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DISEQUILIBRIUM IN ASIA-PACIFIC FUTURES MARKETS: AN INTRA-DAY INVESTIGATION

Mahendra Raj*

Abstract

This paper examines the weak form market efficiency using transactions data. Previous studies have mainly used daily data to investigate whether trading rules can result in abnormal profits with mixed results. This study on the other hand uses trade-by-trade data to apply trading rules such as moving average and filter. Two different futures contracts the Australian All Ordinaries Index traded in Sydney Futures Exchange and the Fuel oil treaded in the Singapore International Monetary Exchange are used. The profitability of the trading rules were tested using a bootstrap methodology. It is found that the simple trading rules used in the study do not generate abnormal profits on tick data suggesting that the markets examined are weak form efficient.

INTRODUCTION

Evidence of the profitability and statistical significance of technical trading rules in financial and commodity futures markets is now widespread and several papers have been published on the subject. (Brock, Josef & LeBaron 1992). Technical analysis' is a general name given for a myriad of trading techniques. Technical analysts attempt to forecast the movement of security prices by studying past prices. Previous papers however, have concentrated on the application of technical trading rules to daily closing prices and assumed that daily returns are normally distributed over the sample period. Another assumption in these papers is that trades can be entered at the closing price whenever a technical signal is given, ignoring the bid-ask spread and the possibility of a large variance between closing prices (when the signal is given) and the opening prices on the following trading day (when a trade is executed following a signal). However, these studies do show that in many instances technical trading rules applied to data on a daily bases can produce abnormal (risk adjusted) profits. A possible reason for these profits is the disequilibrium theory which has been discussed in previous research. This theory argues that prices adjust only slowly to information shocks and thus markets are in a state of short-term disequilibrium. (Beja and Goldman, 1980) state that markets being man-made institutions cannot be so perfect that all price discrepancies would be totally eliminated before they are observed.

In contrast to most previous research, this paper will test the significance of technical trading rules when applied to tick data, and will use the 'bootstrap approach' to test the significance of the results. (Levich & Thomas 1993). The technical trading rules to be tested in this paper are 'moving average crossover rules and filter rules.

Moving average crossovers are a simple yet often effective means of gaining information from past market prices on the likely future overall direction of prices; (trend). A long position is taken in the market when the shorter average crosses up through the longer average, at the prevailing price at the time. Conversely the long position is reversed into a net short position when the shorter average crosses from above to below the longer average. This is done by selling twice the amount of contracts that were previously held open on the long side.

An x% filter rule gives trade signals in the following manner. When the futures price rises by x% above its most recent trough then a long signal is given, and conversely when the price falls x% below its most recent peak a sell signal is given.

Both the moving average crossover rule and the filter rule could be described as trend following techniques in that they both seek trend reversal patterns, and keep the speculator in the market all the time with a net open position on the

*Robert Gordon University
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side of the most recent (prior) price movements. Problems obviously arise with trend following techniques such as these when a market is in a congestion pattern, or trending sideways. Under these conditions numerous false signals can be given which costs the trader small but irritating losses which mount up if the market continues sideways for any length of time. Obviously with the trading rules being applied to tick-data (as in this paper) , longer term congestion patterns will be avoided, although with the market going sideways the result may be a lack of intraday volatility. It would be this lack of volatility which would cause losses under intraday technical trading. Under both the 'dual moving average crossover' and the filter rule described above, a full open position is held at all times, thus the speculator using these rules is always in the market.

DATA AND METHODOOGY

Data

Data for this project were provided by the Sydney Futures Exchange (SFE), and the Singapore International Monetary Exchange (SIMEX). Two contracts on vastly different commodities and from different exchanges were selected for the purposes of this study. The first contract is the All Ordinaries Share Price Index futures traded on the Sydney Futures Exchange (SFE). The index is the Bellwether indicator for the Australian stock exchange and is a capital index comprised of the 50 largest Australian companies by market capitalisation. The economic purpose of the contract is to provide a hedging instrument for large or Institutional investors who hold diversified or near market portfolios. The (AOSPI) futures contract is cash settled ie non deliverable. The contract is heavily traded and an average of over 1,000 individual trades took place every day during 1992.

