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NUMBER PREFERENCE IN AUSTRALIAN STOCK PRICES

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Abstract:

Stock price rallies/declines often terminate at price levels that are interpreted by many as areas of psychological resistance or support, while an alternative interpretation is that they coincide with price clusters. Some of these price levels tend to repeat with a regularity that is inconsistent with mere chance. In this paper, the existence of price clusters and psychological barriers is tested on a sample of 20 Australian stocks. We consider two number sequences, both derived from a base number of 100, as well as integer price levels. It is shown that Australian stock price data are not uniformly distributed and that for the majority of the stocks, price swing highs and lows are associated with certain recurring price levels. Some of the implications for trading and investing are considered.

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Number Preference in Australian Stock Prices[1]

1. Introduction

There has been a global explosion in trading systems, technical analysis, and the number of people trading stocks, currencies, commodities and indexes. Technical analysis has attracted also the attention of academics, and in some cases governments. Technical analysis is a set of techniques for identifying turning points in a stock market price series, be it an individual stock or an aggregate price index. These turning points may be very short term, as in those seen on one-minute charts, or longer term over the course of a year or more. Technical analysis explores both the direction of a move (will the stock rally or collapse?) and the magnitude of a move (how far will the price rally/collapse proceed?).

The techniques used in technical analysis focus on time, pattern, price, or some combination of all three (see Miner 1997 and Gilmore 1997). With respect to time, technical analysts try to identify time cycles in a stock. With regard to price they look for certain price levels which in the past have served as areas of resistance or support. And, with regard to pattern, technical analysts try to establish charting patterns (such as triangles, rectangles and diamonds) that signal a likely directional move (see, for example, Edwards and Magee 1992 and Guppy 1997).

Recently, there has been much interest on the issue of psychological barriers. These are price levels that are said to act as areas of price resistance and price support. These price levels are popular in the financial and popular business press and are popular among many traders (see Mitchell 2001). For example, the Nasdaq was unable to successfully rally beyond the 5000 level and the 10000 level is deemed by many to be important for the Dow. There is much debate about the proper interpretation of these price levels. The term psychological barrier implies that there is a behavioral aspect behind the barriers and implies also price predictability. Many researchers prefer the term 'overrepresentation' rather than psychological barrier, on the basis that what appear to be barriers may be recurring price levels that are consistent with random price movements. That is, it may be in the nature of random numbers to *cluster* around certain price areas giving the appearance of a (non-existent) behavioral price barrier.

The aim of this paper is to explore the existence of price levels that act as points where stock prices reverse direction – either in terms of psychological barriers or in the form of over-

[1] Darren Sheloff and Phillip Hone made several useful contributions to the development of this paper.

representation of prices - among a sample of Australian stocks. Australian stocks have received very little attention from academic researchers, even though many are actively traded and many stocks, such as the National Australia Bank, Rio Tinto and News Corporation are internationally recognized and attract the interest of investors and traders from around the globe.

The paper is set out as follows. Psychological barriers and price clusters are discussed in section 2. Statistical analysis of Australian stock data is presented in section 3. Some of the implications for trading and investment are presented in section 4. Section 5 concludes the paper.

2. Number Preference

Technical analysis is based upon the hypothesis that crowd psychology drives stock prices. According to technical analysts it is the forces of fear and greed that determine the wide swings observed in stock, commodity and currency prices. Greed drives prices upwards and fear drives them down. While fundamentals drive the overall long-term direction of these prices, the short and intermediate swings are said to be driven mainly by psychological factors.

If psychological factors are important in stock markets, then it is plausible that crowd psychology may lead also to price levels of psychological resistance and support. That is, crowd psychology may be such, that certain price levels are given greater weight. As Koedijk and Stork (1994) note: “Such levels appear not to be based on fundamental economic theory, but probably are created and kept alive by mass psychology” (p. 427).

When traders and investors assign greater weight to certain price levels, they are expressing number preference. For example, it is reasonable to postulate that paying $100 for a stock has a different psychological impact on a trader/investor than paying $82 for it. That is, as a stock price approaches say $100, buyers become more anxious and hesitate to pay in excess of $100. At the same time, sellers start to come into the market in greater numbers in the belief that the stock price is now overpriced and it is time for them to sell the stock. The crowd psychology alters as stock prices approach certain price levels. Often prices just crash through these price levels and to many this is a clear signal that the directional move is powerful and will continue in its current direction.

The efficient market hypothesis postulates that day-to-day changes in the price of a stock should have a mean value of zero. Number preference theory however indicates that as a stock price approaches a psychological price level, investors and traders will start to reassess the price

movement and that a retracement is expected. That is, number preference theory appears to be at odds with the efficient market hypothesis.

Mitchell (2001) has presented an extensive list of behavioral and economic reasons for the existence of psychological barriers. For example, Mitchell notes that the decimal system encourages decision makers to think in groups and multiples of 10, and points out that "... rounding and fixed formats speed up numerical processing and comprehension …". Moreover, since numbers are used to convey information, it is rational for people to "… select numbers that they believe others will recognize or that are readily discernible to other parties to facilitate the decision-making process".

The issue of psychological barriers has received only limited empirical attention. Koedijk and Stork (1994) explored the presence of psychological barriers in five major stock exchanges and tested for psychological barriers for all levels where the last two digits are zero (100, 200, etc.). They found that psychological barriers are a real phenomenon but also found that these could *not* be used for predicting stock prices.

