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# Intraday momentum and contrarian effects on the JSE

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## ABSTRACT

We study ultra short term return predictability based on intraday momentum and contrarian effects on the JSE. Statistically significant return predictability is found to be present to some extent when returns are calculated from mid-quote prices. However, when returns are calculated under bid-ask pricing assumptions which are more realistic from a trading point of view, intraday momentum and contrarian effects largely disappear and cannot be exploited profitably.

## 1. INTRODUCTION

A growing number of papers report findings that contrarian and momentum strategies can yield predictably positive returns. Many of these papers use the so-called "loser/winner ranking" approach which can be briefly described as follows. Given a list of stocks in which to invest, rank them by their returns over a recent period (called the formation period). Those with low ranks (say the bottom 10%) are termed the "losers" and those with high ranks (say the top 10%) are the "winners" over the formation period. A contrarian investor believes that the market has overreacted to available relevant information over the formation period and therefore expects that the losers will rebound and the winners will sag as the market perception is corrected in a subsequent period. This subsequent period is referred to as the holding period. In an effort to profit from his view the contrarian investor would buy the losers and sell the winners at the beginning of the holding period. At the end of the holding period he terminates the investments, enjoying a profit if his view turned out to be correct. By contrast a momentum investor believes that the market has under reacted to the available information over the formation period and therefore expects the losers to continue losing and the winners to continue winning as the market perception is corrected subsequently. To profit from this view, the momentum investor would sell the losers and buy the winners at the start of the holding period and reverse these trades at the end of the holding period.

Empirical studies reporting on the profitability of **contrarian** strategies go back to the papers of DeBondt and Thaler (1985, 1987). Subsequent contributions were made by many authors among whom Poterba and Summers (1988), Chan (1988), Lehmann (1990) and Chopra, Lakonishok and Ritter (1992). The early papers dealt with profitability of contrarian strategies over long holding periods while the later papers showed that profitability also holds for periods with durations as short as a week. While the early papers related to the US markets, a large

number of subsequent papers report on contrarian profitability in other markets, e.g. Baytas and Cakici (1999) for the G-7 countries, Gaunt (2000) for the Australian market, etc.

An important early paper on **momentum** portfolios is that of Jegadeesh and Titman (1993) who report that using a formation period of 3 to 12 months may lead to momentum profits of about 1% per month during a holding period consisting of the following year. Rouwenhorst (1998,1999) find similar momentum profitability in European and emerging markets. Chan, Jegadeesh and Lakonishok (1996) and Jegadeesh and Titman (2001) find support for the persistence of these momentum effects over time and in different markets. The recent paper of McInish, Ding, Pyun and Wongchoti (2008) concludes that in many Asian markets winners display subsequent price reversals (contrarian movement) while losers show subsequent price momentum, i.e. it could be profitable to act both in contrarian and momentum fashion depending on appropriate stock selection. This is in line with other reported results to the effect that investors respond asymmetrically to good and bad news (see e.g. Nam, Pyun and Kim (2003)).

The reader interested in an overview of the large literature dealing with contrarian and momentum effects when the formation and holding periods have durations of at least one day should consult the paper of McInish, Ding, Pyun and Wongchoti (2008) which provides a detailed discussion as well as an up to date list of references.

Our paper deals with **intraday** contrarian and momentum effects which means that both the formation and the holding periods are at most a few hours long. The literature dealing directly with this case is quite small. One reason for the relative paucity of studies on the intraday case is the lack of availability of the required intraday data until recently. Another reason is that ultra-short term returns tend to be quite low and this suggests that the prospects for successful intraday exploitation of momentum and contrarian effects are limited. However, it is fairly common for individual stocks to experience return movements in the range of 1% and more over short periods especially during volatile times and this leaves sufficient room for success if such movements could

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be anticipated correctly often enough. Certainly technical traders seem to believe that this is possible.

A Google search of the phrase 'intraday momentum trading' yielded more than 100000 references, many of whom promise software that will reliably identify so-called "high probability intraday trades". Also return enhancing trading may be done using derivatives such as futures or contracts for differences. All of this suggest that it is worthwhile taking a closer look at momentum and contrarian effects on an intraday basis.

Papers relevant to the intraday case are Fabozzi, Ma, Chittenden and Pace (1995), Fung, Mok and Lam (2000), Fung and Lam (2004), Grant, Wolf and Yu (2005) and Kang (2005). The first four of these papers deal with the intraday contrarian or price reversal effect only and use approaches rather different from the winner/loser ranking method used here. Nevertheless their results cast light on our findings as will be indicated in Sections 3 and 4 below.

The study of Kang (2005) follows the winner/loser ranking method and is most relevant for our purposes. Kang (2005) used two thousand NYSE stocks, based intraday returns on mid-quote prices (average of highest bid and lowest ask prices) and analysed the influence of various formation and holding period durations on the average decile portfolio returns, finding that statistically significant momentum and contrarian effects are indeed present in the intraday context. The extreme losers (first decile of the ranked stocks) and the extreme winners (tenth decile) show contrarian movements while the rest of the deciles show momentum movements over the holding periods to various degrees.

Kang (2005) also reports that return momentum of large capitalisation stocks behave differently from that of small stocks. Generally for large stocks momentum continues for about one and half hours after which reversal sets in. For small stocks momentum tends to continue throughout the day once it starts in the formation period. Although these effects are predictable in the sense of being statistically significant, Kang (2005) concludes that they are not "enough to cover the bid-ask spread as the transaction cost" and that "... the simple trading strategy of buying the intraday winners and short-selling the losers may not be profitable".

Our study uses intraday trading data of stocks listed on the JSE over the year 2007. Some liquidity and data availability criteria (detailed in Section 2 below) must be met for a stock to be included in our list of eligible stocks. This resulted in the 144 stocks listed in Table 1 that were used in this study. Clearly our list is much smaller than the two thousand strong list of the Kang

(2005) study. Nevertheless, some features of the intraday results reported by Kang (2005) are also present on the JSE when we also work with mid-quote prices. Among these are that the first and tenth deciles also show contrarian behaviour and this differs strongly between small and large cap stocks. However, significant intraday momentum behaviour does not seem to be present.

The sizes of the contrarian effects are larger than those reported in the Kang (2005) study and this raises the question whether it is more than a statistical price feature that could actually be traded on profitably. While the mid-quote price assumption is useful and simplifying in studies of intraday price movements, it ignores the fact that one cannot necessarily buy or sell a stock at the mid-quote price at given moments such as the start or end of the holding period. If a stock is liquid enough, there will be best bid and ask prices at all times through-out the day and it is more realistic to assume that we can buy at the best (lowest) ask price and sell at the best (highest) bid price. Replacing the mid-quote pricing assumption by this best bid-ask price assumption, we find that the simple contrarian trading rule that sells winners and buys losers at the beginning of the holding period and keeps them to the end of the holding period, is not profitable.

We also investigated more complex strategies which incorporate profit targets, stop losses and bid-ask spread stock selection. While these do better than the simple rules, they too are not convincingly profitable. It may be argued that the volumes available at the best bid and ask prices should also be taken into account. However, if sufficient volumes were not available at the best bid and ask prices one has to move further out to second or third best prices. This would imply that trading costs would become even higher than under the best bid-ask assumption and if trading under this assumption is not profitable then it will be even less so when we take volumes into account also.

