Contrarian Arbitrages and Market Efficiency: Evidence in International Interest Rate Futures Markets

(March 2005)

Andrew H. Chen, Distinguished Professor of Finance
Southern Methodist University, Dallas, Texas, U.S.A.

Joseph Kang*, Associate Professor of Finance
Nanyang Business School, NTU, Singapore

Donald Lien, Richard S. Liu Distinguished Chair in Business
University of Texas at San Antonio, Texas, U.S.A.

Key words: US and non-US futures markets; Futures returns and risk premium; Return reversal and continuation; Contrarian and momentum strategies; Basis trading; Delivery options; Interest-rate futures; Daily roll-over implementation; Empirical analysis.

JEL classification: G13; G15; G19

***Corresponding author.** Phone: (65) 6790-4639, Fax: (65) 6791-3697, E-mail: acskang@ntu.edu.sg. The authors have received valuable comments from C.Y. Hwang, D. Lien and C. Chen. The first author acknowledges the research grants (RCC20/2002 and RCC4/2003) of the Nanyang Business School, Nanyang Technological University.

Contrarian Arbitrages and Market Efficiency:
Evidence in International Interest Rate Futures Markets

ABSTRACT

In this paper, we examine the profitability of contrarian and momentum strategies for 33 long- and short-rate futures contracts that are traded in two US and ten non-US exchanges. Our methodology closely follows Lo and Mackinlay (1990) methodology for testing the profitability of return-based contrarian strategies except that in our study, ten symmetric strategies are implemented on a daily rollover basis for each spot-month quarters. Our main findings are as follows: (1) the results of {5,5} strategies that are based on 5-day evaluating and holding horizons are representative of the results of all other symmetric strategies; (2) in short-rate futures segments, momentum strategies were more successful in most exchanges during both the pre- and post-Euro subperiods; (3) in long-rate futures segments, momentum strategies were more successful in most exchanges during the pre-Euro period, whereas during the post-Euro period the contrarian (momentum) strategies were more successful in the exchanges of US (European) trading-time zones; and (4) these profits tend to be concentrated on certain weekdays. These findings are robust to, among other things, alternative ways of implementing the return-based strategies.

I. Introduction

As Fama (1998) noted, the predictability of asset returns over time is among the most controversial issues on market efficiency. In equity markets, Jegadeesh (1990) and Lehmann (1990) find return reversals in relatively short-term horizons (one month and six months, respectively), whereas Jegadeesh and Titman (1993) document return continuations in intermediate horizons (three to twelve months). The sources of contrarian profits (return reversals) and momentum profits (return continuations) are also examined by, e.g., Lo and Mackinlay (1990) and Jegadeesh and Titman (1995) in the US market. In international markets, their profits and sources are examined by, e.g., Chang, et al. (1995) for Japan, Schiereck, et al. (1999) for Germany, Kang, et al. (2002) for China, and Rouwenhorst (1998) for other international markets.

Such studies in futures markets barely exist, which may not be surprising for at least two reasons. First, such studies are difficult because the sources or factors of futures returns and their predictability are quite complicated. For example, for futures contracts that are cash settled, average futures return (usually measured as dollar price change) accounts for the expected spot price change net of expected basis change.[1] In contrast, for most futures contracts that can be settled by delivery, expected futures return accounts for the expected change in CTD (cheapest-to-deliver) prices net of expected CTD basis change.[2] Second, empirically measuring the profitability of return-based strategies in an asset pricing context is not an easy task because relevant futures pricing models substantially differ in theorizing pricing factors and return predictability.[3]

---

[1] That is, $(\in F_1 - F_0) = (\in S_1 - S_0) - [(\in S_1 - \in F_1) - (S_0 - F_0)]$. In equilibrium, expected futures return (futures price bias) would account for risk premium net of expected basis: ie, $(\in F_1 - F_0) = (\in S_1 - F_0) - (\in S_1 - \in F_1)$.

[2] That is, $(\in F_1 - F_0) = (\in S^*_1 - S^*_0) - [(\in S^*_1 - \in F_1) - (S^*_0 - F_0)]$, where $S^*_t = \min (S_{t,1}, \ldots, S_{t,i}, \ldots, S_{t,n})$ at t, $S_{t,i}$ (= i-th spot price divided by its CF_i) is a delivery-adjusted price of the i-th deliverable spot at t, and CF_i is the conversion factor of i-th spot.

