) before the end of trading at time t_e in relation to the number of all short and long positions that have ever existed in the examined contract.

Calculation of the smoothing-out ratio *SOR*

The smoothing-out ratio can be calculated by:[vi]

$$SOR = \frac{\sum_{i=1}^{t_e} V_i - OI_{t_e}}{\sum_{i=1}^{t_e} V_i + OI_{t_e}} \qquad (1)$$

Note that the open interest at time t_e, which needs to be known to calculate the SOR, is not published by the Eurex. The published value for the last day is OI_T (= 0). The estimation of the real value of OI_{t_e} is treated in the next section.

Even more important is the average holding period, for it averages all individual holding periods of short and long positions. Since we have to modify the formulae of Bamberg and Dorfleitner (1998) slightly, we will in the following give a short derivation of the formulae that are relevant for this paper.

Calculation of the average holding period

In order to calculate the average holding period, we look at the open interest over time function, where the open interest is multiplied with factor 2. This is done to meet the fact that the open interest is equal to the number of open short positions. Since we want to calculate the average holding period of all positions (short or long) and since there is one short and long pair behind each single open interest count, the factor 2 is needed to get the correct number.

At the end of each trading day the open interest is reported. First we consider a certain time interval $(s,t]$. Note that this is the time span from the end of day s, i.e. the beginning of day $s+1$, to the end of day t. (Again, s and t are integers.)

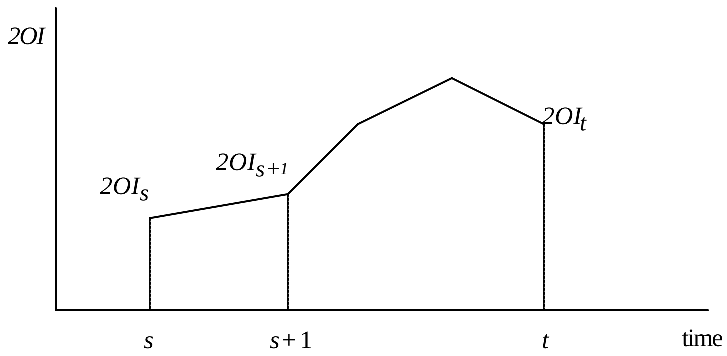

FIGURE 1

Open interest over time between *s* and *t*

As a basic assumption (A1) for holding period assessment, we linearly interpolate the discrete function (cf. Figure 1). In reality the changes from one open interest value to the one of the next day will not exactly follow a linear function. But first, the actual intraday values will due to the structure of real futures markets never be assessable. And second, the relative *OI* changes from one day to another are relatively small, which implies a small error caused by this assumption. The assumption can thus be regarded as uncritical.

We now consider all futures positions (short or long) that were open at any time during the interval $(s,t]$, including all contracts that were open at time s or t. If the open interest at time s or t is not zero, we need the following additional assumption (A2): All positions that have been opened before time s or that have not been closed until time t have the same average holding period as the positions that remain completely within the interval.

Now we can calculate the average holding period of all futures positions that were open during the interval $(s,t]$ by dividing area F_{st} below the $2OI$ function by the cumulated trading volume of the interval $(s,t]$.

We have:

$$F_{st} = \frac{2OI_s + 2OI_{s+1}}{2} + \frac{2OI_{s+1} + 2OI_{s+2}}{2} + ... + \frac{2OI_{t-1} + 2OI_t}{2} = OI_s + 2\sum_{i=s+1}^{t-1} OI_i + OI_t . \qquad (2)$$

This yields an average holding period d_{st} of:

$$d_{st} = \frac{OI_s + 2\sum_{i=s+1}^{t-1} OI_i + OI_t}{\sum_{i=s+1}^{t} V_i} . \qquad (3)$$

Note that this formula is only valid under the above-mentioned assumptions A1 and A2. Several studies (like e.g. Wiley and Daigler (1998)) intuitively use the number of days until the open interest is completely turned over in terms of cumulated volume. The idea behind that is similar to formula (3), which is the exact answer to the average holding period question.

The average holding period for the complete lifetime of a contract

To calculate the average holding period for the complete lifetime of a contract, we set $s = 0$ and $t = t_e$. The length of the interval from $T - 1$ until the settlement at time t_e is denoted with x. Figure 2 shows the open interest over time function during the whole lifetime.

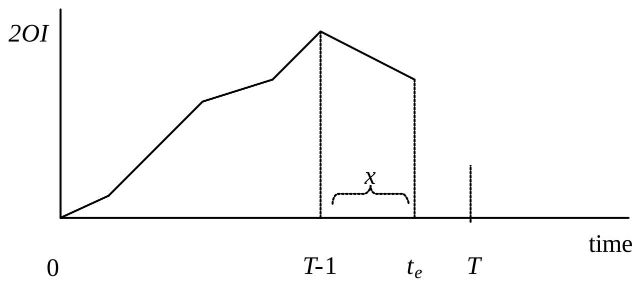

FIGURE 2

Open interest over time (complete lifecycle of a contract)

The open interest starts with a value of zero at time $t = 0$ and ends with a value of OI_{t_e} at time t_e. Immediately after the settlement the open interest diminishes to zero. The area F_{st} now is:

$$F_{st} = \underbrace{2\sum_{i=1}^{T\text{-}2} OI_i + OI_{T\text{-}1}}_{\text{area without last day}} + \underbrace{\frac{2OI_{T\text{-}1} + 2OI_{t_e}}{2} \cdot x}_{\text{last day}} = 2\sum_{i=1}^{T\text{-}2} OI_i + (1+x)\cdot OI_{T\text{-}1} + x \cdot OI_{t_e} \tag{4}$$

This yields an overall average holding period

$$d = \frac{2\sum_{i=1}^{T\text{-}2} OI_i + (1+x)\cdot OI_{T\text{-}1} + x \cdot OI_{t_e}}{\sum_{i=1}^{t_e} V_i + OI_{t_e}} \tag{5}$$

The value derived by formula (5) is the average holding period of **all** positions that have existed during the lifetime of the contract.