The layout of rest of the paper is as follows. Section 2 presents more details of the stocks used in this study and summarizes the relevant features of their data. Section 3 gives the momentum and contrarian predictability results based on mid-quote prices. In Section 4 we base the pricing assumption on the best bid-ask quotes and show that this changes the results drastically, in particular finding that profitability disappears. We also report the results of various extensions of the simple loser-winner approach. Section 5 considers the scope for profitable trading and finds that it is sufficient if only the day trader was smart enough to identify price movements over the holding period correctly and brokerage rates are below 40 basis points. This section also concludes the paper with relevant comments.

**Table 1: Data for the stocks used in the study**

Shown are the JSE codes of the stocks used in the study, their investable market capitalisations (IMC), percentage of trading days used, daily average number of trades, average ZAR volume, average percentage return, standard deviation of returns and average start and end bid-ask spreads (in basis points) over the holding period. The formation period was 9:15 to 10:15 and the holding period was 10:15 to 16:45. The averages and standard deviations were calculated over the trading days of 2007

No	Code	IMC (ZARbn)	% use	Trades	ZARvol (m)	%Return	%Std Dev	Start bid-ask spread (bp)	End bid-ask spread (bp)
1	AGL	616,40	99,60	1390,60	890,72	-0,05	1,87	15,49	13,33
2	BIL	557,65	99,60	1278,21	650,80	-0,04	1,44	16,24	13,61
3	MTN	247,72	100,00	1430,20	480,27	0,04	1,70	19,19	19,75
4	RCH	238,29	99,60	833,15	294,09	0,00	1,08	18,68	14,71
5	SOL	217,43	99,60	1397,70	539,02	0,05	1,66	15,47	14,03
6	SAB	210,76	99,60	565,58	219,67	-0,03	1,17	18,82	16,11
7	IMP	153,34	99,60	1441,27	365,45	-0,25	2,19	21,51	21,65
8	SBK	149,27	99,60	1541,71	335,50	-0,14	1,53	15,95	17,31
9	OML	127,01	99,60	594,20	169,86	-0,01	1,24	24,64	17,42
10	AMS	98,93	99,60	1124,78	313,50	-0,10	2,00	23,98	22,49
11	REM	92,90	99,60	661,51	153,95	-0,10	1,16	25,40	22,77
12	FSR	88,20	100,00	1318,09	222,38	-0,17	1,60	20,09	19,69
13	ANG	84,18	99,60	917,83	176,17	0,07	1,46	24,16	23,65
14	GFI	69,19	99,60	1302,56	258,32	-0,28	1,56	20,00	20,81
15	NPN	67,29	100,00	780,69	209,99	-0,10	1,64	24,08	23,99
16	LBT	56,95	99,60	384,20	77,40	-0,07	1,32	26,14	18,49
17	SLM	54,13	100,00	770,60	101,72	0,07	1,34	25,28	24,02
18	TKG	41,74	100,00	811,81	225,00	-0,13	1,54	20,30	20,90
19	BVT	40,79	99,60	642,97	115,44	-0,08	1,36	32,24	26,49
20	ASA	40,50	99,60	836,05	150,21	-0,17	1,53	22,51	23,17
21	MUR	33,85	100,00	493,02	75,03	0,30	2,05	40,49	35,54
22	NED	30,96	100,00	668,93	105,31	0,00	1,44	28,64	24,00
23	TBS	30,19	100,00	537,75	96,74	-0,05	1,19	26,88	21,69
24	INP	29,89	99,60	583,45	95,78	-0,26	1,47	27,74	20,39
25	RMH	29,40	100,00	607,79	43,08	-0,13	1,71	34,73	35,09
26	HAR	28,90	99,60	847,71	94,42	-0,27	2,08	35,11	29,76
27	PPC	26,20	99,60	538,97	55,51	-0,03	1,50	38,83	33,49
28	KIO	25,59	100,00	334,06	54,13	0,29	2,00	52,40	43,89
29	SHF	25,10	99,60	698,56	110,99	-0,24	1,64	24,52	27,46
30	AEG	24,16	100,00	311,55	52,94	0,24	1,79	54,10	43,16
31	SAP	23,19	100,00	569,58	84,25	-0,06	1,56	34,83	30,79
32	SHP	22,99	100,00	192,20	25,57	0,20	1,46	84,01	61,27
33	IPL	22,83	99,60	582,02	97,93	-0,27	1,69	28,77	24,98
34	BAW	22,33	99,60	663,57	120,76	0,01	1,63	26,23	27,87
35	GRT	18,41	99,20	101,92	23,17	0,13	1,14	64,95	42,22
36	ABL	17,04	99,20	486,48	52,20	-0,03	1,62	39,65	36,32
37	NTC	16,56	100,00	511,90	48,65	-0,15	1,65	34,55	33,89
38	INL	16,43	99,60	521,84	57,34	-0,28	1,56	34,78	28,21
39	SUI	15,40	55,42	105,00	27,47	-0,12	1,41	70,91	50,24
40	NPK	15,10	99,60	152,44	16,91	0,28	1,78	109,94	80,64
41	RLO	14,94	99,60	287,42	43,58	-0,11	1,27	39,48	33,11
42	MSM	14,36	99,60	355,73	57,61	0,05	1,61	44,11	35,06
43	WHL	13,37	100,00	644,70	66,91	-0,15	1,65	33,37	32,60
44	LGL	13,06	100,00	356,57	34,02	0,06	1,55	51,85	41,90
45	TRU	13,00	100,00	458,92	61,69	0,02	1,84	48,96	35,59
46	DDT	12,93	99,60	208,99	22,33	0,11	1,36	47,92	35,76
47	ARI	12,52	100,00	221,70	22,34	0,11	2,43	103,11	69,22
48	APN	12,12	100,00	225,81	31,70	0,13	1,62	60,69	45,54
49	FOS	11,33	99,60	317,94	56,23	-0,03	1,41	49,68	41,42
50	LON	10,52	99,60	152,06	18,20	0,12	2,44	49,20	32,37
51	ELH	10,43	99,60	215,59	51,91	-0,02	1,66	64,78	43,96
52	SPP	10,37	100,00	178,23	22,07	-0,04	1,36	87,30	70,07
53	AFE	9,48	100,00	89,82	20,00	0,06	1,62	81,61	56,30
54	JDG	9,45	99,60	331,82	65,72	-0,12	1,70	45,98	38,93
55	PIK	9,35	99,60	331,40	28,88	0,11	1,28	55,54	41,66
56	GND	8,42	100,00	218,94	20,56	0,04	1,36	37,24	38,95
57	MET	8,34	100,00	248,51	25,07	-0,03	1,42	72,26	48,65
58	DSY	7,86	100,00	127,65	14,28	-0,04	1,58	102,69	64,71
59	NHM	7,81	99,60	214,91	33,63	-0,31	1,89	56,15	41,68
60	JSE	7,62	100,00	83,38	17,88	0,17	1,60	90,86	69,41
61	MTX	7,62	99,60	206,89	21,20	-0,15	2,07	63,56	55,85
62	EXX	7,34	100,00	414,68	45,74	-0,11	2,11	54,09	42,67
63	MVL	7,22	100,00	124,70	23,52	0,03	2,09	107,69	70,64
64	AVI	6,94	99,60	133,34	18,28	0,01	1,79	130,89	78,31
65	MDC	6,78	100,00	59,22	7,11	0,12	2,04	152,37	94,48
66	WBO	6,60	100,00	51,48	7,27	0,20	1,46	110,46	83,30
67	ARL	6,56	99,60	63,63	10,50	0,11	1,15	78,64	55,10
68	SNT	6,43	98,80	39,68	8,69	0,23	1,77	149,13	98,94

