UNIVERSITY OF SOUTHAMPTON

FACULTY OF LAW, ARTS AND SOCIAL SCIENCES

School of Management

ANCHORING EFFECTS: EVIDENCE FROM A SPECULATIVE FINANCIAL MARKET

by

Shuang LIU

Thesis for the degree of Doctor of Philosophy

September 2008

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

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This thesis explores the use of the anchoring and adjustment heuristic by decision makers in a speculative financial market. In particular, this thesis aims to investigate the extent to which bettors in the HK and UK horserace betting markets anchor their subjective judgements of horses' winning probabilities on publicly available information.

To achieve this, four hypotheses are developed to test the existence of anchoring effects, the strength of the anchors, the impact of bettors' expertise on their probability judgements, and differences in market behaviour between the HK and UK markets.

This is the first study which explores anchoring effects in a real world environment using a large amount of quantitative data and the results offer a new and surprising perspective on anchoring effects. In particular, the empirical results suggest that overall, no significant anchoring effects exist in the HK and UK horserace betting markets on the information associated with horses', jockeys' and trainers' past performance, horses' post-positions, or the performance of previous favourites. This finding challenges results of previous studies which suggest that anchoring is a wide-spread decision bias. This contrast may be explained by the characteristics of the naturalistic environment, by the features of the judgemental procedure in horserace betting, and by the market data employed in this study. In addition, the existence of some anchoring effects on particular information, namely, on horses' post-positions in the HK market and on the performance of previous favourites, may be due to the characteristics of each market.

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DECLARATION OF AUTHORSHIP

I, Shuang LIU, declare that the thesis entitled

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and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- Part of this work has been published as: Liu, S. and Johnson, J.E.J. (2007), "Searching for Anchoring Effects in a Naturalistic Environment: Evidence from the Hong Kong Horserace Betting Market", *The Journal of Gambling Business and Economics*, 1, pp. 69-84.
- Part of this work has been submitted for publication as: Schnytzer, A., Liu, S. and Johnson, J.E.J. (2008), "To What Extent Do Investors in a Financial Market Anchor Their Judgements? Evidence from the Hong Kong Horserace Betting Market", Working Paper, University of Southampton, Submitted for Publication.

Signed: ……………………………………………………………………

Date: ………………………………………………………………………

ACKNOWLEDGEMENTS

I would like to dedicate this thesis to my parents, Mr. Yaxue Liu and Mrs. Xiaojing Li, for their great love and life-long support.

I would like to give my deepest gratitude to my dedicated supervisor, Professor Johnnie Johnson, for his valuable ideas and suggestions for this thesis with his profound knowledge in judgement and decision making and horserace betting areas. His patience and kindness are greatly appreciated. His positive attitude towards life always inspires me and this will be the key thing I learn from him.

I would also like to give my grateful thanks to Mr. William Benter for his generosity in providing invaluable research data for this study. His invaluable suggestions on my PhD study are indispensable to the completion of this thesis. His kindness, patience, and great support are always appreciated. Dr. Frank McGroarty's great help in generating the UK market data is also sincerely appreciated.

Grateful thanks also go to my friends, who never failed to give me great carefulness and encouragement. Special thanks to Mr. Shih-wei Wu, Miss. Sha Zhang, Mrs. Xiang Song, and Miss. Beauty Zindi for their invaluable friendship. Thanks to Mr. Liang Liu for his patience and support during my PhD study.

This thesis could not be finished without the help and support from all these people.

CHAPTER 1
INTRODUCTION

1.1 Introduction

The rationality of human behaviour and the quality of human judgement have been explored by researchers within disciplines such as economics, management, and psychology. Traditional economic theories assume that individuals are able to gather all the information they need without time and cost constraints and that they have sufficient intellectual capacity to solve complicated decision tasks (von Neuman and Morgenstern, 1944; Savage, 1954). However, in the real world, individuals are not fully rational. Under time and/or cost pressure and within the constraints of their limited knowledge and cognitive capacity, people employ simple 'heuristics' to undertake complex decision tasks (Simon, 1955, 1956; Tversky and Kahneman, 1973, 1974). These rules of thumb are useful in making rapid decisions but may also result in systematic biases (Kahneman, Slovic and Tversky, 1982; Kahneman and Tversky, 1972; Tversky and Kahneman, 1974).

One of the commonly used and investigated heuristics is the *anchoring and adjustment heuristic*. Laboratory research suggests that people make absolute estimates (the target value) by starting from an initial value (the anchor value) and make adjustments upwards or downwards from the anchor. However, these adjustments are often insufficient (Tversky and Kahneman, 1974). Two types of anchoring effects have been identified. One is traditional anchoring effect which involves a two-step judgement procedure: individuals first compare the target value with an anchor value and then make an absolute estimate of the target to achieve their final answers (e.g., Cervone and Peake, 1986; Joyce and Biddle, 1981; Mussweiler and Strack, 1999b; Quattrone, Lawrence, Warren, Souza-Silva, Finkel and Andrus, 1981; Russo and Schoemaker, 1989; Tversky and Kahneman, 1974). The other is basic anchoring effect which arises even when individuals are not required to make direct comparisons between anchor values and target values (Brewer and Chapman, 2002; Wilson, Houston, Etling and Brekke, 1996).

The majority of the literature focuses on traditional anchoring effects. The effects have been demonstrated in a variety of judgemental contexts, such as general knowledge questions (e.g., Mussweiler, 2001; Strack and Mussweiler, 1997; Tversky and Kahneman, 1974; Wong and Kwong, 2000), estimates of self-efficacy (Cervone and Peake, 1986), probability estimates and gambles (e.g., Carlson, 1990; Chapman and Johnson, 1994; Davies, 1997; Englich, Mussweiler and Strack, 2006), negotiations (e.g., Chertkoff and Conley, 1967; Galinsky and Mussweiler, 2001; Kristensen and Garling, 2000; Ritov, 1996), judicial judgements (Chapman and Bornstein, 1996; Englich and Mussweiler, 2001; Farina, Arce and Novo, 2003), real estate judgements (Northcraft and Neale, 1987), and auditing judgements (Joyce and Biddle, 1981). In addition, a number of factors have been demonstrated to influence the degree of anchoring, including the sources of anchors (self-generated or externally provided) (e.g., Cervon and Peake, 1986; Davies, 1997; Hinsz, Kalnbach and Lorentz, 1997; Mussweiler and Neumann, 2000; Strack and Mussweiler, 1997), the relevance of anchors to targets (e.g., Cervone and Peake, 1986; Chapman and Johnson, 1994; Mussweiler and Strack, 1999b; Mussweiler and Strack, 2000b; Strack and Mussweiler, 1997), and the level of knowledge or experience of decision makers (e.g., Bhattacharjee and Moreno, 2002; Diaz, III, 1997; Joyce and Biddle, 1981; Mussweiler and Strack, 2000b; Northcraft and Neale, 1987; Tversky and Kahneman, 1974). Moreover, anchoring effects have been demonstrated to be durable, even when absolute estimates are made one week after the appearance of anchors (Mussweiler, 2001).

Whilst the existence and durability of anchoring effects have been widely demonstrated in a large number of laboratory-based and field-based studies, little investigation has been conducted in real world decision-making environments. It has been argued that although experiments enable researchers to investigate the influence of each discrete factor under manufactured and highly controlled conditions (Collis and Hussey, 2003; Robin, 1993), they cannot completely reflect or simulate real world environments and may omit vital elements of real world settings (Bruce and Johnson, 1997; Liu and Johnson, 2007). For example, experiments are often associated with low-risk tasks in stress free settings whilst real world decisions are generally made in stressful environments with high-stake tasks (Anderson and Brown, 1984; Yates, 1992).

In addition, participants used in laboratory experiments are often students who lack the experience of solving the constructed tasks, whereas decision makers in the real world often face similar tasks many times and thus have more experience or knowledge in solving the problems. Moreover, the students in laboratory experiment are aware of their involvement in an experiment. Therefore, different behaviours may be expected between laboratory subjects and real world decision markers (Bruce and Johnson, 1997).

To fill the gap between laboratory and real world studies on anchoring, this study focuses on a real world environment in which judgements are made where participants are not watched or manipulated by researchers. The data generated from such real world environments are even distinguished from those made under the real world field experiments. The former is considered 'real' (i.e., individuals make judgements without being aware that their judgements will be studied), and sometimes instant if a quick response is required, and dynamic if a fast feedback-loop is involved in the judgemental procedure. Having identified a clear gap in the existing literature, this study explores the degree to which that decision makers in a real world setting, the horserace betting market, employ the anchoring and adjustment heuristic when making betting judgements. In particular, the study examines the extent to which bettors in the Hong Kong and the UK horserace betting markets anchor their subjective probability judgements on certain publicly available information concerning horses' winning probabilities.

The reminder of this chapter outlines, respectively, the research objectives, research scope, research questions and hypotheses, and research methodology of this study. Finally, the structure of the thesis is outlined and justified.

1.2 Research Objectives

The research objectives to be achieved in the current study are as follows:

1. To provide a broad and extensive review of the existing literature on anchoring effects, including an analysis of papers exploring the definition, underlying mechanisms, causes and influential factors of this judgement bias, based on both laboratory and real world anchoring studies.

2. To explore anchoring effects in a new dynamic real world environment, the horserace betting market, using econometric techniques to analyse large datasets, in order to see if there are differences in the degree and strength of anchoring displayed between this environment and those discussed in laboratory-based studies.

3. To investigate the existence of anchoring effects and the strength of anchors in the horserace betting market.

4. To examine the influence of bettors' expertise on their degree of anchoring on specific pieces of information.

5. To understand the similarities and differences between the anchoring displayed by bettors in the HK and UK horserace betting markets.

1.3 Research Scope

Most previous studies investigate anchoring effects using experiments conducted in psychological laboratories (laboratory-based studies) or real world environments (field studies). However, this study explores anchoring effects in a dynamic real world environment, the horserace betting market, using real and instant decision making data, which is distinct from any existing literature. This study seeks to contribute to the existing literature from the following perspectives:

1. This study provides an extensive review of existing literature on anchoring effects, including the analysis of the definition of anchoring, classification of anchoring, and underlying mechanisms of anchoring. In addition, the study reviews all the factors investigated in previous studies, which are considered to cause and influence anchoring effects, from both the external (related to the decision tasks) and internal (related to decision makers) perspectives. The review provides a broad and extensive understanding of existing anchoring studies and provides a useful approach to categorising previous studies.

2. This is the first study to explore anchoring effects in a real world environment using real, instant and dynamic decision making data. In particular, the real world environment employed in this study, the horserace betting market, provides an ideal environment in which a large number of judgements and decisions are made based on a large amount of public information; this is quite distinct from the environment

constructed in laboratories. In addition, this is the first time that horserace betting market data is used to explore real world anchoring effects.

3. The data employed in this study to detect anchoring effects is much larger than that employed in any previous laboratory or field studies. An entire record of all the races run on the two racetracks (Sha Tin and Happy Valley racetracks) in HK from 1998 to 2007 (in the pari-mutuel system) is used in this study. Similarly, records from the bookmaker betting system for all races run on 38 racetracks from 1996 to 2007 in the UK horserace betting market are employed. There are in total 66,244 horses (5,133 flat races) in the HK database and 554,830 horses (49,881 flat races) in the UK database.

4. This study demonstrates that anchoring effects in the real world are more difficult to detect than those demonstrated in laboratory and field experiments. In particular, no significant anchoring effects are found on information such as horses', jockeys' or trainers' past performances in both the HK and UK markets, even when the anchor is relevant and prominent (e.g., an outcome has been repeated three times). In addition, the research finds that expert bettors do incorporate public information more appropriately than casual bettors. However, none of the casual and expert bettors are found to anchor their subjective probability judgements of horses winning on the information tested in this study. Therefore, anchoring in the real world is either weaker or more complex than has been thought by previous researchers.

5. This study demonstrates that a mis-specification of a problem can be easily caused by combining or splitting data inappropriately. For example, bettors in the HK market are found to anchor their subjective judgements on horses' post-positions in a race at the ST racetrack. However, this cannot be detected in tests using the market data as a whole (i.e., it can only be observed when the data are split according to certain criteria). Therefore, the way information is presented and categorised should be carefully considered in future research which studies anchoring.

6. The cross-market tests to be conducted in this study aim to explore market differences in the use of anchoring. The cultural difference may be one of the reasons which cause these differences. Although the impact of the culture on people's decisions is difficult to measure, it is assumed to be observed by comparing the results of similar tests in different markets (the horserace betting markets in HK and UK in this study).

1.4 Research Questions and Hypotheses

Three broad research questions are derived from the literature in relation to the anchoring effect in real world environments. To answer these questions, four specific hypotheses associated with a dynamic real world environment, the horserace betting market, are developed, as follows.

Research question one investigates whether the anchoring effects caused by relevant or less relevant information exist in real world environments and how strong the anchors need to be to lead to anchoring effects. Two specific hypotheses are developed to answer this question.

1. The *anchoring factor* hypothesis: Bettors in the horserace betting markets anchor their judgements of a horse's winning probability on information associated with (i) the past performance of the horse, (ii) the past performance of the horse's jockey or trainer, (iii) the post-position of the horse, and (iv) the performance of the favourite in the previous race(s).

2. The *anchoring strength* hypothesis: Anchoring effects in the horserace betting market are fragile and they only occur if the anchor is based on consistent results in the previous (i) two races, or (b) three races (i.e., the anchors based on more than one previous race).

Research question two is concerned with whether the degree of anchoring is affected by the degree of expertise of decision makers in real world environments. To examine this research question, a hypothesis concerning the utilisation of bettors' expertise in betting judgements is described as follows.

3. The *expertise* hypothesis: Bettors with greater expertise are subject to a lower level of anchoring than those with less expertise.

Finally, the third research question explores to what extent the degree of anchoring is affected by the cultural environment in which decisions are made. The hypothesis associated with this research question is as follows.

4. The *market* hypothesis: The degree of anchoring effects varies between the HK and the UK horserace betting markets.

Justification for each of these hypotheses will be provided in the research design and methodology chapter, Chapter 3.

1.5 Research Methodology

A positivism paradigm is adopted in this study. Under this paradigm, a deductive approach, a positivistic strategy, and a quantitative research method are considered appropriate to empirically explore the research questions. A full discussion of the research design and methodology, including the research paradigm, approach, strategy and methods, is provided in Chapter 3. The research questions and hypotheses are also discussed in that chapter, as well as the data employed and the variables developed.

1.6 Structure of the Thesis

This study is structured in five chapters (see Figure 1.6-1).

The first chapter provides a brief introduction on the motivation, objectives, scope, and methodology of the study. Since the majority of existing studies have been associated with laboratory or field experiments, this study aims to explore anchoring effects in a real world environment, the horserace betting market. A structure of the thesis is finally provided together with an outline of the contents of each chapter.

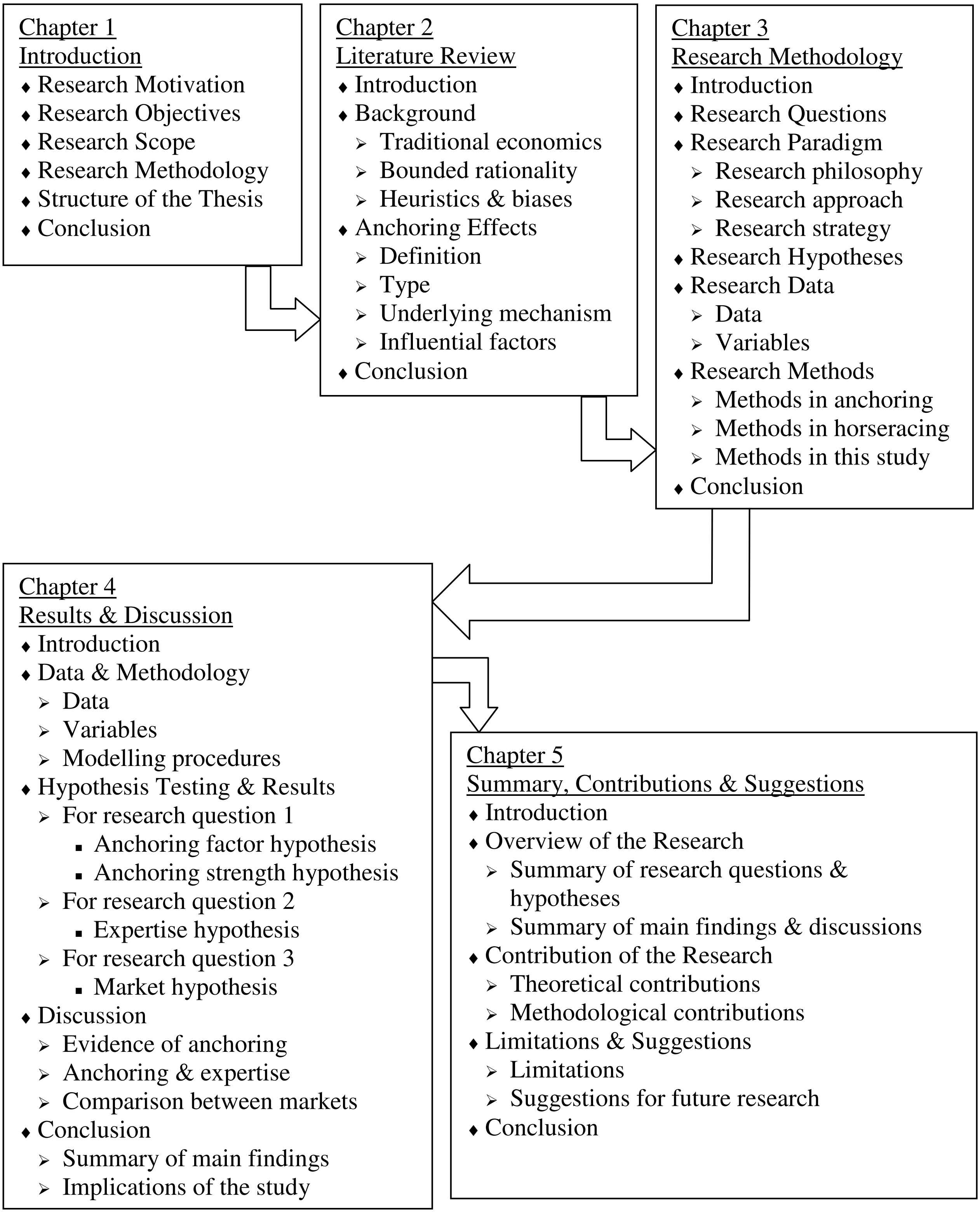
Chapter 2 provides an extensive review of the anchoring literature, based on laboratory and field studies. Two types of anchoring effects are defined: traditional anchoring effects involve a comparison between the target and anchor values before absolute estimates are made, whereas basic anchoring does not require such comparison. Four alternative underlying mechanisms have been developed to explain why anchoring occurs. The demonstration of anchoring effects has been concerned from different aspects, such as the judgemental contexts of anchoring (e.g., general knowledge, judicial judgements, negotiations), the sources of anchors (self-generated and explicitly provided), the relevance of anchors to targets (relevant and irrelevant), and the expertise of individuals (experts and novices). All these factors can have different impacts on the degree of anchoring effects.

Based on the literature review provided, three research questions concerning anchoring effects in real world environments are derived in Chapter 3. To answer these questions, a positivism research paradigm, a deductive research approach, and a quantitative research method are identified to be appropriate to this study. As a result, four specific hypotheses are developed to explore the degree to which that decision makers in a real world setting, the horserace betting market, employ the anchoring and adjustment heuristic when making betting judgements. In particular, these hypotheses explore the existence of anchoring effects in this market, the impact of anchor strength on bettors' judgements, the impact of expertise on the degree of anchoring, and the difference of anchoring between HK and UK markets. The data and modelling procedures employed in this study are described in detail in this chapter.

The results and analyses of hypothesis tests are provided in Chapter 4. In particular, the extent to which bettors in the HK and UK horserace betting markets anchor their subjective judgements on certain publicly available information concerning horses' winning probabilities (e.g., horses', jockeys' and trainers' past performances, post-positions of horses, and previous favourites' performances) is examined. The impact of the strength of anchors on bettors' judgements is investigated by observing the influence of an anchoring factor when a result is repeated two or three times. The exploration of experts and non-experts in anchoring effects is conducted by analysing the weekday and weekend races and by investigating early and late bets in each race. The results suggest that overall no significant anchoring effects exist in the horserace betting markets. This is clearly inconsistent with previous studies. A number of reasons are raised to explain the discrepancies between the findings of this study and previous literature. The implications of the findings are discussed at the end of the chapter.

A summary of the main findings and discussions is provided in Chapter 5, together with a review of the research questions and hypotheses conducted in this study. A number of theoretical and methodological contributions are addressed in this chapter, followed by the limitations of the study and suggestions for further research.

Figure 1.6-1 Flowchart of the structure of the thesis



1.7 Conclusion

A number of heuristics and behavioural biases have been investigated in previous studies. This study focuses on one of these, the anchoring and adjustment heuristic, and explores to what extent decision makers in a real world environment, the horserace betting market, employ this heuristic and anchor their judgements on the publicly available information. By employing a large amount of real market data from the HK and UK horserace betting markets, this study seeks to fill the gap between experimental and real world studies and provides a new insight of anchoring effects in the real world.