[3] For example, futures pricing literature is still evolving to explain complex interactions amongst various demands of long and short hedgers and long and short speculators. The modeling difficulty due to complex

Despite these problems, a study of profitability of return-based strategies in futures markets should be of interests to both academicians and investment professionals in equity, futures, and basis trading markets for at least three reasons. First, doing such studies provides direct tests of the applicability of return-based strategies to futures markets. Second, such studies also contribute to market efficiency literature. For example, significant results obtained from such liquid futures markets can provide indirect tests of the claims that the profitability of some return-based strategies might have been spuriously caused by illiquid trading.[4] Third, as futures returns (net of risk premium) account for the changes in spot basis (i.e., spot price minus futures price) during most spot-month periods (i.e., the relatively liquid trading periods that exclude delivery months), any significant findings would also have important implications on basis trading strategies.

In this paper, we examine the profitability of return-based contrarian and momentum strategies in two US and ten non-US interest-rate futures markets for the period from January 1990 to December 2002. The interest-rate futures contracts are chosen for the analysis not only because these (and their basis) products are traded in very liquid markets but also because sources of return predictability in short- and long-rate futures are different due to availability of delivery options in long-rate futures. Our methodology closely follows Lo and Mackinlay (1990) methodology for testing the profitability of return-based contrarian strategies in equity markets. In our study, however, both contrarian and momentum strategies based on ten symmetric combinations of evaluating and holding horizons are implemented on a daily rollover basis for each of 50 spot-month periods. To account for the potential effect of Euro-currency introduction on interest-rate futures trading, our sample period is subdivided into pre- and post-Euro subperiods.

---

interactions is superbly explained by Duffie (1989) who categorizes several scenarios of such interactions and relates them to relevant literature. See Chapter 4 in Duffie (1989).

[4] See, e.g., Lehmann (1990).

The results of {5,5} strategies that are based on 5-day evaluating and holding horizons represent our overall results, which can be summarized as follows: (1) in short-rate futures segments, momentum strategies were more successful in most exchanges during both the pre- and post-Euro subperiods; (2) in long-rate futures segments, momentum strategies were more successful in most exchanges during the pre-Euro period, whereas during the post-Euro period, contrarian (momentum) strategies were more successful in the exchanges of US (European) trading-time zones; and (3) these profits tend to be concentrated on certain weekdays.

The remainder of this paper is organized as follows. Section II describes the data and methodology employed for formation and implementation of contrarian and momentum portfolio strategies. Section III reports the findings, whereas Section IV provides further analyses on issues including the weekday effect on contrarian and momentum profits. Section V contains a summary and conclusions.

II. Data and Methodology

1. Data

Our initial sample contain daily open and close prices, open interests and trading volumes for 133 interest-rate futures contracts that are traded in 31 US and non-US international futures exchanges. The data are obtained from *the nearby series* of Datastream International Database for the period from October 1990 to September 2002. These data series contain data on nearest-maturing contracts for their spot-month quarters, each of which covers the period from the March-cycle delivery month of an earlier contract to the month prior to the next delivery month.

This initial sample is refined by eliminating futures contracts with substantial missing observations if these data are unavailable also in the database of Bloomberg Professional

System or websites of relevant Exchanges. The sample is further refined by eliminating the futures contracts that are delisted before January 2000 or have insufficient trading volume and open interests. Such elimination led to the final sample containing data for 33 contracts that are traded in 12 futures exchanges. These contracts are grouped by their three trading-time zones (namely, US and Canada, Europe, and Asia trading-time zones) and then by long- and short-rate maturity segments. To account for possible distortion effects of the introduction of Euro currency, the sample period is also subdivided to Pre- and Post-Euro sub-periods with one-quarter interval between them.

Table 1 provides a summary of contract specifications. These contracts are quoted as a percentage of par value, index points, or "100 minus yield in percent". The contract size and margin requirements substantially differ by contracts and across exchanges in different trading-time zone.

[Insert Table 1 About Here]

Table 2 provides mean returns and standard deviations. Contrary to comparable findings in equity markets, volatility of futures returns in the exchanges of Asian trading-trading time zone is much smaller than those of US and EU trading-time zones. The return volatility of long-rate futures is larger than that of short-rate futures in most exchanges, which contrasts with the well-documented pattern that volatility of long rates is smaller than that of short rates.

[Insert Table 2 About Here]

2. Methodology

Our methodology closely follows Lo and Mackinlay (1990) methodology for testing the profitability of return-based contrarian strategies in equity markets. In our study, we consider ten different trading horizons for both evaluating (E = 1, …, 10 trading days) and

holding (H = 1, …, 10 trading days). In our paper, we consider only ten symmetric contrarian $\{(E, H): E = H\}_C$ and ten symmetric momentum $\{(E, H): E = H\}_M$ strategies, each of which has identical evaluation and holding horizons. For both short- and long-rate futures segments of all exchanges, these strategies are implemented on a daily rollover basis for each of 50 spot-month quarters.