Responding to the findings of the psychological barriers literature (such as those by Koedijk and Stork 1994 and Ley and Varian 1994), De Ceuster *et al.* (1998) have noted correctly that these price levels are consistent with a random walk process, and hence do not necessarily represent psychological barriers. De Ceuster *et al.* argue that the psychological barriers literature is picking up an overrepresentation of prices - prices tend to be more represented in certain price brackets than in others. That is, prices are clustered.[2]

In contrast to some of the behavioral underpinnings listed earlier, the notion of overrepresentation is said to be a phenomenon of nature and is part of the nature of number progression. Clustering has been observed in many random numbers, such as street addresses and areas of rivers. Data clustering has been portrayed by Benford's (1938) Law of Anomalous Numbers, which describes the frequency of first and higher placed digits. The law states that first digits follow a logarithmic relationship. For example, the probability that the first digit is a 1 is 0.301, a 2 is 0.176 and a 9 is 0.046. The law applies also to higher digits, such as the probability of a 5 in second place (which is 0.097) and a 7 in third place (which is 0.099), although these are conditional on the digits that have preceded them. The law basically states that the probability of observing a particular first and second digit is non-uniform, but becomes uniform for third and

[2] The tendency of clustering of security prices around integers has been observed also with respect to other asset prices, such as retail deposit interest rates (see Kahn *et al.* 1999).

higher placed digits. Regardless of the academic interpretation, it has to be acknowledged that in the business and finance media and probably for most traders, these prices are assigned with psychological significance. That is, the practitioners act as if the price levels are barriers.

The price levels explored in this paper all stem from the number 100. The number 100 has importance in psychology and culture. For example, it is the basis of the (almost) universally accepted metric system. As Mitchell (2001) has noted recently:

> *Number counting and number representation (ciphers) of the decimal system suggest a natural tendency to think in terms of 10s and powers of 10. … Grouping by the powers of 10 facilitates the mental order and the correspondence process and provides computationally convenient breaks between groups.*

We can derive a number grid from this basing number in two ways, both of which appear to be important to financial markets.

Direct Transformations

Scaling the number 100 gives a number of transformations of it which are said to act as psychological barriers:

$$1, 10, 100, 1000, 10000 \text{ etc} \quad (1)$$

For example, 10000 is an important number for the Dow Jones index, and 10 and 100 is a very important price level for individual stock prices.

Divisions

Sequentially dividing 100 into two gives rise to the following number series:

$$\$100, \$50, \$25, \$12.50, \$6.25, \$3.125, \$1.56, \$0.78 \text{ etc.} \quad (2)$$

Note that all of these numbers are multiplicative regenerative. Hence, we can derive also the following sequence, 0.625, 6.25, 62.50, 625.0 etc. and 0.25, 2.50, 25.00, 250 etc.

The number series represented by (2) looks unusual. It includes numbers that are *a priori* unexpected, but at least some of which appear to be important in financial markets. This series has not previously been investigated in the price clusters and psychological barriers literature,

which has focused solely on integers. This series is interesting in that it includes odd-ending prices, which according to some research are not recalled as easily as even-ending prices (see Schindler and Wiman 1989).

The first division of 100 into two generates the number $50. This is an obvious potential psychological barrier, and transformations of it appear important, such as 5, 500 and 5000. It is not clear why numbers such as $12.50 and $6.25 should be important.[3] However, in section 3.2 evidence is presented that this number sequence does appear to be important, as least for the Australian stock market. Many traders use these numbers as part of their trading strategy. This number sequence is also part of the Murrey Math trading system (Murrey 1995).

According to number preference theory, these numbers should be of greater significance than many other numbers. In particular, we can expect these numbers to act as areas of price resistance, where price rallies stall, or as areas of price support, where prices bounce back upwards, at least temporarily.

Prices do not usually match these price levels exactly. The normal pattern is that they either shy away from the psychological levels, or penetrate them temporarily, before retracing some of their prior move. These price levels can retain their importance for several decades. For example, Figure 1 shows that in the case of Australian mining company Western Mining (code WMC), using an Open-High-Low-Close (OHLC) chart format[4], the $10 psychological barrier acted as resistance in 1987, 1996 and again in 2001 (highlighted by the rectangles). The stock price highs in 1987, 1996 and 2001 did not fall exactly on $10, but came close to it. Notice also the importance of $6.25, which acted as both resistance in 1988 and 1989 and support in 1994 and 2000, and the importance of the $4.00 integer price level as an area of support for this stock.[5]

FIGURE 1 HERE

It is not just stocks that respond to psychological barriers. Figure 2 is the monthly chart of Light Crude Cash prices showing the significance of $25 as both an area of resistance (in 1989 and

[3] One possible explanation maybe that these numbers arise from brokers' recommendations. That is, it is possible that the average of brokers stock price recommendations fall around these levels. Investigation of this is beyond the scope of this paper.

[4] The OHLC stock price bars show the opening price as the horizontal line on the left, the closing price as the horizontal line on the right, and the high and low prices.

[5] One way to interpret a chart like Figure 1 is that no-one thinks that the stock is worth more than $10 but everyone wants to buy the stock at $4.00. This would make the demand curve for the stock horizontal at $4.00 and intersecting the price axis at the $10 price level. Alternatively, or in addition, it may be the supply curve is horizontal at the $10 price level.

1996-97) and as an area of support (in 1984-85 and 2000-2001).[6] Notice also the importance of $10 price level as an area of support.

Psychological barriers are also evident on indices. For example, Figure 3 shows that the 5000 psychological barrier proved too much for the Nasdaq in March 2000. Other indices display similar behavior. For example, 10000 was and continues to be an important psychological level for the Dow, 25000 (25.00 times 100) was an important level for the Nikkei, 6250 (6.25 times 100) was an important level for the FT-100, and 3125 (3.125 times 100) was an important level for the Australian All Ordinaries Index.

FIGURE 2 HERE

FIGURE 3 HERE

3. Statistical Analysis

A handful of charts proves little. The whole foundation of technical analysis is the analysis of chart patterns. Yet, humans are good at finding patterns where none exist. Accordingly, it is important to explore in more detail the existence of psychological barriers.

The aim of this paper is not to uncover all the psychological barriers that may exist in Australian stocks. Rather, the focus is on the existence of the barriers relating to the number 100, as outlined in section 2 above. In this paper the incidence of psychological barriers is explored through a sample of Australian stocks. Some traditional tests are performed on this data, as well as a newer test using swings as the basic unit of analysis.