The second contract is Fuel Oil traded on the Singapore International Monetary exchange (SIMEX). This contract is deliverable and thus displays the characteristic drop off in volume and open interest towards its maturity date, which is some weeks before physical delivery must take place. The economic rational for this contract is for Oil refineries or petroleum importers and exporters to hedge their input costs or sales prices. The contract is sparsely traded compared to the All Ordinaries contract with an average of 25 individual trades per day. This may be due to the fact that there are more than four maturities per year in the commodity. There are six consecutive months of the contract with no contracts open for further out dates. This compares to the All Ordinaries futures where only contracts for Mar/Jun/Sep/Dec exist out 18 months.

Methodology

Breaking away from traditional studies on this subject we will not be constructing a single time series of prices. Continuous time series construction has posed problems in prior studies due to the fact that contracts only exist for a limited amount of time. Because of this fact there nearly always exists a significant price discrepancy between any two contracts of differing delivery or settlement dates. These price differences can be explained by the fact that a futures price is the 'sum total' of the markets best guess of the spot price on the delivery date of a contract. There is also the possibility of a built in risk premium, which would be higher on the more distant contract. It has also been found that volatility is far greater in nearer contracts than in more distant ones. To avoid the problems associated with a sudden change in volatility and price we will take a different approach in this study. All intra-day sales prices have been gathered during 1992 on two different contracts. This data has been grouped into 8 different series, 4 for Fuel Oil and 4 for the (AOSPI). Each of these 4 series being specifically for one contract maturity. For example, we have got the All Ordinaries contract for March delivery, June delivery, September delivery, and December delivery as separate 'three month' time series, and similarly for Fuel Oil. Each series is 3 months in duration and runs from the day after the previous near contract has settled and ceased trading, until the settlement day of the current contract. Only Mar/Jun/Sep/Dec contracts are studied for fuel oil; all contracts in between are discarded. This is to keep the data consistent with the (AOSPI).

With these 4 separate series, trading rule returns are then calculated for each contract during its nearest three months until settlement day. Returns are also calculated on the numerous random series we generate for each of the contracts. In this fashion we get four returns for any 12 month period which we can sum into a per/annum rate of return if we wish to do so. Using this method means that the only time a position will not be held open will be from the delivery point of the maturing contract until the first signal is given, at or near the market opening on the following day. It should be noted at this point, that the construction of four three month time series in any 12 month period may only be appropriate when using tick-data due to the many thousands of observations and hundreds of trades during any 3 month period given by the trading rules. However, by doing this the problems discussed above are avoided and in the authors opinion give more meaningful results.

Return Characteristics

The return from any futures trade can be expressed simply as the following:

$$R_{t,t+1} = \ln(F_{t+1} / F_t)$$

where F_t = the futures price at time t.

Total returns over the trading period can be expressed as the following:

$$TR_{1,n+1} = \sum_{t=1}^{N} R_{t,t+1} = \sum d_t n(F_{t+1} / F_t)$$

where d_t is a dummy variable. d_t = +1 when it is a long futures trade and **-**1 when it is a short trade.

Given a null hypothesis that futures markets are perfectly efficient, then the total returns (TR) from the trading rules should equal zero unless there is the presence of a risk premium to the long side (assuming normal backwardation). If such a risk premium exists in the markets studied in this paper then the total return may not be a true reflection of an excess return. However, the effects of such a risk premium can be discounted because it would only be earned when a long position is held. Thus, we can assume that a risk premium would have to be paid when a short position is held.

Therefore; RP(earned) **-** RP(paid) = 0 if open positions were 'net long' and 'net short' an equal amount of time.

Bootstrapping Methodology

In financial markets as the sampling distribution itself varies over time, an alternative to the traditional statistical tests are inappropriate. An alternative method is the bootstrapping method developed by (Efron 1979). Bootstrapping is a technique wherein generally a new series of asset prices are created by the random reordering of the original series. In this paper 300 random arrangements of the original series are created as it is deemed sufficient to prove statistical significance. Moving average rules and filter rules are applied to each of the new series. The profits of the original series is compared to the distribution of results from the numerous random series.

In this method no assumptions are made about the volatility of the assets over time, or about the distribution of the asset prices. Only the price changes from tick data are randomly reshuffled keeping the exact same starting and ending values of the time series so that each of the new series will have identical distributional properties to those of the original series.