CHAPTER 2
ANCHORING EFFECTS: THE LITERATURE

Of all the ways of defining man, the worst is the one which makes him out to be a rational animal.

Atanole France

(Montier, J., Behavioral Finance: A User's Guide, p.1)

This chapter provides a broad but profound review of the existing literature on judgements, heuristics, and particularly, on anchoring effects. A number of research questions are therefore derived from this extensive review and some hypotheses are consequently developed to explore these questions in the following chapters.

2.1 Introduction

Traditional economic theories assume that individuals are fully rational and are able to maximise expected utilities when they make decisions (von Neuman and Morgenstern, 1944; Savage, 1954). However, observation suggests this is not the case in the real world. For example, people in the real world may not have the time or ability to obtain all the information that they need, and they may not have sufficient knowledge or appropriate skills to solve complicated decision tasks (Camerer, 1998; Gigerenzer and Selten, 2001; Keren, 1996; Shiller, 1999; Simon, 1955, 1956; Tversky and Kahneman, 1974).

To relate economic theories to real world situations, Herbert Simon (1955, 1956) proposed a 'bounded rationality' model to explain how people behave when they have limited information, are under time pressure, and/or do not have appropriate knowledge or skills. Within this model, people *do* make rational decisions, but only within their limited knowledge and computational capacities. In particular, they use simple rules of thumb, ‘heuristics’, to reduce the complexity of decision tasks and make rapid but rational decisions. A simple example is that if someone is asked to estimate how far an item is from him/her, a quick way of getting a reasonable answer is to assess how large the item is: the smaller it looks, the further the distance.

However, although heuristics are useful in making rational and rapid decisions, they may also lead to systematic biases (e.g., Cervon and Peake, 1986; Goodwin and Wright, 2004; Kahneman *et al.*, 1982; Kahneman and Tversky, 1972; Keren and Teigen, 2004; Tversky and Kahneman, 1974). One of the most common heuristics (*anchoring and adjustment*), has received considerable attention in the literature. In particular, individuals who use this heuristic to make estimates start from an initial value (the anchor) and adjust this upwards or downwards to obtain the target value of the decision task. Previous studies suggest that these adjustments are often crude and insufficient (e.g., Kahneman *et al.*, 1982; Mussweiler and Strack, 1999b; Northcraft and Neale, 1987; Tversky and Kahneman, 1974).

Two types of anchoring effects have been identified: traditional and basic anchoring. Generally, *traditional* anchoring effects involve two judgement steps: individuals first compare the target value with an anchor value and then make an absolute evaluation of the target to arrive at their final judgement (e.g., Cervone and Peake, 1986; Joyce and Biddle, 1981; Mussweiler and Strack, 1999b; Quattrone *et al.*, 1981; Russo and Schoemaker, 1989; Tversky and Kahneman, 1974). Whereas a second form of anchoring, *basic* anchoring, arises when individuals’ final judgements are influenced by anchor values even though they are not required to make direct comparisons between initial values and final judgements (Brewer and Chapman, 2002; Mussweiler and Englich, 2005; Wilson *et al.*, 1996). Experimental results suggest that due to the lack of a comparison process between anchors and targets, basic anchoring effects are fragile and can easily disappear (Wilson *et al*., 1996).

The majority of the literature focuses on traditional anchoring effects, which provides a profound basis for the basic anchoring study. In these studies, a number of factors have been demonstrated to affect the degree of anchoring: for example, the sources of anchors (self-generated or externally provided), the relevance of anchors to targets, and the level of knowledge or experience of decision makers. Individuals anchor their judgements more on self-generated rather than externally provided anchors because they are more likely to confirm internally generated knowledge (self-generated anchors) and view it as relevant to the targets (e.g., Cervon and Peake, 1986; Davies, 1997; Hinsz *et al.*, 1997; Mussweiler and Neumann, 2000; Northcraft and Neale, 1987; Strack and Mussweiler, 1997). A number of studies suggest that anchoring effects occur even when the anchor value is unreasonable, implausibly extreme, or completely irrelevant to the target value (e.g., Cervone and Peake, 1986; Chapman and Johnson, 1994; Mussweiler and Strack, 1999b; Mussweiler and Strack, 2000b; Strack and Mussweiler, 1997). It is also suggested that even those with relevant experience, knowledge or expertise are subject to anchoring effects (e.g., Diaz, III, 1997; Joyce and Biddle, 1981; Mussweiler and Strack, 2000b; Northcraft and Neale, 1987; Tversky and Kahneman, 1974) but to a less extent than those without these advantages (Bhattacharjee and Moreno, 2002; Mussweiler and Strack, 2000b).

It is noted that most studies exploring anchoring effects are undertaken in laboratories and only a few are developed with tasks in naturalistic environments. These studies often analyse the judgements of individuals under artificial conditions where they are aware that they are being monitored (which may result in modified behaviour). The main findings of these experimental studies are reported in this chapter. A more criticised justification about differences between laboratory and naturalistic studies will be discussed in full detail in Chapter 3 when identifying appropriate research methodology for this study. According to those differences, an analysis of anchoring effects in a naturalistic environment in which individuals do not know that their decisions are being investigated is required to fill the gap between laboratory and real world studies.

Consequently, this chapter is organised as follows. Section 2.2 starts with the background of rationality assumptions, summarises the development of rationality theories and provides a general review of heuristics and biases explored in judgement and decision making. Studies investigating the anchoring-and-adjustment heuristic and the anchoring effects are reviewed in Section 2.3 in full detail. In particular, two different types of anchoring (the ‘contrast’ and ‘assimilation’ anchoring) are introduced in Section 2.3.1. What this study explores are two judgement biases caused by the assimilation anchoring – ‘traditional’ and ‘basic’ anchoring effects. The definitions of these two effects are provided in Section 2.3.2, the underlying mechanisms of these effects are discussed in Section 2.3.3, and the explorations of objective and subjective factors which may affect the degree of anchoring effects are presented in Section 2.3.4. Finally, a summary of the exploration and some conclusions are provided in Section 2.4.

2.2 Background

Expected utility theory has dominated economic theory since the 1940s. In the following few decades, economic researchers devoted countless effort to the technical details and measurements of expected utility and how to apply the theory to different areas such as risk-sharing and asset pricing (Camerer, 1998). Even so, it has been shown that individuals do not perform strictly according to the basic requirements of rationality, at least in certain circumstances (Shiller, 1999). Consequently, a number of alternative theories are developed to explain the phenomena or effects which do not follow the principles of expected utility theory. The development of economic theories and human behaviour research is briefly reviewed in this section as an introduction to the heuristic and bias literature.

2.2.1 Traditional Economic Theory

The rationality of human behaviour and the quality of human judgement have been explored by researchers in economics, psychology, and other fields such as animal biology and artificial intelligence. Traditional economic theories assume that individuals are both 'economic' and 'rational'. In particular, a *rational agent* or what has been termed an 'economic man' is supposed to have "knowledge of the relevant aspects of his environment" (Simon, 1955, p. 99), to have well-organised, stable and coherent preferences, and certain computational skills which enable him to rationally maximise those preferences (Rabin, 1998).

To explain how individuals and organisations *should* behave rationally, a series of theories and models have been developed. Expected utility theory is one of those which has dominated the rationality study in the past couple of decades. The key principle of this theory is that the utility of a risky gamble should be the probability-weighted average of the utilities of its possible outcomes (von Neuman and Morgenstern, 1944; Savage, 1954). As a reasonable and rational person, each individual will calculate the utility of each choice and choose the one which can achieve the highest preference scale (utility). The underlying assumption of this approach is that individuals are able to gather all the information that they need without time and cost constraints and that they have sufficient intellectual capacity and knowledge to maximise their expected utility when solving complicated decision tasks (Camerer, 1998; Gigerenzer and Selten, 2001; Keren, 1996; Shiller, 1999). Consequently, the concept of 'rationality' and the process of calculating probabilities, utilities, and optimal decisions are adopted in many other disciplines such as animal biology and artificial intelligence (Gigerenzer and Selten, 2001).

Although the notion of rationality and the exploration of technical details of expected utility have dominated economic theories since the 1950s, a relaxing but competing notion of 'bounded rationality' emerged at about the same time (Simon, 1955, 1956).

2.2.2 Bounded Rationality Theory

The notion of 'bounded rationality' is a modification of the 'rationality' notion in economics and human behaviour theories. As suggested by Simon (1955, 1956, 1990), the bounded rationality concept is like a pair of scissors with the 'cognitive limitations' of actual humans as one blade and the 'structure of the environment' as the other blade (Gigerenzer and Selten, 2001; p. 4). In particular, bounded rationality theory accepts limited information obtained by individuals due to the time and cost constraints, and limited information processing capacities of individuals due to the shortage of knowledge or computational facilities. In this sense, only 'approximate' rationality might be employed in their decision processes. In addition, the structure of the environment also plays an important role in determining appropriate simplifications to different choices. Gigerenzer and Todd (1999) argue that the success of models of bounded rationality depends on their ability to exploit the information structure in the ecological[1] and social environment[2]. Consequently, by carefully analysing the structures

[1] Ecological environment refers to the natural environment where an event occurs. It should be considered in the decision making process. A decision strategy (or a heuristic) can only be successful when employed in an appropriate environment. If applied in a wrong ecological environment, heuristics will lead to biases or cognitive illusions (Gigerenzer, 2004).

[2] Social environment refers to how fast the environment changes and the need to consider decisions of other people in this environment. For example, the *do-what-the-majority-do* heuristic is likely to be valid

of environments in which the choice mechanisms are processed, individuals with limited time, information, knowledge, and other resources are also able to make 'satisfying' (if not 'optimised') decisions (Simon, 1956). To illustrate the areas where simple heuristic models are and are not effective, Hogarth and Karelaia (2005) identified 'regions of rationality' by comparing the performances of different models on factors characterising environments. They found the terrain mapped by their tests is complex and no single model is 'best'.

Models of unbounded rationality tell people what they *should* do (a normative perspective), whereas models of bounded rationality try to describe what people *actually* do (a descriptive perspective) and explain how they behave when holding limited information and are under time pressure (Camerer, 1998; Gigerenzer and Todd, 1999; Rabin, 1998). Some researchers refer to bounded rationality as 'optimization under constraints' (Sargent 1993; Stigler, 1961). The key characteristic of bounded rationality is limited search. The idea of optimization under constraints develops optimization models but taking constraints in human minds (such as limited knowledge or memory) and environments (such as information costs or social contexts of events) into account. Whereas Gigerenzer and Selten (2001) argued that even optimization under certain constraints may require a collection of massive information and large degrees of knowledge. Therefore, if ordinary people do not actually have the computational capabilities and statistical skills to deal with such information, the model of optimization under constraints cannot be regarded as a form of bounded rationality. Some researchers have attributed cognitive illusions (actual behavioural fallacies and biases such as overconfidence bias) to humans' bounded rationality, in the sense of irrationality or limitations on rationality (Kahneman *et al.*, 1982; Thaler, 1991). Gigerenzer and Selten (2001) argued that bounded rationality is not simply a discrepancy between human reasoning and a 'norm' (e.g., a law of probability, logic, or optimization). They suggested that bounded rationality is neither optimization under constraints nor irrationality, but a type of theory which rethinks the norms and explore the actual behaviour of human minds and organisations.

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when the observer and demonstrators are under similar, stable, and noisy environments. Fast and frugal heuristics (rather than complicated models) are suitable to environments when other people's behaviour makes a rapid change to the environment, when many decisions are required to be made in a successively dependent order in an environment, or when decisions have to be made in coordination with other individuals (Gigerenzer, 2004).

Bounded rationality has also been regarded as a series of fast and frugal heuristics which are suitable to different decision environments. When people are under time and/or cost pressure and are within the constraints of their limited knowledge and cognitive capacities, they often employ simple 'heuristics' (or rules of thumb) to deal with complex decision tasks (Camerer, 1998; Conlisk, 1996).

As suggested by Gigerenzer and Todd (1999), simple heuristics can be very helpful and accurate if used appropriately. This is clearly in line with Simon's original concept that an individual in a well-structured environment "requires only very simple perceptual and choice mechanisms" to satisfy his/her needs even over a long-term (Simon, 1956, p. 137). However, many studies have suggested that these heuristics may also result in systematic biases (see, for example, Kahneman *et al.*, 1982; Kahneman and Tversky, 1972; Tversky and Kahneman, 1974). The research interest explored in this thesis has drawn on one of these heuristics (and its related bias) and these will be discussed in later sections.

2.2.3 Heuristics and Biases in Judgement and Decision Making

Decisions made under conditions of uncertainty require estimates of probabilities of possible outcomes of the decision. When under time and/or cost pressure of searching information and within their constraints of limited knowledge and cognitive capacities, people use simple 'heuristics' to cope with the complexities of probability estimating and value predicting. Generally, these heuristics are useful and efficient in finding satisfying answers to decision tasks, but they may also cause systematically biased judgements in certain circumstances.

The representative studies which first systematically introduced and discussed heuristics and biases in human judgements and decision making were by Tversky and Kahneman (1973, 1974). In their studies, Tversky and Kahneman described three heuristics which are employed by people in their everyday life: (i) representativeness, (ii) availability and (iii) anchoring and adjustment. Since then, a huge number of studies have been carried out to (1) demonstrate and analyse these three heuristics in different contexts and (2) to delineate the circumstances and conditions under which specific biases would appear or disappear (e.g., Chiodo, Guidolin, Owyang and Shimoji, 2004; Goodwin and Wright, 2004; Keren and Teigen, 2004; Koehler, 1996). Some additive heuristics and associated biases have subsequently been identified (e.g., Evans, 1989; Goldstein and Gigerenzer, 2002; Pelham, Sumarta and Myaskovsky, 1994; Slovic, Finucane, Peters and MacGregor, 2002).

2.2.3.1 Representativeness Heuristic

The representativeness heuristic is often used to judge how likely it is that an object or a person belongs to a category, or the likelihood that an event originates from a process. This is evaluated by estimating the degree to which X is representative of Y, or the degree to which X resembles Y (Kahneman and Tversky, 1972, 1973; Tversky and Kahneman, 1974). For example, if you see a lady who is wearing nice suits and high heel shoes and carrying a laptop, you may think the probability that she is an office lady is very high.

As a general mechanism which can be employed in both singular and repeated events, the representativeness heuristic is valid and effective in many circumstances. Therefore, this heuristic could be an easy and fast approach which requires little cognitive resources and effort (Keren and Teigen, 2004). However, the representativeness heuristic may also generate a set of judgemental biases or falsifiable predictions if applied in an inappropriate environment.

One of the most common biases associated with the representativeness heuristic is ignorance of base-rate frequency (prior probability) of outcomes. In an experiment by Tversky and Kahneman (1974), subjects were given personality descriptions of some individuals who were from a group of 100 professionals composed of engineers and lawyers and were asked to estimate the probability of each description that belonged to an engineer. In one condition, subjects were told that there were 70 engineers and 30 lawyers in the group and in another condition, the base-rates were reversed (30 engineers and 70 lawyers). Surprisingly, the probability judgements produced by the subjects in the two conditions had no difference. This indicates that subjects in each condition made their assessments based on how likely the description was representative of an engineer, but with little or no regard to the base-rate probability of engineers being in the group. Further experiments demonstrated that when no description was given, people were able to use the base-rate frequencies properly. However, when specific descriptions were provided, people tended to ignore the base-rates and made judgements based on the descriptions, even when they were entirely uninformative. Another example of ignoring base-rates using the representativeness heuristic is the so-called *conjunction fallacy*. This judgement bias occurs when the conjunction (or co-occurrence) of two events is overestimated due to the representative description of each event. A typical example might be: Which is most likely, (1) Linda is a bank teller, or (b) Linda is a bank teller who is active in the feminist movement, if Linda is described as a 31 year old single woman who is bright, outspoken, majored in philosophy, was deeply concerned with issues of discrimination and social justice and also participated in anti-nuclear demonstrations as a student? Although it is more likely that the single event rather than the conjunctive event happens, almost 90% of the subjects thought it was more probable that Linda was a bank teller who was active in the feminist movement (Tversky and Kahneman, 1982). Clearly, subjects in this experiment ignored the base-rates of Linda being a bank teller and of Linda being a bank teller *and* active in the feminist movement, and make assessments based on how representative the description was to the question.

Other biases associated with the representativeness heuristic are the gamblers' fallacy, the misconceptions of regression, and ignorance of sample size (Goodwin and Wright, 2004; Keren and Teigen, 2004; Montier, 2002; Tversky and Kahneman, 1974, 1982). The gambler's fallacy refers to an over-estimation of the occurrence of certain outcome when a series of opposite outcomes have continuously occurred, although the occurrence probability of each outcome is identical and independent. For example, after observing a long sequence of heads in a fair coin toss, many people will believe it's more probable to get a tail in the next throw. This is because in a random process, heads and tails would be expected to occur equally in a long run, whereas people tend to regard a short and random sequence of events as the representative of what the random process should be (Montier, 2002; Tversky and Kahneman, 1974). Another consequence of the representativeness heuristic is that people ignore the regression to the mean and expect an extreme value to be followed by another extreme value rather than by a value towards the mean (Montier, 2002; Tversky and Kahneman, 1974). For example, given no fundamental changes in the market conditions or salesman's marketing strategies, a month of extremely high sales is more likely to be followed by a month of poor sales and vice versa. However, people often ignore the regression to the mean of sequential events and expect similar extremes in the following events (Montier, 2002). Finally, people are found to neglect the influence of sample size and expect the probability of an event to occur in a small sample to be the same as that in a large sample (Tversky and Kahneman, 1974). This is because individuals regard both small and large samples as the representatives of the entire population and suppose the two sample sets are independent and share the same characteristics. However, small samples are actually more likely to be a departure from the average value according to the sample set theory (Goodwin and Wright, 2004).

The representativeness heuristic has been applied in many areas. For example, in financial markets investors tend to over-react to a sequence of good earnings and expect the probability of the firm's earnings in the next period to be continuously high (ignorance of the regression to the mean) (Montier, 2002). In addition, professionals (financial analysts) are also found to employ this heuristic when predicting future earnings. If their previous forecasts are extremely high, they are more likely to over-react to these excessively extreme forecasts and consequently persist with a high prediction for the next period (Amir and Ganzach, 1998).

2.2.3.2 Availability Heuristic

People use the availability heuristic to estimate the frequency of an instance from a category or the probability of the occurrence of an event by how easily these instances or events can be brought to mind (Tversky and Kahneman, 1973, 1974). In particular, they believe that the more easily that a number of instances are recalled, the more frequent the event would be and the more likely that it will happen again in the future (Keren and Teigen, 2004). For example, if one is asked to estimate the probability of a train going off the track and there happened to be a train accident a few days ago, it will be more possible for the person to easily recall this event. Consequently, they would be likely to assess the chance of a similar accident in the future to be high.

Availability is a useful heuristic for assessing frequency of instances, especially for instances in large frequency classes which are recalled more easily and quickly than instances in low frequency class. However, it has been argued that the recall of a target event is not only a simple generalization from the size/frequency of the sample of recalled instances to the entire population, but is also affected by other factors such as public exposure, vividness, primacy and recency of events (Keren and Teigen, 2004). In addition, the availability principle may also involve a process of mental productions of feelings: 'ease of recall' is regarded as more important than 'number of instances' recalled (Schwarz, Bless, Strack, Klumpp, Rittenauer-Schatka and Simons, 1991). Consequently, the application of availability may lead to a series of systematic biases which are illustrated below (Taylor, 1982; Tverskay and Kahneman, 1974).

The first set of biases caused by the availability heuristic is related to the retrievability of instances. As illustrated by Tversky and Kahneman (1974), the retrievability of instances is affected by many factors such as the familiarity, salience (colourful, dynamic, or vivid information), and recency of recalled events to the whole population of events. One example of the implication of familiarity in availability is the recall of celebrities' names. After hearing a list of well-known personalities of both men and women, subjects were asked to estimate whether the list contained more names of males than of females. Results showed that subjects judged the proportions of men and women on the list according to their familiarities of the names that they heard: if they recognised more male names than female names, they reported more men than women on the list and vice versa. A simple example concerning salience of retrievability is that, for example, seeing a bank robbery on the street will actually have greater impact on the estimated probability of the occurrence of such an accident than the impact of reading it in a newspaper. Another example of salient information in availability is that the probability that people need earthquake insurance will be significantly overestimated after a large earthquake (Chlodo *et al.*, 2004). Rothbart, Fulero, Jenson, Howard and Biffell (1978) pointed out that salient and negative information in media coverage would be retrieved more easily than modest and positive information. In addition, people are likely to select stocks from the newspapers or other professional tipsters because the public and salient information is easier to recall. However, a study by Gadarowski (2001) found that stocks with very high levels of press coverage actually underperformed the market in the subsequent two years. This indicates the recall of public information may lead to judgement biases. Finally, the occurrence of a recent accident will have greater impact on the subjective probability estimate that similar event happens again than the impact of an accident which happened a year ago.

Another example of retrieval biases is the study of egocentric attributions and the judgements of responsibility for joint products (Ross and Sicoly, 1979). It was demonstrated that when asked to assign the contribution of each participant of a joint product, people tended to recall more contributions of their own to the group product than the contributions of others, and therefore attributed their own responsibilities to the joint product more than other participants do. One possible explanation of this effect relies on motivational principles that people tend to attribute more credit to their own contribution and enhance their self-image. A so-called *exposure bias* provides another explanation for this effect: when estimating participants' responsibilities to the group project, people bring their own contributions to mind more easily because they observe their own contributions more closely than other people do.