3.1 Data

Australian stocks do not trade at price levels as high as those in other countries, such as the US. Hence, it is not possible to test all the possible psychological price barriers. The analysis is restricted to those barriers which have been tested by the stocks themselves. Only those stocks which have traded at least to $6.25 were considered.[7] A random sample of 20 Australian stocks was chosen, and this serves the basis of the analysis. The data commences in November 1986 and ends in 17th August 2001, giving a sufficient time span for the investigation. For several of

[6] Indeed, in some areas where oil is the most important source of economic activity, the $25 price level is watched by many decision makers and is even important for wage negotiations.

the stocks the data does not commence in 1986, as the stocks were not listed until after that date. Appendix A presents some basic information on the stocks included in the analysis. The data was purchased from Almax Information Systems, and includes all of the publicly listed stocks on the Australian Stock Exchange, from which the sample was drawn.

3.2 Uniformity in Australian Stock Prices

A number of statistical tests can be carried out on the data in order to extract additional information regarding the behavior of the stocks. In this paper three different tests are applied, a Chi-square test, a dummy variable regression test and a swing based regression test. Koedijk and Stork (1994) use a Chi-squared goodness-of-fit test to explore the uniformity of stock prices. This involves comparing the actual frequency of price levels with the expected frequency of price levels, based on the assumption of uniformity in prices. Following Koedijk and Stork (1994) we consider all possible price levels (from 0 to 99) and explore the existence of stock price uniformity. Daily closing prices are used for each of the 20 stocks for the period 1986 to 2001. The results are presented in column 2 of Table 1. For all of the stocks, the hypothesis of uniformity in stock prices is rejected. The conclusion is that for this sample of Australia stocks, prices are not uniformly distributed.

TABLE 1 HERE

It is possible to test whether there is an association between the non-uniformity of prices and specific price levels clusters. Following Koedijk and Stork, this test involves a regression with the dependent variable constructed as a vector of the relative frequency of prices between 00 and 99, and a constant and three dummy variables used as explanatory variables. The dummies (D_i) are constructed as follows: D1 takes the value 1 for values 98, 99, 00, 01 and 02 and 0 otherwise, D2 takes the value of 1 for values of 93 to 97 or 03 to 07 and 0 otherwise, and D3 takes the value of 1 for values of 85 to 92 or 08 to 15 for D3 and 0 otherwise.

The results are presented in Table 1 columns 3, 4, 5 and 6, and they differ to those found by Koedijk and Stork. Koedijk and Stork investigated several major world indexes and found that the coefficients on the dummy variables decreased as i (the dummy number) increased. This implies that the further away from a hypothesized barrier the lower is the effect.

[7] Subsequent to this analysis, one of the stocks (MRL) experienced a bonus issue. This effectively resulted in a scaling down of the stock price. The pre-bonus data is used in this paper.

The results for Australian stocks are mixed. For ten of the stocks none of the dummy variables are statistically significant. All three dummies are statistically significant for only 4 of the stocks (ETR, DAD, MRL and TLS), and the coefficient on D1 is significant for 7 of the 20 stocks. For some of the stocks the coefficients on the dummies are increasing while for others it is decreasing. If prices were uniform, then the constant should be close to 1. For all stocks this is not the case.

A random walk will also tend to display non-uniformity in stock prices. Hence, we can conclude from Table 1 only that the non-uniformity confirms an overrepresentation of prices, but this does not in itself indicate the presence of psychological barriers.

A swing based test

The regression analysis presented in Table 1 used daily closing prices. In this section, the focus is on the analysis of price swings rather than the day-to-day price changes. A swing is a price retracement of a specified percentage, typically lasting more than two days. The swings are of more importance as they are of larger magnitude than daily price fluctuations and are of more practical importance, as most traders aim to capture at least part of a swing, rather than just the day-to-day fluctuations. By making the swings the focus of analysis, it is possible to remove the day-to-day fluctuations in the stock, which can be regarded as short-term stock price movements. Swings capture the medium- to long-term stock price movements, and hence abstract from the 'noise' associated with short-term movements. For example, Figure 4a is a daily OHLC chart of Rio Tinto, for the period December 1997 to March 1999. Figure 4b uses the same data for the same period and maps the associated swings of *at least* 5 percent, and removes much of the noise in the stock.[8]

FIGURE 4a HERE

FIGURE 4b HERE

The swing test can be conducted as follows. First, construct a set of price swings for each stock price series. For this paper a 5% swing is used.[9] It is possible to construct swings of any percentage. A swing of at least 5 percent captures all of the important swings (as it allows for

[8] The swings have the added advantage of identifying the market condition. For example, lower lows are associated with bear markets and higher highs are associated with bull markets.
[9] The software Dynamic Trader was used to construct swing files.

larger swings), as well as the smaller swings.[10] The distribution of the price swings is listed in Table 2. As expected, the distribution of price swings is positively skewed, with the majority of swings in the 5% to 10% interval. This is consistent with a random walk process.

TABLE 2 HERE

The second step is to code each swing as a high or a low (see Figure 4b for examples). This becomes a binary dependent variable with each high assigned a 1 and each low assigned a 0. A high is made when a stock has rallied and then retraces. A low is recorded when a stock has fallen and then rallies. Third, identify the price at the high and the price at the low. Fourth, construct a set of dummy variables, for specific psychological price barriers, allowing for 5 percent either side of the price barrier. We consider all the dollar increments ($1, $2, …. $39, etc.) as well as the price series represented by (2) above. For example, for the $2 price level, we look for highs or lows to come in the range of $1.90 to $2.10, while for the $2.50 price level, we look for highs and lows that fall in the range of $2.38 to $2.63. As the price levels rise, there is some overlap. For example, for the $12 price level, we look for highs and lows that fall in the range of $11.43 to $12.60, while for the $12.50 price level, we look for highs and lows that fall in the range of $11.90 to $13.13. The reason for allowing a range, is that we do not expect prices to hit specific price levels exactly (see Figures 1, 2 and 3). Allowing for a 5% band means that we allow prices to come close to the target, but they can overshoot it, or stop below it and then retrace. Because of the overlap in the higher price levels, it is best to think of a band effect. The $12 and $12.50 price levels are derived from two different number series, but the two can be combined into a $12 to $12.50 band.