Futures returns are computed as Open-to-Settlement price changes.[5] The individual returns (eq. 1) and equal-weighted segment returns (eg. 2) at t for E evaluation periods are computed as:

(1) $\mathbf{R_{i,t,E} = \log_e(PS_{i,t}/PO_{i,t-E-1})}$

(2) $\mathbf{R_{S,t,E} = (\sum_i R_{i,t,E}) / N}$

In maturity segment, we rank the past returns of segment portfolios and individual futures in a descending order. The winner is identified as the contract with the highest past return, whereas the loser is recognized as the one with the lowest past return. A contrarian (momentum) portfolio takes a long (short) position in the loser contract and a short (long) position in the winner contract. The winner weights (eq. 3) and loser weights (eq. 4) in contrarian and momentum portfolios are assigned as follows:

(3) $\mathbf{\Phi^C_{w,t,E} = -0.5 (R_{w,t,E} - R_{S,t,E}) = - \Phi^M_{w,t,E}}$

(4) $\mathbf{\Phi^C_{l,t,E} = -0.5 (R_{l,t,E} - R_{S,t,E}) = - \Phi^M_{l,t,E},}$

Portfolio weights of winner and loser are based on their return performance relative to that of segment portfolio. For contrarian (momentum) strategies, the loser's (winner's) weight is positive and the winner's (loser's) weight is negative. The contrarian and momentum gross profits (eq 5 and eq 6) and net profits (eq 7 and eq 8) are computed as:

(5) $\mathbf{\pi^C_{t+H} = \Phi^C_{w,t,E} (R_{w,t+H}) + \Phi^C_{l,t,E} (R_{l,t+E})}$

(6) $\mathbf{\pi^M_{t+H} = \Phi^M_{w,t,E} (R_{w,t+H}) + \Phi^M_{l,t,E} (R_{l,t+E})}$

(7) $\pi^{C*}_{t+H} = \pi^{C}_{t+H} - R_{S,\,t+H}$

(8) $\pi^{M*}_{t+H} = \pi^{M}_{t+H} - R_{S,t+H}$

Both gross and net profits of symmetric contrarian (and momentum) strategies are computed on a daily rollover basis for each of 50 spot-month quarters. Statistical significance of gross and net returns of respective strategies is tested for each of 50 spot-month quarters, pre- and post-Euro subperiods. The test is based on the right-tailed t-test, whereas practical significance of these strategies is measured by the percentage of spot-month quarters with statistically significant profits.

III. EMPIRICAL FINDINGS

The results of {5,5} strategies that are based on 5-day evaluating and holding horizons represent our overall results.[6] In the next three sub-sections, we report these results. The last sub-section provides a summary of the international findings.

1. Contrarian and Momentum Strategies in the US Trading-Time Zone

Table 3 reports the profitability of {5,5} contrarian and momentum strategy for short-rate and long-rate futures that are traded in the US trading-time zone.

[Insert Table 3 About Here]

In short-rate futures markets, net and gross profits of contrarian (momentum) strategies are negative (positive) at the 1% and 5% significance levels, respectively, for overall and pre-Euro periods. During the post-Euro period, net (gross) profits of momentum strategies are positive at the 1% (5%) significance level. Out of 16 pre-Euro spot-month quarters, there are 3(4) quarters in which net (gross) contrarian profits were statistically significant, whereas there are 7(6) quarters in which net (gross) momentum profits were

[5] We have also considered open-to-open and settlement-to-settlement price changes. Their results are qualitatively similar to the results reported in this study and hence are not reported here.

statistically significant. Out of 15 post-Euro spot-month quarters, there are 6(5) quarters in which net (gross) contrarian profits were statistically significant whereas there are 9(5) quarters in which net (gross) momentum profits were statistically significant. These results indicate that in short-rate futures markets, momentum strategies appear to outperform contrarian strategies during both pre- and post-Euro periods.

In long-rate futures markets, net profits of contrarian (momentum) are negative (positive) at 1% significance level for overall and post-Euro periods, whereas gross profits of contrarian (momentum) strategies are positive (positive) at the 5% significance level for pre-Euro (post-Euro) periods. Out of 16 pre-Euro spot-month quarters, there are 3(9) quarters in which net (gross) contrarian profits were statistically significant, whereas there are 9(3) quarters in which net (gross) momentum profits were statistically significant. Out of 15 post-Euro spot-month quarters, there are 2(2) quarters in which net (gross) contrarian profits were statistically significant, whereas there are 9(4) quarters in which net (gross) momentum profits were statistically significant. These results indicate that in long-rate futures markets, momentum strategies appear to outperform contrarian strategies only during the post-Euro period.

2. Contrarian and Momentum Strategies in the EU Trading-Time Zone

Table 4 reports the profitability of {5,5} contrarian and momentum strategy for short-rate and long-rate futures that are traded in the EU trading-time zone. We report only the results for the post-Euro period since the results of short- and long-rate futures are not comparable.