## Intraday momentum and contrarian effects on the JSE

69	AFX	6,00	100,00	70,55	7,68	0,04	1,37	94,66	77,22
70	DTC	5,80	99,60	112,32	15,74	0,16	2,08	88,95	68,05
71	HVL	5,57	100,00	52,55	6,86	0,15	5,75	139,70	97,85
72	MPC	5,53	100,00	210,73	23,90	-0,26	1,66	66,33	57,01
73	NCL	5,36	100,00	114,25	16,42	0,31	1,78	149,98	79,63
74	GRF	5,13	99,60	128,12	16,07	-0,16	1,86	75,48	59,90
75	HYP	5,13	100,00	17,26	4,68	-0,26	2,38	267,97	138,77
76	APB	5,06	99,60	42,29	8,09	0,03	1,08	93,13	56,19
77	LEW	4,98	99,60	137,54	26,38	0,01	1,81	140,43	67,96
78	RDF	4,98	100,00	48,93	7,05	-0,03	1,38	130,04	70,01
79	SPG	4,76	100,00	98,78	14,83	-0,20	1,42	103,98	64,48
80	PAP	4,51	100,00	24,02	6,87	-0,03	1,83	132,23	89,50
81	EMI	4,34	99,60	26,02	5,04	0,02	1,54	161,97	78,68
82	ILV	4,32	100,00	57,82	5,40	0,17	1,99	166,62	98,39
83	APA	4,23	99,60	31,72	6,02	0,12	1,13	126,43	81,21
84	HCI	4,17	100,00	8,53	2,38	-0,18	4,17	499,85	395,89
85	SIM	4,17	99,60	355,72	23,91	-0,32	2,16	45,04	49,37
86	PSG	3,92	99,60	50,08	4,48	-0,07	1,44	95,64	80,37
87	TRE	3,91	100,00	20,77	3,87	0,57	6,54	338,67	298,25
88	SYC	3,75	98,39	18,52	3,82	0,13	2,05	205,51	117,79
89	CPI	3,70	99,60	11,85	0,97	0,16	2,14	231,23	189,34
90	ITE	3,70	76,31	2,28	0,65	0,39	1,79	478,61	335,65
91	WEZ	3,62	99,20	199,96	11,23	-0,16	3,07	94,85	89,02
92	PGR	3,53	99,60	56,94	6,67	0,16	1,53	141,49	95,35
93	CLH	3,51	100,00	32,36	4,23	0,25	1,31	124,38	91,79
94	ALT	3,45	100,00	32,18	6,08	0,09	1,81	177,74	128,17
95	CAT	3,45	100,00	21,45	2,77	0,03	1,87	304,89	216,18
96	ACP	3,35	96,39	10,67	4,89	0,15	1,63	213,76	166,73
97	OMN	3,19	100,00	23,22	4,25	0,25	2,01	203,66	157,93
98	RES	3,14	97,19	12,83	4,18	-0,02	7,12	266,05	130,70
99	CPL	3,07	100,00	20,32	4,69	-0,20	1,60	197,44	139,95
100	BAT	2,98	99,60	38,90	6,62	0,38	2,12	169,49	107,15
101	GDF	2,90	99,60	41,82	6,33	0,11	1,42	119,35	70,30
102	AFR	2,76	100,00	44,06	4,81	0,43	3,15	201,44	144,75
103	WGR	2,72	98,80	5,91	0,47	1,41	7,31	787,87	682,47
104	DAW	2,67	99,20	25,03	2,28	0,13	2,78	217,20	178,33
105	JNC	2,66	97,99	9,99	1,12	0,35	4,25	404,49	373,75
106	ILA	2,41	100,00	56,84	6,31	0,00	1,81	121,84	96,16
107	MKL	2,36	99,60	7,35	2,35	0,32	1,50	179,31	111,95
108	CML	2,27	99,60	28,75	2,06	0,35	1,79	181,64	133,43
109	RBW	2,20	99,20	47,51	4,79	0,02	1,21	122,36	96,54
110	BSR	2,10	99,20	49,69	3,55	0,30	1,90	125,11	98,61
111	MRF	2,08	99,60	174,30	10,67	-0,01	2,35	82,69	81,91
112	MDN	2,07	99,20	19,76	2,57	0,24	1,74	210,25	167,05
113	ADR	2,01	99,60	14,15	2,34	0,25	2,11	277,60	242,27
114	DRD	1,98	99,60	145,67	3,95	-0,56	2,58	94,63	91,58
115	ADH	1,96	100,00	18,39	1,16	0,42	2,01	243,63	202,32
116	ATN	1,89	99,60	23,55	2,40	0,05	2,40	274,00	220,20
117	ENV	1,82	99,20	12,70	0,88	0,53	2,95	338,82	239,59
118	VKE	1,80	96,79	8,07	1,54	0,26	1,88	262,45	172,36
119	ENL	1,77	99,60	76,71	3,87	0,10	1,95	114,69	100,12
120	MVG	1,75	100,00	87,85	10,12	0,01	2,35	86,54	70,57
121	IVT	1,70	98,80	6,68	1,29	-0,01	2,04	330,56	310,29
122	ZED	1,65	98,80	69,65	2,68	0,02	1,56	110,33	97,91
123	MTA	1,63	99,60	29,06	2,05	0,44	2,41	371,15	171,36
124	BTG	1,60	99,60	33,38	2,28	0,26	1,79	159,41	120,17
125	BCX	1,54	98,80	44,54	5,00	0,13	1,70	135,16	106,21
126	BRN	1,50	100,00	11,09	1,08	0,50	2,56	403,39	309,05
127	CSB	1,47	99,60	12,48	1,86	0,21	3,13	336,08	269,40
128	AXC	1,44	100,00	41,12	3,07	0,34	1,87	145,00	114,79
129	APK	1,42	100,00	35,13	3,36	-0,11	1,54	156,96	127,21
130	PAM	1,42	98,39	35,12	2,74	0,12	2,24	234,04	160,53
131	ZCI	1,42	97,59	3,42	0,21	0,36	4,83	881,97	768,11
132	KGM	1,39	99,20	12,28	1,75	-0,04	1,99	257,63	220,36
133	HDC	1,38	99,60	20,40	4,49	0,01	1,35	181,26	135,75
134	MTL	1,38	97,99	17,65	0,32	-0,11	2,43	365,09	357,39
135	PMM	1,36	95,58	3,11	0,65	0,84	2,47	520,19	396,31
136	ART	1,35	99,60	42,37	2,59	0,13	1,37	109,52	98,23
137	BEL	1,35	99,60	28,01	2,95	0,35	2,31	241,80	167,33
138	HPB	1,32	95,58	8,67	1,25	-0,03	1,94	319,19	259,86
139	OCT	1,26	76,31	3,08	0,55	0,82	2,79	423,85	328,15
140	RAH	1,25	98,39	8,75	0,81	0,17	1,90	364,59	300,40
141	CRM	1,21	87,55	3,41	0,79	-0,12	4,05	625,40	625,76
142	DIV	1,21	93,98	4,45	1,13	-0,21	1,84	352,91	271,71
143	WES	1,05	99,60	12,44	2,50	0,29	2,26	356,75	265,33
144	SUR	1,03	99,60	12,04	0,79	0,07	1,52	278,91	239,75

## 2. DATA

We restricted attention to stocks that were listed on the JSE over the full year of 2007 and had investable market capitalisation (IMC) of at least ZAR1bn according to the FTSE/JSE index committee papers (see [http://ftse.jse.co.za/index\\_reviews.jsp](http://ftse.jse.co.za/index_reviews.jsp)) at the end of December 2007. In addition the intraday trading data had to be available on the BMI-IDDB (the intraday data base of the BMI Centre of North-West University) which was our data source for this study. Columns 2 and 3 of Table 1 show the JSE codes and IMC values (in ZARbn) of the 144 stocks that met these criteria. The median IMC value is about 5,4 and we shall also look separately at the large and small cap stocks whose IMC values are above and below 5,4 respectively. The average IMC values of the large and small cap stocks are 55,87 and 2,65 respectively so that the large cap stocks are on average 21 times larger than the small cap stocks.