A second group of availability biases is associated with the effectiveness of searching and imagination. Wood, Atkins and Tabernero (2000) examined the relationship between self-efficacy and performance on complex tasks by exploring individuals' perceived capabilities for conducting searches and for processing available information. Results showed that low search efficacy caused greater use of the availability heuristic, and the low processing efficacy, however, was found to lead to greater use of the anchoring and adjustment heuristic and the representativeness heuristic. Tversky and Kahneman (1973) illustrated that in some circumstances, if the instances of which the frequency to be estimated were not stored in people's memory, they intended to construct these instances according to certain rules and estimated the frequency of such instances of a class by the ease with which they were constructed. The bias caused by the imagination of events under the availability heuristic is that events which are easily imagined may not necessarily have a high probability of occurrence. For example, civil engineers who are in charge of a construction project may overestimate the risk of the project being delayed but underestimate other risks. This is because it is easier for a civil engineer to imagine all the circumstances which may cause the delay of the project, such as strikes, bad weather, and the interruptions in the supply of materials and equipment. However, it might be difficult for the engineer to imagine risks associated with a course of action (Keren and Teigen, 2004).

Finally, biases may come from illusory correlation (i.e., when conditional probabilities have to be estimated, people tend to overestimate the frequency with which the two events occur together). One example of the bias of illusory correlation is from the experiment conducted by Chapman and Chapman (1969). In their experiment, naïve judges were given a diagnosis of a disease and a drawing made by a hypothetical mental patient. They were then asked to estimate how frequently certain characteristics of the diagnosis (such as suspiciousness) were accompanied by some features of the drawing (such as peculiar eyes). Results showed that the judges significantly overestimated the frequency with which suspiciousness and peculiar eyes were together, due to the bias of illusory correlation. Further experiments suggested that even contradictory evidence was not able to eliminate this judgement bias.

2.2.3.3 Anchoring and Adjustment Heuristic

The anchoring and adjustment heuristic refers to a phenomenon whereby people make estimates by starting from an initial value (the *anchor* value) and adjusting upwards or downwards to reach the final answer (the *target* value) (Tversky and Kahneman, 1974)[3]. For example, if a sales manager is asked to estimate the sales level for next month, s/he may rely on the sales level of this month and move upwards or downwards to produce the final answer. However, it has been demonstrated that these adjustments are often insufficient.

As suggested by the literature, the anchor value can either be generated by the decision makers or suggested by an external source. In either condition, the estimates of the target values are highly influenced by the anchor values and the adjustments from anchors to targets are often insufficient (e.g., Quattrone *et al.*, 1981; Tversky and Kahneman, 1974). It has been demonstrated that even irrelevant anchors (Wilson *et al.*, 1996) or even ridiculously implausible/extreme anchors (Strack and Mussweiler, 1997) can also lead to anchoring. In addition, both novices and experts are subject to the bias of anchoring effects (Tversky and Kahneman, 1974).

The application of the anchoring and adjustment heuristic also leads to a number of decision biases. The first and important bias caused by the anchoring and adjustment heuristic is the conservative bias due to insufficient adjustment. This may raise problems in the estimations of costs, payoffs and probability forecasts. A second group of biases which come from this heuristic are the over-estimation of conjunctive events and the under-estimation of disjunctive events. When estimating the probability of occurrence of a conjunctive/disjunctive event, people are demonstrated to anchor their judgements on the probability of one single event in this task. Therefore, the

[3] The target value is the quantity that needs to be estimated in a judgemental task. The anchor value refers to the number different from the target value but would influence the estimates of decision makers. The anchor can be either generated by judges themselves or provided by the external sources.

conjunctive probability (a multiple of the probability of each single event) is overestimated and the disjunctive probability (sum of the probability of each single event) is underestimated. A third type of bias is related to overconfidence. Because people tend to be overconfident about their estimates from the anchor values, the ranges of their adjustments are often too 'narrow' to include the true value (Alpert and Raiffa, 1982; Goodwin and Wright, 2004; Keren and Teigen, 2004; Quattrone *et al.*, 1981; Tversky and Kahneman, 1974).

The current study will be focusing on anchoring effects, the judgemental bias associated with the anchoring and adjustment heuristic, and the application and influential factors of anchoring effects in the real world environment. A more detailed review of anchoring effects will be documented in Section 2.3.

2.2.3.4 Other Heuristics

Following the studies of the three main heuristics discussed above, a number of new heuristics (e.g. Goldstein and Gigerenzer, 2002; Slovic, 2002) have been identified and have begun to draw more and more attention of judgement and decision making research. Specifically, the *recognition heuristic* suggests that the alternatives that can be recognised by decision makers are more likely to be assigned a bigger or better value than those which cannot be recognised (Goldstein and Gigerenzer, 2002). This is different from the availability heuristic due to the difference between capacity for recognition and capacity for recall. One example, given by Craik and McDowd (1987), is that one may recognise a face but cannot recall who he is. The *affect heuristic* refers to the fact that people tend to consider activities positively rather than negatively. This seems to indicate that it is broadly believed that positive outcomes appear with higher probabilities while negative outcomes occur with lower probabilities (Slovic, *et al.*, 2002). The *alternative outcomes effect* is about the phenomenon that people only choose strongest competitors from the whole set of alternatives when comparing the probability of target outcomes with that of the alternatives (Windschitl and Wells, 1998). The *positivity heuristic* refers to a phenomenon whereby humans tend to seek information consistent with their current beliefs and avoid the collection of potentially falsifying evidence (Evans, 1989). This heuristic indicates that people like to adopt strategies that are designed to confirm rather than refute their beliefs or individual perceptions of the world (Havard, 2001).

Furthermore, a large number of other judgemental biases in probability estimation have been explored by researchers. For instance, the *desirable bias*, associated with the positivity heuristic, refers to the phenomenon that people tend to produce a higher probability for desirable outcomes than for undesirable outcomes. Similarly, the *citation bias* suggests that people pay more attention to the information or events desirable to them whilst paying no or less attention to undesirable information/events. In addition, the *conservatism* (or *conservative*) bias and *overconfidence* are related to the anchoring and adjustment heuristic because people tend to make insufficient adjustments from an anchor value either when they are too conservative or too confident about their judgements (Goodwin and Wright, 2004). The recognition heuristic will lead to a counterintuitive effect, the *less-is-more effect*, which means that less information could conduct more accurate estimates under some circumstances.

In summary, the heuristics and the decision biases caused by these heuristics are discussed in this section. The interest of the current study is the anchoring effect, the bias associated with the anchoring and adjustment heuristic. A full exploration of the anchoring heuristic and corresponding effects is provided below in Section 2.3.

2.3 Anchoring Effects

As introduced in Section 2.2.3, individuals use the anchoring and adjustment heuristic to estimate the values of decision tasks based on some anchor values which are generated by decision makers themselves or provided by external sources. Numerous studies have demonstrated that people's adjustments are usually insufficient to produce the right answers. The effects caused by the application of the anchoring and adjustment heuristic are termed *anchoring effects*.

As the main focus of this study, this type of anchoring effects belongs to a category called *assimilation anchoring* in psychological judgements. In Section 2.3.1, two types of anchoring, the *contrast anchoring* and *assimilation anchoring* are defined. Under the notion of assimilation anchoring, definitions of two types of anchoring effects are introduced in Section 2.3.2; traditional and basic types of anchoring are identified, followed by a discussion of the strength and durability of anchoring effects. The underlying mechanisms of the anchoring effects, according to different judgemental theories, are described in Section 2.3.3. In section 2.3.4, the external and individual factors which are considered to have impacts on the strength (how strong the anchors should be to cause anchoring) and durability (how long the anchoring can last) of anchoring effects are discussed. Section 2.3.5 explores issues which have been covered by the literature but not been categorised into previous sections, such as the type of settings in which anchoring effects are explored, the impact of incentives on anchoring, and the way of debiasing of anchoring bias. A rich picture of the anchoring literature is displayed below in Figure 2.3-1.

2.3.1 Types of Anchoring

It should be noted that in different research areas, the concept 'anchoring' refers to different judgemental phenomena. In psychological judgements, the term 'anchoring' has been used to describe 'contrast phenomena' whereas according to the study by Tversky and Kahneman (1974), it refers to 'assimilation phenomena'. Although both phenomena involve a judgemental process in which individuals' judgements are influenced by certain anchor stimulus, they are distinguished from each other in terms of judgemental processes, characteristics of the judgemental tasks, and resulting effects (Mussweiler and Strack, 1999a).

2.3.1.1 Contrast Anchoring

In the area of psychological judgement, 'anchoring' refers to a phenomenon that a concrete context consideration is processed to make a categorical judgement based on a different target stimulus (Brown, 1953; for an overview, see Chapman and Johnson, 2002; Mussweiler and Strack, 1999a). This is termed the 'contrast anchoring' effect and is mediated by changing judges' experiential adaptation of the context stimulus to affect their perception of the target stimulus. For example, a target stimulus is regarded as being lighter in the context of a heavy stimulus but considered as heavier in the context of a light stimulus (Helson, 1964). This can be explained by a 'judgemental contrast' process, which achieves the response scale of a subjective judgement (target stimulus) based on a calibration of a given scale (given stimulus) (Parducci, 1968). It is suggested that an extremely high/low stimulus (anchor) may lead to a shift of people's judgemental calibration towards the upper/lower end of the judgemental dimension (Mussweiler and Strack, 1999a; Wyer and Srull, 1989).

2.3.1.2 Assimilation Anchoring

'Assimilation anchoring' discovered by Tversky and Kahneman (1974) is the focus of this study (if not specified, the terms 'anchoring' or 'anchoring effects' in the rest of this study all refer to the notion of 'assimilation' anchoring). It involves a numerical anchor value and an absolute judgement about the target question (Mussweiler and Strack, 1999a, 2000a). In particular, the assimilation anchoring effect is caused by two numerical judgements: a comparative judgement between the anchor and the target values and, consequently, an absolute judgement about the target value. For example, in one of Tversky and Kahneman's (1974) classic experiments, each participant was provided with an arbitrary number (the anchor value) which was randomly generated by spinning a wheel of fortune. They were then asked to compare this number with the percentage of African countries in the UN (the comparative judgement). Subsequently, they were required to give their own answer about the target question (the absolute judgement). It has been suggested that people's absolute judgements about the target question are highly assimilated to the anchor value generated by or provided to them. In particular, people who receive a high value as the comparison standard give higher estimates about the target value whereas those who receive a low anchor give lower estimates about the target (e.g., Chapman and Johnson, 1994; Northcraft and Neale, 1987; Quattrone *et al.*, 1981; Tversky and Kahneman, 1974).

The assimilation anchoring effect has been demonstrated to be remarkably robust in terms of certain characteristics. For example, this effect may occur when the anchor value is randomly selected and totally uninformative (e.g., Cervone and Peake, 1986; Mussweiler and Strack, 2000b; Tversky and Kahneman, 1974) or implausibly extreme (e.g., Chapman and Johnson, 1994; Mussweiler and Strack, 1999b; Strack and Mussweiler, 1997; Wegener, Petty, Detweiler-Bedell and Jarvis, 2001) to the target question, or when the anchor value is informative and relevant to the target (e.g., Northcraft and Neale, 1987). It appears when the anchor is self-generated (e.g., Davies, 1997; Mussweiler and Neumann, 2000; Mussweiler and Strack, 1999b, Tversky and Kahneman, 1974) or externally provided (e.g., Tversky and Kahneman, 1974). This effect applies not only to novices but also to the experts who have professional knowledge about the judgemental tasks (Englich and Mussweiler, 2001; Joyce and Biddle, 1981; Northcraft and Neale, 1987; Wilson, *et al.*, 1996; Wright and Anderson, 1989). The involvement of motivations or incentives for judgemental accuracy does not diminish the effect of anchoring (Wilson, *et al.*, 1996).

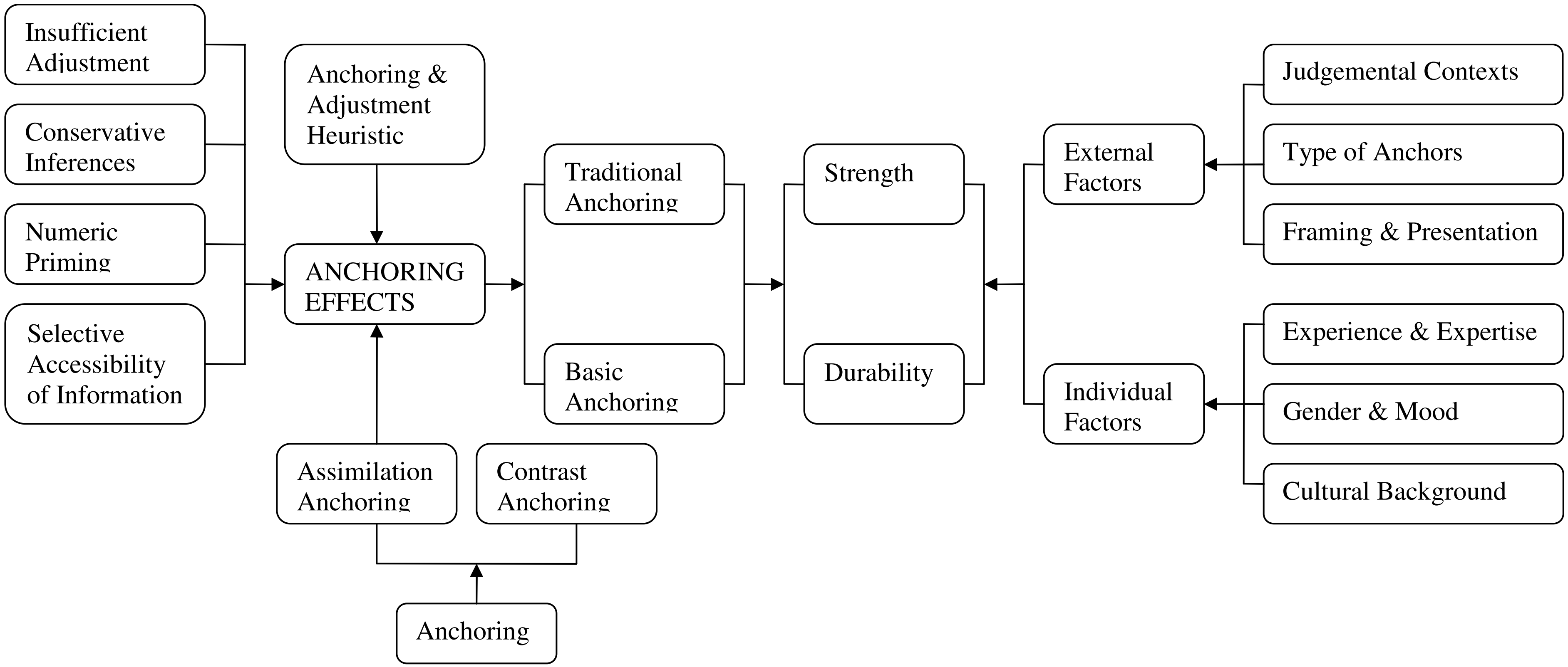
Moreover, the assimilation anchoring effects have been observed in a large variety of judgemental areas besides laboratory settings. For example, they are detected in general knowledge questions (e.g., Mussweiler, 2001; Strack and Mussweiler, 1997; Wegener, *et al.*, 2001), estimates of self-efficacy (Cervone and Peake, 1986), probability estimates (Plous, 1989), price estimates and auctions (e.g., Dholakia and Simonson, 2003; Dodonova and Khoroshilov, 2004; Mussweiler, *et al.*, 2000), evaluations of lotteries and gambles (Carlson, 1990; Chapman and Johnson, 1994; Englich, 2006; Ganzach, 1996), judicial judgements (Chapman and Bornstein, 1996; Englich, 2006; Englich and Mussweiler, 2001), negotiations (e.g., Chertkoff and Conley, 1967; Galinsky and Mussweiler, 2001; Kristensen and Garling, 2000; Ritov, 1996), real estate judgements (Northcraft and Neale, 1987), auditing judgements (Joyce and Biddle, 1981), and military and political judgements (Plous, 1989; Whyte and Levi, 1994). Finally, it is argued that the assimilation anchoring effect may be used to explain a number of judgemental phenomena and biases (Chapman and Johnson, 1999, 2002; Mussweiler, 1997; Mussweiler and Strack, 1999a) such as (i) the confirmation bias – people tend to seek information which is consistent with the hypothesis (e.g., Snyder and Swann, 1978), (ii) overconfidence – people are too confident with the accuracy of their judgements (this bias is less when the anchor is self-generated than externally provided, e.g., Block and Harper, 2001; Griffin and Tversky, 1992), and (iii) the hindsight bias – people tend to believe that they would have predicted the outcome once they are aware of it, and the outcome knowledge works as an anchor which influences people's judgements about their predictability of the outcome (e.g., Chapman and Johnson, 1999; Fischhoff, 1975; Hawkins and Hastie, 1990).

The research interest of my study is on the effect of assimilation anchoring in a real world environment. If not mentioned specifically, the term 'anchoring effects' in the rest of this study refers to the assimilation anchoring effects. More details about the characteristics and applications of these effects will be discussed in Section 2.3.4 and Section 2.3.5.

2.3.2 Two Types of 'Assimilation' Anchoring Effects

Two types of assimilation anchoring effects are defined in this section. The first and traditional definition of anchoring effects was suggested by Tversky and Kahneman (1974). In their study, anchoring effects were identified as a phenomenon whereby people make estimates by starting from an initial value and make insufficient adjustments from this starting point to generate the final answer. In this definition, a comparison between anchor values and target values is essential. This definition has been the building block of subsequent anchoring research and is adopted and cited by most of the anchoring studies since then. However, about twenty years later, Wilson *et al.* (1996) demonstrated that anchoring may occur even when the anchor number is completely irrelevant to the target question and when no comparison is involved in the judgemental process. This concept of anchoring is termed basic anchoring and has been demonstrated to be trivial and fragile (Brewer and Chapman, 2002), compared with the traditional anchoring. The details of these two types of anchoring effects are presented as below.

Figure 2.3-1 Rich picture of the anchoring literature



2.3.2.1 Traditional Anchoring Effects

Traditional anchoring effects appear when a two-stage procedure is involved in people's judgements: subjects are firstly asked to compare the anchor and target values (a comparison procedure), and consequently required to give their own estimates of decision tasks (a judgement procedure). Although anchoring effects have been demonstrated in a large number of judgemental environments, these various decision tasks all involve this two-stage procedure (e.g., Chapman and Johnson, 1999; Jacowitz and Kahneman, 1995; Joyce and Biddle, 1981; Mussweiler and Strack, 1999a; Quattrone *et al.*, 1981; Strack and Mussweiler, 1997; Tversky and Kahneman, 1974; Whyte and Sebenius, 1997).

For example, subjects in Tversky and Kahneman's (1974) experiment were asked to estimate a number of quantities such as the percentage of African countries in the United Nations. For each quantity, a wheel of fortune was spun in front of the subjects to generate a number ranged between 0 and 100. The subjects were firstly asked whether the target quantity was higher or lower than the wheel number (the comparison procedure) and then were asked to give their own judgements of the target quantity. Different groups of people were all found to evaluate the target quantities based on the number that they were given: for example, the group who received a lower number of 10 gave an average estimate of 25% and the group who received a higher number of 60 gave an average estimate of 45%. Clearly, the random numbers generated by the fortune wheel were used as anchors in people's judgements. Although these numbers had obviously no relationship with the question subjects were asked, they still anchored their estimates on this number and made insufficient movements from it. It is argued that it is the comparison procedure that successfully draws people's attention to this piece of information and the underlying mechanism behind the procedure is discussed in Section 2.3.3 (e.g., Chapman and Johnson, 1999; Mussweiler, 1997; Strack and Mussweiler, 1997).

Another experiment undertaken by Tversky and Kahneman (1974) demonstrated that individuals anchored their numerical estimates on the numbers extrapolated or adjusted by some incomplete computation. In particular, two groups of high school students were asked to quickly estimate a numerical expression. According to the way the expression was presented, students in different groups gave answers with different average levels. For the product of an ascending sequence 1×2×3×4×5×6×7×8, students gave answers averaging 512, whereas for the product of a descending sequence 8×7×6×5×4×3×2×1, the average estimate was 2,250. Although both estimates, typically, moved insufficiently towards the right answer (40,320), the result of the ascending expression was significantly lower than that of the descending expression. This suggests that under high time pressure (within 5 seconds) the subjects can only make part of the calculation and rely their judgements on the first few steps of the computation (from left to right). Therefore, an ascending sequence generates a lower value than a descending sequence does. In this case, the anchors were the predictions generated by the subjects themselves, but even so, a comparison procedure between the target estimate and the computation result generated still existed and highly influenced people's final estimates.