[Insert Table 4 About Here]

In short-rate futures markets, net (gross) profits of contrarian and momentum strategies for post-Euro period are negative and positive, respectively, at the 1% (5%)

[6] Overall results suggest, however, that contrarian (momentum) profits at shorter (longer) horizons are slightly

significance levels. Out of 15 post-Euro spot-month quarters, there are 3(4) quarters in which net (gross) contrarian profits were statistically significant, whereas there are 7(7) quarters in which net (gross) momentum profits were statistically significant. Similar to findings in the US trading-time zone, these results indicate that in short-rate futures markets, momentum strategies appear to outperform contrarian strategies.

In long-rate futures markets, net (gross) profits of contrarian and momentum strategies are positive and negative at 5% (1%) significance level. Out of 15 post-Euro spot-month quarters, there are 6(7) quarters in which net (gross) contrarian profits were statistically significant, whereas there are 6(2) quarters in which net (gross) momentum profits were statistically significant. These results indicate that in long-rate futures markets, momentum strategies appear to underperform contrarian strategies in the post-Euro period.

3. Asia Trading-Time Zone

Table 5 reports the profitability of {5,5} contrarian and momentum strategies for short-rate and long-rate futures that are traded in the Asia trading-time zone.

[Insert Table 5 About Here]

In short-rate futures markets, net (gross) profits of contrarian and momentum strategies are negative and positive, respectively, at the 1% (5%) significance levels for the overall and both pre- and post-Euro periods. Out of 16 pre-Euro spot-month quarters, there are 2(3) quarters in which net (gross) contrarian profits were statistically significant, whereas there are 8(5) quarters in which net (gross) momentum profits were statistically significant. Out of 15 post-Euro spot-month quarters, there are 5(5) quarters in which net (gross) contrarian profits were statistically significant, whereas there are 8(6) quarters in which net (gross) momentum profits were statistically significant. These results indicate that in short-

more successful.

rate futures markets, momentum strategies appear to outperform contrarian strategies during both pre- and post-Euro periods.

In long-rate futures markets, net (gross) profits of contrarian and momentum strategies are negative and positive, respectively, at 1% (5%) significance level for overall period. In the pre-Euro period, net profits of momentum (contrarian) strategies are positive (negative) at 1% significance level, whereas gross profits of contrarian (momentum) strategies are positive (positive) at the 5% significance level. Out of 16 pre-Euro spot-month quarters, there are 4(2) quarters in which net (gross) contrarian profits were statistically significant, whereas there are 10(7) quarters in which net (gross) momentum profits were statistically significant. Out of 15 post-Euro spot-month quarters, there are 3(7) quarters in which net (gross) contrarian profits were statistically significant, whereas there are 5(3) quarters in which net (gross) momentum profits were statistically significant. These results indicate that in long-rate futures markets, momentum strategies appear to outperform contrarian strategies in the pre-Euro period, whereas such pattern is not so clear in the post-Euro period.

4. Section Summary

Our findings are as follows: (1) in short-rate futures segments, momentum strategies were more successful in most exchanges during both the pre- and post-Euro subperiods; and (2) in long-rate futures segments, momentum strategies were more successful in most exchanges during the pre-Euro period, whereas during the post-Euro period, contrarian (momentum) strategies were more successful in the exchanges of US (European) trading-time zones.[7]

The specific finding in the long-rate futures markets of the US trading-time zone that momentum (contrarian) profits were more significant during the pre-Euro (post-Euro) sub-

[7] In contrast, an earlier study finds dominance of contrarian strategies in US futures market.

period might have been due to relatively large differences in yield levels between the two sub-periods.[8] The yield levels in the pre-Euro period were much higher than those in the post-Euro period, suggesting relatively higher yield volatility (or low duration of long-rate futures) in the pre-Euro period. Hence, relatively higher price volatility of long-rate futures in the post-Euro period could have led to more frequent return reversals and contrarian profits in the US and Canadian exchanges.

IV. ADDITIONAL ANALYSES

1. Portfolios with Multiple Winners and Losers

Our results can be sensitive to whether our portfolios include multiple winner and loser contracts or extreme winner and loser contracts. To test the robustness, we have implemented the {5,5} portfolios with multiple winners and losers. These results are not materially different from those reported earlier. We therefore conclude that our findings are robust to alternative portfolio composition.[9]

2. Serial Correlation Analyses

In our study, momentum and contrarian net profits are relative profits. In general, momentum (contrarian) profits are larger if extreme winner and loser returns are positively (negatively) auto-correlated and negatively cross-correlated each other. We examine serial correlations of frequent winners, losers, and respective segments in {5,5} momentum and contrarian portfolios to see if their serial correlations could explain our main findings. The cross serial-correlations can mislead because in our sample, many frequent winners in some spot-month quarters were also frequent losers in other spot-month periods.