Note that for the validity of formula (5) we only need the basic assumption (A1) of linearity between the discrete supporting points of the $2OI$ function.

3 Data base and error correction

Overview of the Eurex futures of the survey

On the German derivative exchange many options and different futures contracts are traded. In our survey, we restrict to the seven most important ones.[vii] We consider the following index futures:

- DAX Future (FDAX)
- Dow Jones STOXX 50 Future (FSTX)
- Dow Jones Euro STOXX 50 Future (FESX),

the bond futures contracts

- Euro-Bund future (FGBL)
- Euro-Bobl future (FGBM)
- Euro-Schatz future (FGBS)

and the interest rate future

- 3 months Euribor Future (FEU3).

The index futures FDAX, FSTX, FESX and the bond futures FGBL, FGBM, FGBS have a lifetime of nine months, with maturity in March, June, September, and December. Thus in every of these six futures products three contracts with different maturities are traded in parallel at any time. As usual, the nearest contract is the most liquid one. The three index futures refer to the indices with the same names, i.e. the German DAX (which is a performance index), the Dow Jones STOXX 50 and the Euro zone related Dow Jones Euro STOXX 50. Both latter indices are price indices. The contracts are settled in cash on the third Friday of the delivery month. One index point equals 25 Euro for the FDAX and 10 Euro for the FSTX and the FESX.

The bond futures require physical delivery. The underlying of these futures is a virtual 100,000 Euro German Federal Government national debt security with a coupon rate of 6% and with different years to maturity. The bond maturity is 8.5-10.5 years for the Euro-bund future (FGBL), 4.5-5.5 years for the Euro-Bobl future (FGBM) and 1.75-2.25 years for the Euro-Schatz future (FGBS). For the actual delivery, several real-world bonds are possible and certain conversions factors are applied. As will be seen below, almost 100% of all positions held in any of these futures are closed before settlement, so that physical delivery is almost irrelevant. At last, the FEU3 future refers to the three months Euro interbank offered rate (Euribor), the relevant Euro zone money market interest rate. There is also a one month Euribor future, but with almost no volume. Each FEU3 contract has a maturity of 36 months and is settled in cash. Delivery months are the same as with the other futures, implying that we have up to 12 contracts traded in parallel at any time.

To draw conclusions with respect to market participants and their behaviour, these seven futures are now to be compared with respect to *SOR* and *d*. Since we do not want to consider the time before the EURO introduction, we restrict to contracts where the major trading activities and, of course, the settlement has taken place in 1999 or later. For all futures except the FDAX the 09/99 contract is the first to consider.[viii] Our data set starts on 1998/12/21 for all futures (except the FDAX where it is the 1998/09/21). The first FDAX contract of our examination is the FDAX 06/99 because we wanted to study the June contract phenomenon (the increased average holding period due to the concentration of dividend payments during May and June in Germany) and because there were no data errors.

As pointed out in the previous section, we need to know the length x of the trading interval on the settlement day in order to calculate the average holding period. Table I shows the trading times (in CET) and x values for the different contracts considered.

TABLE I

Trading hours of the examined futures contracts on usual days and on the last trading day

	Period	Trading time (Xetra)	Trading on last trading day until	x (length of interval $[T-1; t_e]$)
FDAX	98/09/21 to 99/09/17	08.30-17.00	13.00	9/17
	99/09/20 to 00/06/02	09.00-17.30	13.00	8/17
	as of 00/06/05	09.00-20.00	13.00	4/11
FESX	98/12/21 to 02/12/28	09.00-17.30	12.00	6/17
	as of 02/01/02	09.00-20.00	12.00	3/11
FSTX	98/12/21 to 02/06/14	09.00-17.30	12.00	6/17
	as of 02/06/17	09.00-20.00	12.00	3/11
FGBL/FGBM/FGBS	as of 98/12/21	08.00-19.00	12.30	9/21
FEU 3	until 00/04/17	08.30-19.00	12.00	7/21
	as of 00/04/18	08.30-19.00	11.00	5/21

Both open interest and volume data are freely available, at least on a daily basis. But whereas the volume data are usually correct, the open interest data has to be prepared before usage.

Open interest estimation on the settlement day

The open interest is published at the end of day T-1 and at the end of T, where it is equal to zero. For our calculations we need the open interest at time t_e, though. Obviously, the value OI_{t_e} can not be far from OI_{T-1}. The maximum distance is V_{t_e}. To estimate the value of OI_{t_e} we use two alternative assumptions. Either

- 100% of the trading volume V_{t_e} of the last trading day or
- 50% of the trading volume V_{t_e} of the last trading day

are used for position closing. Of course the reality lies somewhere in between, but one has to make some plausible assumptions. As will be seen in the next section, the differences between the 50% and the 100% alternative are negligible in most cases.

Open interest error correction algorithm

It is known that reported open interest data are not completely reliable. This follows from the fact that sometimes position closings are mistakenly registered as openings of new positions and vice versa. Often the reported open interest is higher than the true open interest.[ix] Usually we can not recognize when an open interest error takes place. But sooner or later it gets adjusted by the exchange. Sometimes such adjustments are striking. If the OI change from day t-1 to day t is higher than the trading volume on day t, then this is a hint that a major OI error adjustment has taken place on day t.