Experiments carried out by many other researchers follow the same two-step procedure, although the tasks adopted may belong to various decision contexts such as psychology, negotiation, real estate, and auditing (e.g., Cervone and Peake, 1986; Chapman and Johnson, 1994, 1999; Diaz, III, 1997; Jacowitz and Kahneman, 1995; Joyce and Biddle, 1981; Mussweiler and Strack, 1999a; Plous, 1989; Quattrone *et al.*, 1981; Russo and Schoemaker, 1989; Strack and Mussweiler, 1997; Whyte and Sebenius, 1997). For example, people are found to anchor their estimates of vodka's freezing point on the figure of 32^{o} F since this is the benchmark of the freezing point of anything (Epley and Gilovich, 2001). In addition, real estate agents may anchor their estimates of property values on the listing price which is believed to be relevant to the market price of the property.

2.3.2.2 Basic Anchoring Effects

Demonstration of Basic Anchoring Effects

In contrast to numerous studies on traditional anchoring effects, little attention has been paid to basic anchoring effects, a phenomenon whereby people anchor their judgements on some particular numbers even when they are not asked to compare this number to the target value (for examples, see below). The basic anchoring effect was first detected by Wilson *et al.* (1996) in a series of well-manipulated experiments. The results suggest that (1) basic anchoring occurs if sufficient attention is paid to the anchor value, even if the anchor is completely irrelevant to the target question, (2) people who are knowledgeable about the target question are subject to a lower level of basic anchoring effects, and (3) basic anchoring effects are conducted unintentionally and unconsciously, and therefore are difficult to avoid even when incentives are provided for judgement accuracy and when people are forewarned of the influence of anchoring. It is argued that if individuals anchor on arbitrary anchors even without being asked to do so, the anchoring effect may be more common in natural decision contexts than researchers had thought (Wilson *et al.*, 1996). However, further studies show that due to the lack of a comparison process between anchors and targets, basic anchoring effects are fragile and can easily disappear, when other anchor numbers are used or the order of the anchor numbers is changed (Brewer and Chapman, 2002).

The five experiments conducted by Wilson *et al.* (1996) to demonstrate the basic anchoring effect are described as below. In the first experiment, 116 undergraduate students were asked to estimate the number of countries in the United Nations (the target value) in different conditions. In one condition, participants were given a large number on a piece of paper (the anchor value); in the control condition, participants were given a piece of blank paper (no anchor). In each of these conditions, participants were either asked to compare the number to the target question (as a relevant anchor) or to an unrelated question[4] (as an irrelevant anchor)[5]. Consequently, all the participants were asked to rank how knowledgeable they were to the target question and how confident they were with their answers. A multiple regression with a 2(control vs. anchor) × 2(relevant vs. irrelevant anchor) × Level of Knowledge analysis of variance (ANOVA) was conducted. The results demonstrated a significant traditional anchoring effect in the condition with the anchor and a comparison between the anchor number and the estimate of the target question. Participants who received the anchor number but compared this number with an unrelated question were also found to anchor their estimates on the received number. This was attributed to a demonstration of the basic anchoring effect[6]. In addition, both traditional and basic anchoring effects occurred

[4] The target question (or the relevant question) is how many countries there are in the UN. The unrelated question (or the irrelevant question), compared to the target question, is how many physicians and surgeons there are in the local phone book.

[5] Participants in the no anchor condition were also asked these two types of questions and were instructed to leave this question blank.

[6] Although this example (to explicitly compare a number with a question which is unrelated with the target question and then provide the absolute estimate of the target value) was regarded as an demonstration of basic anchoring effects (Wilson *et al.*, 1996), I think it might be more suitable to regard it as an effect somewhere between traditional and basic anchoring effects.

among people with low knowledge in the target question, whereas the estimates given by knowledgeable people were fairly accurate to the right answer.

Because asking participants in the irrelevant condition to compare the anchor value with an irrelevant question may still make them compare it to the target question, further studies are required (Wilson *et al.*, 1996). Experiment two constructed four conditions[7] which required different amounts of attention of people to the anchor number (a four-digit ID number). Participants were asked to firstly check the condition of their ID numbers and then to answer the target question. No instruction of comparing the anchor number with the target value was involved. The results indicate that people who paid more attention to the anchor number experienced a higher level of the anchoring effect. This confirms the researchers' hypothesis that to cause the basic anchoring effect, sufficient attention is needed. Similarly, the third experiment demonstrated that people who were asked to copy five pages of large numbers (with 7 numbers on each page) gave higher estimates of the target question than those who copied four pages of words plus one page of numbers and those who copied five pages of words (no anchor number). This study confirms with the second experiment that basic anchoring only occurs when sufficient attention has been paid to the anchor number. Another two conditions in which participants were asked to make simple computations on the five or one page of numbers showed similar results as the copy conditions; simple computations of anchor numbers had no extra influence in causing anchoring.

People in experiments two and three all gave a low rate of being aware of the influence of anchor numbers. Furthermore, experiment four repeated experiment two but provided monetary incentives to encourage accuracy of estimates and in experiment five participants were warned not to be influenced by the anchor numbers. Results showed that the monetary incentives did not moderate the effects of anchoring; the pre-warnings reduced people's effects of anchoring to some degree but were not sufficient to eliminate them.

Mussweiler and Englich (2005) provided confirmation of the existence of basic anchoring effects. For example, in one experiment, participants were asked to think about the annual mean temperature in Germany. During the thinking time, people were

[7] In particular, the conditions of the ID numbers to be checked are: (1) whether it is written in red or blue ink, (2) whether it is a four-digits number, (3) whether it is greater than 100 (the GT-100 condition), and (4) whether it is greater than either 1920 or 1940 (the GT-1920-1940 condition).

presented with a string of letters and a high/low (20/5) anchor number in sequence on the computer screen 10 times in a total of 60 seconds. The anchor numbers were merely presented to the participants without any instructions on the use of the number. The results showed a significant basic anchoring effect: participants who were presented with a high anchor value gave a higher estimate of the mean temperature whilst people who were subliminally primed with a low anchor value suggested a lower estimate. A further study in another context (asking the average price of a midsize car) was conducted and provided similar results. Consequently, Mussweiler and Englich conducted a third experiment to demonstrate that a selective increase in the accessibility of target knowledge was produced by the subliminal anchors. This may suggest an underlying mechanism of selective accessibility model to explain people's judging processes (see Section 2.3.3 for a further discussion of this mechanism).

Challenge of Basic Anchoring Effects

The idea of basic anchoring, which may widen the scope of natural contexts in which anchoring effects can be detected, is challenged by Brewer and Chapman (2002). It is argued that although significant basic anchoring effects are demonstrated, Wilson *et al.*'s experiments encounter some flaws which may lead to biased outcomes. One concern is that the anchors used in Wilson *et al.*'s experiments are all high-magnitude anchors (both high and low anchor numbers are normally used in other anchoring studies). This makes Wilson *et al*. only look at the difference between high anchors and the target but miss out the difference between low anchors and the target. Another concern relates to their anchor selection. For example, in the 'ID number' experiment, Wilson *et al*. used year-like anchor numbers which are unusual and unique in their salience and would therefore attract special attention of people. In the 'copying' study, the basic anchoring effect was only elicited on a large quantity of numbers (five pages of anchor numbers rather than one page of numbers). Therefore, basic anchoring may only occur as a result of some special anchors which can attract sufficient attention of people.

Therefore, Brewer and Chapman (2002) re-examined two experiments of Wilson *et al.* (1996) and extended them by using different anchors, including low anchor numbers, and changing the order of anchors. In particular, they replicated Wilson *et al.*'s 'ID number' experiment with high numbers (5600s), low numbers (600s), the year-like numbers (1900s) and zip-codes (08900s) as anchor numbers. The results showed that the basic anchoring effect occurred only when the year-like numbers were used. Both high and low ID numbers were not found to be significantly anchored on; even the zip-codes which were supposed to be as salient as the year-like numbers did not cause basic anchoring. This seems to indicate that basic anchoring effects merely occur in some very special circumstances such as when the year-like numbers are used as anchors. To generalise basic anchoring from the specific year-like numbers to other salient numbers, such as the zip-code-like seems to be difficult. In addition, an extremely large anchor number (such as 5600s in this study) may not necessarily cause anchoring effects, although some studies suggest that higher anchors can result in a stronger anchoring bias (Chapman and Johnson, 1994; Chapman and Bornstein, 1996).

The second and third experiments conducted by Brewer and Chapman (2002) extended Wilson *et al.*'s 'copying' study by including low anchor values and changing the order of the anchor numbers. In experiment two, Brewer and Chapman used both low and high numbers which were approximately a tenth and ten times the numbers that Wilson *et al.* used as anchors. Four conditions of these anchor numbers (five pages vs. one page, copying vs. computation) were manipulated as Wilson *et al.*'s experiment. In the high anchor condition, Brewer and Chapman's experiment failed to get a basic anchoring effect as was found in Wilson *et al.*'s experiment. In the low anchor condition, only five pages of numbers with simple computations were demonstrated to raise anchoring and none of the other conditions. This may indicate that the basic anchoring is sensitive to a large number of anchors and to a computational operation which requires deeper cognitive processing.

The third experiment manipulated by Brewer and Chapman (2002) replicated the second experiment but with anchor numbers appearing on all the five pages in a random order[8]. A 2(Computation) × 2(Anchor Level) × 2(Anchor Order) ANOVA analysis was conducted and the results showed that neither computation, anchor level, or order of anchors had effects on people's estimates of the target question.

In summary, experiments developed by Brewer and Chapman (2002) suggest that highly specific manipulations are required to obtain basic anchoring effects. Such effects are fragile, easy to be reduced or eliminated by trivial changes of tasks such as

[8] In Wilson *et al.*'s "copying" experiment, the anchor numbers displayed on each page were presented in a carefully scripted order: the first four in a descending sequence and the last three in an ascending sequence starting from one number greater than the first number of the seven numbers on this page.

using different anchor numbers or changing the order of anchors, and therefore are difficult to generalise but easy to debias.

2.3.2.3 Strength and Durability of Anchoring Effects

Strength of Anchoring Effects

As discussed in Section 2.2.3, one of the decision biases which may lead to anchoring effects is overconfidence: people are too overconfident about their estimates so make only a small range of adjustments from the anchor values. These are often not sufficient to achieve the correct answers (Alpert and Raiffa, 1982; Goodwin and Wright, 2004; Keren and Teigen, 2004; Quattrone *et al.*, 1981; Tversky and Kahneman, 1974). In judgement and decision making, overconfidence and underconfidence are referred to as judgemental miscalibrations (Griffin and Tversky, 1992; Nelson, Bloomfield, Hales and Libby, 2001). As suggested by Griffin and Tversky (1992), these miscalibrations are elicited because people tend to pay too much attention to information strength[9] and too little attention to information weight[10]. As a result, overconfidence of judgement occurs when information is of high strength but low weight whereas underconfidence occurs with low strength but high weight information (Griffin and Tversky, 1992).

One example to describe the impact of information strength and weight on judgements is the coin-flipping exercise (Bloomfield, Libby and Nelson, 2000; Griffin and Tversky, 1992). There are an equal number of heads-biased coins which have a 60% chance of coming up heads and a 40% chance of coming up tails and tails-biased coins which have a 40% chance of coming up heads and a 60% chance of coming up tails. The information strength in this example is the sample proportion (i.e., (the number of heads coming up – the number of coins coming up) / the number of flips), and the information weight refers to the sample size (i.e., the number of flips). Each coin is thrown a number of times and whether it is heads-biased or tails-biased has to be estimated. It is found that when the sample proportion strongly supports the heads-biased coins (3/3=100%), whereas the sample size is fairly small (for example, flip 3 times with the results of 3 heads and no tails, the difference between heads and tails is 3), people tend to overestimate the possibility of the coin being heads-biased. On the

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[9] Information strength refers to the proportion of the appearance of a certain event in a sample.

[10] Information weight relates to the size of a sample and the statistical reliability of an inference which can be drawn from the sample.

contrary, a sample of 17 flips with 10 heads and 7 tails (the difference between heads and tails is 3 too), the evidence strength suggested by the sample proportion (10/17=58.8%) is moderated whereas the sample size of 17 becomes more reliable and should be given a more information weight. Therefore, a lower-weight 3-flip sample may cause overconfidence and a higher-weight 17-flip sample may lead to underconfidence.

Moreover, Nelson *et al.* (2001) adopted Griffin and Tversky's (1992) example of coins and employed it in an artificial financial market to explore the impact of information strength and weight on investors' confidence, trading volumes, trading prices and wealth. They found that investors tend to make more extreme estimates of the value of the security when they have high-strength and low-weight information than those who have low-strength and high-weight information. However, investors with more extreme estimates of security values are found to trade as aggressively as those with less extreme estimates do. In addition, because the market price is biased toward high-strength and low-weight information, investors with such type of information tend to buy at high prices (when their information is favourable, their estimates tend to be too high) and sell at low prices (when their information is unfavourable, their estimates tend to be too low). Therefore, their wealth is transferred to investors with low-strength and high-weight information.

It seems that the concept of information strength has a large number of implications in the contexts where anchoring effects may occur. For example, in Wilson *et al.*'s (1996) studies, basic anchoring only occurs when people copied five pages of numbers but is absent in the condition of four pages of words plus one-page of numbers. This suggests that the anchor information should be strong (extreme, salient, or repeated a number of times) enough to cause anchoring effects. However, to the researcher's knowledge, no study has systematically examined the impact of the strength of anchors on the degree of anchoring effects either in laboratory experiments or in the natural environments. This study will be a preliminary research which intends to explore this issue in a real world environment.

Durability of Anchoring Effects

Another remarkable characteristic of the phenomenon of anchoring is its durability (i.e., the effect may remain, uninfluenced, over time). A number of researchers have proposed a Selective Accessibility Model (for more details, see Section 2.3.3) to conceptualise anchoring as an impact of people's accessible knowledge about anchors on their judgements. Under this conceptualisation, anchoring is mediated by a selective increase in the accessibility of anchor-consistent knowledge (i.e., knowledge which supports rather than challenges the use of anchors in their judgements) about the judgemental target (Mussweiler, 1997; Chapman and Johnson, 1999; Mussweiler and Strack, 1999a, 1999b, 2000a; Strack and Mussweiler, 1997). In particular, decision makers are supposed to compare the target and the anchor value by examining the assimilability of the anchor to the target. To do so, they tend to selectively retrieve the information and knowledge which is consistent with their assumption about the relationship between the anchor and the target rather than information and knowledge which is against it. Therefore, people's estimates about the target would be heavily influenced by this anchor-consistent and easily accessible knowledge that they retrieve (Mussweiler, 2001). Various studies on knowledge accessibility effects (e.g., Higgins, 1996; Sedikides and Skowronski, 1991; Srull and Wyer, 1979, 1980; Wyer and Srull, 1989) have repeatedly demonstrated the durability characteristic of these effects: the influence of some trait priming to judgement is remarkably durable if the trait concept is easily and increasingly accessible. In consequence, the anchoring effect as a special case of knowledge accessibility effects may also encounter a similar characteristic: durability.

The durability of anchoring effects is examined by Mussweiler (2001) in three carefully constructed experiments. Study 1 examined the durability of people's judgemental anchoring on a fictitious target ('Xiang Long'). The participants were firstly asked to compare the age of 'Xiang Long' with either 2000 or 60 years old, and then were required to give their own estimates of the target object's age either immediately after the comparison or one week later. A 2(high vs. low anchor) × 2(no vs. one-week delay) ANOVA analysis was conducted and the results found significant anchoring effects in both the no-delay and the one-week delay conditions. Participants who received the high anchor (2000 years old) gave fairly high estimates of the age of 'Xiang Long' (about 1000 in average in both no-delay and one-week delay conditions) whereas those who received the low anchor (60 years old) made relatively low estimates of this target (about 80 in average in both no-delay and one-week delay conditions). The estimated difference between the high and the low anchor conditions is significant in both no-delay and one-week delay conditions, although participants in the delay condition said they did not remember the anchor value which they had received one week earlier. These findings suggest that the effects of judgemental anchoring are significantly durable. It is argued that judgements about a fictitious target (such as 'Xiang Long') are more likely to encounter anchoring (Mussweiler and Strack, 2000b) and the anchoring effects caused by the fictitious target are more likely to be durable (Mussweiler, 2001). This is because judges are less likely to retrieve additional information about the fictitious target during the period of delay and hence are more likely to stick their judgements to the anchor value over a long time (Mussweiler and Strack, 2000b).

To reduce the influence of fictitious targets on people's judgements, Mussweiler (2001) replaced the fictitious 'Xiang Long' question by questions about two actually existing targets (the year in which Albert Einstein visited the USA for the first time; the maximum length that a whale can reach) in the second experiment. The results replicated the findings of study 1 and showed a significant anchoring effect in both no-delay and one-week delay conditions. The effects of anchoring could even remain till one week later once the anchor value was provided. Furthermore, a target question which may encounter more interactions from other relevant information about the target during the delay period was adopted in study 3. Participants were asked to compare the annual mean temperature in Germany with a particular anchor number ($20^{o}C$ as the high anchor value and $5^{o}C$ as the low anchor value), and then to give their own estimates of the temperature either immediately or one week later. In this study, the alternative relevant information about the target value (the temperature in Germany) is encountered more frequently (on a daily basis) than the previous two studies. But again, significant anchoring effects in the no-delay and one-week delay conditions are demonstrated, although none of the participants in the delay condition could recall the anchor value that was given to them one week earlier.

The social judgement research has suggested that the degree of durability of judgement will be damaged if alternative relevant information about the judgemental task is encountered frequently during the judgemental delay (Wyer and Srull, 1989). This is not consistent with the case of anchoring effects. In Mussweiler (2001)'s three experiments, the possibility that relevant information about the target object is encountered between the judgemental priming and the time when they are required to give the absolute estimate is increasing. However, increasing the frequency of relevant information does not seem to diminish the durability of the anchoring effects demonstrated in these studies. This might result from the self-generation process of knowledge activation in judgemental anchoring. In particular, self-generated information affects people's judgements more deeply than externally provided information (Davies, 1997; Mussweiler and Neumann, 2000; Mussweiler and Strack, 1999b; Slamecka and Graf, 1978). In terms of anchoring effects, although the anchor value is externally provided to the judges, the absolute estimates of the target question need to generate by themselves. The information involved in the delay interim, is however, "typically externally provided rather than self-generated and will consequently have a rather shallow effect" (Mussweiler, 2001; p. 439) on judgements. Therefore, the influence of frequent but external information is "too weak to undermine" (Mussweiler, 2001; p. 439) the influence of the self-generated target value estimated one week later. In summary, anchoring effects may be more robust and durable than other knowledge accessibility effects, i.e. less likely to be affected by new alternative information during the delay (Mussweiler, 2001).

2.3.3 Underlying Mechanism of Anchoring Effects

Whilst the robustness of anchoring effects has been demonstrated in a variety of judgemental domains (as mentioned above), the underlying mechanisms of these effects still remain unclear. Mussweiler and Strack (1999a) discussed four models which intend to explain anchoring effects: insufficient adjustments, conversational inferences, numerical priming, and selective accessibility. They argued that the first three models are all insufficient to explain the anchoring effect, and the selective accessibility model provides a better understanding of it. In addition, Chapman and Johnson (2002) proposed two models to explain anchoring effects: anchoring as adjustment (which is similar to the insufficient adjustment model) and anchoring as activation (which is similar to the selective accessibility of information model). Finally, it is suggested that "judgemental anchoring is not a single mental trick but a set of tricks" (Epley, 2004; p. 241). If one single model cannot fully explain the mechanism of anchoring effects, probably a better idea is to combine some of the models together.

2.3.3.1 Insufficient Adjustment

In Tversky and Kahneman's (1974) original study, *insufficient adjustment* is used to explain the effect of anchoring. In this mechanism, the anchor serves as a starting point and people adjust their estimates upwards or downwards from the anchor value to reach the final answer. Such adjustment is often insufficient, which biases the final estimate toward the initial value. One possible explanation for insufficient adjustment is judges' uncertainty about the value that they need to estimate (Chapman and Johnson, 2002). For example, Quattrone *et al.* (1981) pointed out that subjects will stop the adjustment shortly after they find a range of plausible values for the target question. Jacoowitz and Kahneman (1995) also suggested that judges adjust their estimates in the appropriate direction until an acceptable value is reached. Another possible explanation for insufficient adjustment is that adjustment is effortful whereas people terminate too soon before they get the right answer due to lack of cognitive effort or resources (Chapman and Johnson, 2002).

However, researchers argue that the model of insufficient adjustment is only appropriate for cases with implausible anchors (Mussweiler and Englich, 2005; Mussweiler and Strack, 2001b; Strack and Mussweiler, 1997). In addition, Epley and Gilovich (2001) demonstrated that insufficient adjustment only contributes to anchoring effects when the anchors are self-generated and extremely implausible compared to the target value. In their further studies, Epley and Gilovich (2006) suggested that self-generated anchor values tend to lead to insufficient adjustments because people stop the adjustment once they reach a plausible value. Thus, it is difficult to explain why plausible, acceptable and relevant information also causes anchoring. For example, Northcraft and Neale (1987) found that even experts anchor their estimates of the cost of a house on a series of plausible and acceptable prices of the house, such as the listing price. Therefore, insufficient adjustment is not sufficient to explain anchoring effects. In fact, insufficient adjustment is more like a description of the anchoring effect rather than an explanation of it.