[Insert Table 6 About Here]

[8] Based on {1,1} strategy implemented to a period comparable to our pre-Euro subperiod, Lin et al. (1999) document contrarian profits.

Table 6 reports only the autocorrelation results for selected numbers of lags. The statistical significance of lag-5 serial correlations of the returns of segment portfolios and frequent winners and losers indicate that these returns tend to be positively (negatively) serially correlated in the case of futures traded in non-US (US) trading-time zone. The negative serial correlations in the futures traded in US trading-time zone partially support the relatively strong contrarian profits in the long-rate segments of US and Canadian exchanges during the post-EU period. In contrast, the lag-10 results indicate that those returns tend to be positively serially correlated in most exchanges. These results are by and large consistent with our finding that momentum strategies tend to outperform contrarian strategies in most exchanges during most spot-month periods from 1990 to 2002.

3. Weekday Variations in Short-Horizon Contrarian and Momentum Strategies

To see if there are any weekday effects on the profits of our return-based strategies, we examine the weekday variations in the {5,5} momentum and contrarian profits. Although the details are not reported here, contrarian and momentum profits tend to be concentrated on certain weekdays, a finding consistent with other studies.[10]

V. SUMMARY AND CONCLUSIONS

Using a methodology following Lo and Mackinlay (1990) methodology for testing the profitability of contrarian strategy, we examined the profitability of both contrarian and momentum strategies for 33 long- and short-rate futures contracts that are traded in two US and ten non-US futures exchanges. We implemented ten symmetric strategies on a daily rollover basis for each of 50 spot-month quarters.

---

[9] Our contrarian results are by and large consistent (inconsistent) with the corresponding equity-market results reported in Cox and Peterson (1994) (Bowman and Iverson (1998)).
[10] See, e.g., Lin et al. (1999) and Zarowin (1990).

Our findings are as follows: (1) in short-rate futures segments, momentum strategies were more successful in most exchanges during both the pre- and post-Euro subperiods; (2) in long-rate futures segments, momentum strategies were more successful in most exchanges during the pre-Euro period, whereas during the post-Euro period, contrarian (momentum) strategies were more successful in the exchanges of US (European) trading-time zones; and (3) these profits tend to be concentrated on certain weekdays. These findings are robust to, among other things, alternative implementation of the strategies.

The specific finding in the long-rate futures markets of the US trading-time zone that momentum (contrarian) profits were more significant during the pre-Euro (post-Euro) sub-period might have been due to relatively large differences in yield levels between the two sub-periods. The yield levels in the pre-Euro period were much higher than those in the post-Euro period, suggesting relatively higher yield volatility (or low duration of long-rate futures) in the pre-Euro period. Hence, relatively higher price volatility of long-rate futures in the post-Euro period could have led to more frequent return reversals and contrarian profits in the US and Canadian exchanges.

REFERENCES

[1] Bowman, R.G., Iverson, D., 1998, Short-Run Overreaction In The New Zealand Stock Market, Pacific-Basin Finance Journal 6, 475-491.

[2] Chang, R.P., McLeavey, D.W., Rhee, S.G., 1995, Short-Term Abnormal Returns Of The Contrarian Strategy In The Japanese Stock Market, Journal of Business Finance and Accounting 22, 1035-1048.

[3] DeBondt, W., & Thaler, R, 1985, Does The Stock Market Overreact?, Journal Of Finance 40, 793-805.

[4] Cox, D.R., Peterson, D.R., 1994, Stock Returns Following Large One-Day declines: Evidence On Short-Term Reversals And Longer-Term Performance, Journal Of Finance, 255-267.

[5] Duffie, D., 1989, Futures Markets, Prentice-Hall Inc, Englewood Cliffs, NJ.

[6] Fama, E., 1998, Market Efficiency, Long-term Returns and Behavioral Finance, Journal of Financial Economics 48, 283-306.

[7] Jegadeesh, N., 1990, Evidence Of Predictable Behavior Of Security Returns, Journal Of Finance 45, 881-898.

[8] Jegadeesh, N., Titman, S., 1993, Returns To Buying Winners And Selling Losers: Implications For Stock Market Efficiency, Journal of Finance 48, 65-91.

[9] Jegadeesh, N., Titman, S., 1995, Overreaction, Delayed Reaction, And Contrarian Profits, Review Of Financial Studies 8, 973-993.

[10] Kang, J., Liu, M.H., Ni, S.X., 2002, Contrarian And Momentum Strategies In The China Stock Market: 1993-2000, Pacific-Basin Finance Journal 10, 243-265.

[11] Lehmann, B.N, 1990, Fads, Martingales And Market Efficiency, Quarterly Journal Of Economics 105, 1-28.