In Section 3 below we follow Kang (2005) in using mid-quote prices in stead of transaction prices to compute intraday returns “.. to avoid effects of bid-ask spread bounce”. Not all the stocks are active enough on any particular day to be included on that day. It must have both best bid and best ask prices at the start and at the end of the formation period as well as the end of the holding period so that mid-quote prices can be calculated at those times and hence also formation and holding period returns.

The JSE opens with an auction period over the first 10 minutes of the day and during this period it often happens that best ask prices are below best bid prices. Such anomalies cast doubt on the usefulness of those prices and to avoid this effect we only use bid and ask prices starting at 9:15. Similarly we stop at 16:45 to avoid the closing auction and we also rule out using all other cases during the trading day when the best ask prices are below the best bid prices. All of this means that the number of eligible stocks from which the deciles can be constructed do not stay fixed at the level of 144 every day.

For illustration purposes we take the formation period as 9:15 to 10:15 and the holding period as 10:15 to 16:45. Then Column 4 of Table 1 shows the percentage of the 249 trading days of the year 2007 on which each stock was actually eligible for use. For most stocks this was either 100% or close to 100%. Columns 5 and 6 of Table 1 show some liquidity related measures of the stocks. Column 5 gives the average of the number of trades during the combined formation and holding periods (i.e. 9:15 to 16:45). Column 6 gives the average ZAR valued volume (in ZARmn) over the same period. Both measures have a strongly decreasing tendency with decreasing IMC values reflecting the relation between liquidity and market cap. Columns 7 and 8 show the average and

the standard deviation of the returns of the stocks during the same combined formation and holding periods. The average returns vary around zero and the standard deviations vary around 1,96%. Extreme average returns and standard deviations tend to occur only among the small cap stocks implying that they are more volatile as one would expect. Columns 9 and 10 show the average bid-ask spreads of the stocks at the start and end of the holding period. Bid-ask spreads were calculated as the differences between the ruling best ask and bid prices relative to the mid-quote prices and are expressed in basis points. The average spreads tend to increase substantially with decreasing IMC values and the end spreads are on average smaller than the start spreads (ratio about 80%).

The number of eligible stocks from which the daily deciles are constructed need not be an integer multiple of 10 so that our “deciles” are not exact deciles in the sense of being equally sized. We follow the rule that takes deciles number 2 to 9 equal to the integer part of the number of eligible stocks divided by 10 and then makes deciles 1 and 10 larger to take up the slack. Thus for example, with all 144 stocks eligible deciles 2 to 9 would have 14 stocks each, while deciles 1 and 10 would have 16 each; with 143 eligible stocks we allocate 16 to decile 1 and 15 to decile 10. A similar rule is followed when we work with quintiles rather than deciles.

## 3. CONTRARIAN AND MOMENTUM EFFECTS USING MID-QUOTE PRICES

We considered formation periods of durations 1, 1½, 2 and 2½ hours, all starting at 9:15 and holding periods of durations 1, 2, 3, 4 and 5 hours following the formation period. For each trading day and all eligible stocks we calculated the mid-quote price returns over the formation period and ranked the stocks increasingly according to these returns. Then ten deciles of stocks were formed as explained above and the stocks in each decile were taken to form an equally weighted portfolio. These portfolios were numbered from 1 to 10 with 1 corresponding to the extreme losers and 10 to the extreme winners in the sense of having the lowest and highest returns respectively. The returns of long positions in these portfolios were then calculated over the holding period for each day. These long portfolio holding period returns were then averaged over the 249 trading days of the year 2007. This was done using all the stocks as well as using the large and small cap stocks separately. The results below deal mostly with these long portfolio returns. Since the returns of short positions are just the negatives of those of the long portfolios we do not need to discuss them separately.

Table 2 shows the average holding period long returns (in basis points) of the ten decile portfolios for all

combinations of formation and holding period durations. The most prominent feature in this table is the contrarian effects displayed by portfolios 1 and 10.

Portfolio 1 had the extreme losers during the formation period but then reversed to give positive average returns over the holding period. Portfolio 10 had the extreme winners but also reversed to give negative average returns over the holding period. For these portfolios formal two-sided t-tests of the hypotheses that the expected returns were zero yield p-values much smaller than 1% so that these contrarian effects are statistically significant. Only weak evidence of momentum effects are visible in Table 2.

Portfolio 3 was on the side of the losers during the formation period and its holding period returns tended to be negative also, implying continued negative momentum. Similarly portfolio 6 was on the side of the winners and showed a continued tendency to yield positive returns provided the formation period was short, implying some positive momentum in those cases. However, the average returns for portfolios 2 to 9 were all quite small and statistically non-significant. Further to the contrarian effects, for the shorter formation durations the reversals tended to be larger on the loser side than on the winners side, i.e. early losers tend to reverse more strongly than early winners. The reversals for the shorter formation periods also tended to be larger than the reversals for the longer formation periods, especially for shorter holding periods.

Table 3 compares the holding period returns when using all stocks with those obtained when using either only the small cap or the large cap stocks. Here we fixed the formation period at one hour and varied the holding period from 1 to 5 hours. It is evident that the reversals were stronger for small cap stocks than those for all the stocks, both on the extreme loser and extreme winner sides. However, the reversals were much smaller for the large cap stocks than for all stocks or small cap stocks. Again no significant momentum effects are visible if we use only small or large cap stocks. Similar conclusions hold when we compare the returns over different cap sizes at the other formation period durations and to save space we do not show the results. Clearly, the contrarian effects are primarily due to the small cap stocks.

It follows that the contrarian strategy of buying the extreme losers and selling the extreme winners would

yield the best holding period returns. Table 4 shows the results of this strategy for the different formation and holding period durations when using either all stocks, or the small or the large caps only. It is again clear that using only the small caps yielded the best returns and with the longer holding periods the results were fairly similar over the different formation periods. Again t-tests show that the average returns were statistically significantly different from zero for all cases when using all stocks or the small cap stocks.

For the large cap stocks this is also the case when the formation period is 1 hour and when the holding period is 5 hours. However, average returns for the large cap stocks were much smaller than those of the small cap stocks, consistent with the conclusion above that the contrarian effect is mostly a small cap stock feature.

In addition to our contrarian results being consistent with those of Kang (2005), they are also in line with the results of Fabozzi, Ma, Chittenden and Pace (1995) notwithstanding that their results are based on a so-called event study rather than the loser/winner ranking method. Using intraday transaction records of stocks listed on the NYSE and the AMEX in 1989, they identify events and their times where individual stocks experience large price changes over the preceding hour (e.g. 2% up or down measured in terms of excess returns). The subsequent return paths starting from such an event are then tracked over the rest of the day. These paths are averaged over all events identified from all stocks and all trading days.