Once each new random series is generated, the technical trading rules are applied and profits calculated. This process is repeated 300 times for each different trading rule on each of the four maturity time series on the Fuel Oil and All Ordinaries contracts. This now creates an empirical distribution of profits on which the original profits can be compared and measured. If profits from the original series are above the α percent cut off level then they can be stated as significant. The null hypothesis in this situation is that there is no information for making excess returns in the original time series. This is rejected of course if the profits on the original series are significant compared to the 'distribution of profits'.

Trading Rules

The details of the trading rules used are as follows:

* Moving averages crossover combinations.

5/20 10/50 20/100

* Filter.

1%

RESULTS

The results are very mixed and are summarised in Tables 1A and 1B, below. The sample statistics for the two futures contracts are given below.

(SFE) All Ordinaries Index Futures Summary Return Statistics 1992

	March	June	September	December
Mean	0.0000176	-0.0000065	0.00000208	-0.0000033
Std. Dev.	0.000789	0.000944	0.000578	0.001162
Skewness	1.906446	-0.96377	0.561108	-1.7191
Kurtosis	39.08402	10.19318	15.98508	24.07892

SIMEX Fuel Oil Futures Summary Return Statistics 1992

	March	June	September	December
Mean	-0.000067	0.000195	0.0000727	-0.000054
Std. Dev.	0.002507	0.002901	0.004567	0.002959
Skewness	-2.934	1.719919	3.666564	2.821311
Kurtosis	32.53153	29.1631	519.9906	50.98791

Per Annum Average Return Statistics

	AOSPI Futures 1992	SIMEX Fuel Oil Futures 1992
Mean	0.00000247	0.0000367
Std. Dev.	0.00086825	0.0032335
Skewness	-0.2153	1.3175
Kurtosis	22.33	158.16

TABLE 1A
Profitability of Technical Trading Rules on (AOSPI) for 1992

Delivery Month	5/20	10/50	20/100	Filter 1%
March				
(n=25,345)				
Gross profit%	19.169	16.135	5.938	-11.053
Sum trades	1820	628	309	7
Rank in 300	292	275	212	38
Approx profit in				
$/contract.	$7,667	$6,454	$2,375	-$4,421
Transaction cost	$12,740	$4,396	$2,163	$49
Net profit/contract	-$5,073	$2,058	$212	-$4,470
Fraction long	.48	.476	.47	.36
Fraction short	.52	.524	.53	.64

Delivery Month	5/20	10/50	20/100	Filter 1%
September				
(n=23,923)				
Gross Profit	9.932	18.498	15.896	-4.164
GvSum trades	1801	588	288	5
Rank in 300	263	280	279	104
Approx profit in				
$/contract	$3,972	$7,399	$6,358	-$1,665
Transaction costs	$12,607	$4,116	$2,016	$35
Net profit/contract	-$8,635	$3,283	$4,342	-$1,700
Fraction long	.485	.468	.451	.622
Fraction short	.515	.532	.549	.378

Delivery Month	5/20	10/50	20/100	Filter 1%
June				
(n=20,445)				
Gross profit %	1.286	9.605	-0.773	-2.51
Sum trades	1634	579	259	4
Rank in 300	155	245	144	131
Approx profit in				
$/contract	$514	$3,842	-$309	$1,004
Transaction cost	$11,438	$4,053	$1,813	$28
Net profit/contract	-$10,924	-$211	-$2,122	$976
Fraction long	.5	.5	.495	.242
Fraction short	.5	.5	.505	.758

Delivery Month	5/20	10/50	20/100	Filter 1%
December				
(n=36,867)				
Gross profit	-1.223	13.016	14.291	1.55
Sum trades	3196	1006	426	32
Rank in 300	130	209	238	156
Approx profit in				
$/contract	-$489	$5,206	$5,716	$620
Transaction costs	$22,372	$7,042	$2,982	$224
Net profit/contract	-$22,861	-$1,836	$2,734	$396
Fraction long	.5	.5	.5	.558
Fraction short	.5	.5	.5	.442

NB. Gross profit % is the percentage return for the holding period of each particular contract, i.e., 3 months.