2.3.3.2 Conversational Inferences

The second model used to explain the underlying mechanism of anchoring is *conversational inferences*. People tend to use the anchor value to infer possible target values because an implicit conversation which favours the anchor value is applied in their mind (Grice, 1975). In particular, subjects may assume the anchor value provided by the experimenter is informative (which may not be the case) to the target question and hence make an estimate similar to it. In addition, it is more likely and reasonable that people regard the relevant anchor value as a hint to the real value (see for example, Northcraft and Neale, 1987).

Although the conversational inferences model explains the anchoring effect caused by informative anchors (no matter whether they actually are or not), it cannot explain the impact of implausible values on people's judgements. In addition, it cannot explain the effects caused by randomly selected anchors (Mussweiler and Strack, 1999a). Obviously, numbers generated by spinning a wheel of fortune (Tversky and Kahneman, 1974), throwing dice (Mussweiler and Strack, 2000a), or drawing cards (Cervone and Peake, 1986) have no relationship with the values to be estimated and should not be taken into account as informative hints. However, subjects still anchor their estimates on them, even if they are aware that the numbers are generated randomly.

2.3.3.3 Numeric Priming

Due to the limitations of insufficient adjustment and conversational inferences discussed above, a *numeric priming* model is adopted as an alternative to explain anchoring effects. In particular, the number priming suggests that the anchor value draws people's direct attention and increases its accessibility to people's knowledge when they make estimates about the target. Therefore, the anchor value is easily brought to mind and leads to values similar to the anchor value (Mussweiler and Strack, 1999a). As a consequence, a number of studies have argued that it is the anchor value itself that works and anchoring effects are superficial and purely numeric in nature (Jacowitz and Kahneman, 1995; Wilson *et al.*, 1996; Wong and Kwong, 2000). For example, Wilson *et al.*'s 'copying' study (1996, study 3) demonstrated anchoring effects when subjects were merely asked to copy five pages of numbers which had no relationship with the target value (the number of current students at the university who are expected to have cancer in the next 40 years) to be estimated. In addition, Wong and Kwong (2000) argued that it is the absolute value of the anchor that draws people's attention and leads to anchoring effects. A simple example is that when asked to compare the length of the runway of the Hong Kong Kai Tak Airport with an anchor value, subjects who received a high absolute value (7300m) gave greater estimates of an unrelated target value (the price of a bus) than those who received a low absolute value (7.3km).

Although the numeric priming has successfully attributed the numeric nature of the anchor value to all the anchoring phenomena, it is criticised for ignoring the semantic content with which the anchor values are associated (Mussweiler and Strack, 1999a, 2001b; Strack and Mussweiler, 1997). First, the change of the dimension of the same target object may affect the degree of anchoring. For example, Strack and Mussweiler (1997, study 1) first asked subjects to compare the *height* of the Brandenburg Gate with a low anchor value (25m), and then asked them to estimate the *height* (no change of dimension) or the *width* (change of dimension) of the Gate. The results showed that when the dimension of the target value was changed, the assimilation of their estimates to the anchor value was diminished. Similarly, after comparing whether the Cathedral of Cologne was *taller* or *shorter* than 320m (a high anchor value), subjects who estimated the *height* (no change of dimension) of the Cathedral were subject to a greater level of anchoring effect than those who estimated the *length* (change of dimension) of it for the absolute question. Second, the change of the target object may also lead to different degrees of anchoring. For example, after comparing the number of African countries in the United Nations with a specific anchor number, people's estimates of the target value of the same object (how many African countries are there in the UN) are more assimilative to the anchor value than the estimates of a different object (how many physicians are listed in the local phone book) (Wilson *et al.*, 1996, study 3).

Taken together, the change of the semantic context in which the anchor value is presented will significantly affect the influence of the anchor value on people's absolute estimates of the target value. Therefore, a framework of purely numeric priming is argued to be insufficient to explain such phenomena of anchoring (Mussweiler and Strack, 1999a, 2001b; Strack and Mussweiler, 1997).

2.3.3.4 Selective Accessibility of Information

Mussweiler and Strack propose a *selective accessibility* model to explain the underlying mechanism of anchoring effects (Mussweiler, 1997; Mussweiler and Englich, 2005; Mussweiler and Strack, 1999a, 1999b, 2000a, Strack and Mussweiler, 1997). Two fundamental principles of social cognition are associated with this model: *hypothesis-consistent testing* and *semantic priming*. The hypothesis-consistent testing process is related to a *selectivity hypothesis*. That is, participants selectively relate their retrieved knowledge about the target of a decision task to an anchor value and test the possibility that the target is consistent with the anchor value. The semantic priming process is related to an *accessibility hypothesis*. That is, generating knowledge from the comparison between the anchor and the target increases the accessibility of the knowledge, and makes it more likely to be relied on in the subsequent absolute judgement of the target value (Mussweiler and Strack, 1999a).

In particular, Mussweiler and Strack (1999a, 1999b, 2000a) suggest that to compare the judgemental target with the specific anchor value, people selectively retrieve knowledge, from memory or external resources, which is maximally consistent with the anchor value (Mussweiler, 1997; Strack and Mussweiler, 1997). Consequently, the accessibility of anchor-consistent knowledge is increased. To make the absolute estimate of the target value, subjects simply rely on the easily accessible knowledge (Higgins, 1996; Wyer and Srul, 1989) and their estimates are found to be heavily influenced by the anchoring information which has previously been retrieved. A significant assimilation of the target value to the anchor value is then performed (e.g., Mussweiler and Englich, 2005; Strack and Mussweiler, 1997). For example, people who are asked whether the Mississippi River is longer or shorter than 3,000 miles are assumed to estimate the possibility that the Mississippi River actually is 3,000 miles long. To do so, they selectively retrieve knowledge from an external resource (the provided anchor value, 3,000 miles, in this example) which is assumed to be maximally consistent with the target value. After increasing the accessibility of anchor-consistent knowledge, judges heavily rely on this easily accessible, anchor-consistent information and give their final estimates highly assimilative to the anchor value (Strack and Mussweiler, 1997). A number of studies (e.g., Higgins, 1996; Slamecka and Graf, 1978) have suggested that self-generated information is highly accessible and will lead to a higher level of anchoring, compared with anchors from external resources.

In addition, Chapman and Johnson (1999, 2002) review a number of studies (e.g., Jacowitz and Kahneman, 1995; Chapman and Johnson, 1994; Mussweiler, 1997; Strack and Mussweiler, 1997) exploring the underlying mechanism of anchoring effects and propose a notion of the *anchoring as activation*. In particular, it refers to the notion that "anchors influence the availability, construction, or retrieval of features of the objects to be judged" (Chapman and Johnson, 1999; p. 120). The target estimate is influenced by the anchor information. However, Chapman and Johnson point out that "factors that affect retrieval or construction can bias the judgement" (Chapman and Johnson, 1999; p. 120). For example, if the target and anchor share some features in common, the presence of an anchor will help increase the activation of these features and heavily influence the target evaluation. If the target object is different from the anchor, however, the features of the target will be difficult to be retrieved or constructed; therefore, the influence of anchor value to target value will be reduced.

In summary, the underlying mechanisms of anchoring effects have been of much interest in many anchoring studies and a number of models (namely, insufficient adjustment, conversational inferences, numeric priming, and the selective accessibility model) have been proposed to explain the effect of anchoring (e.g, Chapman and Johnson, 1999, 2002; Epley and Gilovich, 2001; Mussweiler and Englich, 2005; Mussweiler and Strack, 1999a, 2001b; Strack and Mussweiler, 1997). Each of these models has its own features and can at least explain some, if not all, of the anchoring phenomena. It has been suggested that anchoring effects may be due to several, not one, independent mechanisms (Epley, 2004). The exploration of these underlying mechanisms brings out an increasingly deep understanding of the operation of anchoring effects. However, the interests of this study are not focusing on *how* and *why* anchoring effects occur but on *what* factors will influence the degree of anchoring. The impacts of these influential factors on the degree of anchoring in a broad variety of judgemental environments will be discussed in more details in the following section.

2.3.4 Factors Which Influence Anchoring Effects

Following the definition, type and underlying mechanisms of anchoring effects, the factors which may cause and affect the occurrence and degree of anchoring effects are reviewed in this section. In particular, these factors are classified into two general categories: (1) external factors which describe the objective aspects of decision tasks in which anchoring occurs (judgemental context, type of anchors, framing and data presentation), and (2) the individual factors which represent the subjective aspects of decision makers who experience anchoring in judgement (experience and expertise, gender and mood, cultural background).

2.3.4.1 External Factors

The external factors which influence anchoring effects relate to the characteristics of decision tasks which are used to distinguish one task from another. Three aspects concerning the nature of the tasks are particularly considered in this study, namely, the judgemental context in which anchoring effects occur, the type of anchors (i.e., whether the anchors are self-generated or externally provided, relevant or irrelevant to the targets), and the framing and data presentation of decision tasks (i.e., how the tasks are described and presented to the decision makers). The applications of these factors in anchoring are discussed below.

Judgemental Context

Anchoring research has been conducted in a large variety of judgemental contexts. For example, anchoring has been investigated in the areas of general knowledge questions (e.g., Mussweiler, 2001; Strack and Mussweiler, 1997; Tversky and Kahneman, 1974; Wegener, *et al.*, 2001; Wilson *et al.*, 1996; Wong and Kwong, 2000), estimates of self-efficacy (Cervone and Peake, 1986), probability estimates and gambles (e.g., Carlson, 1990; Chapman and Johnson, 1994; Davies, 1997; Englich, Mussweiler and Strack, 2006; Ganzach, 1996; Plous, 1989), price estimates and auctions (e.g., Dholakia and Simonson, 2003; Dodonova and Khoroshilov, 2004; Mussweiler, *et al.*, 2000), negotiations (e.g., Chertkoff and Conley, 1967; Galinsky and Mussweiler, 2001; Kristensen and Garling, 2000; Ritov, 1996), judicial judgements (Chapman and

Bornstein, 1996; Englich and Mussweiler, 2001; Englich *et al.*, 2006; Farina *et al.*, 2003), real estate judgements (Northcraft and Neale, 1987), auditing judgements (Joyce and Biddle, 1981), medical judgements (Brewer, Chapman, Schwartz and Bergus, 2007), and military and political judgements (Plous, 1989; Whyte and Levi, 1994).

Based on these studies, a number of judgemental biases caused by anchoring have been identified (Chapman and Johnson, 1999, 2002; Mussweiler, 1997; Mussweiler and Strack, 1999a), for example the confirmation bias (e.g., Snyder and Swann, 1978), overconfidence (e.g., Block and Harper, 2001; Griffin and Tversky, 1992), and the hindsight bias (e.g., Chapman and Johnson, 1999; Fischhoff, 1975; Hawkins and Hastie, 1990).

(1) General knowledge questions

Researchers in psychology often use general knowledge questions to investigate anchoring effects. University students are often used as subjects in these experiments. For example, in their original study, Tversky and Kahneman (1974) used a general knowledge question, the percentage of African countries in the United Nations, to explore anchoring effects. Similarly, Wilson *et al.* (1996, Study 1) adapted this question in their study, asking subjects whether the number of African countries in the UN is higher or lower than a specific anchor value, and consequently asked them to give their own estimates of the target value.

A number of general knowledge questions used in laboratory experiments are designed by Mussweiler and his colleague Strack (e.g., Mussweiler, 2001; Strack and Mussweiler, 1997). For example, Strack and Mussweiler (1997, Study 1) asked male and female non-psychology students at the university to estimate the height or width of the Brandenburg Gate or the length or height of the Cathedral of Cologne, in order to examine the influence of changing the dimension of the target question on the degree of anchoring. Moreover, Mussweiler (2001) adapted the question used by Wong and Kwong (2000) about the length of the runway of the Kai Tak Airport in Hong Kong to one which German students should have general knowledge (i.e., the length of the runway of the airport in Nuremberg in Germany) to test the nature of the semantics of anchoring.

Other general questions such as the hottest temperature in Seattle, the age at which George Washington died (Wegener, *et al.*, 2001), the annual mean temperature in

Germany (Mussweiler and Englich; 2005), have also been employed in anchoring studies.

Since it does not require specific knowledge or experience to answer these types of questions, it is argued that answers to general knowledge questions may be more likely to reflect subjects' unconscious reactions to anchor values and target questions. Therefore, general knowledge questions are regarded as ideal examples to be used by psychological experimenters in anchoring research.

(2) Estimates of self-efficacy

A number of studies have been conducted to examine self-efficacy, a belief referring to people's judgements about their capabilities in executing required actions and solving problems or tasks (Cervone and Peake, 1986; Wood *et al*., 2000). For example, Cervone and Peake (1986) explored the impact of the anchoring effect on individuals' self-efficacy judgements about their performance capabilities. The results showed that people's estimates of their capabilities for task performance were strongly affected by the effect of anchoring. In particular, participants were firstly asked to withdraw a card from a series of cards with a number on each of the cards (actually, only two numbers appeared on the cards, one high and one low). Then they were given a set of 40 problem-solving tasks to finish within 15 minutes, after estimating the number of tasks that they expected themselves to complete. Participants who received a high number from the cards gave a higher estimate about their capabilities in finishing the forthcoming tasks, whereas those who received a lower anchor value beforehand provided a lower self-efficacy estimation about the number of tasks that they could finish. These results suggest that even randomly selected anchor values which are obviously uninformative to the target question can bias self-efficacy judgements. It should be noted that the researchers used half males and half females as subjects in their experiments and found no gender differences in the degree of anchoring effects.

In addition, Wood *et al.* (2000) examined the relationship between self-efficacy and performance on complex tasks by exploring individuals' perceived capabilities for conducting searches and for processing information. They found that individuals who are low in search efficacy are more likely to rely on memory rather than external search, and hence are more likely to employ the availability heuristic. However, people who are low in processing efficacy are more likely to use the anchoring and adjustment heuristic and the representativeness heuristic in order to reduce cognitive effort required in making judgements and decisions.

(3) Probability estimates and gambles

The judgemental tasks associated with probability estimates and gambles have been widely explored in a number of studies and strong anchoring effects have been detected (Carlson, 1990; Chapman and Johnson, 1994; Englich *et al.*, 2006; Ganzach, 1996; Schkade and Johnson, 1989). For example, Carlson (1990) conducted three experiments to examine the relationship of subjects' minimum selling prices to three-outcome gambles. In particular, subjects were asked to assume that they had a ticket to play a gamble and that they could either choose to play the gamble or sell the ticket. They were then asked to estimate the minimum price at which they would like to sell the ticket and give up the gamble. For a gamble, they had a 35% chance to win $5.95, a 35% chance to win $5.60, and a 30% chance to win $5.25. The results showed that subjects' estimates of the minimum selling prices were heavily influenced by the intermediate outcome (the winning price of $5.60 in this example), rather than the expected utility, of the gamble. This effect of anchoring on the intermediate outcome of the gamble is explained as follows: when none of the outcomes has a chance of more than 50%, the intermediate outcome is given more attention in that it is similar to both the small outcome and the large outcome. Therefore, people tend to anchor their estimates on the intermediate outcome and forget about the rule of expected utility. However, when one of the outcomes had a higher probability (greater than 50%) to occur, they then anchored their judgements on the high-probability outcome rather than the intermediate one.

Another example of anchoring judgements on the outcome of gambling is given by an experiment associated with playing dice and criminal sentences (Englich *et al.*, 2006). Englich *et al.* (2006) found that the sentencing decisions of experienced legal professionals were significantly influenced by irrelevant sentencing demands, even if when they were aware that the demand was determined randomly or when the judges themselves determined the demands by throwing dice. In addition, the participants' expertise and experience in criminal sentencing were found to have no contribution in reducing the effect of anchoring.

(4) Price estimates and auctions

The effect of anchoring has been widely demonstrated in many studies in the areas of consumer choice, purchase price and quantity estimates, online auctions, and investments (e.g., Birnbaum and Zimmermann, 1998; Dholakia and Simonson, 2003; Dodonova and Khoroshilov, 2004; Mussweiler, *et al.*, 2000; Wansink, Kent and Hoch, 1998).

It is argued that anchoring is likely to happen in a bargaining setting since the fair market value of the object is not objectively determinable, and the selling price is actually achieved by a bidding process in which the seller's asking or listing price may serve as an anchor (Northcraft and Neale, 1987). For example, Dholakia and Simonson's (2003) field and laboratory experiments suggested that when consumers were explicitly encouraged to compare listing prices, they tended to be more cautious and careful in their purchase and bidding behaviour. In addition, Dodonova and Khoroshilov (2004) demonstrated anchoring effects from the bidding prices of online auctions. The bidding prices placed by the bidders were found to be significantly affected by the seller's 'buy now' prices. The higher the 'buy now' price was, the higher price the bidders were willing to pay, and therefore, the higher winning bid price resulted. Since the winning bid price could be affected by some other factors such as the seller's reputation, the number of bidders, reserve prices, the researchers chose identical products from the same seller with the same product descriptions to avoid interactions caused by these other factors.

Besides the price, the purchase quantity has also been shown to be subject to anchoring effects. Wansink *et al.* (1998) conducted two field studies and two laboratory experiments to explore the relationship between purchase promotions (which served as anchors) and consumers' purchase quantities. They found that a multi-unit price promotion (such as "On sale – 6 cans for $3") would lead to a larger purchase quantity than a single-unit price promotion (such as "On sale – 50 cents each"). A further experiment constructed a 2(anchor vs. no anchor) × 3(no discount vs. 20% discount vs. 40% discount) factorial design using 6 well-known products. The promotion descriptions without quantity implications (such as "Snickers bars – buy them for your freezer") provide a no-anchor condition, and the descriptions with quantity suggestions (such as "Snickers bars – buy 18 for your freezer") serve as the anchors. The results showed that the potential purchase quantity increased according to the degree of the discount, and the promotion with external anchors even increased the purchase quality when there was no discount on the price (i.e., encouraged people to buy a certain quantity of products even without a change of price). This seems to support the notion of basic anchoring effects: there was no change in the price of the product, hence subjects in the experiment would not have a comparison between the original price and the discount price, but they were still affected by the promotions and intended to buy more than without promotions.

(5) Negotiations

The use of anchoring and adjustment heurist has been explored in the context of negotiations and bargaining in a number of studies (e.g., Black and Diaz, 1996; Chertkoff and Conley, 1967; Galinsky and Mussweiler, 2001; Kristensen and Garling, 1997, 2000; Poucke and Buelens, 2002; Ritov, 1996; Whyte and Sebenius, 1997). All the studies demonstrated strong evidence of anchoring on the opening offer (an initial price elicited by the buyer or the seller at the beginning of the bargaining process) of the negotiation. In particular, Black and Diaz (1996) found that in a simulated bargaining experiment, the final agreement between the buyer and the seller was strongly similar to the initial offer. Therefore, they argued that eliciting an extreme opening offer (no matter from the buy-side or the sell-side) was a better strategy than eliciting a moderate opening offer. By testing the interactions between opening offers and the frequency of concessions, they found that an extreme opening offer with an infrequent movement rate of concessions did better than with a moderate movement rate of concessions. However, no significant difference was detected in participants' performances in conditions of frequent and infrequent movement rates when using the moderate initial offer. Consequently, Chertkoff and Conley (1967) suggested that starting with an extreme initial offer together with infrequent concessions might be a superior strategy in negotiations. Similarly, Black and Diaz (1996) examined the use of the seller's asking price in the context of real property negotiation and found that the buyer's opening offer for the property was strongly influenced by the asking price, even when the latter was obviously incongruous. No significant difference between graduate students and mid- to upper-level real estate executives was detected in their estimates. They attributed this bias to the limited processing capacity of the human mind (Newell and Simon, 1972; Simon, 1978).

Besides the influence of an opening offer on the final settlement price in negotiations (Black and Diaz, 1996; Chertkoff and Conley, 1967; Galinsky and Mussweiler, 2001), a number of studies have extended the examination to other internal prices generated by buyers and sellers in negotiation processing, such as the reservation prices[11] and the aspiration prices[12] (e.g., Kristensen and Garling, 1997, 2000; Poucke and Buelens, 2002; Ritov, 1996). For example, Kristensen and Garling (1997) indicated that the first counteroffer[13] of the buyer in a negotiation was jointly affected by the seller's initial offer and the buyer's reservation price. In a further study, Kristensen and Garling (2000) demonstrated that the size of counteroffers in a price negotiation was affected by the proposed selling price and reservation price. In addition, Poucke and Buelens (2002) investigated the difference between the aspiration price and the initial offer, which they called the 'offer zone', for both buyers and sellers. They identified a significant and consistent influence of offer zone on the final negotiated result. However, Galinsky and Mussweiler (2001) suggested that the influence of the opening price offered by one side (no matter which side, buyer or seller) of the negotiation was negated if the other side of the negotiation focused on other information, such as the reservation price, aspiration price, or other alternative prices made by the latter. This finding can be used to debias the influence of first offer: the more alternative information involved in the judgemental procedure, the less impact the anchor value has on negotiators' judgements (Galinsky and Mussweiler, 2001).

Apart from the influence of internal prices (e.g., opening offer, reservation price) on a negotiation's final settlement price, the impact of externally provided prices (e.g., fair market price) on the final price is also significant (Poucke and Buelens, 2002). Whyte and Sebenius (1997) found that even irrelevant information, such as an unreliable anchor introduced just before the negotiation started, is sufficient to cause significant anchoring effects in the context of negotiation for both individual and group judgement. Moreover, group estimates are not made by using the anchoring heuristic but by adopting the majority view at the beginning of group discussion or by averaging

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[11] A reservation price, also called the bottom line, is an indifference point where the negotiator should theoretically be indifferent between accepting the offer and terminating the negotiation. It is the lowest outcome that a negotiator is willing to accept.