We now present an algorithm that performs a minimal error correction on the published OI data by eliminating values that can not be true. We call this procedure the *logical correction.*

The algorithm moves from the end of trading backwards to the beginning. Two items are realistically assumed to be reliable: all volume data and the open interest on the last but one trading day T-1. With cOI we denote the corrected open interest data. The algorithm works step by step from t to $t-1$.

Be cOI_t the logically corrected value. Now we examine the logical correctness of $OI_{t\text{-}1}$. If $|cOI_t - OI_{t\text{-}1}| > V_t$ then there is a need for correction, since the change of the open interest from one day to the next can not be higher than the volume on the next day.

Thus we set cOI_t to that value closest to $OI_{t\text{-}1}$ which does not anymore contradict V_t and cOI_t. The exact calculations are given below. Note that this kind of error correction does not lead to the true open interest values (which can not be reconstructed anymore), it just makes the reported value "less false".

The above considerations lead to the following correction algorithm.

1. Set $cOI_{T-1} \coloneqq OI_{T-1}$ and t:=T-1

2. Correction of OI_{t-1}:

a) if $\left(cOI_t - OI_{t-1}\right) < -V_t$ then $cOI_{t-1} \coloneqq cOI_t + V_t$

b) if $\left(cOI_t - OI_{t-1}\right) > V_t$ then $cOI_{t-1} \coloneqq cOI_t - V_t$

c) otherwise $cOI_{t-1} \coloneqq OI_{t-1}$ (no correction)

3. decrease t, if t=1 then stop, otherwise continue with 2.

The results we present in the next section are completely based on *cOI* data.

4 Results

The following tables and figures show the results of the different futures. First we take a look at the FDAX (Table II).

TABLE II

Open interest error correction, *d*, *SOR* and total volume for several subsequent DAX futures contracts

FDAX

	***OI* error corr.**		***d***		***SOR***		**Total volume**
Contract	positive	negative	100%	50%	100%	50%	
06/99	0	-576	14.1179	14.0709	0.8546	0.8482	3,101,028
09/99	0	0	7.0647	7.0417	0.9487	0.9419	3,127,477
12/99	2	0	6.1299	6.1015	0.9515	0.9417	3,316,290
03/00	0	-220	6.4645	6.4376	0.8764	0.8680	3,603,567
06/00	0	-12	17.3966	17.3596	0.7920	0.7881	2,819,230
09/00	0	-961	9.4392	9.4071	0.9442	0.9373	2,153,438
12/00	0	0	7.2021	7.1714	0.9571	0.9483	2,921,624
03/01	4106	-128	7.5136	7.4798	0.9173	0.9082	2,987,987
06/01	20349	-263	13.9430	13.9076	0.8847	0.8798	3,508,259
09/01	0	0	4.9001	4.8765	0.9706	0.9604	4,175,454
12/01	0	0	4.9207	4.9104	0.9707	0.9662	4,230,475
03/02	378	-183	5.5207	5.5053	0.9591	0.9533	3,457,245
06/02	86	-234	7.4641	7.4347	0.9549	0.9468	4,301,848
09/02	255	0	4.5355	4.5202	0.9923	0.9849	5,743,846

The open interest error correction in Table II (and all following Tables) is defined basically on the difference *cOI – OI* summed up over all those days where the sign of the difference is positive resp. negative. A negative (positive) open interest error correction value thus means that there were days with a too high (low) reported open interest.

We see that despite the effort of the Eurex to avoid open interest errors these errors still happen; some of them, for instance in the 06/01contract, are non-negligible. In relation to the total volume these errors are still not serious, though.

With respect to the average holding period there is a clear trend over time towards smaller *d* values. The significance of this trend is examined below. At the same time we have seasonality in the average holding period data: the June contract phenomenon of about twice as high values (as first described by Bamberg and Dorfleitner (2002)) is still observable. It may be due to decreased dividend payments in 2002 or due to the general decreasing trend that the phenomenon has a smaller magnitude in the 06/02 contract. A very low *d* value can be observed at the 09/01 and the 12/01 and the 09/02 contract. The first two facts may be due to the 09/11 terror attacks, an issue which we will discuss in the next section. The latter may again be a consequence of the trend towards decreasing *d* values, since the 09/02 contract is the newest contract of the survey.

As already reported in Bamberg and Dorfleitner (1998) there are high *SOR* values of about 90% to 100% (except in the June contracts). One can not observe a clear increase in parallel to the holding period decrease.

Next, Table III shows the results for the FESX.

TABLE III

Open interest error correction, *d*, *SOR* and total volume for several subsequent DJ Euro STOXX50 futures contracts

FESX

Contract	*OI* error corr. positive	*OI* error corr. negative	*d* 100%	*d* 50%	*SOR* 100%	*SOR* 50%	Total volume
09/99	163	0	20.8803	20.8247	0.9159	0.9107	1,389,842
12/99	0	-1028	15.0392	14.9924	0.8880	0.8820	1,903,319
03/00	862	-65	15.5900	15.5273	0.8657	0.8580	2,627,758
06/00	1539	-1730	13.6988	13.6703	0.9359	0.9318	3,172,725
09/00	0	-1183	18.9718	18.9262	0.8061	0.8017	3,118,334
12/00	0	0	13.0039	12.9583	0.9370	0.9300	4,848,410
03/01	6	-529	12.1176	12.0875	0.9115	0.9066	5,419,570
06/01	0	-372	11.1207	11.0971	0.9257	0.9215	6,860,046
09/01	749	-10	8.8901	8.8385	0.9493	0.9375	10,946,440
12/01	0	-397	7.9327	7.9144	0.9521	0.9474	13,952,918
03/02	0	-2875	9.1297	9.0986	0.9615	0.9546	12,189,529
06/02	8923	-2453	7.8702	7.8463	0.9694	0.9632	15,929,007
09/02	42	-3731	5.4057	5.3906	0.9872	0.9813	28,772,619

With the FESX the open interest error corrections are negligible compared to the trading volume. At the same time we observe

- a strong decrease in *d* and
- a very strong increase in total volume (factor 20 from 09/99 to 09/02).