These averages show significant price reversals which also tend to be larger for small stocks than for large stocks. In such an event study all stocks in the event set have preceding price changes exceeding a prespecified threshold. This is different from the ranking approach where the stocks in the loser and winner deciles are determined by how large their preceding price changes are relative to their peers. Nevertheless, one would expect that those in the loser decile will have experienced substantial price changes downwards and those in the winner decile substantial changes upwards. Consequently it is not unexpected that the results of the ranking method should have some similarities with the results of the event studies, at least as far as contrarian or price reversal effects are concerned.

**Table 2: Average holding period returns of decile portfolios using all stocks**

Returns over the formation and holding periods are calculated from mid-quote prices and are shown in basis points. The formation period varies from 0,5 hours to 2,5 hours and the holding period varies from 1 to 5 hours.

Formation period	Holding Period (hrs)	Decile portfolio number									
		1	2	3	4	5	6	7	8	9	10
0,5	1	29,7	5,2	-1,0	1,1	-1,8	4,1	3,2	2,3	-1,6	-10,2
	2	32,2	4,4	-2,6	1,8	2,8	4,1	2,2	1,5	-1,9	-11,8
	3	28,8	1,9	-2,7	2,1	-1,2	4,1	-0,9	1,4	-4,5	-12,9
	4	29,0	1,9	-2,7	1,7	1,7	8,0	-1,4	2,1	-4,7	-14,7
	5	28,2	2,0	-3,3	0,8	1,0	7,8	1,2	2,7	-5,7	-12,5
1	1	20,8	1,3	-2,2	-1,8	2,6	4,1	-0,5	0,5	-3,0	-16,1
	2	21,9	-0,5	-4,4	-3,5	2,4	3,4	-1,8	-2,2	-3,0	-17,5
	3	23,7	-1,1	-6,1	-3,0	1,7	1,4	-0,1	-4,3	-4,2	-19,9
	4	25,0	-1,3	-6,5	-4,8	3,6	4,4	0,8	-3,6	-4,7	-19,0
	5	26,7	-0,4	-5,7	-4,8	5,3	5,1	3,0	-1,3	-3,8	-17,9
1,5	1	15,8	-1,0	-1,4	-1,9	3,1	-1,5	0,4	0,4	-0,8	-11,5
	2	15,9	-5,0	-2,8	-3,2	2,0	-1,6	-1,3	-0,4	-2,2	-16,4
	3	17,0	-5,2	-3,3	-3,9	2,4	1,0	0,7	-1,3	-2,7	-15,3
	4	17,1	-6,0	-4,3	-3,6	2,1	0,2	1,6	0,5	-2,7	-14,4
	5	20,7	-4,9	-4,2	-1,1	4,8	-1,4	5,3	1,3	-2,6	-16,3
2	1	12,1	-1,3	-3,8	-3,4	0,1	-1,2	-1,3	-3,0	-1,1	-8,5
	2	16,2	-2,0	-5,1	-3,9	-3,9	-0,5	-1,2	-2,7	-0,8	-13,7
	3	17,9	-2,6	-5,2	-4,1	-2,0	0,4	-0,2	-1,8	0,4	-14,6
	4	21,2	-2,1	-4,7	-3,6	-1,4	1,7	2,2	0,0	0,7	-13,6
	5	20,4	-1,5	-4,6	-4,2	1,4	5,2	1,0	-0,6	0,0	-16,5
2,5	1	8,6	-1,7	-1,7	-1,3	-1,7	-3,0	-0,2	-0,6	-2,6	-12,1
	2	13,6	-1,6	-3,3	-2,9	-2,1	-0,3	-0,7	-1,8	0,1	-12,9
	3	15,6	-2,3	-3,4	-3,6	-2,0	0,7	0,6	-1,9	-0,2	-14,0
	4	20,4	-0,9	-3,0	-2,2	0,9	1,3	2,8	-1,9	-0,4	-16,7
	5	22,5	1,6	-3,8	-4,1	3,6	2,0	3,9	-1,7	-1,5	-17,0

**Table 3: Comparison of holding period returns of all stocks with those of small and large cap stocks**

Returns over the formation and holding periods are calculated from mid-quote prices and are shown in basis points. The formation period is fixed at 1 hour and the holding period varies from 1 to 5 hours.

Stock size	Holding Period (hrs)	Decile portfolio number									
		1	2	3	4	5	6	7	8	9	10
All	1	20,8	1,3	-2,2	-1,8	2,6	4,1	-0,5	0,5	-3,0	-16,1
	2	21,9	-0,5	-4,4	-3,5	2,4	3,4	-1,8	-2,2	-3,0	-17,5
	3	23,7	-1,1	-6,1	-3,0	1,7	1,4	-0,1	-4,3	-4,2	-19,9
	4	25,0	-1,3	-6,5	-4,8	3,6	4,4	0,8	-3,6	-4,7	-19,0
	5	26,7	-0,4	-5,7	-4,8	5,3	5,1	3,0	-1,3	-3,8	-17,9
Small	1	30,4	3,5	-0,6	-4,6	6,7	3,2	1,0	-1,5	-1,4	-23,4
	2	34,2	4,2	-0,3	-3,2	8,3	4,6	-4,0	2,1	-1,4	-26,3
	3	40,4	4,1	0,8	-3,4	5,6	0,8	-0,5	2,0	-2,2	-31,2
	4	42,1	3,1	-0,6	-2,5	6,9	5,2	6,4	2,7	-3,2	-28,8
	5	45,5	5,4	-0,6	0,4	7,5	7,4	8,0	8,1	0,9	-25,2
Large	1	10,3	2,9	-4,7	-0,6	0,2	0,9	0,1	-1,7	-1,2	-7,3
	2	9,1	-2,0	-9,5	-2,5	-4,8	-3,4	-2,4	-2,8	-1,8	-8,1
	3	8,0	-3,5	-10,5	-3,7	-7,1	-4,2	-3,7	-2,8	-2,7	-8,7
	4	9,7	-4,4	-10,3	-5,9	-7,8	-5,9	-4,3	-2,0	-2,1	-9,8
	5	9,6	-4,6	-9,8	-4,3	-7,0	-7,5	-3,3	-4,2	-2,3	-11,1

Two further price reversal intraday event type studies are reported by Fung, Mok and Lam (2000) and Grant, Wolf and Yu (2005). They deal with trading in stock index futures (US and Hong Kong) rather than portfolios of stocks. In both papers an event day occurs if the overnight return (log of opening price divided by previous day's closing price) exceeds a prespecified threshold. The cumulative returns over time on event days are tracked and averaged over

event days. It is found that these averages show that significant price reversals occur after large overnight price changes. Similar results are also reported by Fung and Lam (2004) who work with the Hong Kong index futures and define events in terms of the relative pricing errors between the previous day's closing futures price and closing index value. In summary, though intraday price reversal studies can be approached in various ways, the consistent finding is

that large price changes due to excessive overreaction tend to be followed shortly thereafter by reversals to more temperate price levels. Our study shows that this pattern also holds on the JSE.

Returning to the results of Table 4, an average gain of 50 basis points per trading day would be sufficient to treble an investor's capital over 250 trading days. Do the results on the contrarian strategy imply that this is actually possible on the JSE? Unfortunately this is not necessarily the case. As noted above, assuming that returns over the holding period can be calculated by use of the mid-quote prices imply that the investor would be able to buy or sell at the ruling mid-quote price at the exact moments of the start and the end of the holding period. This is unrealistic as a trading assumption. A more realistic assumption is that buying and selling can be done instantaneously at the ruling ask price and bid price respectively. In the next section we study the implications of this change in the pricing assumption.