[12] An aspiration price refers to the best outcome at which a negotiator would expect to obtain in a price negotiation (Blount, Thomas-Hunt and Neale, 1996).

[13] The counteroffer is the price generated by the negotiator in a negotiation processing, according to the initial offer presented.

the individual estimates if the majority does not exist. Therefore, anchoring effects elicited by individuals cannot be reduced by the group.

(6) Judicial judgements

A large number of anchoring studies have been focusing on judicial judgements and decisions (e.g., Chapman and Bornstein, 1996; Englich and Mussweiler, 2001; Englich *et al.*, 2006; Farina *et al.*, 2003; Mussweiler and Englich, 1998). Both experimental trials and actual judicial decisions have been examined. Judgements and decisions made by amateurs (university students) and experts with professional knowledge (jurors) are both explored.

For example, Chapman and Bornstein (1996, Study 1) constructed a mock trial to examine the influence of monetary compensation requested by the plaintiff (the anchor value) on jurors' judgements of compensation awarded. Undergraduate students were used as mock jurors in this study. They were provided with a one-page description of a personal injury suit with the complete case summary in the Appendix. All the information provided to each student was the same but with one difference: the amount of the compensation ($100, $20,000, $5 million, and $1 billion, respectively) requested by the plaintiff. The result suggested a reversal effect for the influence of the extremely high compensation anchor ($1 billion) because the value is too extreme to be true. The extremely high request caused the jurors to think the plaintiff was greedy and selfish and regarded her compensation request as less favourable and reliable. In contrast, an extremely low compensation request ($100) may lead to a low estimate of the probability that the defendant caused the plaintiff's injury because the value is too low. For the middle compensation, jurors' compensation judgements were strongly influenced by the amount that the plaintiff requested, providing a significant demonstration of anchoring effects. Therefore, it was suggested that the more the plaintiff requested, the more she would get (unless the request is regarded as 'greedy'). It might be argued that the knowledge and experience of the mock jurors (undergraduate students) would affect the judgemental accuracy of this task.

Another study examined the relationship between judges' sentencing decisions and the sentence demanded by the prosecutor in criminal trials (Englich and Mussweiler, 2001). The first experiment used identical cases as decision tasks which controlled all the other potential influential factors (such as, severity of the crime, defendant's criminal record) and only differed in the sentencing demand (a longer demand of 34 months and a shorter demand of 2 months, requested by the prosecutor). Criminal trial judges were used as decision makers. The results showed that judges' sentencing decisions were strongly affected by the sentence demand from the prosecutor. The final sentences for the same case differed by 10 months according to the high and low anchor values. The second experiment was designed to detect the influence of uninformative/irrelevant anchors on judges' sentencing decisions. The materials were identical to those in the previous study. However, half of the participants were instructed to make sentencing judgement based on a demand suggested by a first-year computer student; clearly this student had no relevant expertise or knowledge related to the case. The other half were provided with the sentence demand by a prosecutor; obviously the prosecutor was an experienced and knowledgeable expert in the area. The results replicated the findings of other studies concerning the influence of irrelevant anchors (e.g., Cervone and Peake, 1986; Chapman and Johnson, 1994; Mussweiler and Strack, 1999b, 2000a; Strack and Mussweiler, 1997). That is, participants in the experiment showed a significant effect of anchoring on the demand suggested by the computer science student, even if they knew that this person had no experience or knowledge in the case and that his suggestion should be regarded as entirely irrelevant to the decision task. Finally, the third experiment demonstrated that judges' sentencing estimates were independent from their experience. In particular, even trial judges from superior court with an average of more than 15 years of experience in criminal judgements were found to strongly assimilate their estimates of the sentence to an obvious irrelevant sentencing demand. This result confirmed the findings of previous studies on experts' anchoring effects (e.g., Northcraft and Neale, 1987; Wilson *et al.*, 1996). However, since such anchoring was detected under a strictly controlled environment which eliminated interactions from other factors, whether anchoring effects occur will appear in a pure (i.e., not manufactured) but complicated (i.e., with all the influential factors) real world environment remains unclear.

Based on the laboratory studies in judicial anchoring (for a more detailed review, see Englich and Mussweiler, 2001), Farina *et al.* (2003) explored the bias of anchoring effects by reviewing actual judicial decisions. In particular, they analysed the protocols of 555 penal judgements from a total of 99 judges/courts in a region in northwest Spain. The period of judgements covered 15 years from 1980 to 1995. The results reported a considerable impact of anchoring on 63.6% of the judges' judgements, driven by a sentence request from the public prosecutor or, if in the case of an appeal, by the prior judicial decision. Although no general solutions have been indicated in debiasing the effect of anchoring in decision making, two methods are suggested, at least partially, to be useful in reducing the effect (Farina *et al.*, 2003). Specifically, one is to provide training to judges and magistrates about sources of bias, so that they can be more aware of the potential bias which may occur in their decisions and make efforts to make more objective decisions. The other one is to provide more information during the judgemental processes, such as generating and/or considering alternative anchoring values. The interactions between the information from a variety of sources may interact with each other and therefore, the judges' specific attention on a specific piece of information may be eliminated (Plous, 1993).

(7) Real estate judgements

The representative study exploring the anchoring effect in the field of real estate property was conducted by Northcraft and Neale (1987). They first invited participants to visit a house which was located in the place where the participants lived and which was currently for sale. Subsequently, they were asked to estimate four different prices for the house (namely, the appraised value of the house, an appropriate advertised selling price, a reasonable price to pay for the house, and the lowest offer they would accept if they were the seller) according to the information provided. The information package provided to each subject contained the same information which real estate agents suggested would be useful in property appraisal, with only one exception – the listing price of the house. Four listing prices ($65,900, $71,900, $77,900, $83900) were equally distributed around the actual listing price ($74,900), serving as the extremely low, low, high, and extremely high anchor values, respectively. The results revealed that both novice (undergraduate students) and expert (professional real estate agents) participants significantly anchored their estimates of the listing price on the number they were provided with. This suggested that the anchoring phenomena detected in the context of the artificial and manufactured laboratory experiments (Hogarth, 1981; Tversky and Kahneman, 1974) is also available in informative-rich and dynamic real world settings, such as real estate property. In addition, the results revealed that the extremity of the anchor values actually reduced the impact of listing prices on participants' estimates (i.e., the mean deviations of the estimates were higher for the more distant anchors, either extremely high or low).

Further investigations (e.g., to check what information participants used in those decision processes, what the 'top three' considerations were for them in reaching an answer, etc.) found that the degree to which the participants' estimates focused on the provided anchor values was higher for the students than for the real estate agents. Moreover, the students were more likely to admit the use of listing price as the reference in their decision process than the experts. However, whether the denial of the experts was due to their lack of awareness of using the listing price as anchors, or simply due to their unwillingness to admit it, remains unclear (Northcraft and Neale, 1987).

Following Northcraft and Neale's (1987) investigation, a number of studies have been conducted to examine anchoring effects in the context of real estate property from the aspect of valuation, appraisal and negotiation(e.g., Black and Diaz, 1996; Diaz, 1997). Again, these studies revealed a significant anchoring effect derived from the anchor values (usually the opening price in negotiations) to the final settlement price agreed on both sides by those negotiating. Diaz (1997), however, found that valuations of a property made by expert appraisers were not biased towards anchors if the experts were familiar with the object to be estimated, such as the location and physical conditions of the house. This suggests that experts who have professional knowledge or experience in the decision task are subject to a lower level or to no anchoring effects, compared with novice judges (see Section 2.3.4.2 for more details). It should be noted that the means of data presentation, data collection, and analysis techniques of decision makers may also contribute to the anchoring bias (see the section of 'Framing and Presentation' below for more details).

(8) Auditing judgements

Judgement and decision making in professional auditing have been broadly explored from various perspectives. Studies show that the judgemental performance of auditors are affected by a number of internal and external factors, such as the experience and knowledge of the auditors, the emotions of the auditors, and the type of information and judgemental tasks (Ashton, 1991; Ashton and Ashton, 1988; Bhattacharjee and

Moreno, 2002; Bonner, 1990; Hoffman and Patton, 1997; Krull, Reckers and Wong-On-Wing, 1993; Shelton, 1999; Smith and Kida, 1991).

Auditors' previous experience has been demonstrated to have a strong impact on their professional judgements about the fairness of their clients' financial statements (Ashton, 1991; Bhattacharjee and Moreno, 2002; Bonner, 1990; Krull *et al.*, 1993; Shelton, 1999). For example, Bonner (1990) found in exploring the impact of auditors' experience on their judgements, their knowledge of specific tasks played an important role. Ashton (1991) further examined auditors' knowledge about the base rate of, and the underlying reason for, the occurrence of an error in an individual financial statement account. It was indicated that auditors' experience was related to specific audit tasks and the knowledge corresponding to the task, rather than simply the length of audit experience in any or a specific industry, or the number of clients audited.

In terms of the use of information, a diluting effect of irrelevant information (i.e., the involvement of irrelevant information dilutes the impact of relevant information on auditors' judgements) was confirmed among less experienced auditors (audit seniors), but was not encountered by more experienced auditors (audit managers and partners) (Shelton, 1999). Similarly, Bhattacharjee and Moreno (2002) explored the impact of realistic but irrelevant affective information on auditors' professional judgements of a client's inventory obsolescence risk. The results indicated that judgements of less experienced auditors were significantly influenced by the negative affective information provided to them, whereas auditors with more experienced were not affected by this piece of irrelevant information. Smith and Thomas (1991) also confirmed a reduction in the degree of bias displayed by expert auditors (for more details of experience and expertise related factors, see Section 2.3.4.2).

Moreover, Joyce and Biddle (1981) demonstrated that auditors encountered a significant anchoring effect in their estimates of the probability of a significant executive-level management fraud, given the information provided. In particular, subjects were first asked to compare whether the number of firms which had significant executive-level management fraud was higher or lower than an anchor number in every 1,000 firms. Both high (20 firms out of 1,000 Big Eight clients, i.e., 1%) and low (10 firms out of 1,000 Big Eight clients, i.e., 2%) anchor values were employed. They were then asked to give their own estimates of proportion of the firms which might encounter management fraud (target value). The results showed that in both high and low anchor conditions, subjects' absolute estimates were strongly biased towards the anchor number provided. However, although the two starting points both led to significant anchoring effects, the effect was eliminated when the anchor value increased to an extremely high level (3% in this study). This seems to suggest that the magnitude of the anchoring effect is not monotone increasing with an increase in the anchor value. This finding is confirmed by other literature (Chapman and Johnson, 1994).

(9) Medical judgements

Anchoring effects have also been detected in the area of medical judgements and have been demonstrated to affect doctors' and patients' choices (Brewer *et al.*, 2007). In their first experiment, Brewer *et al.* (2007) asked 99 HIV+ patients to compare the chance of infecting their partners with HIV if a condom broke during sex. They were provided with an uninformative anchor number (1% as the low anchor and 90% as the high anchor). They were then required to give an absolute judgement of the chance of infection, and asked to choose the treatments that they would recommend for their partners. The results showed that the patients' judgements were strongly affected by the irrelevant anchor value that they received. However, there was no significant relation between the patients' anchor level and the aggressiveness of their choices of treatment (i.e., no evidence showed that they chose more aggressive treatment if they estimated a higher chance of getting infected).

In the second experiment they used skilled experts in medical decision making (physicians) to replicate the previous findings. Physicians' estimates of the probability that a patient had a pulmonary embolism were significantly influenced by the irrelevant anchor values provided to them (1% as the low anchor and 90% as the high anchor). Similar to the first experiment, the physicians' choices of treatment for the patient had no or little relation to their level of anchoring. Note that the anchoring effects were not moderated by increasing the subjects' motivation for accuracy.

Finally, the researchers emphasised that this study may be the first one examining how anchor values affect choices through judgements. However, they only examined the situations in which judgements were related to the corresponding choices and the relationship between anchoring effects and choices which are not related to judgements requires further exploration.

(10) Military and political judgements

An early study exploring anchoring effects in the domain of the military was conducted by Plous (1989). A strong anchoring effect was demonstrated on subjects' likelihood estimates of a nuclear war. The results also suggested that increasing the ease with which participants imagined a nuclear war (by providing an instruction of the most likely path to a nuclear war) did not affect the level of their likelihood estimates or the level of anchoring.

More recently, Whyte and Levi (1994) explored the origins and function of the reference point (a standard point against which the comparisons and evaluations of potential outcomes of the choice are made; this can also be regarded as the anchor value in an evaluation) in risky group decision making based on a case study of the Cuban missile crisis. The researchers analysed the 7-day documentation of the group (consisting of American President John F. Kennedy and his advisers) decision making process concerning the Cuban missile crisis. A piece of information mentioned in one of JFK's public statements was found to be used as a neutral reference point (the anchor value) during that period. They found that in a group decision making process, the privilege of placing the reference point was under the group leader. Therefore, to influence the judgement of other decision makers in the group appears to have no impact on judgements of the group. Contributions of this study to the anchoring research were that (1) it investigated the impact of a reference point (the anchor value) on decisions made by groups of experienced decision makers, rather than individuals, and (2) the investigation was conducted using data obtained from real world decisions, rather than observed from laboratory or field experiments.

Type of Anchors

Anchoring effects have been demonstrated to be caused by different types of anchors which may have different impacts on the degree of anchoring. For example, judges may anchor their absolute estimates of the targets on self-generated anchors (e.g., Davies, 1997; Mussweiler and Neumann, 2000; Mussweiler and Strack, 1999b, Tversky and Kahneman, 1974), or externally provided anchors (e.g., Tversky and Kahneman, 1974). It has been suggested that self-generated anchors may have a deeper impact on people's judgements and therefore lead to a higher level of anchoring than externally provided anchors do (Davies, 1997; Epley and Gilovich, 2001, 2005; Mussweiler and

Neumann, 2000). In addition, anchoring effects may occur when the anchor value is informative and relevant to the target (e.g., Northcraft and Neale, 1987), or when it is randomly selected and totally uninformative (e.g., Chapman and Bornstein, 1996; Cervone and Peake, 1986; Mussweiler and Strack, 2000b; Tversky and Kahneman, 1974) or implausibly extreme and unreasonable (e.g., Chapman and Johnson, 1994; Mussweiler and Strack, 1999b; Strack and Mussweiler, 1997; Wegener, Petty, Detweiler-Bedell and Jarvis, 2001) to the target value.

(1) Self-generated anchors vs. Externally-provided anchors

Generally, two types of anchors have been explored in the literature. One type is self-generated anchors, which are internally generated by decision makers themselves during the judgemental processes (e.g., Epley, Keysar, Van Boven and Gilovich, 2004; Epley and Gilovich, 2005; Keysar and Barr, 2002; Mussweiler, 2001; Mussweiler and Neumann, 2000; Mussweiler and Strack, 1999b; Poucke and Buelens, 2002; Slamecka and Graf, 1978; Tversky and Kahneman, 1974). Self-generated anchors are often formulated in the comparison stage of developing an estimate, through a calculation or prediction process, when no external anchors are provided. For example, in Tversky and Kahneman's (1974) original study, two groups of high school students were asked to estimate in 5 seconds the results of the expressions $1\times2\times3\times4\times5\times6\times7\times8$ and $8\times7\times6\times5\times4\times3\times2\times1$. Within strict time limits, subjects could only calculate the first few steps of the expression and used it as an anchor to estimate the final answer. Therefore, the average estimate for the ascending expression (512) was much lower than that for the descending expression (2250).

Rather than self-generated, anchors may also be external. External anchors are explicitly provided by external sources such as the experimenter in an experiment (e.g., Brewer *et al.*, 2007; Davies, 1997; Dholakia and Simonson, 2003; Hinsz *et al.*, 1997; Mussweiler and Neumann, 2000; Mussweiler and Strack, 1999b, 2000a; Poucke and Buelens, 2002; Rutledge, 1993; Tversky and Kahneman, 1974). The majority of anchoring studies are conducted in experiments using externally provided anchors. A typical example was the random number spun by a wheel of fortune in front of the subjects in Tversky and Kahneman's (1974) study. The subjects were asked to compare the real answer to a specific question with this externally provided anchor number, and then to give their own estimates of the target value. Similarly, Hinsz *et al.* (1997)

examined people's estimates of self-set goals for their task performance. Participants were found to give higher goal estimates and actually performed better in tasks, when instructed to set a goal with an unreasonable high anchor value in the instruction rather than with a low anchor or no anchor value in the instruction. In Wong and Kwong's (2000) experiments, subjects were asked to compare whether the length of the runway of the Hong Kong Kai Tak Airport was higher or lower than an explicitly provided anchor value (7300m or 7.3km). Practice physicians were asked to compare the chance that a person was affected with HIV+ with an anchor number provided by the experimenter (Brewer *et al.*, 2007). A suggestion of the number of hours that a student might need to complete an accounting project was provided, in Rutledge's study (1993), to the participants before they estimated the actual time required. All these studies demonstrated a significant effect of anchoring on these externally provided anchor numbers, relevant or irrelevant, arbitrary or plausible.

Although both self-generated and externally provided anchors have strong impacts on the participants' final estimates, the influence of self-generated anchors may be greater (i.e., lead to an estimate more similar to the anchor value) than that of external anchors (Davies, 1997; Mussweiler and Neumann, 2000; Poucke and Buelens, 2002). This suggestion is inferred from a number of studies investigating the impact of internal and external sources on judgement. For example, Davies (1997) examined the impact of self-generated and provided explanations for event outcomes. They found that explanations generated by the subjects themselves had a greater impact on subjects' belief persistence after the outcomes were discredited compared with explanations which were provided, even when the provided explanations were shown to be a higher quality. Mussweiler and Neumann (2000) explained the influence of mental contamination of self-generated and externally provided information on judgement. The results of two experiments demonstrated that judges are more likely to be consistent with internally generated information because it yields assimilation to their judgements, whereas externally provided information is more likely to elicit contrast and leads to mental contamination and judgemental correction.

Overall, the results of these studies suggest that anchors generated by judges themselves may have a greater impact than externally provided anchors on the judges' final estimates; their estimates may be more similar to self-generated anchors rather than to externally provided ones. Therefore, Mussweiler (2001) suggested that self-generated information may lead to stronger and more durable anchoring effects than that associated with information which is provided. This can be explained by the model of selective accessibility of knowledge: self-generated information has a greater accessibility to people than explicitly provided information because the former is generated by decision makers themselves and it is therefore more easily accepted and serve as an anchor (Mussweiler, 1997; Mussweiler and Strack, 1999a, 2000a; Mussweiler, Strack and Pfeiffer, 2000; Strack and Mussweiler, 1997). Further studies have suggested that only anchoring effects caused by self-generated anchors were sensitive to incentives and forewarnings (Epley and Gilovich, 2005).

Note that although the difference in the impacts of anchors from different sources can be induced from the literature of cognitive research, it has not been empirically demonstrated in anchoring studies. Further research is therefore required to confirm these findings.

(2) Relevant anchors vs. Irrelevant anchors

Anchoring effects are not only caused by anchors which are relevant, informative, and plausible to the target tasks (Mussweiler, 2001; Mussweiler and Strack, 2000a; Northcraft and Neale, 1987; Strack and Mussweiler, 1997), but can also be elicited by uninformative, irrelevant, or randomly selected anchors (e.g., Brewer *et al.*, 2007; Cervone and Peake, 1986; Chapman and Johnson, 2002; Joyce and Biddle, 1981; LeBoeuf and Shafir, 2006; Mussweiler and Strack, 2000b; Thorsteinson, Breier, Atwell, Hamilton and Privette, 2008; Tversky and Kahneman, 1974), or implausible and extreme anchors (Chapman and Johnson, 1994; Mussweiler and Strack, 1999b, 2000a, 2001a; Strack and Mussweiler, 1997; Thomas and Handley, 2005; Wegener *et al.*, 2001; Wilson *et al.*, 1996).

Several studies have found that anchoring occurs when anchors are relevant, informative, and plausible to the target questions. As discussed before, Northcraft and Neale (1987) found that both students and real estate agents anchored their estimates of a house's selling price on a piece of relevant information, the listing price of the house provided by the seller. In addition, Mussweiler (2001, Study 3) asked subjects to estimate the average annual temperature in Germany after comparing the mean temperature with a high or low anchor value. A significant anchoring effect was found even one week after the comparison process. However, it is suggested that an involvement of relevant information (the temperature on a daily basis during the week) did not eliminate the impact of the externally provided anchor on the subjects' estimates during the delay period.

The vast majority of anchoring studies have demonstrated that even irrelevant, uninformative, or arbitrary and implausible anchors can elicit strong anchoring effects. Tversky and Kahneman's (1974) study suggested that people's estimates about the target value were affected by a randomly selected number, a number generated by a wheel of fortune in front of the subjects, even if it was obviously irrelevant to the target to be estimated. Joyce and Biddle (1981) found that practicing auditors' judgements about the proportion of 1,000 clients of the Big Eight Accounting Firms which had encountered significant executive-level management fraud was significantly influenced by an arbitrary number provided to them. Similar results were found by Brewer *et al.* (2007) when examining the anchoring effect of practicing physicians on irrelevant and arbitrary anchors externally provided by the experimenters.