TABLE 1B
Profitability of Technical Trading Rules on SIMEX Fuel Oil for 1992

Maturity Date	5/20	10/50	20/100	Filter 1%
March				
(n=471)				
Gross profit %	-6.102	-1.747	6.978	0.627
Sum trades	28	11	3	8
Rank in 300	37	118	283	155
Approx profit in $/contract	-$518	-$148	$593	$53
Transaction costs	$196	$77	$21	$56
Net profit/contract	-$714	-$225	$572	-$3
Fraction long	.513	.514	.425	.52
Fraction short	.487	.486	.575	.48

Maturity Date	5/20	10/50	20/100	Filter 1%
September				
(n=1,603)				
Gross profit %	2.98	7.307	3.473	4.753
Sum trades	88	36	24	20
Rank in 300	167	193	161	155
Approx profit in $/contract	$253	$621	$317	$404
Transaction costs	$616	$252	$168	$140
Net profit/contract	-$363	$369	$149	$264
Fraction long	.601	.565	.558	.62
Fraction short	.399	.435	.442	.38

Maturity Date	5/20	10/50	20/100	Filter 1%
June				
(n=1,178)				
Gross profit %	1.578	0.8223	-2.513	-21.29
Sum trades	55	24	16	30
Rank in 300	109	71	39	1
Approx profit in $/contract	$134	$70	-$213	-$1,809
Transaction costs	$385	$168	$112	$210
Net profit/contract	-$251	-$ 98	-$325	-$2,019
Fraction long	.394	.393	.668	.678
Fraction short	.606	.607	.332	.322

Maturity Date	5/20	10/50	20/100	Filter 1%
December				
(n=1,657)				
Gross profit %	19.288	11.352	7.395	12.299
Sum trades	84	36	18	25
Rank in 300	277	228	215	238
Approx profit in $/contract	$1,639	$964	$629	$1,045
Transaction costs	$588	$252	$126	$175
Net profit/contract	$1,051	$712	$503	$870
Fraction long	.449	.442	.426	.381
Fraction short	.551	.558	.574	.619

NB. Gross profit % is the percentage return for the holding period of each particular contract, i.e., 3 months.

Rankings are the original profits compared to the 300 random profits generated from the same price series. They are ranked from 300 to 1, 300 being the best profit, 299 being the second best, so on and so forth.

All transaction costs are assumed to be $7.00 round trip. This is based on the actual cost to a bank taking position in the market. The cost is made up of brokerage, $5.00 per contract and an exchange fee of $2.00 per contract. This is the lowest end of the scale however, and most private traders pay more. Brokerage rates range from $60.00 round trip for small private traders to around $12.00 for clients trading in sufficient volume and frequency. However the bank rate of brokerage will be applied for the purposes of this paper because this minimum rate would more than likely apply to any trading program executing trades as frequently as the one in this paper.

As can be seen by the figures in the ‘fraction long, fraction short’ columns the effects of a risk premium on the results can be discounted. Even on the 300 random returns we can discount the effects of a risk premium as approximately half of these random series would yield a risk premium and half a risk discount. Thus the original profits rank, compared to the random series would not be affected. A risk premium is assumed on any long positions, but as the figures in the above tables indicate, long positions are held on average approximately half the time. Given that a risk premium is received for any long positions held then it can be assumed that a risk premium would have to be paid for any short positions held. Thus the affects of such a premium (if it exists) are nullified.

The profits generated by the technical trading rules are in general ‘not significant’, either statistically or financially! Table 1A shows that in only one instance was any profit significant at the 5% level in the All Ordinaries contract during 1992. This was in the March contract using the 5/20 moving average crossover rule. However, after making deductions for transaction costs there is a significant financial loss. The most profitable observation was the September contract using the 20/100 moving average crossover rule which was significant at the 10% level. Here a profit of $4,342 per contract could have been achieved.

By summing all profits for the year we can better understand the results. Below is a list of summary per annum results for the various trading rules for the All Ordinaries contract for the 1992 period.