Compared with the FDAX both changes over time are much stronger here. This contract obviously has attracted a lot of day traders over time. There is no such thing as the June contract phenomenon in this contract. The *SOR* values vary between about 80% and 99% with a slight tendency to increase. The FESX clearly is the most important stock index future at the Eurex.

The reasons for this presumably are:

- The FESX is more international than the FDAX.
- Arbitrage in the FESX is easier than in the FSTX because of the unique currency in which the stocks belonging to the DJ Euro STOXX 50 index are traded.

- The Eurex co-operates with the GLOBEX and the CBOT, thus enabling traders around the world to trade EUREX futures. For these traders the FESX is the most important one as pointed out above.

Table IV displays the results for the FSTX.

TABLE IV

Open interest error correction, *d*, *SOR* and total volume for several subsequent DJ STOXX 50 futures contracts

FSTX

	***OI* error corr.**		***d***		***SOR***		**Total volume**
Contract	positive	negative	100%	50%	100%	50%	
09/99	0	-5769	28.6265	28.5370	0.7824	0.7767	67,219
12/99	0	-10528	42.7168	42.6455	0.7919	0.7889	111,671
03/00	3207	-1394	24.1805	24.0772	0.6527	0.6455	101,233
06/00	474	-1377	27.7145	27.7050	0.8598	0.8591	94,455
09/00	0	-1273	28.5834	28.4659	0.8585	0.8508	68,725
12/00	0	-128	31.1058	30.9653	0.8463	0.8379	87,863
03/01	0	0	29.6062	29.5584	0.7228	0.7200	77,147
06/01	0	-208	29.6517	29.2854	0.8216	0.7988	81,153
09/01	0	-2260	23.7659	23.6404	0.9450	0.9346	123,279
12/01	0	-774	25.8819	25.7970	0.8347	0.8286	167,543
03/02	0	-411	23.3854	23.2664	0.8954	0.8856	120,147
06/02	0	-620	27.6573	27.5512	0.8523	0.8451	120,847
09/02	0	-3	19.0925	18.9968	0.9503	0.9404	203,147

Here, the open interest error correction in the 12/99 contract is so high that the corrected open interest value still may be too high, since the correction method is rather cautious. The *d* value of about 43 days presumably is too high.

The FSTX has also increased in volume, but still the total volume is rather low. As mentioned above, the FSTX is dominated by the FESX. The *SOR* values are also lower which fits to the observation of rather large average holding periods.

Now we want to compare the three stock index futures with respect to the average holding period. The Figures 3 and 4 graphically show the d values with the 50% resp. the 100% assumption. In Figure 4 the FSTX future is missing, because measured in trading volume it is far less important than the two other futures.

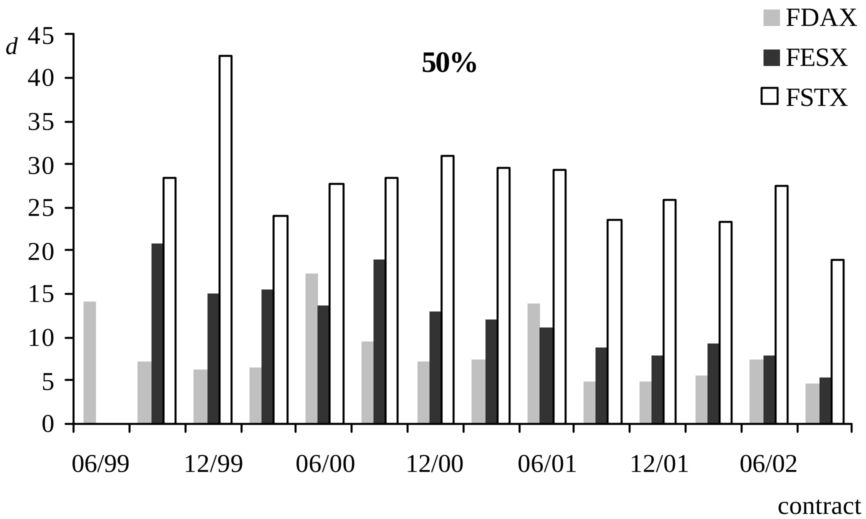

FIGURE 3

Average holding periods of several subsequent FDAX, FESX and FSTX contracts (50% assumption for the last trading day)

It can be seen that the FSTX future has the largest holding periods whereas FDAX and FESX were far from each other in 1999 and 2000, but seemingly converge in 2002. In the 09/02 contract the FDAX still has the shortest *d* value. The question whether the differences are significant is answered below.