The difference in the degree to which relevant and irrelevant anchors influence judges' final judgements has also been examined. It is suggested that although both types of anchors (relevant or irrelevant, plausible or extremely implausible) can lead to significant anchoring effects, relevant or plausible anchors are more likely to lead to a higher level of anchoring (i.e., more similar to the anchor value) than irrelevant or extreme anchors do (Chapman and Johnson, 1994; Joyce and Biddle, 1981; Quattrone *et al.*, 1981). Wegener *et al.* (2001) also demonstrated that "extreme anchors can have less influence on judgements than more moderate anchors" (p. 62). These results indicate that the irrelevant and extreme anchors may actually reduce the impact of these anchors on people's judgements and therefore judges would adjust further away from these numbers (see also, Wilson *et al.*, 1996).

Framing and Data Presentation

Framing refers to the way that a problem is identified. It provides the context within which certain events or phenomena are given meaning and are explained in a particular way (Beach and Connolly, 2005). It has been suggested that different frames raise the focus on different kinds of information and the way that information is presented may have different impacts on people's judgement and decision making (e.g., Ashton and Ashton, 1988; Chatterjee, Heath, Milberg. and France, 2000; Fox and

Rottenstreich, 2003; Harries, C. and Harvey, 2000; Igou and Bless, 2007; Juslin, Wennerholm and Olsson, 1999; Krull *et al.*, 1993). The way information is handled and processed plays an extremely important role in judgement and decision making in many complex situations (Havard, 2001).

In particular, a number of studies have demonstrated that framing and data presentation can lead to different levels of anchoring effects (Havard, 2001; Krull *et al.*, 1993; Oppenheimer, LeBoeuf and Brewer, 2008; Strack and Mussweiler, 1997; Wong and Kwong, 2000). Wong and Kwong (2000) suggested that how the anchor is presented affects the degree of anchoring. For instance, although two anchors were semantically equivalent, the one with the higher absolute value (7300m) caused a higher estimate of the target whereas the anchor with the lower absolute value (7.3km) generated lower estimates for the target question. It has consequently been argued that it is the absolute value rather than the semantics of the anchors that make the impact on people's absolute numerical judgements (Wong and Kwong, 2000).

Havard (2001) examined the impact of the mode of data presentation of anchors in a context of real estate valuation. In the first experiment the subjects, who were sequentially provided with a series of recent transaction prices of the property (which served as anchors), significantly anchored their estimates of market price of the property on these previous prices. However, those who had no such information did not show the same bias. In the second experiment, the anchor values were presented in a tabulated form and no apparent bias was detected. Therefore, the hypothesis that the property valuation can be influenced by the way that data is presented is confirmed. Similarly, the impact of data presentation on probability judgements in auditing has also been demonstrated (Ashton and Ashton, 1988; Krull *et al.*, 1993). It has been suggested that even when information is irrelevant to the target question, the order in which the information is received/presented has a different impact on the auditors' judgements. When subjects received a short series of complex mixed evidence, sequentially, the information received later in the sequence exhibited a greater impact on the outcome of a task, compared with the information received earlier. This is also referred to as the 'recency (or order) effect', whereby individual's judgements tend to hinge more on the most recent evidence in a sequence of evolving information (e.g., Ashton and Kennedy, 2002; Krull *et al.*, 1993).

2.3.4.2 Individual Factors

The individual (or internal) factors of anchoring effects refer to the characteristics of decision makers which may affect anchoring. For the same judgemental task, people with different varieties of experience or knowledge may be subject to different levels of anchoring effects (e.g, Bhattacharjee and Moreno, 2002; Wilson, *et al.*, 1996). Decision maker's gender and mood are also found to have different impacts on people's judgements (e.g., Bhattacharjee and Moreno, 2002; Croson and Gneezy, 2004; Greene and Noice, 1988). Finally, it has been demonstrated that the cultural background of decision makers may also contribute to the discrepancies in their decisions (e.g., Hsee and Weber, 1999). The impact of these subjective factors of anchoring effects is discussed in detail below.

Experience and Expertise

The impact of anchoring effects on the novices as well as on the experts has been investigated in many studies in a variety of judgemental contexts (Birnbaum and Zimmermann, 1998; Black and Diaz, 1996; Brewer *et al.*, 2007; Caverni and Peris, 1990; Englich and Mussweiler, 2001; Ho and Keller, 1994; Joyce and Biddle, 1981; Mussweiler and Strack, 2000b; Mussweiler *et al.* 2000; Northcraft and Neale, 1987; Poucke and Buelens, 2002; Tversky and Kahneman, 1974; Wilson *et al.*, 1996; Wright and Anderson, 1989).

Many studies have demonstrated that anchoring effects apply not only to novices but also to experts who have much experience and professional knowledge in the target tasks (Englich and Mussweiler, 2001; Joyce and Biddle, 1981; Mussweiler *et al.* 2000; Northcraft and Neale, 1987; Wright and Anderson, 1989). Tversky and Kahneman (1974) argued that both naïve and experts were subject to overly narrow confidence intervals about the probability distributions of which a security price or market index may be located in financial markets. This phenomenon of overconfidence in the certainty about one's assessment in the market can be explained by an effect of anchoring to his/her judgements. Joyce and Biddle (1981) found that even professional experts (practising auditors) were significantly influenced by irrelevant anchors in the context of auditing judgement. Wright and Anderson (1989) demonstrated that increasing situational familiarity did not reduce anchoring effects.

However, some other studies provide a conflicting picture. On the one hand, a few studies have detected a lower level of anchoring effects among expert judges. This is because experts have more knowledge and experience than novices in dealing with the tasks which help them to incorporate the anchor information more appropriately (e.g., Mussweiler and Strack, 2000b; Wilson, *et al.*, 1996). Wilson *et al.* (1996) demonstrated that people who had more knowledge about tasks than others were less likely to experience anchoring and less likely to be influenced by irrelevant anchors. Northcraft and Neale (1987) demonstrated strong anchoring effects on both students and real estate agents whereas the subjects who lacked real estate knowledge (students) reported a higher possibility of using the anchor value to make estimates. Furthermore, Bhattacharjee and Moreno (2002) found that less experienced auditors were significantly influenced by negative but irrelevant information when assessing the inventory obsolescence risk, whereas more experienced auditors were not affected by such information. On the other hand, Ho and Keller (1994) found that both experts (professional auditors) and non-experts (MBA students) were more likely to be influenced by anchor values when they were familiar with the diagnostic probability judgement tasks. When they had no professional knowledge of the tasks, their estimates of the subsequent diagnostic conjunction probability would not be affected by their previous predictions of the conjunction probability. In this case, decision makers' expertise provides a negative impact on their judgements: people with more knowledge and experience may be misled by their expertise and therefore make less effort in making accurate judgements on tasks than those with less expertise. The reasons for this discrepancy might be (1) the judgemental context of the tasks: in some circumstances expertise has a positive impact in reducing anchoring whereas in other circumstances it has negative impact and leads to a higher level of anchoring, and (2) the complexity of the tasks: the more complex the task is, the more useful decision makers' expertise in reducing judgemental bias. Note that although it is important to explore the underlying reasons why expertise leads to different degrees of anchoring, it is not the interest of this study.

Gender and Mood

As an important factor in distinguishing the differences in judgement and decision making (e.g., Croson and Gneezy, 2004), the gender of subjects has not received sufficient attention from researchers in anchoring studies. A number of studies exploring anchoring effects used both male and female subjects in their experiments (Cervone and Peake, 1986; Mussweiler, 2001; Northcraft and Neale, 1987; Strack and Mussweiler, 1997; Wilson *et al.* 1996; Rutledge, 1993). However, none of them analysed the differences in judgements between male and female participants.

Another factor which is considered important to people's judgement and decision making is their mood. For example, the target is usually evaluated more favourably if the judge is in a positive rather than a negative mood (e.g., Schwarz, 2002). It has been suggested that a positive affect has a strong impact on performance in many cognitive tasks such as creative problem solving, strategy changing in decision making (e.g., Isen and Geva, 1987), and facilitating memories of neutral and positive material (e.g., Isen, Shalker, Clark and Karp, 1978). Moreno, Kida and Smith (2002) found that accounting managers were generally risk avoiding/taking for gains/losses when no affective information was available, whereas the reverse was true when positive affective information was provided.

In terms of anchoring, Estrada, Isen and Young (1997) demonstrated that physicians with positive affect considered the diagnosis of a disease significantly earlier and showed less anchoring than those that had no positive affect. Bhattacharjee and Moreno (2002) found less experienced auditors were strongly influenced by irrelevant but negative affective information on a client and gave a significantly higher risk assessment than when they were not provided such information. The influence of affective information was not found on more experienced auditors. This may indicate the importance of professional experience in reducing the influence of affective information on people's judgement and decision making.

Note that although the issues of the gender and mood of decision makers have been broadly explored in cognitive research, they have not received sufficient attention in the study of anchoring. Further research on these types of issues on the degree of anchoring is therefore needed.

Cultural Background

A number of cross-national studies on a variety of issues have been conducted (e.g., Hsee and Weber, 1999). For example, Hsee and Weber (1999) demonstrated systematic cross-national differences in risk preferences between Americans and

Chinese. Chinese were found to be significantly more risk seeking than the Americans, but only in the investment domain rather than in other domains such as in medical or academic decisions. Although different aspects of anchoring effects have been explored, as discussed above, little is known, however, about whether people in different regions and nations encounter different levels of anchoring. Therefore, studies involving cross-national observations and comparisons on different aspects of anchoring effects will be useful to better understand the effect.

2.3.4.3 Other Issues Concerned Anchoring Effects

A number of issues which have been discussed in the literature and demonstrated to have a strong influence on the degree of anchoring, but difficult to be categorised into previous sections, are discussed here.

Research settings

Over the past forty years, anchoring effects have been broadly investigated by a huge number of studies. Most of these studies are undertaken in psychological experiments in laboratories (e.g., Chapman and Johnson, 1999, 2002; Havard, 2001; Mussweiler, 1997; Mussweiler and Englich, 2005; Mussweiler and Strack, 1999a, 1999b; Strack and Mussweiler, 1997; Wilson *et al.*, 1996). The anchoring research has been extended to a variety of real world settings, such as auditing judgements (Bhattacharjee and Moreno, 2002; Joyce and Biddle, 1981), negotiations (Black and Diaz, 1996; Kristensen and Garling, 2000), judicial judgements (Englich and Mussweiler, 2001; Farina *et al.*, 2003), and estimations of real estate property (Diaz, 1997).

However, most of the ‘real world anchoring studies’ are actually studies using designed experiments to explore anchoring effects, but in a real world setting with information in a specific profession and with subjects who have specific knowledge in this field. Although the studies are experimental, they have extended the anchoring research to more realistic conditions, compared with conditions in laboratories.

The only study which used real world decision making data (collected outside a laboratory) was conducted by Whyte and Levi (1994) in detecting the reference point and anchoring effects in the case of the Cuban missile crisis. All the materials and information analysed in this study were from the records of previous meetings, minutes, records, and other resources, without any manipulation. A strong anchor point was detected in this complicated and dynamic decision making environment. It is therefore suggested that more attention should be paid to develop similar real world studies (i.e. a dynamic and real decision making environment which involves feedbacks and instant judgements).

Incentives and Forewarnings

Whether incentives for accuracy and forewarnings of the occurrence of anchoring effects have any impact on the degree of anchoring has been investigated in many studies.

Some studies suggest that incentives do not reduce anchoring (Chapman and Johnson, 2002). Tversky and Kahneman (1974) indicated that payoffs for accuracy did not reduce the effect of anchoring on experts. Wilson *et al.* (1996) suggested that basic anchoring processes were unintentional and unconscious, and therefore difficult to be avoided even when incentives for judgemental accuracy or forewarnings of the notion of anchoring were involved. Moreover, anchoring effects were not moderated by increasing the subjects' motivation for accuracy (Brewer *et al.*, 2007, Study 2).

However, Wright and Aboul-Ezz (1988) found no significant anchoring effects on frequency distribution assessments under conditions involving extrinsic incentives (financial rewards and public recognition). Wright and Anderson (1989) demonstrated that although increasing situational familiarity did not reduce anchoring effects, the involvement of monetary and performance-contingent incentives significantly diminished the anchoring effect. The contradictions between different studies regarding the effects of incentives may be due to the level of incentives. Individuals with more incentives will make more effort in performing more accurate judgements whereas individuals offered small amounts of incentives may not take the tasks seriously.

Furthermore, Simmons, Leboeuf and Nelson (2008) suggested that the impact of motivation on people's final estimates depended on the characteristic of the tasks. In particular, when people were certain about the direction of judgemental adjustment, increasing motivation for accuracy could reduce the degree of anchoring and hence increased the gap between anchor values and final estimates. However, when participants were not certain about the adjustment direction of the decision tasks, increasing motivation did not help increase the difference between anchor values and target values.

Debiasing

Due to the robustness of anchoring effects in laboratory experiments as well as in a variety of 'real world experimental decision settings', it is necessary to investigate the ways of reducing the effect. Besides incentives for judgemental accuracy and forewarnings of anchoring occurrence, a number of studies have suggested other methods or strategies in anchoring debiasing (Bhattacharjee and Moreno, 2002; Black and Diaz, 1996; Farina *et al.*, 2003; Galinsky and Mussweiler, 2001; Mussweiler *et al.*, 2000; Whyte and Sebenius, 1997).

Black and Diaz (1996) suggested an educational intervention to negotiators about the influence of sellers' asking prices on buyers' opening offers and settlement prices, in order to reduce buyers' estimate biases affected by the asking prices in negotiations. Similarly, Farina *et al.* (2003) suggested that judges and magistrates should be provided with relevant training about the occurrence of potential anchoring, since anchoring effects can be reduced if judges are more aware of the influence of anchor values. The usage of a proper training to subjects in reducing judgemental bias has also been confirmed by Bhattacharjee and Moreno (2002).

A 'consider-the-opposite' strategy can be employed to reduce anchoring effects (Lord, Lepper and Preston, 1984). This strategy often involves an active consideration of alternative anchors, anchor-inconsistent information, or different ways of problem framing (Galinsky and Mussweiler, 2001; Mussweiler *et al.*, 2000). For example, the anchoring effect in a negotiation can be reduced by including alternative prices which are inconsistent with the opening offer or the asking price of the target object. In a judicial judgement context, Farina *et al.* (2003) also suggested that a protection factor against anchoring, establishing an alternative anchor value, or considering multiple anchor values (Plous, 1993) could be used to reduce the anchoring. Anchoring effects occur when individuals have more access to knowledge about the anchor value (Mussweiler *et al.*, 2000). Consequently, a consider-the-opposite strategy enables judges to increase their access of non-anchor knowledge and hence decrease their focus on anchor values (i.e., their attention to anchor values are reduced or eliminated by more attention paid to non-anchor information). Consequently, effects of anchoring on particular information were reduced by providing non-anchor information (anchor-inconsistent knowledge) or alternative anchors to judges (Mussweiler *et al.*, 2000).

2.4 Conclusion

In this chapter, the background of rationality and bounded rationality theories is used as a basis to explore one of the commonly used heuristics, the anchoring and adjustment heuristic, and the judgemental bias, anchoring effects. In particular, different types of anchoring effects are introduced, a number of theories which are developed to explain the underlying mechanisms of anchoring effects are reviewed, and a number of factors which affect the degree of anchoring effects are discussed. The extensive demonstration of anchoring effects in a variety of judgemental contexts indicates that the anchoring effect has been a widely-observed phenomenon which may occur in many environments, including both laboratory and real world field experiments.

However, the investigation of previous studies also reveals that anchoring effects are complicated. For example, some studies have demonstrated that there was no difference between expert and non-expert decision makers in terms of the degree of anchoring on a particular task (Englich and Mussweiler, 2001; Joyce and Biddle, 1981; Mussweiler *et al*. 2000; Northcraft and Neale, 1987; Wright and Anderson, 1989), whilst other studies suggested that individuals with more knowledge or expertise about the decision tasks were subject to a lower level of anchoring effects (e.g., Mussweiler and Strack, 2000b; Wilson, *et al.*, 1996). The impacts of incentives and forewarnings to decision makers on the degree of anchoring also remain conflicting. Some studies demonstrated no use of incentives and forewarnings in reducing anchoring effects (Brewer *et al.*, 2007; Chapman and Johnson, 2002; Tversky and Kahneman, 1974; Wilson *et al.*, 1996) whereas others revealed they did help in the debiasing of this effect (e.g., Wright and Anderson, 1989).

In addition, the anchoring studies reviewed in this chapter are limited in the following aspects. First, the majority of the studies are undertaken in laboratories or field experiments. Due to the weaknesses of experimental studies (e.g., lack of similarity of the real world environment, subjects are not familiar with decision tasks and are aware of their involvement in experiments), whether anchoring effects are a generalised phenomenon in the real world decision making environment (i.e., in which decisions are made without being manufactured or controlled by experimenters) remains unclear. Second, the sample size of observations is limited in experimental studies. Generally, at most hundreds of subjects are involved in experiments whereas in the real world setting similar decisions may be repeated thousands of times. Whether subjects used in experiments can represent real world decision makers is questioned. Finally, many real world environments which involve dynamic and instant decision making processes, such as the horserace betting market, have not been explored in terms of effects of anchoring on participants' judgements.

Consequently, a new study is required to explore anchoring effects in a real world environment with a large data sample. This study aims to fill the gap left by experimental studies by employing a new method to detect anchoring effects in a dynamic real world environment which contains rich information. The research questions derived from previous literature, research paradigm, strategy and methods are discussed in the next chapter, in order to identify the most appropriate methodology to achieve the purpose of this study. The research data and modelling procedures are also described in Chapter 3.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

Previous literature suggests that when faced with uncertainty, decision makers tend to anchor their estimates of the value of a decision task on a reference point (the *anchor*) and make *insufficient* adjustments from the anchor value to reach the target value (e.g., Cervone and Peake, 1986; Epley and Giovich, 2001; Kahneman and Tversky, 1972; Tversky and Kahneman, 1974). However, although strong anchoring effects have been demonstrated in a number of laboratory-based studies (see Chapter 2), a limited amount of research has focused on anchoring effects in real world environments. Therefore, the following chapters will fill this gap by exploring anchoring effects associated with judgements and decisions in a real world environment involving risk under uncertainty: the horserace betting markets. In particular, the aim of this chapter is to develop a methodology to detect whether these effects exist in the real world environment, how strong the anchors are to cause these effects, and whether they are affected by the degree of decision makers' expertise and differences between markets.

In order to explore the existence of anchoring effects in the real world and the degree to which that decision makers anchor their judgements on particular information in a real world environment, an appropriate research design is required. In particular, an appropriate research paradigm, research strategy, and research method are required to answer these research questions.

The remainder of this chapter is structured as follows. Section 3.2 specifies the research questions which have been developed from previous literature. Section 3.3 introduces research paradigms and explains why the *positivism* paradigm is the most appropriate paradigm applied to the current research. This is followed by a discussion of a suitable research strategy for the study. Anchoring effects have mainly been detected in laboratory experiments and have largely remained unexplored in the real world environment, other than in small scale studies. Consequently, the present study seeks to extend the existing literature by applying statistical models to explore potential anchoring effects in a large scale study associated with horserace betting markets. Consequently, a series of research hypotheses are developed in Section 3.4 to explore the existence and the degree of anchoring effects in this real world decision environment. The data employed to conduct the hypothesis testing are described in Section 3.5 and the specific research method adopted in this study to test these hypotheses is identified in Section 3.6. A summary and some conclusions are developed in Section 3.7.

3.2 Research Questions

Existing literature suggests that anchoring effects are a very common phenomenon in human decision making processes. These effects can be caused by different types of anchors. For example, in some experiments participants are provided with an externally generated irrelevant number (e.g., a number generated by a wheel of fortune): they are asked whether the answer to a question is higher or lower than that value. In these experiments, participants are found to anchor their estimates of the answer on that given number, which is obviously irrelevant to the right answer (e.g., Chapman and Johnson, 2002; Ritov, 1996; Shelton, 1999; Tversky and Kahneman, 1974). In terms of the source of anchors, the literature has demonstrated that anchoring and insufficient judgements can also occur when participants personally generate the anchors without being provided with a reference number (e.g., Epley and Gilovich, 2001). It is also found that how the anchor is represented (e.g., Wong and Kwong, 2000; Havard, 2001; Strack & Mussweiler, 1997) and the degree of the decision makers' knowledge about the target object (e.g., Joyce and Biddle, 1981; Mussweiler and Strack, 2000; Northcraft and Neale, 1987) can affect the degree of anchoring effects.

In contrast to these laboratory studies, a few studies also explore anchoring effects in the field by asking people to answer specifically designed surveys or questionnaires according to their daily decision tasks (e.g., Joyce and Biddle, 1981; Shelton, 1999). These field studies also detect a strong anchoring effect in circumstances associated with real world decision tasks (e.g., auction, auditing, and accounting). However, these tasks are undertaken when participants are aware of their involvement in a survey or an experiment and their judgements being studied. Therefore, they may pay more attention to their judgements in the survey to increase their judgement accuracy. In other words, their behaviour might be different from when they do not know their decisions are examined.