[12] Lin, J.B., Onochie, J.I., Wolf, A.S., 1999, Weekday Variations In Short-Term Contrarian Profits In Futures Markets, Review Of Financial Economics 8, 139-148.

[13] Lo, A., Mackinlay, C, 1990, When Are Contrarian Profits Due To Stock Market Overreaction?, Review Of Financial Studies 3, 175-250.

[14] Zarowin, P., 1990, Size, Seasonality, And Stock Market Overreaction, Journal Of Financial And Quantitative Analysis 25, 113-125.

[15] Rouwenhorst, K.G., 1998, International Momentum Strategies, Journal of Finance 53, 267-284.

[16] Schiereck, D., DeBondt, W., Weber, M, 1999, Contrarian And Momentum Strategies In Germany, Financial Analysts Journal 55, 104-116.

Table 1: International Interest-Rate Futures Contracts

	Futures Contract	Exchange	Size	Margin	Price Quotation
US					
Short Rate (5)	1-mth LIBOR	CME	US$3m	US$ 540	Index points
	30-day Fed Fund	CBOT	US$5m	US$ 540	100 ─ Fed Funds Rate
	3-mth Eurodollar	CME	US$1m	US$ 810	Index points
	13-week U.S. T-Bill	CME	US$1m	US$ 440	Index points
	90-day Canadian B.A.	ME	C$1m	US$ 800	100 ─ annual yield
Long Rate (6)	2-year U.S. T-Note	CBOT	US$0.2m	US$ 1,220	Index points
	5-year U.S. T-Note	CBOT	US$0.1m	US$ 1,350	Index points
	10-year U.S. T-Note	CBOT	US$0.1m	US$ 1,760	Index points
	30-year U.S. T-Bond	CBOT	US$0.1m	US$ 2,700	Index points
	LT Muni. Bond Index	CBOT	US$0.1m	US$ 1,890	Index points
	10-year Canadian Bond	ME	C$0.1m	US$ 2,100	% of par
EU					
Short Rate (4)	3-mth LIBOR	LIFFE	£0.5m	£ 280	100 ─ 3-mth Libor
	3-mth EuroSfr	LIFFE	Sfr1m	Sfr 600	100 ─ interest rate
	3-mth Euribor	LIFFE	€ 1m	€ 550	100 ─ 3-mth Euribor
	3-mth Euribor	EUREX	€ 1m	€ 700	100 ─ 3-mth Euribor
Long Rate (8)	5-year Euro-BOBL	EUREX	€ 0.1m	€ 1,000	% of par
	Long Gilt	LIFFE	£ 0.1m	£ 1,300	% of par
	10-year JGB	LIFFE	¥100m	¥ 1M	% of par
	Euro Bund	LIFFE	€ 0.1m	€ 1,100	% of par
	Euro Bund	EUREX	€ 0.1m	€ 1,600	% of par
	Swiss Fed Bond	LIFFE	Chf 0.1m	Chf 1,600	% of par
	Euro10-year T-Bond	MATIF	€ 0.1m	€ 1,500	% of par
	10-year Spanish Bond	MFB	€ 0.1m	€1,650	% of par
Asia					
Short Rate (5)	3-mth Eurodollar	SGX	US$1m	US$ 810	Index points
	3-mth Euroyen	TIFFE	¥100m	¥ 10,130	100 ─ interest rate
	3-mth Euroyen	SGX	¥100m	¥ 70,130	100 ─ interest rate
	3-mth Australian B.A.	SFE	A$1m	A$ 700	100 ─ annual yield
	3-mth NZ B.A.	SFE	NZ$1m	NZ$ 600	100 ─ annual yield
Long Rate (5)	3-year Australian Bond	SFE	A$0.1m	A$ 700	100 ─ annual yield
	3-year NZ Bond	SFE	NZ$0.1m	NZ$ 600	100 ─ annual yield
	10-year JGB	TSE	¥100m	¥ 940	% of par
	10-year JGB	SGX	¥10m	¥ 75,600	% of par
	10-year Australian Bond	SFE	A$0.1m	A$ 2,000	100 ─ annual yield

Sources: Datastream International Database, Bloomberg Professional System and websites of Respective Exchanges

Table 2: Descriptive Statistics by Segments and Trading-Time Zones

Trading-Time Zone	Segment	Mean Return (%)	Std. Dev. (%)
US	***All (11)***	0.008	0.179
	Short Rate Futures (5)	0.002*	0.037
	Long Rate Futures (6)	0.013	0.309
EU	***All (12)***	0.012*	0.182
	Short Rate Futures (4)	0.002*	0.027
	Long Rate Futures (8)	0.013	0.205
Asia	***All (10)***	0.006*	0.058
	Short Rate Futures (5)	0.002*	0.024
	Long Rate Futures (5)	0.011*	0.109