All Ordinaries Futures, 1992 Per Annum Results

	5/20	10/50	20/100	Filter 1%
Gross Profit %	29.164	57.254	35.352	-16.177
Net Profit/Contract	-$47,493	$3,294	$5,166	-$4,798
Average Rank Out of 300	210	252.75	218.25	107.25
Profit From Buy & Hold	-3.73%		$1,492 per contract	

Looking at the above information, it can be seen that the 10/50 moving average is the most statistically significant in the All Ordinaries contract although it is not significant at the 10% level because it ranks below 270 which is the 10% cut off. The financial profit of A$3,294 for the year of 1992 equates to a 219.6% p.a. return on an initial margin deposit of approximately A$1,500 per contract. The 20/100 rule whilst giving a higher financial profit over the year 1992 was not as statistically significant as the returns on the 10/50 crossover rule. The 20/100 crossover was less consistent and had swings in profitability during the year greater than that of the 10/50 crossover rule. The filter rule used in this study produced significantly negative financial returns over the year and ranked below the average for a return on a random time series. Thus, it can be seen that none of the rules generate significant profits consistently.

The results for the SIMEX Fuel Oil contract are listed in a summary for the year below.

SIMEX Fuel Oil Futures, 1992 Per Annum Results

	5/20	10/50	20/100	Filter 1%
Gross Profit %	17.744	17.735	15.333	-3.611
Net Profit/Contract	-$277	$758	$899	-$888
Average Rank Out of 300	147.5	152.5	174.5	137.25
Profit From Buy & Hold	18.2%		$1,540 per contract	

The results for the SIMEX fuel oil are even less statistically significant than for the Australian All Ordinaries contract. Once again the Filter rule has proved to be the most ineffective for generating significant profits, ranking below the average random profit for a filter rule for that period. The trading rule with the highest level of statistical significance is the 20/100 moving average crossover which also generated the highest financial profit. The net profit after costs of $899 equates to an approximate 106% gain on an assumed initial margin of $850 which is 10% of the contract underlying value. The initial margin is assumed to be higher for fuel oil than for the (AOSPI) as a percentage of underlying value because fuel oil is a deliverable contract whereas the (AOSPI) is cash settled.

The 20/100 crossover rule (the best for fuel oil) has no statistical significance and ranks 174.5 out of 300 which is only marginally above the mean random profit. As in the Australian sharemarket contract none of the trading rules tested would be recommended for use in the markets.

As would be expected by using trading rules on tick data, the volume of trade signals given is very large and the costs associated with this amount of trading is significant to the point where transaction costs overwhelm any profits generated in the market. The 5/20 crossovers whilst producing significant gross returns in many contracts produced financial losses in all but the December fuel oil contract. Over the 1992 period, the use of this rule would have produced disastrous results for a trader. As the moving averages used are extended in length out to the 10/50 and 20/100 levels the trade signals generated decline significantly making way for some net financial returns.

CONCLUSIONS

The main objective of this paper was to test the significance of mechanical trading rules in futures markets. Specifically these rules were tested on tick, or trade-by-trade data on two different commodities from two different exchanges. These were the Australian All Ordinaries Share Price Index Futures traded on the Sydney Futures Exchange and Fuel Oil Futures traded on the Singapore International Monetary Exchange. There have been previous papers which suggest that mechanical trading rules generate significant risk adjusted profits when tested on daily data sets, but little evidence exists on the profitability of these rules when tick data sets are used. Also this paper uses the 'bootstrap' method for testing the significance of any profits generated, which has several advantages over more traditional methods.

The results of this series of tests indicate that simple technical trading rules 'do not' generate significant profits when used on tick data. Some profits on the moving average crossovers may seem large, but it must be remembered that a large amount of trades was necessary to generate them and most of these profits did not Rank sufficiently high in the random profits to be statistically significant. Most of the financial profits were eaten up by transaction costs, particularly with the 5/20 crossover rule. The 10/50 and 20/100 rules generated profits over the 1992 calendar year in net $ terms in both contracts studied. However, these profits were extremely variable and even net losses in some contract maturities. Thus it could be concluded that there is no information in 'tick price changes' for Fuel Oil or All Ordinaries futures that can be utilised to generate significant risk adjusted profits. Tick price changes in these contracts could be described in general as 'near random walks'.

One possible drawback from using the raw tick data in a study of this nature is the volume of ticks at the same price before a price movement is observed in any period of time. This may cause difficulties for the detection of any short run trends in the market by mechanical trading rules. For example a string of consecutive trades at the same price would have the effect of causing any dual moving averages to converge, thus making it likely to give a trade signal if a subsequent price movement of only one or two points moves against the prior direction detected by the trading rule. This may give rise to many bad signals or 'whipsaws'. It may be that the trading rules studied in this paper would be more significant if tested not on the raw tick data, but on data of price changes only.

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