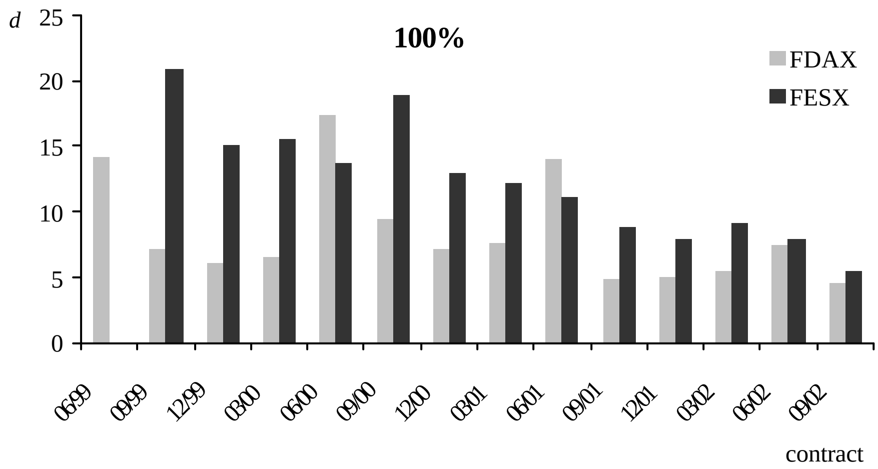

FIGURE 4

Average holding periods of several subsequent FDAX, FESX contracts (100% assumption)

Now we take a look at the FGB futures. Figure 5 shows the average holding periods of the three futures FGBL, FGBM and FGBS under the 100% assumption for the last trading day. Under the 50% assumption the Figure looks practically the same.

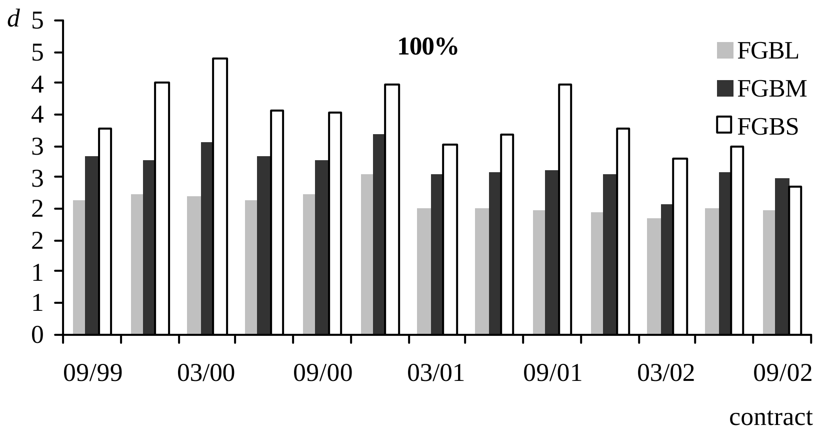

FIGURE 5

Average holding periods of several subsequent FGBL, FGBM, FGBS contracts (100% assumption)

The Tables V, VI and VII give the complete results. Again, we can see a certain decrease of the average holding period over time, but not as drastically as with the stock index futures. The reason for this may be that these futures have a *d* value of about 2 to 4 trading days and that they have been very short-termed from the beginning.

TABLE V

Open interest error correction, *d*, *SOR* and total volume for several subsequent Euro-Bund futures contracts

FGBL

	***OI* error corr.**		***d***		***SOR***		**Total volume**
Contract	positive	negative	100%	50%	100%	50%	
09/99	0	0	2.1382	2.1370	0.9951	0.9936	42,175,319
12/99	0	-529	2.2278	2.2268	1.0000	0.9989	37,751,860
03/00	0	-1019	2.1915	2.1901	0.9998	0.9982	36,034,936
06/00	0	-19	2.1207	2.1195	0.9972	0.9958	41,488,680
09/00	0	-45	2.2257	2.2241	1.0000	0.9982	35,343,296
12/00	0	-165	2.5303	2.5280	0.9934	0.9913	35,897,417
03/01	0	-169	1.9939	1.9927	0.9940	0.9925	42,187,256
06/01	0	-255	1.9922	1.9909	0.9970	0.9952	44,068,182
09/01	514	-34	1.9707	1.9694	0.9986	0.9970	40,508,476
12/01	0	-1478	1.9447	1.9446	1.0000	0.9998	50,309,675
03/02	0	-227	1.8212	1.8203	0.9947	0.9934	43,368,954
06/02	0	-204	2.0120	2.0101	0.9998	0.9974	41,089,237
09/02	0	-1488	1.9621	1.9611	1.0000	0.9987	53,119,354

The results of the Euro-Bund future are remarkable. The increase of the trading volume and the decrease of *d* values are not as high as with the stock index futures. But the average holding periods are located around 2. Taking into account that this is an averaged value, a huge amount of day trading must take place in this future. The Euro-Bund future has been the most heavily traded derivative since 1999. Probably, but not surprisingly, it is also the one with the world's lowest average holding period.