Table 3 lists the occurrence (or rather recurrence) of price levels, for all the stocks combined for price levels ranging from $1 to $12.50. Column 2 is the raw number of the number of times a price level is associated with either a swing high or a swing low. Not all stocks have traded into the same absolute price levels (see Appendix A). Hence, it is necessary to scale the raw data by the number of stocks that have actually traded into that price level. This gives the scaled frequency which is presented in column 3. The highest scaled frequencies are the $2.50 and $4 price levels, followed by $5.

TABLE 3 HERE

[10] Trading strategies differ among traders. For example, some traders focus on 1 percent swings (see Downs 1999).

The final step is to run a regression of the highs and lows against the dummy variables for specific price levels. Since the dependent variable is a dummy variable, the appropriate estimation framework is either a probit or logit regression model. This is a test of whether there is a tendency for certain price levels to lead to swing highs or lows. This test has not been used in the price clustering and psychological barriers literature before.

The probit regression coefficients and the associated z-statistics are presented in Table 4, and are grouped into low price levels (less than $10), medium price levels ($10 to less than $20) and higher price levels (greater than $20). Only those price levels that proved to be statistically significant are listed in columns 2, 4 and 6.[11] For example, the entry for MRL reads that only the $3.13 price area was statistically significant with a coefficient of 1.59.[12]

Several remarks need to be made about these results. First, as expected most of the swings in these stocks are *not* related to any of the price levels listed in Table 4. Second, for SNX and SME, no price levels are statistically significant. This means that there is no association between specific price levels and the probability of a swing high or low. However, for 18 of the 20 stocks, there is at least 1 price level which is statistically significant. This means that there is solid evidence that for Australian stocks, there do exist specific price levels that are associated with swing highs and lows, and this does not appear to be due to chance.

Third, the results relate to the probability of a high or a low been associated with a certain price level. If a price level is associated equally with both highs and lows, then it will not appear as statistically significant in the probit regression results.

Fourth, there is no clear pattern in the results. That is, no price level seems to be consistently associated with highs or lows, and many are equally spread between highs and lows. The most common price level is $4.00, although this is statistically significant in only 6 of the 17 stocks which have traded into this price area. In addition, three recurring price clusters are the $12 and $12.50 band, the $10 and $11 band, and the $6 and $6.25 band.

It was established earlier that closing prices of Australian stocks are non-uniformly distributed. It was noted also that this non-uniformity is consistent with a random walk process. Do the probit regression results violate the assumption of a random walk? Since closing prices

[11] The full set of results is available from the author. The focus in this paper is the statistical significance of a price level. Hence the marginal effects for the probit estimates are not presented.

[12] 19 percent of the highs in MRL came in the $3.13 area, with a median price retracement from the $3.13 area, of 15 percent.

are non-uniformly distributed across the number spectrum, then it is also possible that prices associated with swing highs and lows are consistent with a random walk.

TABLE 4 HERE

3.3 The Incidence of Psychological Barriers in Australian Stock Prices

In this section, we consider whether the psychological barriers or price clusters (depending on the interpretation) offer profitable opportunities. For the purposes of this investigation, a psychological barrier/price cluster is said to contain prices if prices come within 5 percent of a price level (either below or above) and then move away from it. This allows stock prices to bubble temporarily above or *below* a price level. Thus, if a stock price rallies to say $10.50 and then collapses to below $10, the conclusion is that the $10 psychological barrier has contained the rally. There is also a time component to this. A stock that hovers around the $10 mark is said to be in a congestion or consolidation zone. These formations will not be classified as psychological barriers. What we are looking for is relatively rapid responses to the barriers/price clusters. Hence, we allow the stock to trade above or around the $10 mark for up to four days only before it retraces. In fact most of the examples of price resistance at the psychological levels happen within a couple of days of hitting or coming close to the barrier.

The results are presented in Table 5, which offers two important pieces of information. First, column 2 lists the proportion of the sample of stocks that have traded into a psychological barrier *and* then retraced below it when they hit the psychological barrier. Second, the average percentage retracement in a stock price from the psychological barrier is listed in column 4.[13] The results are for upside resistance only, that is for those cases where a stock has rallied and is now experiencing a wall of resistance that prevents any further increases in price. Since some stocks have tested these price levels on several occasions, the number of occurrences will exceed the number of stocks. Where a stock finds resistance at a level and retraces from this on more than one occasion, we take an average of all the price retracements to calculate the percentage price retracement. The number of retracements is presented in the third column. For example, 89% of the stocks that have traded into the $6.25 price area retraced from it. In total, there were 46 such instances. The mean retracement from the $6.25 barrier was –16 percent, while the

median retracement was –12 percent. Not all stocks have traded into the $12.50 area. However, of those stocks that have done so, 80% have experienced a price retracement, with an average price fall of 12%.

TABLE 5 HERE

The figures presented in Table 5 are very revealing. At least 60% of the stocks that have traded into the lower ($2.50 and $3.13) price levels and at least 80% of those that have traded into the higher price levels, have experienced a price reaction. Importantly the reactions are of economic significance, with at least a 10 percentage point price retracement. As expected, the $5 and $10 price levels are the most common ones, and are associated with the largest price retracements. The conclusion that can be drawn from Table 5 is that psychological barriers appear to be a real phenomenon in the Australian stock market. Further, Table 5 implies that there is some degree of predictability associated with these price levels.

4. Implications for trading and investing

Whether the opportunities represented by the psychological levels are realized by traders and investors depends on a number of factors such as traders' risk profile, money management, entry and exit strategies, and the use of stop losses.