#### **4. EFFECTS OF TRADING AT THE BID AND ASK PRICES**

The momentum/contrarian trader does not do any trading over the formation period so that use of the mid-quote prices to calculate returns over that period is not questionable on trading considerations. It is merely a device to obtain a ranking of the stocks so that losers and winners can be identified before entering into trades over the holding period. Therefore we change the pricing assumption only for the holding period. We assume that a long position in a stock is acquired at the start of the holding period at the ruling best ask price and terminated at the end of the holding period at the best bid price ruling then. Similarly, a short position is acquired at the start of the holding period at the best bid price and terminated at the end of the holding period at the best ask price. This implies that the returns of short portfolios are no longer necessarily just the negatives of those of long portfolios and we need to track long and short portfolio returns separately.

Table 5 shows the average holding period returns of the long and short portfolios using all stocks when the formation period was one hour long while the holding period duration varied from 1 to 5 hours. The last five rows of the table show the differences between the returns of the long and short portfolios. It is immediately clear that neither the long nor the short portfolios were actually profitable under the bid-ask pricing. Hence no combinations of these can be profitable either. Keep in mind that the investor is faced twice with the bid-ask spread, both at the start and at the end of the holding period. To be profitable with a long position the end bid price must be larger than the start ask price and to be profitable with a short

position the end ask price must be lower than the start bid price. These requirements are not being met often and reliably enough under the winner/loser ranking scheme and the cost implied by trading at the bid-ask spread overwhelms any possible contrarian or momentum profits.

The difference entries still indicate some contrarian effects. For the extreme losers (portfolio 1) the long choice had higher average returns than the short choice while for the extreme winners (portfolio 10) the short choice had higher average returns than the long choice. It was still better to go contrarian rather than momentum on the extreme ends but unfortunately this was no longer profitable and the investor would be better off by staying out completely. There are only small differences between the returns of the long and short portfolios for numbers 2 to 9 and for these the smallest losses occur at 2 and 9 while the largest losses occur at the neutral portfolio 5. It would be better to go for the mild losers (2 or 3) or mild winners (8 or 9) rather than the more neutral portfolios (4 to 7) and it matters little whether taking long or short positions in these cases, but again the investor would be better off staying out completely. The results are quite similar at the other formation period durations. In particular no profitability is achieved in any of these cases. To save space we do not show the details.

Table 6 shows the average holding period returns of the long and short portfolios using only the small cap stocks when the formation period was one hour long while the holding period duration varied from 1 to 5 hours. Here the average returns were uniformly more negative than those of Table 5 where all stocks were used, but otherwise the conclusions are similar. In Section 3 we saw that under mid-quote pricing investors do better when using only the small cap stocks rather than all stocks. Under bid-ask pricing we find the opposite, namely that they do worse. The primary reason for this is that the bid-ask spreads of the small cap stocks tend to be larger than those of the large cap stocks as indicated in Table 1, so that buying and selling at the bid-ask spread imply greater trading costs when focusing on the small cap stocks. This conclusion is reinforced by Table 7 which shows the equivalent results of Tables 5 and 6 but with trading restricted to the large cap stocks. In that case the average returns are less negative than for the small and all stocks cases, although still being unprofitable. Thus while the small cap stocks have larger contrarian effects for the extreme losers and winners under mid-quote pricing, this advantage is now more than cancelled out by their larger implied trading costs due to their higher bid-ask spreads. The investor would be better off trading in the large cap stocks although this is still not profitable.

**Table 4: Average holding period returns of contrarian portfolios consisting of buying the extreme losers and selling the extreme winners**

Returns over the formation and holding periods are calculated from mid-quote prices and are shown in basis points. The formation period varies from 0,5 hours to 2,5 hours and the holding period varies from 1 to 5 hours. Either all stocks or the small or the large cap stocks are used separately.

Stock size	Holding period (hrs)	Formation period (hrs)			
		1	1,5	2	2,5
All	1	37	27	21	21
	2	39	32	30	27
	3	44	32	33	30
	4	44	32	35	37
	5	45	37	37	40
Small Caps	1	54	41	34	40
	2	61	55	53	50
	3	72	54	57	53
	4	71	53	59	62
	5	71	61	61	66
Large Caps	1	18	11	5	3
	2	17	6	3	2
	3	17	7	4	3
	4	19	8	6	9
	5	21	11	11	13

**Table 5: Average holding period returns of decile portfolios using all stocks**

Returns for ranking over the formation period are calculated from mid-quote prices while returns over the holding period are calculated from bid-ask prices and are shown in basis points. The formation period is fixed at 1 hour and the holding period varies from 1 to 5 hours. Returns for long and short portfolios and their differences are shown.

Type	Holding Period (hrs)	Decile portfolio number									
		1	2	3	4	5	6	7	8	9	10
Long	1	-132,7	-86,4	-96,0	-167,4	-210,4	-179,9	-132,1	-93,0	-88,1	-161,7
	2	-125,7	-84,6	-96,2	-161,6	-200,9	-172,9	-127,9	-91,9	-85,5	-157,1
	3	-122,8	-84,1	-96,1	-160,1	-199,1	-173,1	-125,8	-92,7	-84,8	-159,5
	4	-118,4	-83,7	-96,3	-161,4	-195,3	-170,1	-122,5	-91,2	-84,8	-156,0
	5	-117,1	-82,0	-94,0	-158,6	-192,3	-170,2	-119,1	-87,8	-84,4	-154,8
Short	1	-184,7	-89,1	-91,8	-165,9	-216,8	-188,9	-131,4	-94,3	-82,3	-132,8
	2	-180,2	-84,0	-87,6	-157,1	-207,7	-180,8	-124,9	-87,7	-79,6	-125,6
	3	-180,6	-82,3	-84,1	-156,7	-204,8	-177,5	-126,3	-84,4	-76,7	-122,7
	4	-179,7	-81,4	-83,6	-153,9	-204,9	-180,3	-124,9	-84,2	-75,7	-121,6
	5	-181,9	-81,6	-83,0	-151,5	-205,3	-180,5	-126,1	-85,6	-77,0	-122,2
Difference	1	52,0	2,8	-4,2	-1,5	6,5	9,0	-0,7	1,2	-5,8	-28,9
	2	54,5	-0,7	-8,5	-4,4	6,8	7,9	-3,0	-4,1	-5,9	-31,5
	3	57,8	-1,8	-11,9	-3,4	5,7	4,3	0,5	-8,2	-8,1	-36,8
	4	61,2	-2,3	-12,7	-7,5	9,6	10,2	2,4	-7,0	-9,1	-34,4
	5	64,8	-0,4	-11,0	-7,2	13,1	10,3	7,1	-2,3	-7,4	-32,6

**Table 6: Average holding period returns of decile portfolios using the small cap stocks only**

Returns for ranking over the formation period are calculated from mid-quote prices while returns over the holding period are calculated from bid-ask prices and are shown in basis points. The formation period is fixed at 1 hour and the holding period varies from 1 to 5 hours. Returns for long and short portfolios and their differences are shown.