TABLE VI

Open interest error correction, *d*, *SOR* and total volume for several subsequent Euro-Bobl futures contracts

FGBM

Contract	***OI* error corr.** positive	negative	***d*** 100%	50%	***SOR*** 100%	50%	**Total volume**
09/99	0	-1780	2.8297	2.8266	0.9919	0.9893	16,216,909
12/99	189	-35	2.7554	2.7540	0.9988	0.9976	16,185,525
03/00	389	-527	3.0529	3.0501	0.9992	0.9971	15,395,322
06/00	0	0	2.8220	2.8200	0.9989	0.9972	15,777,487
09/00	0	-401	2.7671	2.7631	1.0001	0.9966	13,921,732
12/00	0	-2827	3.1876	3.1810	0.9935	0.9887	15,821,906
03/01	0	-1291	2.5309	2.5265	0.9888	0.9846	22,345,289
06/01	0	-35	2.5787	2.5770	0.9959	0.9943	24,083,811
09/01	0	-4505	2.6109	2.6087	0.9991	0.9971	21,201,979
12/01	6000	-1123	2.5367	2.5356	1.0000	0.9989	30,694,013
03/02	0	-5576	2.0638	2.0620	0.9993	0.9970	24,977,908
06/02	0	-3050	2.5627	2.5602	0.9999	0.9975	25,631,003
09/02	0	0	2.4732	2.4729	1.0000	0.9997	30,316,276

TABLE VII

Open interest error correction, *d*, *SOR* and total volume for several subsequent Euro-Schatz futures contracts

FGBS

Contract	***OI* error corr.** positive	negative	***d*** 100%	50%	***SOR*** 100%	50%	**Total volume**
09/99	0	-2910	3.2707	3.2650	0.9862	0.9822	6,132,144
12/99	0	0	4.0122	4.0096	0.9986	0.9971	7,224,159
03/00	0	0	4.3769	4.3667	0.9930	0.9878	7,752,011
06/00	0	-1470	3.5611	3.5573	0.9974	0.9950	10,491,203
09/00	0	0	3.5376	3.5332	0.9963	0.9935	10,402,757
12/00	0	-100	3.9919	3.9852	0.9940	0.9903	12,242,084
03/01	0	-877	3.0154	3.0134	1.0000	0.9984	17,687,494
06/01	0	-1244	3.1841	3.1817	0.9910	0.9892	22,190,142
09/01	0	-2108	3.9871	3.9857	1.0000	0.9992	19,701,202
12/01	0	-969	3.2866	3.2839	1.0000	0.9981	30,006,885
03/02	0	-1228	2.7830	2.7830	1.0000	1.0000	24,777,971
06/02	0	-4330	2.9750	2.9717	0.9999	0.9973	24,727,497
09/02	0	-1703	2.3388	2.3385	1.0000	0.9997	30,029,440

The very high *SOR* numbers close to 100% in all three bond futures are not so much a consequence of average holding period but rather of the complicated delivery regulations. Almost all market participants (even hedgers) avoid this effort by smoothing out their positions before settlement. In the FGBM and the FGBS we also can observe a strong increase in volume. Still the FGBL is the most important future, but his two "younger brothers" have also gathered more importance. Again, this may be a consequence of the Eurex co-operations with other exchanges.

Finally, we consider the Euribor future, a product in the shadow of the FGB contracts (Table VIII, Figure 6). From the *SOR* and *d* values it is most similar to the FSTX future. But, here the total volume is decreasing.

TABLE VIII

Open interest error, *d*, *SOR* and total volume for several subsequent 3 months Euribor futures contracts

FEU3

Contract	maturity	***OI* error**		***d***		***SOR***		**Total volume**
		positive	negative	100%	50%	100%	50%	
06/99	9 months	0	-91	16.8056	16.8035	0.8159	0.8157	497,268
03/00	18 months	0	-340	21.4256	21.4239	0.8691	0.8690	739,457
06/00	21 months	0	-1181	19.4153	19.4122	0.8962	0.8959	550,908
09/00	24 months	0	-3520	23.0074	23.0072	0.9084	0.9084	442,785
12/00	27 months	0	-3273	27.9047	27.8975	0.9118	0.9113	284,815
03/01	30 months	104	-1126	23.5556	23.5556	0.8552	0.8552	267,645
06/01	33 months	0	-1922	22.3058	22.2600	0.8609	0.8570	224,859
09/01	3 years	0	-629	20.8019	20.7492	0.9161	0.9112	168,506
12/01	3 years	0	-668	21.7161	21.7086	0.8836	0.8829	137,702
03/02	3 years	0	-381	24.0697	24.0697	0.8710	0.8710	108,601
06/02	3 years	0	-396	27.2320	27.0118	0.8735	0.8582	113,777
09/02	3 years	0	-202	20.9848	20.9831	0.9169	0.9167	120,703

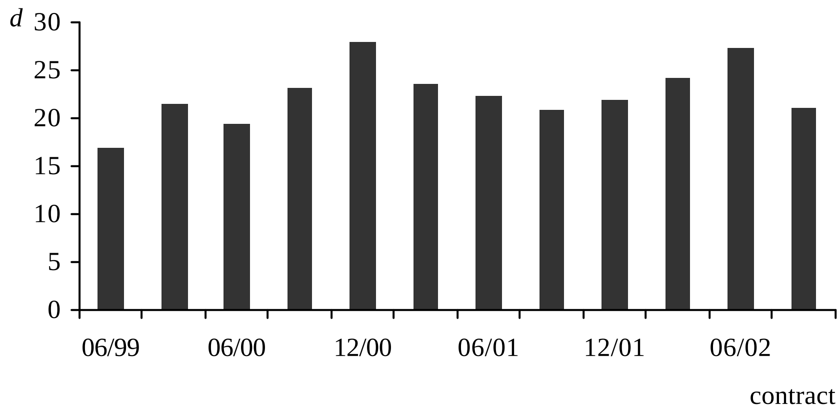

FIGURE 6

Average holding periods of several subsequent FEU3 futures (100% assumption)

The question arises whether or not the differences between different futures are significant. We apply a Wilcoxon rank test to answer this question. Table IX shows the hypotheses and the results of the test. The test statistic $W^+ = \sum_{i=1}^{n} rg(|D_i|) \cdot T_i$ is based on the differences D_i that belong to the ith contract maturity (e.g. 09/01). The trigger T_i is defined as

$$T_i = \begin{cases} 1, \text{ if } D_i > 0 \\ 0, \text{ if } D_i < 0 \end{cases}$$