There are at least five ways in which the psychological barriers/price clusters can be traded. The first approach is to short sell at a price cluster. This is not a very viable option in the Australian market as the market for put warrants and options is very illiquid and underdeveloped in Australia. Furthermore, short selling, possible but not a widespread practice, is associated with higher transaction costs and is available only through a limited number of brokers and for only a fraction of stocks.[14] Indeed, it may be that the lack of short selling opportunities is one reason for the existence of price clusters. The second approach is for long term investors to sell their long positions once these levels are hit, with the anticipation of repurchasing the stock at a lower price. However, this strategy does not appear to be fruitful either. Long-term investors typically carry a large tax burden and in Australia are discouraged generally by the popular finance media and financial advisors from liquidating positions. For most Australian investors, the aim is to carry long term positions until retirement when lower tax rates apply. Given that the median

[13] Lower price psychological barriers are not reported as most of the stocks have never traded into the lower price barriers. Only those barriers where most of the stocks have tested are included in Table 5.

[14] Short selling in Australia is not available through internet brokers.

price percentage retracement is not very large, a tax penalty together with transaction costs and the uncertainty of closing a long term winning position, would suggest that this would not be a desirable strategy.

The third strategy would be for buy and hold positions to be maintained, but put warrants purchased to cover these positions. A put warrant on an Australian stock is only likely to gain in value if a substantial fall in the stock price occurs. This however means that investors would trade warrants and options, but not the physical stock. This strategy is also likely to attract little appeal as most investors try to avoid making trading decisions on stocks, let alone on the more volatile and underdeveloped Australian derivatives market.

The fourth strategy is for traders to exit their positions at the price clusters. That is, once they have entered a trade on the basis of some other indicator, they can use the price cluster as an exit point. For example, if a moving average trading system is used to initiate trades, traders can exit at the price cluster and maybe get a better exit than relying on a lagging indicator which would get them out at a lower price and hence lower rate of return.

The fifth strategy would be for traders to use the price cluster as a filter, which can be used as part of a bundle of trading techniques. For example, they can avoid taking positions near a price level that is expected to contain a price rally.

The final strategy would assist buy and hold positions. Investors are entering buy and hold positions throughout a stock's trading history, as new cohorts enter the stock in their portfolio or additions are made to an existing portfolio. For example, the strategy would mean that buy and hold investors would not add positions/make new commitments until after a retracement of around 10 percent from a psychological barrier had occurred. This would mean that they maybe able to enter at a better price.

The last three strategies appear to be more attractive in the Australian sharemarket.

5. Summary

The price of a stock is obviously important to traders and investors. In this paper it was shown that Australian stock prices are not uniformly distributed. This means that certain prices are over-represented in Australian stock price series. This is consistent with the findings of other researchers. Exploration of price swings in Australian stocks shows that certain price levels appear important to most Australian stocks. The interpretation of these phenomena differ, with most traders viewing these price levels as psychological barriers, while a number of academics

consider them as price clusters and an over-representation of prices that is consistent with a random number series.

It was shown also that there are profitable opportunities associated with some of these price levels and that there is some degree of predictability associated with them. However, the occasions to exploit these opportunities are limited because of the underdeveloped nature of short selling in the Australian market.

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Appendix A: Basic Data on Stocks included in the study

Stock	Industry	Historical Low	Historical High	Number of Observations	Number of Swings
AMP	Insurance	13.58	45.00	806	70
ANZ	Banking	2.49	17.47	3733	319
BEN	Banking	2.3994	7.02	2165	118
CPU	Investment & Financial Services	0.1375	9.90	1832	135
DAD	Investment & Financial Services	2.743	7.80	733	109
ECP	Internet Investments	0.26	8.60	556	152
ETR	Investment & Financial Services	0.41	11.3413	686	189
HAH	Building Materials	1.90	6.30	3751	375
KYC	Miscellaneous	0.47	17.45	2946	248
MRL	Retail	0.54	6.84	821	113
NAB	Banking	3.30	35.13	3733	263
RIO	Diversified Resources	3.91	38.97	3733	309
SGB	Banking	4.715	16.30	2316	151
SME	Banking	4.966	15.45	1086	56
SNX	Miscellaneous	0.01	19.90	1067	79
TAH	Gaming	1.986	13.45	1778	159
TLS	Telecommunications	3.835	9.20	953	82
TOL	Transportation	1.19	25.49	1987	163
WBC	Banking	2.40	14.55	2946	213
WMC	Mining	2.35	10.22	3734	321