Type	Holding Period (hrs)	Decile portfolio number									
		1	2	3	4	5	6	7	8	9	10
Long	1	-209,3	-162,4	-187,4	-285,1	-275,9	-279,0	-236,4	-183,6	-162,9	-247,7
	2	-195,2	-155,1	-182,4	-271,5	-263,7	-263,0	-231,8	-175,1	-156,2	-242,3
	3	-188,9	-153,1	-175,3	-271,4	-258,3	-267,3	-227,2	-169,9	-156,0	-248,0
	4	-181,9	-152,4	-177,0	-271,1	-256,2	-260,2	-216,7	-167,2	-155,1	-240,8
	5	-178,4	-150,3	-175,9	-262,1	-251,5	-260,8	-212,8	-160,3	-151,2	-238,3
Short	1	-290,7	-169,7	-187,0	-280,2	-291,2	-286,7	-239,6	-181,1	-160,4	-207,2
	2	-284,6	-163,9	-182,7	-270,4	-283,2	-274,4	-225,3	-179,9	-153,9	-196,3
	3	-290,2	-162,0	-178,0	-269,5	-273,2	-271,1	-227,7	-175,0	-151,8	-191,5
	4	-288,5	-159,3	-176,9	-270,2	-273,7	-273,0	-231,5	-173,8	-149,0	-190,0
	5	-291,8	-161,7	-176,0	-267,7	-271,0	-275,8	-230,8	-177,8	-153,3	-193,9
Difference	1	81,4	7,3	-0,4	-4,9	15,2	7,7	3,1	-2,5	-2,5	-40,5
	2	89,4	8,8	0,3	-1,1	19,5	11,4	-6,5	4,8	-2,3	-46,0
	3	101,3	8,9	2,7	-1,9	15,0	3,9	0,6	5,1	-4,1	-56,6
	4	106,6	6,9	-0,1	-1,0	17,5	12,8	14,8	6,6	-6,0	-50,9
	5	113,4	11,4	0,1	5,6	19,5	15,0	18,0	17,4	2,1	-44,4

**Table 7: Average holding period returns of decile portfolios using the large cap stocks only**

Returns for ranking are calculated from mid-quote prices and over the holding period from bid-ask prices and shown in basis points. The formation period is fixed at 1 hour and the holding period varies from 1 to 5 hours. Returns for long and short portfolios and their differences are shown.

Type	Holding Period (hrs)	Decile portfolio number									
		1	2	3	4	5	6	7	8	9	10
Long	1	-49,6	-38,9	-46,3	-46,1	-45,7	-44,3	-41,8	-45,5	-46,5	-66,7
	2	-48,3	-42,6	-49,4	-46,4	-49,0	-46,9	-42,8	-44,5	-45,2	-64,7
	3	-48,2	-43,7	-49,9	-48,4	-51,5	-47,8	-43,9	-43,7	-45,1	-63,8
	4	-45,6	-44,9	-49,8	-49,3	-52,1	-48,7	-43,9	-43,0	-44,7	-64,5
	5	-45,8	-44,4	-49,2	-47,4	-50,2	-50,4	-42,7	-44,5	-45,0	-64,9
Short	1	-70,5	-44,8	-36,9	-45,0	-46,1	-46,1	-42,0	-42,2	-44,2	-52,3
	2	-66,9	-38,8	-30,5	-41,5	-39,4	-40,3	-38,0	-39,0	-41,6	-48,6
	3	-64,5	-36,8	-28,9	-41,0	-37,3	-39,4	-36,6	-38,3	-39,8	-46,6
	4	-65,3	-36,2	-29,3	-37,5	-36,5	-37,0	-35,4	-39,0	-40,6	-45,2
	5	-65,3	-35,3	-29,6	-38,8	-36,2	-35,5	-36,2	-36,1	-40,5	-42,9
Difference	1	20,9	5,9	-9,4	-1,1	0,5	1,9	0,2	-3,3	-2,3	-14,4
	2	18,6	-3,9	-18,9	-4,9	-9,6	-6,7	-4,7	-5,5	-3,6	-16,1
	3	16,3	-6,9	-20,9	-7,4	-14,2	-8,4	-7,3	-5,4	-5,3	-17,3
	4	19,7	-8,7	-20,5	-11,7	-15,6	-11,7	-8,5	-3,9	-4,1	-19,3
	5	19,5	-9,1	-19,6	-8,6	-14,0	-14,9	-6,5	-8,3	-4,5	-22,0

We looked at many other combinations of formation and holding period cases and found none that were profitable under the bid-ask pricing assumption. We also changed the return calculation on which the ranking of stocks were based over the formation period, using the prices of the first and last actual trades in the formation period rather than the first and last mid-quotes. This too did not yield profitable long or short portfolios for any choice of the formation and holding period durations. A further possibility is to change the fixed holding period rule used up to this point. For example, if it becomes possible to achieve some profit target (say 1%) during the course of the holding period, take advantage of it by terminating at that moment, otherwise terminate at the end of the holding period. This too did not yield overall profitability: the profitable opportunities that arose were simply too few to make up for the losses. Finally, also using stop losses did not help in this context.

The bid-ask pricing assumption over the holding period is more realistic than the mid-quote pricing assumption. The conclusion must therefore be that profitable intraday trading is not possible using the simple loser-winner ranking scheme based only on formation period returns to identify portfolios for possible momentum or contrarian strategies. It was apparent above that the bid-ask spread is an important variable to take into account. Therefore we explored also in that direction by considering the following dynamic filtering rule applied prior to stock ranking at the start of the holding period, namely retain only those stocks whose bid-ask spreads are below some threshold (e.g. 30 basis points).

According to Table 1, when the holding period starts at 10:15 on average only 25 stocks have bid-ask spreads below 30 basis points. However, the bid-ask spreads at 10:15 vary from day to day and on any particular day there may be more (or less) than 25 stocks to rank

and construct portfolios from. In addition the spreads vary over the time of the day and will thus be different if the holding period starts at other times. Still, the available number of stocks will be much smaller than the number dealt with before so that setting up deciles following ranking will lead to very few stocks per decile and the average returns per decile would likely be quite unstable. For this reason we use quintiles rather than deciles from here on.

Table 8 shows the average returns for long quintile portfolios with bid-ask spread thresholds of 30, 20 and 10 basis points respectively and Table 9 shows the same for short portfolios. Throughout the formation period was 9:15 to 10:15 and the holding periods varied from 1 to 5 hours as before. Comparing the results in Table 8 with the long entries of Table 7, it is clear that the long portfolios did better with the bid-ask spread restriction of 30 basis points than even under the large cap stock restriction. Table 8 also shows that there were further slight improvements with the stricter thresholds of 20 and 10 basis points. It also appears that the shorter holding period of 1 hour was generally better than the longer holding periods (with some exceptions for portfolio number 1).

There still seems to be some contrarian effects in that the average returns of portfolio 1 tend to be higher than those of 2 while the average returns of 5 tend to be lower than that of 4. However, none of the average returns were positive so that profitability was still not achieved by these long portfolios. Comparing Table 9 with the short entries of Table 7 it is clear that the short portfolios do substantially better with the bid-ask spread restriction and moreover, contrary to what happens with the long portfolios, the results improve notably with the stricter thresholds of 20 and 10 basis points. The best results were achieved with the mild loser portfolio 2 when the holding period duration was

two hours or more and this may be classified as a momentum effect since the mild losers are shorted.

We studied other combinations of formation and holding period durations in this context and also based the formation period returns on trade prices rather than mid-quote prices. The results of the tables discussed above are quite representative of these further cases. We offer the following as a possible explanation for the finding that the short portfolios tend to do better than the long portfolios. Taking long positions are generally easier and more prevalent than taking short positions in day trading. Closing long positions towards the end of the day thus tends to create relatively more selling pressure than the buying pressure coming from closing short positions. This asymmetry between the effects of closing long and short portfolios works to the advantage of short portfolios. Among the cases we studied no positive average returns were found for long portfolios but occasionally small positive average returns came up for some of the short portfolios although these were not statistically significantly different from zero.