TABLE IX

Hypotheses and test results for the average holding period differences between several futures

H_0	H_1	W^+	
		100%	50%
$E(d_{FDAX})=E(d_{FESX})$	$E(d_{FDAX})<E(d_{FESX})$	3*	3*
$E(d_{FESX})=E(d_{FSTX})$	$E(d_{FESX})<E(d_{FSTX})$	0*	0*
$E(d_{FGBL})=E(d_{FGBM})$	$E(d_{FGBL})<E(d_{FGBM})$	0*	0*
$E(d_{FGBM})=E(d_{FGBS})$	$E(d_{FGBM})<E(d_{FGBS})$	1*	1*

* significant at a 0.5% level

Obviously, all differences are highly significant. Another question of interest is the significance of the above-mentioned trends in the average holding period time series.

Table X shows the slope resulting from linearly regressing the average holding period (100% data) on time. This regression is done for each of the futures. The next column shows the *t* value of the slope coefficient under the normal distribution assumption. The last column shows the results of a non-parametric trend analysis based on Spearman's correlation coefficient.

TABLE X

Significance of trends in the average holding periods over time for the considered futures

Future	slope	*t* value	Spearman's correlation coefficient
FDAX	-0,4069	-1,6350	-0,4813*
FESX	-1,0653	-7,3806**	-0,9451**
FSTX	-0,8366	-2,4044*	-0,5934**
FGBL	-0,0285	-2,5772*	-0,7527**
FGBM	-0,0486	-3,0206**	-0,7802**
FGBS	-0,0983	-2,9498**	-0,6978**
FEU3	0,3559	1,4497	0,3636

* (**) represents significance on the 5% (1%) level

As can be seen, the positive trend in the FEU3 is not significant, whereas all negative trends in the FGB futures and the FESX and ESTX are highly significant. The negative trend in the FDAX has a little less significance, which presumably is due to the seasonal pattern resulting from the June contract phenomenon. Summarizing, we state that the trends towards shorter average holding periods in the index and the FGB futures are seemingly non-random, and thus a real phenomenon.

5 September 11 and the average holding period

As we have seen in the previous section there seems to be a lot of trading activity in some of the contracts that were nearby contracts on 2001/09/11. Since the Eurex was open during and after the terror attacks of that day, the question whether there is a 09/11 effect or not seems very interesting. In this section we want to find out whether or not the average holding period changed after the terror attacks. To do this we need to split up the whole lifetime of a contract into two parts, the time until 09/10 and the time from 09/11 until the end of the contract. For each of these two periods we want to determine separately the average holding period. This can be done by modifying resp. applying formulae (3) and (5).

Period until 2001/09/10

To measure the average holding period within this period, we apply formula (3) with $s = 0$. Since $OI_0 = 0$, the following formula results:

$$d_{[0,t]} = \frac{2\sum_{i=1}^{t-1} OI_i + OI_t}{\sum_{i=1}^{t} V_i} \tag{6}$$

Here t is equal to 2001/09/10. Note that the assumptions A1 and A2 are necessary for this formula.

Period from 2001/09/11 until settlement

To calculate the holding period of this small time window, we modify formula (5). Figure 7 illustrates the area below the open interest function.

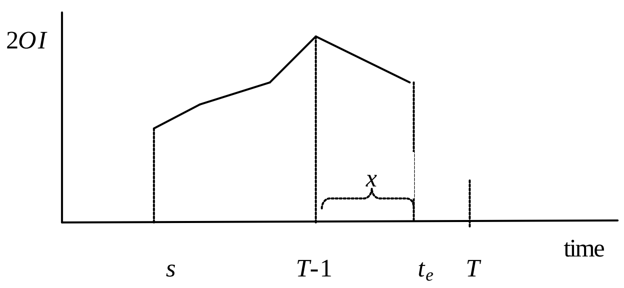

FIGURE 7

Open interest over time between *s* and the end of trading

The area is:

$$F_{st_e} = \underbrace{OI_s + 2\sum_{i=s+1}^{T\text{-}2} OI_i + OI_{T\text{-}1}}_{\text{area without last day}} + \underbrace{\frac{2OI_{T\text{-}1} + 2OI_{t_e}}{2} \cdot x}_{\text{last day}} = OI_s + 2\sum_{i=s+1}^{T\text{-}2} OI_i + (1+x)\cdot OI_{T\text{-}1} + x \cdot OI_{t_e} \quad (7)$$

From this we have:

$$d_{(s\; t_e]} = \frac{OI_s + 2\sum_{i=s+1}^{T\text{-}2} OI_i + (1+x)\cdot OI_{T\text{-}1} + x\cdot OI_{t_e}}{\sum_{i=s+1}^{t_e} V_i + OI_{t_e}} \quad (8)$$

We set s = 2001/09/11.

Results

For the FDAX, FESX (we leave out the FSTX) the 09/01 contract was nearby on 2001/09/11. Including that day, there were 9 trading days left to maturity. For all contracts we now calculate

$d_{[0;T-10]}$ the average holding period up to the T-10 trading day

$d_{(T-10;t_e]}$ the average holding period for the last 9 days.

In the 09/01 contract we possibly can observe a 09/11 phenomenon. The other contracts values create the necessary benchmark.

The Tables XI and XII show the results for the FESX and the FDAX.