Figure 1: Number Preference in Western Mining, Monthly Prices

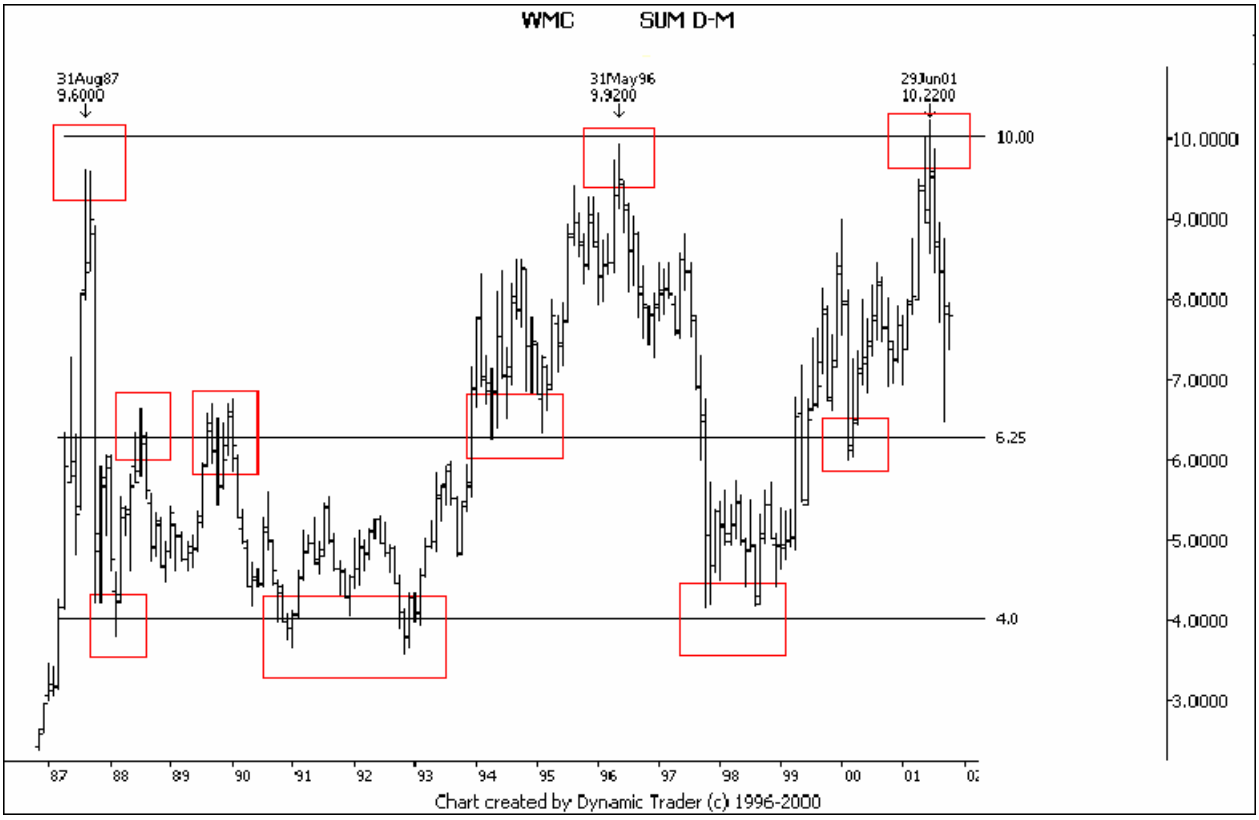

Figure 2: Number Preference in Light Crude Monthly Cash prices

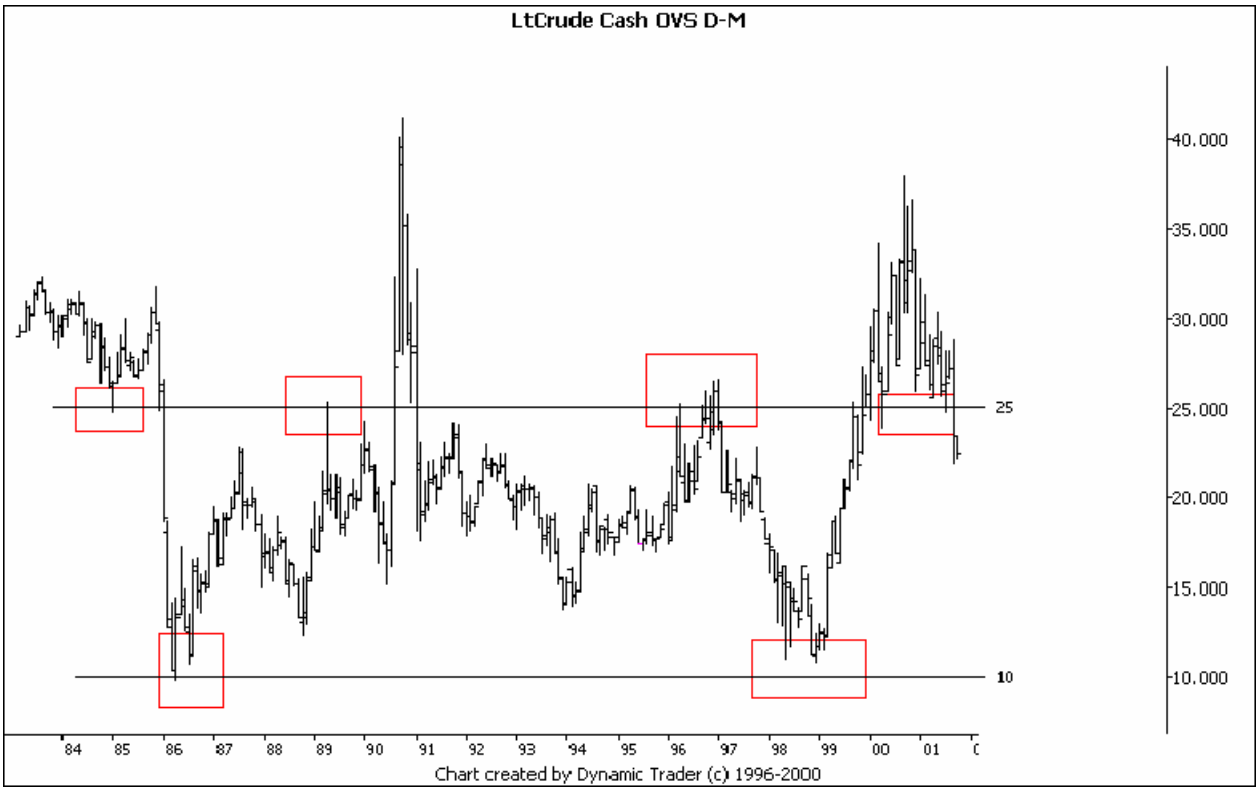

Figure 3: Number Preference in the Nasdaq, Weekly Prices

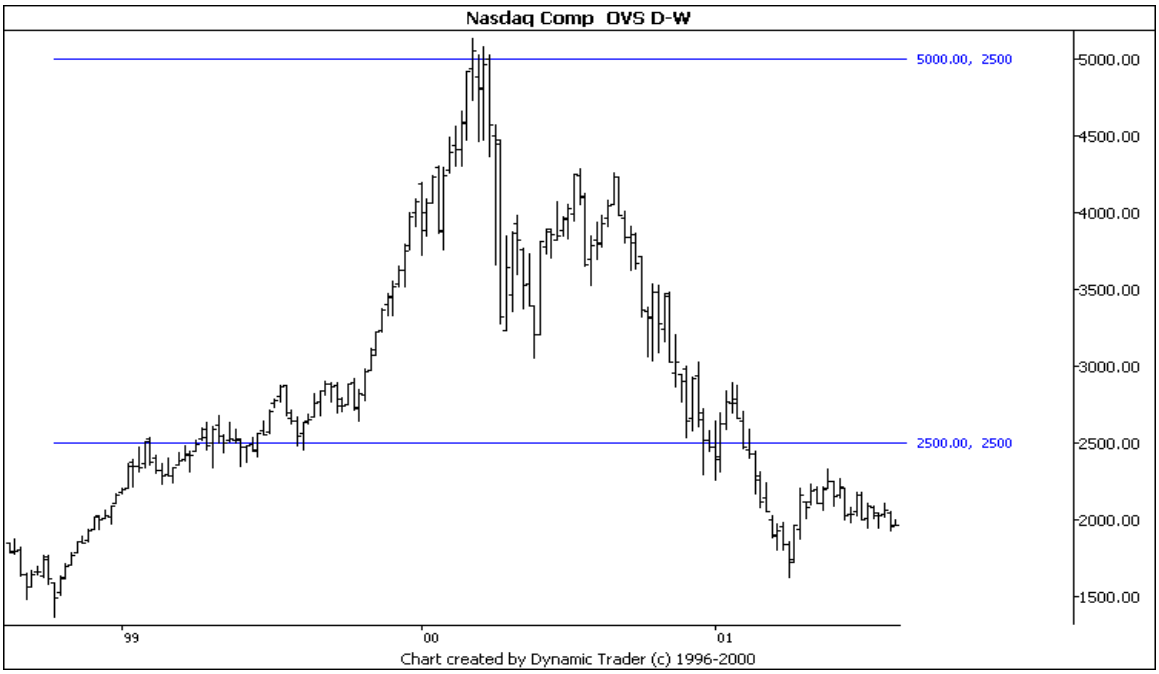

Figure 4a: Daily Stock Price Movements in Rio Tinto

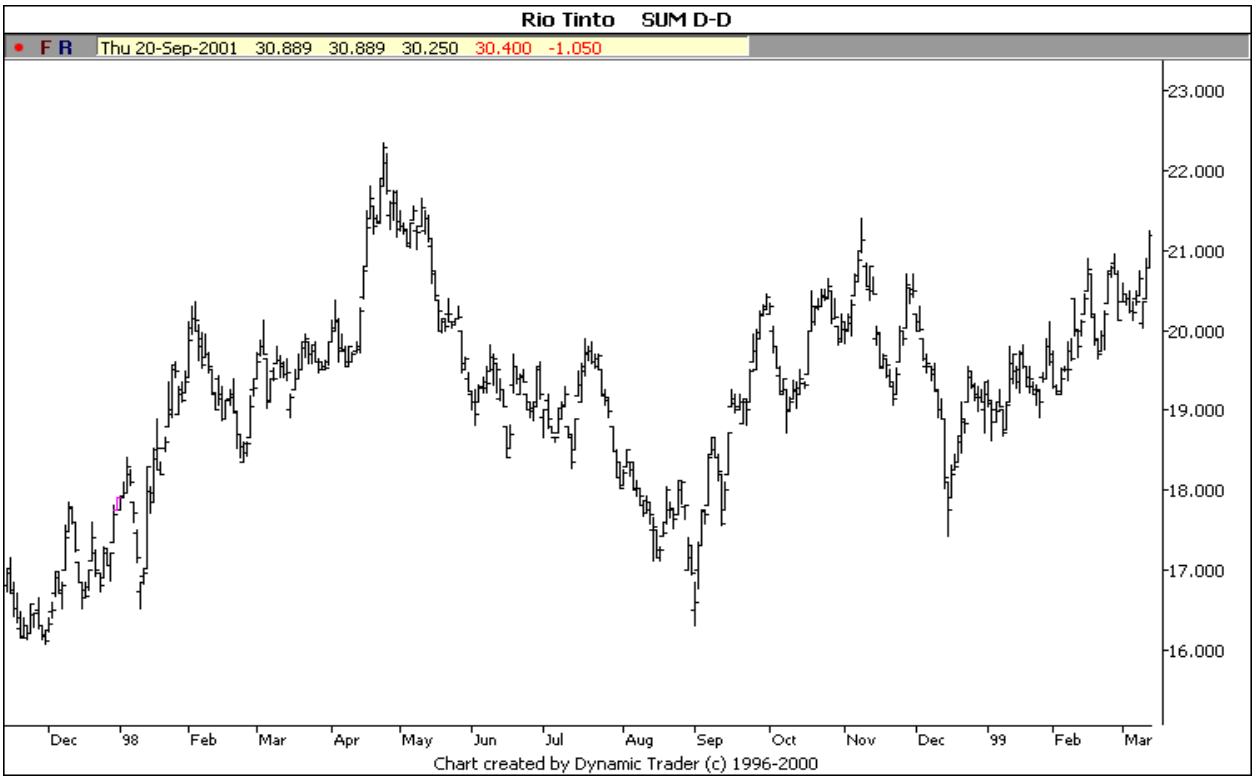

Figure 4b: Five Percent Swing Chart of Daily Stock Price Movements in Rio Tinto

Table 1: Tests of Over-Representation of Stock Prices, Australian Stocks

Stock	Chi-Square Goodness of fit test	Constant	D1	D2	D3
AMP	371***	0.50 (12.53)***	-0.06 (-0.38)	-0.27 (-2.43)**	-0.23 (-2.44)**
ANZ	254***	0.004 (6.02)***	0.005 (1.82)*	0.001 (0.75)	0.001 (0.91)
BEN	772***	0.61 (69.10)***	-0.07 (-1.79)*	-0.02 (-0.94)	-0.02 (-1.09)
CPU	1603***	0.18 (85.33)***	-0.01 (-1.73)*	-0.01 (-1.41)	-0.01 (-1.72)*
DAD	804***	0.48 (37.56)***	0.10 (2.02)**	0.10 (2.89)**	0.05 (1.66)*
ECP	136***	0.49 (31.74)***	0.04 (0.72)	0.05 (1.14)	0.06 (1.58)
ETR	329***	0.41 (33.12)***	0.09 (1.93)*	0.11 (2.91)**	0.11 (3.77)***
HAH	1169***	0.47 (92.56)***	-0.007 (-0.34)	-0.007 (-0.49)	-0.002 (-0.20)
KYC	3135***	0.49 (83.67)***	0.03 (1.31)	0.03 (1.88)*	0.02 (1.72)*
MRL	392***	0.58 (47.88)***	-0.20 (-4.47)***	-0.20 (-6.07)***	-0.19 (-7.00)***
NAB	530***	0.49 (86.82)***	0.03 (1.58)	-0.000 (-0.00)	-0.02 (-1.91)*
RIO	758***	0.49 (85.13)***	0.00 (0.10)	0.00 (0.23)	0.00 (0.26)
SGB	152***	0.46 (64.83)***	0.01 (0.39)	0.01 (0.65)	0.01 (0.76)