Overall, while the results of the bid-ask spread restricted selection are quite encouraging, we still do

not achieve profitability on average over trading days. Keep in mind that there are further costs that have not yet been taken into account so far. Assuming proportional brokerage as low as 10 basis points per trade would mean that an average daily return of about 20 basis points would be required for net profitability. This was not achieved by any of the strategies we have looked at in this study.

We also repeated the analyses discussed so far but using the intra-day data of the same shares for the first six months of 2008. Apart from somewhat larger variability due to averaging over shorter series, the results were similar and our main conclusions were also reflected in those analyses. Thus in line with the conclusion of Grant, Wolf and Yu (2005), while there are significant price reversals on the JSE following large price changes early in the day, "... the question of whether a trader can profit from this information remains open as the significance of intraday reversals ... is sharply reduced when gross trading returns are adjusted by a bid-ask proxy for transaction costs".

**Table 8: Average holding period returns of long quintile portfolios using only stocks with bid-ask spread below thresholds of 30, 20 and 10 basis points**

Returns for ranking over the formation period are calculated from mid-quote prices while returns over the holding period are calculated from bid-ask prices and are shown in basis points. The formation period is fixed at 1 hour and the holding period varies from 1 to 5 hours.

Spread threshold	Holding period (hrs)	Quintile portfolio number				
		1	2	3	4	5
30 bps	1	-27,1	-27,8	-22,7	-24,2	-29,1
	2	-29,3	-34,4	-27,6	-28,6	-31,9
	3	-28,1	-36,9	-29,2	-29,5	-34,2
	4	-28,0	-38,0	-30,0	-29,6	-36,0
	5	-28,6	-37,0	-27,4	-30,3	-34,1
20 bps	1	-26,0	-24,2	-20,7	-21,1	-27,6
	2	-26,5	-30,2	-26,6	-24,4	-33,0
	3	-27,2	-32,4	-27,6	-27,0	-34,6
	4	-26,4	-33,3	-27,9	-25,3	-36,4
	5	-26,9	-31,8	-24,3	-25,5	-35,5
10 bps	1	-26,2	-20,6	-18,8	-16,7	-27,2
	2	-20,6	-27,7	-24,5	-23,9	-29,0
	3	-23,0	-27,7	-27,6	-21,2	-28,2
	4	-19,2	-26,2	-28,5	-20,8	-30,0
	5	-18,6	-26,8	-21,7	-19,2	-33,6

**Table 9: Average holding period returns of short quintile portfolios using only stocks with bid-ask spread below thresholds of 30, 20 and 10 basis points**

Returns for ranking over the formation period are calculated from mid-quote prices while returns over the holding period are calculated from bid-ask prices and are shown in basis points. The formation period is fixed at 1 hour and the holding period varies from 1 to 5 hours.

Spread threshold	Holding Period (hrs)	Quintile portfolio number				
		1	2	3	4	5
30 bps	1	-23,5	-15,6	-21,0	-20,0	-17,5
	2	-19,5	-9,9	-19,4	-17,1	-16,8
	3	-20,5	-9,0	-17,8	-17,6	-14,0
	4	-21,5	-7,1	-16,7	-17,1	-14,1
	5	-21,2	-7,8	-19,3	-16,0	-14,6
20 bps	1	-19,5	-11,5	-14,8	-16,3	-12,4
	2	-15,6	-7,1	-10,7	-13,4	-10,0
	3	-14,6	-6,4	-10,3	-11,3	-6,8
	4	-16,5	-4,2	-9,4	-13,2	-7,2
	5	-15,7	-6,1	-12,4	-12,9	-7,1
10 bps	1	-14,0	-8,4	-8,7	-15,4	-6,2
	2	-15,4	-2,2	-5,0	-6,6	-6,7
	3	-13,1	-2,4	-3,6	-8,0	-4,7
	4	-16,0	-1,4	-1,9	-9,4	-6,7
	5	-16,6	-2,9	-9,5	-11,0	-3,0

**Table 10: Average holding period returns of long and short quintile portfolios using only oracle selected stocks**

Returns for ranking over the formation period are calculated from mid-quote prices while returns over the holding period are calculated from bid-ask prices and are shown in basis points. The formation period is fixed at 1 hour and the holding period varies from 1 to 5 hours.

Oracle type	Holding Period (hrs)	Quintile portfolio number				
		1	2	3	4	5
Long	1	44,4	37,9	35,1	40,4	42,4
	2	57,9	47,6	49,1	53,6	61,3
	3	64,4	57,4	58,0	61,9	70,0
	4	72,5	63,9	64,0	68,4	75,9
	5	80,5	71,1	70,7	77,2	83,1
Short	1	42,7	35,5	34,5	34,9	39,2
	2	58,1	53,3	45,3	46,1	55,7
	3	66,1	63,9	53,2	52,7	64,2
	4	70,8	67,4	62,0	61,5	70,9
	5	75,9	78,1	68,2	65,9	79,4

## 5. CONCLUSION

We noted above that to be profitable under bid-ask pricing returns with a long portfolio the end bid price must be higher than the start ask price and in the case of a short portfolio, the end ask price must be lower than the start bid price. In essence there must be a large enough up or down movement in the best prices over the course of the holding period depending on whether a long or a short portfolio is taken. A pertinent question is whether this actually happens in the data set and if so, whether these movements are frequent and large enough to be worthwhile taking additional transaction cost such as brokerage also into account.

To answer these questions, consider a long and a short oracle day trader. At the start of a holding period, the long oracle trader can predict correctly whether or not the end bid price will be higher than the start ask price for each stock. If his prediction is for the higher outcome he includes the stock in his list of

stocks for a long quintile portfolio following ranking by the formation period returns. Similarly, at the start of a holding period, the short oracle trader can predict correctly whether or not the end ask price will be lower than the start bid price for each stock. If her prediction is for the lower outcome she includes the stock in her list of stocks for a short quintile portfolio following ranking by the formation period returns. If these two oracle traders cannot trade profitably in the context in which we are working then no one else without access to their foresights will be able to do so either.

Table 10 shows the average returns achieved by the long and short oracle traders when the formation period was 9:15 to 10:15 and the durations of the holding period varied from 1 to 5 hours as before. In both cases the average returns were positive and the longer the holding period the better the results. With the 5 hours long holding period the returns are about 80 basis points. This would be sufficient to cover brokerage rates of up to about 40 basis points to stay

net profitable. The long cases achieved best results with the extreme losers (portfolio 1) or winners (portfolio 5). This implies a contrarian effect for portfolio 1 and a momentum effect for 5. For the short case the momentum effect was with portfolio 1 and the contrarian effect with 5. However, these effects are not substantial in either case since the results do not depend much on the portfolio number, i.e. the ranking does not really matter. It turned out that on average each of the oracles had from about 20 to 32 eligible stocks per day depending on the duration of the holding period.

A more discriminating long oracle would also be able to predict correctly whether the end bid price will be higher than the start ask price by some margin greater than zero (say e.g. 0,5%) for each stock. A more discriminating short oracle can be defined similarly. Calculations show that such oracles would be able to trade profitably against even higher brokerage rates than 40 basis points.

Thus the answer to the two questions above are both affirmative: sufficiently large and frequent price movements do indeed occur to yield enough scope for profitable day trading, *if only the day trader were smart enough to identify the opportunities correctly*. The best of the strategies studied above came fairly close to being profitable at very low brokerage rates but they are just not good enough for routine practical purposes.

It would seem that the loser/winner ranking approach applied to a list of eligible stocks during the formation period is simply too crude to yield really reliable information to discriminate between winning, losing and neutral performers over the subsequent holding period, which is what is really required for actual profitable intraday trading.

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