Table 3: Profits of {5,5} Contrarian and Momentum Strategies: US Zone

Period	Short-rate Futures			Long-rate Futures		
	Obs	Gross Profit	Net Profit	Obs	Gross Profit	Net Profit
All	2447	-0.007(*)	-0.023(**)	2441	0.043*	-0.039(**)
Pre-Euro	1693	-0.010(*)	-0.025(**)	1685	0.071*	-0.011(*)
1995 (Mar)	47	0.003	-0.058(*)	46	-0.054(*)	-0.467(**)
(Jun)	54	-0.016(*)	-0.047(*)	54	0.035	-0.409(**)
(Sep)	55	0.013	0.007	55	0.282**	0.353*
(Dec)	53	0.052*	0.031*	52	0.118*	-0.177(*)
1996 (Mar)	52	0.029*	-0.002	51	0.192**	0.310*
(Jun)	55	0.002	-0.003	55	0.149*	0.208*
(Sep)	54	-0.007(*)	-0.044(**)	54	0.145*	-0.095
(Dec)	54	-0.046(**)	-0.103(**)	52	-0.041	-0.519(**)
1997 (Mar)	52	-0.004	-0.012	51	0.055*	0.083
(Jun)	53	0.011*	0.010	53	0.087*	0.080
(Sep)	54	0.011(*)	-0.002	54	-0.003	-0.140(*)
(Dec)	52	0.004	0.008*	52	0.052	-0.187(*)
1998 (Mar)	51	-0.001	-0.004	51	0.068*	-0.046
(Jun)	53	0.004	0.012*	53	0.001	-0.059
(Sep)	55	0.002	0.005	55	-0.071(*)	-0.165(*)
(Dec)	12	-0.010	-0.070(*)	12	-0.089(*)	-0.652(**)
Post-Euro	754	-0.001	-0.018(**)	756	-0.017(*)	-0.098(**)
1999 (Jun)	55	-0.029(**)	-0.033(**)	55	-0.001	0.114*
(Sep)	55	0.034**	0.034*	55	-0.060	-0.085
(Dec)	51	0.004	0.025*	51	-0.068(*)	0.035
2000 (Mar)	52	0.005*	0.027**	52	-0.010	0.072
(Jun)	54	0.010*	0.045**	54	0.035	0.028
(Sep)	55	-0.003	-0.020(*)	55	-0.037	-0.232(**)
(Dec)	52	-0.002	0.004*	52	-0.097(*)	-0.201(*)
2001 (Mar)	50	0.003	-0.103(**)	50	-0.081(*)	-0.176(*)
(Jun)	54	-0.013(*)	-0.072(**)	54	0.023	0.269**
(Sep)	55	-0.002	-0.025(*)	55	-0.018	-0.292(**)
(Dec)	52	-0.024(*)	-0.102(**)	51	-0.052	0.040
2002 (Mar)	50	0.005*	0.009*	52	0.055*	-0.190(*)
(Jun)	54	-0.013*	-0.023(*)	54	0.010	-0.262(**)
(Sep)	54	0.007*	-0.009	54	0.075*	-0.338(**)
(Dec)	11	-0.022(*)	-0.072(**)	12	-0.100	-0.787(**)

* (*) 5% statistical significance of contrarian (momentum) profits.
** (**) 1% statistical significance of contrarian (momentum) profits.

Table 4: Profits of {5,5} Contrarian and Momentum Strategies: EU Zone

Period	Short-rate Futures			Long-rate Futures		
	Obs	**Gross Profit**	**Net Profit**	**Obs**	**Gross Profit**	**Net Profit**
Post-Euro	768	-0.002*	-0.012(**)	770	0.039**	0.047*
99 (Jun)	54	-0.003	-0.025(*)	54	0.074*	0.524*
(Sep)	56	-0.010(*)	-0.008	56	0.121*	0.306*
(Dec)	55	-0.017(*)	-0.007	55	-0.041*	-0.036
00 (Mar)	51	-0.012(*)	0.004	54	0.057	0.198*
(Jun)	53	0.024**	0.040**	53	0.053	0.001
(Sep)	56	0.011*	0.009*	56	0.049*	0.084*
(Dec)	55	0.003	-0.014(*)	55	0.030*	-0.112(*)
01 (Mar)	51	0.009*	-0.001	51	0.098*	-0.007
(Jun)	54	-0.003	-0.006	54	0.015	0.185*
(Sep)	56	-0.012(*)	-0.016	56	0.038*	-0.090(*)
(Dec)	55	-0.013(*)	-0.001(**)	55	-0.004	-0.103(*)
02 (Mar)	51	0.004	0.020*	50	0.065*	0.125*
(Jun)	54	-0.003	-0.027(*)	54	-0.022*	-0.092(*)
(Sep)	55	-0.011(*)	-0.062(**)	55	0.024	-0.247(**)
(Dec)	12	0.024*	-0.037(**)	12	0.065	-0.256(*)

* (*) 5% statistical significance of contrarian (momentum) profits.
** (**) 1% statistical significance of contrarian (momentum) profits.