SME	352***	0.46 (39.19)***	-0.01 (-0.12)	0.00 (0.09)	0.00 (0.05)
SNX	1299***	0.41 (46.95)***	-0.02 (-0.45)	-0.009 (-0.38)	–0.03 (-1.38)
TAH	260***	0.50 (62.68)***	0.000 (0.02)	0.005 (0.24)	0.007 (0.39)
TLS	143***	0.56 (50.95)***	-0.13 (-3.05)***	-0.16 (-5.23)***	-0.16 (-6.16)***
TOL	960***	0.51 (70.67)***	-0.02 (-0.65)	-0.02 (-1.04)	0.00 (0.13)
WBC	244***	0.48 (72.49)***	0.01 (0.58)	-0.001 (-0.07)	0.02 (1.40)
WMC	302***	0.48 (82.06)***	-0.01 (-0.60)	-0.01 (-0.68)	-0.01 (-0.68)

*, **, *** Statistically significant at the 10%, 5% and 1% levels, respectively.

Table 2: Distribution of Price Swings in Australian Stocks

Percentage Change in Stock Price Intervals	Percentage of Downswings	Percentage of Upswings
5% < 10%	54.00	41.84
10% < 15%	25.91	23.33
15% < 20%	10.84	13.59
20% < 25%	4.17	8.13
25% < 30%	1.95	5.14
30% < 35%	1.30	2.14
35% < 40%	0.49	1.82
40% plus	1.25	4.01

Table 3: Frequency of Price Levels Associated with Swing Highs and Lows, All Stocks Combined

Price Level	Number of Swings	Scaled Frequency
$1	21	3.5
$1.56	24	3.4
$2	82	9.1
$2.5	154	11.9
$3	113	8.1
$3.13	120	8.6
$4	201	11.82
$5	195	10.3
$6	168	8.8
$6.25	186	9.8
$7	192	10.1
$8	182	9.6
$9	150	7.9
$10	150	7.9
$11	153	8.1
$12	97	5.1
$12.5	82	4.3

Table 4: Stock Price Swings and Number Preference, Australian Stocks, Probit Estimates

Stock	Lower Price Levels	Coefficient (z-statistic)	Medium Price Levels	Coefficient (z-statistic)	Higher Price Levels	Coefficient (z-statistic)
AMP					$20.00 $21.00	-1.21 (-2.22)** 1.92 (3.17)***