TABLE XI

Average holding period and total volume of the FESX for the time before and after 09/11

FESX	$d_{[0;T\text{-}10]}$	$d_{(T\text{-}10;t_e]}$	$\frac{d_{(T\text{-}10;t_e]}}{d_{[0;T\text{-}10]}}$	$\sum_{i=1}^{T\text{-}10} V_i$	$\sum_{i=T\text{-}9}^{t_e} V_i$
09/00	23.6061	7.3923	0.3132	2,462,463	655,871
12/00	15.1781	5.4919	0.3618	3,872,803	975,607
03/01	14.6427	4.9802	0.3401	4,181,738	1,237,832
06/01	12.6095	5.4766	0.4343	5,626,487	1,233,559
09/01	10.9066	3.7441	0.3433	8,036,866	2,909,574
12/01	8.4645	4.9473	0.5845	12,089,541	1,862,639

TABLE XII

Average holding period and total volume of the FDAX for the time before and after 09/11

FDAX	$d_{[0;T\text{-}10]}$	$d_{(T\text{-}10;t_e]}$	$\frac{d_{(T\text{-}10;t_e]}}{d_{[0;T\text{-}10]}}$	$\sum_{i=1}^{T\text{-}10} V_i$	$\sum_{i=T\text{-}9}^{t_e} V_i$
09/00	10.7836	4.5016	0.4175	1,735,748	417,690
12/00	7.7650	4.5454	0.5854	2,445,601	476,023
03/01	8.5980	4.0332	0.4691	2,363,817	624,170
06/01	15.5308	7.1723	0.4618	3,007,146	501,113
09/01	5.5468	2.5679	0.4630	3,300,622	874,832
12/01	5.1179	3.5036	0.6846	3,748,736	481,459

In both contracts there was a clear increase in volume and a clear decrease of the average holding period in the 9 days after the 09/11 terror attacks. But the decrease in the FDAX started already before this date. The value of $\frac{d_{(T\text{-}10;t_e]}}{d_{[0;T\text{-}10]}}$ shows that the 09/11 decrease was nothing striking in the FDAX. The highest values can be observed in the 12/01 contracts. Again this surely is due to 09/11, which lies in the first half of these contracts lifetime.

The Euro-Bund future 09/01 is not affected by a possible 09/11 phenomenon since trading in this contract stopped on 2001/09/06. Thus the 12/01 contract is the one to be examined with respect to 09/11. In this contract, the day before 2001/09/11 is 64 trading days away from the end of trading. Table XIII shows the results.

TABLE XIII

Average holding period and total volume of the FGBL for the time before and after 09/11

FGBL	$d_{[0;T-64]}$	$d_{(T-64;t_e]}$	$\frac{d_{(T-64;t_e]}}{d_{[0;T-64]}}$	$\sum_{i=1}^{T-64} V_i$	$\sum_{i=T-63}^{t_e} V_i$
09/00	3.4313	2.0952	0.6106	3,406,659	31,936,637
12/00	3.1698	2.4727	0.7801	2,822,207	33,074,510
03/01	3.5026	1.9244	0.5494	1,794,383	39,031,222
06/01	5.1469	1.8348	0.3565	2,076,226	41,991,956
09/01	3.0336	1.9046	0.6278	2,796,556	37,711,920
12/01	2.2036	1.9219	0.8721	4,041,893	46,267,782

Here we have a high total volume, but at the same time the highest ratio of pre and after 09/11 average holding periods. This also can be 09/11 effect, but in the opposite direction of the stock index futures. Locally the holding period increased, a hint that maybe more hedgers than usually went into this future after 09/11.

6 Conclusions

Summarizing the findings of the survey, we state:

- The Eurex gives home to some futures (namely the FDAX, the FGBL, the FGBM, and the FGBS) which reveal very short-termed trading behavior of market participants. This means that possibly there are huge masses of day traders in these futures. The FGBL with less than 2 days of average holding period at the end of our investigation period is the one with the most short-termed behavior of the market participants.
- Within our investigation period we could observe a tendency to even more short-term behavior in all futures (except the FEU3). This tendency cannot be regarded as a stable trend to predict future developments, of course, since the average holding period cannot become lower than zero. But nevertheless it is highly significant.
- Looking at the stock index futures we have seen, that the FDAX is the "most short-termed" one, but FESX came close at the end of our investigation period. In terms of trading volume the FESX is the most important one whereas the FSTX is close to meaninglessness.
- There are hints for a local 09/11 effect of smaller resp. higher average holding periods in the FDAX and FESX resp. FGBL. This effect is superimposed by the general trend towards shorter holding periods.

The methodology we presented in this paper uses only publicly available data, but still is very helpful at the same time. It can be applied to many futures at many exchanges. A suggestion for further research with this methodology is to examine all of the world's most important futures with respect to the average holding period.

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[i] The Eurex still consists of two separately managed divisions, the Eurex Germany and the Eurex Switzerland

[ii] See Eurex (2002).

[iii] Bühler and Kempf (1994), Kempf (1998) and Bamberg and Dorfleitner (2002) are contributions which focus on the DAX future. Ahn et al. (2002) examine the determinants of price moves in the bund future.

[iv] Daigler and Wiley (1999), Wang (2002), (2003) are recent examples of such studies.

[v] See Deutsche Börse (1998) in this regard.

[vi] The formula is derived in Bamberg and Dorfleitner (1998).

[vii] We leave out the Swiss Market products like the SMI and the CONF future and recent innovations like the EONIA future.

[viii] The reason for this restriction is data problems with most of the futures. Presumably these problems are due to the Euro introduction.

[ix] In Bamberg and Dorfleitner (1998) only this case occurs.