Table 5: Profits of {5,5} Contrarian and Momentum Strategies: Asia Zone

Period	Short-rate Futures			Long-rate Futures		
	Obs	Gross Profit	Net Profit	Obs	Gross Profit	Net Profit
All	1588	-0.006(*)	-0.018(**)	1563	-0.010(*)	-0.048(**)
Pre-Euro	810	-0.009(*)	-0.023(**)	791	-0.005(*)	-0.091(**)
95 (Mar)	31	0.000	-0.089(**)	30	-0.082(*)	-0.230(**)
(Jun)	55	-0.021(*)	-0.098(**)	53	-0.058(*)	-0.416(**)
(Sep)	56	-0.002	0.001	56	0.077	0.115*
(Dec)	55	-0.032(*)	-0.041(**)	55	-0.024	-0.171(*)
96 (Mar)	53	-0.036(*)	-0.011	50	-0.057(*)	0.063*
(Jun)	56	-0.034(**)	-0.016(*)	54	0.027	0.005
(Sep)	55	-0.005	-0.039(*)	54	0.022	-0.118(**)
(Dec)	55	0.004	-0.033(*)	54	0.068*	-0.112(*)
97 (Mar)	53	0.012*	0.015*	50	0.100*	0.074*
(Jun)	54	-0.014	-0.038(*)	52	0.049	0.075*
(Sep)	55	-0.012	-0.010	55	-0.058(*)	-0.185(**)
(Dec)	55	0.025*	0.022*	55	-0.011	-0.110(*)
98 (Mar)	53	-0.020	0.008	51	-0.074(*)	-0.096(**)
(Jun)	55	0.008	0.007	53	-0.056(*)	-0.166(**)
(Sep)	56	-0.022	-0.067(*)	56	-0.004	-0.049
(Dec)	13	0.095*	0.018	13	-0.140(*)	-0.487(**)
Post-Euro	778	-0.004(*)	-0.013(**)	772	0.025	-0.005(*)
99 (Jun)	56	-0.004	-0.013(*)	54	-0.068(*)	-0.190(**)
(Sep)	56	-0.010(*)	-0.014(*)	56	0.124**	0.194**
(Dec)	55	0.015*	0.018*	55	0.052	0.022
00 (Mar)	53	0.012*	0.016*	53	0.032	0.044
(Jun)	56	0.029**	0.038**	54	0.031*	-0.050(*)
(Sep)	56	-0.021(**)	-0.028(**)	56	-0.027(*)	-0.011
(Dec)	55	-0.008(*)	-0.017(**)	55	-0.042(**)	-0.138(**)
01 (Mar)	52	-0.008	-0.056(**)	51	0.062*	-0.042
(Jun)	55	0.014*	-0.001	55	0.042*	0.060*
(Sep)	56	0.004	-0.006	56	0.070*	0.064*
(Dec)	55	-0.034(**)	-0.067(**)	55	0.049**	0.023
02 (Mar)	51	0.002	0.010*	50	-0.010	0.034
(Jun)	55	-0.016(*)	-0.013(*)	55	-0.015	-0.065(*)
(Sep)	55	-0.033(**)	-0.060(**)	55	-0.002	-0.099(**)
(Dec)	12	0.038**	0.019*	12	0.278**	0.371**

* (*) 5% statistical significance of contrarian (momentum) profits.
** (**) 1% statistical significance of contrarian (momentum) profits.

Table 6: Autocorrelations of Returns of Segments, Frequent Losers and Winners

	US		EU		Asia	
	Short Rate	**Long Rate**	**Short Rate**	**Long Rate**	**Short Rate**	**Long Rate**
Lag 5						
No. of Observations	*1624*	*1687*	*834*	*1658*	*1664*	*1557*
Frequent Loser	-0.0388*	-0.0437*	0.0183	0.0923*	0.0218	0.0169
Frequent Winner	-0.0615*	-0.0139	-0.0635*	-0.0405	0.0496*	0.0647*
Segment Portfolio	-0.0540*	-0.0541*	0.0289	0.0930*	0.0355*	0.0286*
Lag 10						
No. of Observations	*1614*	*1677*	*824*	*1648*	*1654*	*1547*
Frequent Loser	-0.0273*	0.0689*	-0.0009	-0.0391*	0.0238*	-0.0101
Frequent Winner	0.0348*	0.0817*	0.0665*	0.0307*	0.0731*	0.0729*
Segment Portfolio	0.0530*	0.0542*	0.0140	-0.0221	0.1037*	0.0710*