ANZ	$3.13	-0.79 (-2.07)**	$12.00	0.84 (2.24)**		
BEN	$4.00 $6.25	0.71 (1.88)* 1.21 (2.02)**				
CPU	$8.00	0.88 (2.29)**				
DAD	$5.00	0.84 (2.02)**				
ECP	$2.50 $4.00	-0.67 (-1.76)* -1.24 (-2.07)**				
ETR	$2.50	0.59 (1.65)*				
HAH	$2.00 $4.00	-1.84 (-4.05)*** 0.43 (1.79)*				
KYC	$7.00	-0.89 (-1.95)*				
MRL	$3.13	1.59 (2.72)***				
NAB	$4.00 $6.00	-1.50 (-2.73)*** -0.69 (-2.33)**	$10.00 $11.00 $12.50	-1.32 (-2.26)** -0.65 (-2.06)** 0.59 (1.74)*	$20.00	-1.33 (-3.16)***
RIO	$7.00 $9.00	0.76 (1.71)* 0.70 (1.94)*	$13.00 $17.00 $18.00 $19.00	1.04 (3.29)*** -0.65 (-1.83)* 1.20 (2.95)*** -1.16 (-2.77)***	$20.00 $22.00 $29.00 $35.00	1.54 (3.97)*** 0.94 (2.27)** 1.30 (3.55)*** 1.55 (2.76)***
SGB	$6.25 $9.00	1.09 (2.62)*** 1.34 (3.52)***	$11.00 $12.00	0.77 (2.64)*** 1.27 (2.27)***		
SME	None					
SNX	None					
TAH	$6.00	1.07 (1.65)*	$12.00	0.79 (1.65)*		

	$6.25 $8.00	-0.81 (-1.67)* -1.12 (-1.94)*				
TLS	$5.00 $6.25	-0.75 (-1.67)* -0.71 (-1.94)*				
TOL	$5.00	-1.24 (-2.15)***	$10.00	-1.06 (-1.72)*		
WBC	$4.00 $5.00 $7.00	-0.55 (-1.70)* 0.55 (1.94)* -0.99 (-1.66)*	$11.00	1.33 (3.32)***		
WMC	$4.00 $9.00	-1.34 (-2.50)** 0.55 (1.96)*				

Table 5: Incidence of Psychological Resistance Barriers and Price Retracements, Australian Stocks

Psychological Price Level	% of Stocks Falling	Number of Retracements	% Price Retracement*
$ 2.50	60%	25	16% [11%]
$ 3.13	64%	26	14% [11%]
$ 5.00	94%	42	22% [17%]
$ 6.25	89%	46	16% [12%]
$10.00	92%	23	20% [16%]
$12.50	80%	13	11% [12%]

* figures in square brackets are the median price retracement