Consequently, one of the motivations for this study was to explore whether anchoring effects exist and what factors would affect the degree of anchoring effects in a real world decision making environment when decision makers are unaware that they are being observed. This will provide a clearer picture of the impact of anchoring in real world environments. To achieve this aim, three research questions are proposed:

Question one:

Do anchoring effects caused by relevant or less relevant information exist in real world environments and how strong should the anchors be to lead to anchoring effects?

Literature has shown that anchoring effects can be caused by different types of information, such as relevant or irrelevant anchors and externally given or self-generated anchors. In this study, only anchors relevant and less relevant to decision tasks are considered. In addition, although significant anchoring effects have been demonstrated in many experiments, some studies suggest that anchoring effects are weak and fragile in certain circumstances (e.g., Brewer and Chapman, 2002; Wilson *et al.*, 1996). Therefore, it will be interesting to explore how strong the information should be to cause significant effects of anchoring in real world environments.

Question two:

Is the degree of anchoring affected by the degree of expertise of decision makers?

Question three:

To what extent the degree of anchoring is affected by the environment or market in which decisions are made?

These two questions focus on whether the influence of relevant anchors is affected by the expertise of decision makers or by the market in which decision procedures are conducted.

3.3 Research Paradigm

Research can be classified from different perspectives. Generally, four aspects are considered to describe a piece of research: the purpose, the logic, the process, and the outcome of the research (Collis and Hussey, 2003).

Based on these four aspects, this study which explores anchoring effects in a real world environment (the horserace betting market) can be described as a (1) descriptive and predictive, (2) deductive, (3) quantitative, and (4) applied research. In particular, the study is descriptive because it aims to describe the characteristics of anchoring effects (i.e., the existence and the degree of anchoring) in a real world decision making environment. This study is also predictive because it aims to search for certain circumstances in which anchoring effects would occur and the influence of anchoring effects on outcomes of later races is therefore predictive. Based on a large number of studies, this study is conducted to try to confirm results derived from laboratories rather than to seek patterns or hypotheses. In addition, this study is not to analyse or explain how and why anchoring exists. Therefore, it is not exploratory research. Second, the aims of this study are to search for anchoring effects in horserace betting markets based on results derived from previous literature and to estimate the influence of anchoring effects on outcomes of races. To achieve these aims, a number of research questions are proposed to deduct whether theories and findings provided in the literature can be generalised in a new real world environment, the horserace betting market. In other words, it is not to induct a new theory from the observations but to explore whether an existing theory or phenomenon can be demonstrated to exist in other settings. Therefore, it is deductive rather than inductive research. Third, to conduct deductive research, a large quantity of market data associated with different types of publicly available information (e.g., horses', jockeys' and trainers' past performances) is used to demonstrate the existence of anchoring effects in this market. In order to examine bettors' actual judgements of horses winning probabilities from the market's perspective rather than from each individual bettor's perspective, a quantitative rather than a qualitative method is appropriate to this study. Finally, this study looks for evidence to answer questions such as whether anchoring effects exist in a specific real world environment, the horserace betting market, rather than to provide a basic description or explanation of anchoring in the general area of cognitive psychology. Therefore, this is applied research rather than basic research.

To better clarify and identify the nature of and the process for conducting the current research, a study of research paradigms is required. *Paradigm*, as interpreted by Burrell and Morgan (1979), is

> *"a term which is intended to emphasise the commonality of perspective which binds the work of a group of theorists together in such a way that they can be usefully regarded as approaching social theory within the bounds of the same problematic" (p.23).*

Collis and Hussey (2003) argue that paradigm is about people's opinion of how research should be conducted (i.e., the progress of scientific practice based on people's philosophies and assumptions about the world and the nature of knowledge). Kuhn (1962) regards paradigms as scientific achievements which provide model problems and solutions to a group of practitioners.

In particular, Saunders, Lewis and Thornhill (2003) describe the process of conducting social research as that of peeling an onion: the core of the onion cannot be seen until the layers are peeled away. These layers are *research philosophy*, *research approaches*, *research strategy*, *time horizons*, and *data collection methods*, from outside to the centre, respectively. Burrell and Morgan (1979) argue that a research paradigm is a framework which (1) at the *philosophical* level, reflects one's basic beliefs of the social world; (2) at the *social* level, provides researchers with guidelines for conducting social research; these are also called the *research approach* or *research strategy* in other literature (e.g., Saunders *et al.*, 2003; Collis and Hussey, 2003); and (3) at the *technical* level, refers to specific methods and techniques which are employed to collect data and conduct analysis (i.e., the *research method*). These three levels of research paradigm are described in the following sections to help further identify an appropriate research paradigm under which the research questions can be properly answered.

3.3.1 Research Philosophy

As the first layer of the research 'onion', research philosophy represents the way that a researcher thinks about the development of knowledge (Saunders *et al.*, 2003). The understanding of research philosophy can benefit the research design by clarifying research designs, selecting appropriate research designs and identifying or even creating and adapting new designs (Easterby-Smith *et al.,* 2002).

According to Burrell and Morgan (1979), research is comprised of two independent dimensions. One dimension is about how researchers view the nature of social science: from an objective perspective or a subjective perspective. The objectivists view the social world and the reality as empirical entities no matter what labels they are nominated. The subjectivists, however, believe the social world is "made up of nothing more than names, concepts and labels which are used to structure reality (Burrell and Morgan, 1979; p. 4)". The second dimension focuses on how researchers view the nature of social society within which the research problem exists: from a regulation point of view or a radical change point of view. The sociology of regulation regards society as balanced, consensual, socially ordered and cohesive when providing explanations of society. In contrast, the sociology of radical change focuses on explanations for radical change, deep-seated conflict and structural contradiction which are believed to characterise modern society. Along with these two dimensions, four basic paradigms are formulated to reflect different views of social reality and social theory: *functionalist*, *interpretive*, *radical humanist* and *radical structuralist*. In this framework, each paradigm shares common characteristics with its neighbours in one dimension but is distinguished from them in the other dimension. Similarly, Saunders *et al.* (2003) summarised three different philosophies which are generally adopted in social research: *positivism*, *interpretivism*, and *realism*. The relationships between these paradigms along the two dimensions are illustrated below in Figure 3.3-1 and each of the paradigms will be discussed in more detail.

Figure 3.3-1 Four paradigms for the analysis of social theory

	THE SOCIOLOGY OF RADICAL CHANGE		
	Radical humanist (Realism)	Radical structuralist (Realism)	
SUBJECTIVE	Interpretive (Interpretivism)	Functionalist (Positivism)	OBJECTIVE
	THE SOCIOLOGY OF REGULATION		

(Source: Burrell and Morgan, 1979; p. 22)

3.3.1.1 Functionalist vs. Interpretive

As the dominant framework in research of social science, the *functionalist* paradigm constructs research based on the sociology of regulation and approaches its research subject from an objective point of view (Burrell and Morgan, 1979). It is also labeled as the *positivism* paradigm by many researchers (e.g., Collis and Hussey, 2003; Fisher, 2004; Saunders *et al.*, 2003). Theories within this paradigm are constructed to observe an independent and pre-existing reality; researchers using this paradigm should remain independent and value-free and provide objective views to report the 'what is reality' question (Collis and Hussey, 2003). The *positivism* paradigm intends to develop general laws and knowledge that can be used to predict human behaviour and control the social world (Fisher, 2004). In approach, *positivism* is often problem-orientated and aims to provide essentially rational explanations and practical solutions to social issues and problems. It applies the models and methods of the natural sciences to the study of social affairs and human behaviour (Burrell and Morgan, 1979; Remenyi *et al.*, 1998). The data should be collected in an apparently value-free manner, using a highly structured methodology to facilitate replication (Gill and Johnson, 1997).

The *interpretive* paradigm is often regarded as the same as *interpretivism*, *phenomenology* or *constructionism* (Collis and Hussey, 2003; Fisher, 2004; Saunders *et al.*, 2003). It also explains the social world based upon the *sociology of regulation*, but from a *subjective* point of view. Specifically, theories within this paradigm intend to describe the social world as it is and to understand the nature of the social reality and human behaviour from the observers' own viewpoint and individual experience. In other words, *interpretivism* reflects the sociology of regulation implicitly rather than explicitly. The *interpretive* sociologists believe that reality is socially constructed and dependent on individuals' perspectives. Consequently, they may describe and explain the social world in different interpretations and capture the complexity of social situations from their own point of view. These different interpretations are therefore likely to affect their actions and the nature of their interaction with other people in return (Burrell and Morgan, 1979; Collis and Hussey, 2003; Saunders *et al.*, 2003). To obtain a personal understanding of the meanings of social reality, qualitative strategies such as interviews or observations are often applied within this paradigm.

As the two main paradigms of the social science study, the *positivism* and the *interpretivism* paradigms are contrasted in different ways. Robson (1993) argues that the positivistic approach is usually regarded as starting with theory. Positivistic researchers generalise what they are looking for from theory and previous research; they have specific hypotheses to test in order to confirm or reject their assumptions of the research subject. The interpretive approach, however, involves the collection of data before inducing theories and concepts. It is 'hypothesis generating' rather than 'hypothesis testing' (Robson, 1993). More specifically, Collis and Hussey (2003) summarise the main differences between the paradigms as illustrated in Table 3.3-2.

Table 3.3-1 Features of the two main paradigms

Positivistic paradigm (Functionalist paradigm in Burrell and Morgan, 1979)	**Phenomenological paradigm** (Interpretive paradigm in Burrell and Morgan, 1979)
Tends to produce quantitative data	Tends to produce qualitative data
Uses large samples	Uses small samples
Concerned with hypothesis testing	Concerned with generating theories
Data is highly specific and precise	Data is rich and subjective
The location is artificial	The location is natural
Reliability is high	Reliability is low
Validity is low	Validity is high
Generalises from sample to population	Generalises from one setting to another

(Source: Adapted from Collis and Hussey, 2003; p. 55)

3.3.1.2 Radical Humanist vs. Radical Structuralist

Both of the *radical humanist* and *radical structuralist* paradigms advocate a *sociology of radical change*. The *radical humanist* paradigm develops its concern from a *subjective* perspective which focuses on researchers' human consciousness and personal experience of the social world (Burrell and Morgan, 1979). The theorists within this paradigm believe the reality is socially constructed and can be interpreted in different ways by different people. Consequently, its view of subjectivity to social science is in common with that of the interpretive paradigm. The difference between the sociology of radical change and that of regulation is that the former aims to not only simply interpret or understand the social world but also further change and improve it.

In contrast, the *radical structuralist* paradigm approaches *a sociology of radical change* based upon an *objective* standpoint regarding the social reality. The approach of this paradigm to social science study shares similar features with that of the functionalist paradigm; it aims to provide objective, independent and value-free knowledge and theory of the society. It concentrates on 'structural relationships' and 'basic interrelationships' rather than ideological contradictions within a realist social world. In other words, the radical structuralists emphasise the radical change of society based upon the nature and structure of contemporary society rather than upon human consciousness or individual experience (Burrell and Morgan, 1979).

According to Saunders *et al*. (2003), *realism* involves both *radical humanist* and *radical structuralist* paradigms as discussed above. More specifically, theorists in the context of the *realism* paradigm believe that a social reality exists which is external to individuals within the society and is independent of human beliefs and perspectives. This perspective shares some common philosophical aspects with *positivism* such as "related to the external, objective nature of some macro aspects of society" (Saunders *et al*., 2003; p. 85). However, the *realism* also recognises that people in societies are influenced by social forces and processes, although they may not be aware of the existence of such influences on their interpretations and behaviours. In other words, *realism* involves both objective reality and subjective perception within its social study context: (1) the reality is objective; (2) this reality strongly influences people's views and behaviours; but (3) these people may not recognise such influences when seeking to understand this reality.

3.3.1.3 The Paradigm Adopted in This Study

Burrell and Morgan (1979) argue that the four paradigms are regarded as mutually exclusive. They offer alternative views of social society. These views are based upon different sets of assumptions with regard to the nature of social science and of social society. Therefore, by being clear about which paradigm to adopt in their research, social researchers are able to identify where they are, where they have been and where to go in the future. The understanding of the paradigms also helps researchers to clarify specific assumptions for their research, within a particular paradigm. The researchers are, therefore, able to select appropriate approaches to examine these assumptions and, sequentially, answer the research questions. However, it should be noted that there is no 'better' paradigm than the other. They are 'better' at doing different types of research. To select which paradigm to use depends upon the research question(s) to be answered and the research assumption(s) to be tested in the research (Saunders *et al*., 2003).

According to the discussion above, a *functionalist* paradigm is adopted in the present study to explore anchoring effects in the horserace betting markets. The reason for this can be explained by considering the underlying assumptions about the nature of social science within this paradigm. Respectively, four sets of assumptions, related to ontology, epistemology, human nature and methodology, are discussed below.

Ontology

Ontology concerns assumptions about the nature of the phenomena under investigation. In a context of functionalist paradigm, social scientists accept that the 'reality' to be investigated is external to the individual. It is not a product of individual consciousness or of one's mind; it exists independently and objectively in the world (Burrell and Morgan, 1979). Specifically, the horserace betting market, in which anchoring effects are investigated, is a reality which is composed of different market participants: the betting public, the betting operators (the Tote) and/or the market makers (the bookmakers). These participants may have different impacts on the market but the market is not constructed by any single participant. For example, the racetrack constructed by the racetrack management may favour certain types of horses in relation to the surface or drainage system of the track. Tipsters in the market provide professional predictions of horses' winning chances before a race starts. This may highly influence the decisions of the betting public who rely on the tipsters' assessments. The odds of a horse in the pari-mutuel betting system are determined by the amount of money placed on that horse compared to the total amount of money bet for that race. Odds of horses in a bookmaker betting market are initially determined by bookmakers according to their subjective assessments but are highly affected by the flow of stakes and the interactions of other bookmarkers in that market. In addition, gambling tax and regulations from the government and racing authorities are applied to the horserace betting market. All of these suggest that the betting market is objective to its participants but is affected by the participants' behaviours, perceptions and interactions. Consequently, assumptions associated with ontology of functionalist paradigm are appropriate for the present research.

Epistemology

Assumptions associated with an *epistemological* nature are about the essence of 'knowledge'. These assumptions include how people understand social reality, how they communicate this knowledge with other people (Burrell and Morgan, 1979) and what attitudes people hold to view what they are studying (Hussey and Hussey, 1997).

In the functionalist paradigm, researchers obtain the knowledge of a phenomenon through a series of empirical tests based upon a large data sample in order to answer 'true' or 'false' questions. Although market prices of horses are eventually determined by different market participants, none of them has overwhelming influence on the behaviour of the market. Anchoring effects, if they exist, arise from the decisions of the betting public. Consequently, they should be investigated in the whole market which is impacted by all the market participants. In this sense, the horserace betting market to be investigated according to anchoring effects is regarded as a 'reality' external to both the researcher and to any single individual in the market. In addition, a series hypotheses formulated and tested in previous literature suggest that it is appropriate to test anchoring effects in horserace betting markets using hypotheses derived from laboratory studies. To answer these typical 'true' or 'false' questions (e.g., anchoring exists in horserace betting markets, anchoring in these markets is affected by bettors' expertise), the epistemological nature of the present study indicates that a functionalist paradigm is needed. Furthermore, although most of the studies in the anchoring literature are undertaken in laboratories associated with small data samples, the study of anchoring effects in horserace betting markets enables the researcher to investigate a large amount of information from these markets. This advantage over the laboratory studies is based on a belief that bettors' behavioural bias is indicated by their decisions and is thus reflected in horses' market prices, as discussed in the 'ontology' section. Therefore, an empirical study which follows the approach applied by horserace betting literature (large sample statistical analysis) rather than the psychological anchoring literature (small sample experiments) is regarded as appropriate in this study.

Human Nature

Human nature relates to a third set of assumptions which describe the relationships between human beings and the environment where they live. In a functionalist paradigm, human beings and their behaviours are both regarded as products of the environment: they are conditioned by the circumstances which are external to them. In a horserace betting environment, behaviour of the betting public and other market participants (e.g., the tote, bookmakers and the racetrack management) relies on the maximisation of profits (or utility) from their own perspective. However, the performance of each market participant is dependent upon the situation of the participant in the market. For example, people betting with bookmakers in betting shops have no access to the paddock at the racecourse. Therefore, these people may not be able to assess the physical conditions of horses, whereas people at the racecourse can do this when before the race starts. Moreover, the conditions of the racetrack (such as the surface and the going of the racetrack) and the stall positions of horses, manufactured by the racing authorities, may affect the racing outcome. Consequently, bettors' assessments of horses' winning probabilities (implied by odds) will be affected by consideration of these factors. Meanwhile, the application of track-take and bookmakers' over-round make it impossible for the majority of the betting public to make long-term profits from horserace betting. Taken together, the behaviour of different participants in the horserace betting market and decisions made by these participants are highly influenced by the market environment. This clearly fits closely with the 'human nature' assumptions with the functionalist paradigm.

Methodology

The *methodological* nature of social science is determined by the nature of the three sets of assumptions outlined above. Each set of these assumptions has a significant impact on the way in which one investigates and on the appropriate approach that one uses to obtain the knowledge of a social phenomenon. Consequently, "Different ontologies, epistemologies and models of human nature are likely to incline social scientists towards different methodologies (Burrell and Morgan, 1979; p. 2)." Within the context of a functionalist paradigm, a methodology for the natural science to explore associations or causality is generally adopted. This is often achieved by launching statistical models and involving a large amount of data. In terms of this horseracing study, under the functionalist paradigm, it is appropriate to conduct a series of statistical techniques to explain or predict anchoring effects in this market. This is conducted by analysing the accuracy of bettors' assessments of horses' winning probabilities in a race, and whether they anchor their subjective judgements of horses winning on particular pieces of information. The purpose of this methodology is to describe associations and/or to explain causality of objective facts (odds assessments and anchoring effects in this study).

In summary, the discussion of the nature of the four sets of assumptions within the context of a research framework indicates that a functionalist paradigm is appropriate for this study. The horserace betting market is a social environment which involves different market participants. Within this environment, these participants behave in a different way according to the situation. The purpose of such market behaviours is to maximize their own utility based upon the information which people obtain and upon their ability to make accurate judgements. The aggregate market is therefore constructed of such different behaviours and the interactions between these behaviours. On the other hand, people make their decisions subject to the restrictions of this decision environment and market regulations. Therefore, a research framework which is often employed for the natural science study is appropriate for the present study in order to understand economic behaviour within this environment.

3.3.2 Research Approach

In a research design, the research approach belongs to the *social* level of the research paradigm, which involves the use, construction, and verification of theories. The inductive and deductive approaches are the two approaches which are generally adopted in social research. Researchers who explain a social reality from personal observations and subjective views are employing the inductive approach. People who start their research from a generalised theory and clear research questions are conducting a deductive approach (Burrell and Morgan, 1979; Ghauri and Gronhaug, 2005).

3.3.2.1 Inductive Approach

In an inductive approach, researchers collect data from empirical observations. The purpose of observing and analysing cases is to obtain a deep and vivid understanding of the nature of the social phenomenon that is being studied. The result of this analysis is the formulation of a theory or some generalised conclusions. In this type of research, the research process starts with data, goes from observations to findings and ends up at theory building. In addition, personal views and subjective judgements of researchers are incorporated into the theory generating process (Bryman and Bell, 2003; Ghauri and Gronhaug, 2005; Saunders *et al*., 2003).

According to Creswell's (1994) criteria, the inductive approach is often employed with new research topics, when much debate is involved and when little literature exists. This is often associated with an interpretive philosophy which is to answer the 'why' or 'how' type of questions. A collection of qualitative data often involves in an inductive research (Ghauri and Gronhaug, 2005; Saunders *et al.*, 2003).

As a large amount of literature is readily available on both anchoring effects and on behaviour in horserace betting markets, a series of theories have already been developed which can be used to generate specific hypotheses. The testing of these hypotheses helps to fill the gap between the literature and helps to answer the research questions. Therefore, a deductive rather than an inductive approach is appropriate for the present study.

3.3.2.2 Deductive Approach

In a deductive research, conclusions are drawn through logical reasoning. In particular, theories or hypotheses are firstly generated from the existing knowledge (literature). An empirical scrutiny process (testing) is then developed to test these theories or hypotheses. The results of the tests may accept or reject these theories or hypotheses. Consequently, this acceptance and rejection can help researchers to explain or predict social phenomena so as to provide new evidence for the theory (Hussey and Hussey, 1997; Ghauri and Gronhaug, 2005; Saunders *et al.*, 2003).

Robson (1993) suggests a five-step progress for conducting deductive research. The first step is to deduce a testable hypothesis based on theory. This hypothesis is supposed to identify the relationship between two or more events or concepts. The concepts adopted in this deductive research should be highly relevant to the research topic under study. Secondly, the hypothesis is expressed in operational terms (called 'operationalisation'). These terms or indicators are transferred from the concepts clarified in the previous step. The purpose of this transformation is to explain how the variables are to be measured and to describe the relationship between two specific variables. Thirdly, the operational hypothesis is tested by experiments or other types of empirical inquiries. The fourth stage of deduction involves examination of the specific outcome of the inquiry. The findings may confirm or reject the hypothesis and the underlying theory. It should be noted that in most cases, the theory proved from the empirical analysis is only based upon the validity of a limited sample. This suggests that a modification of hypothesis or theory may also be needed. If so, the fifth step will then be undertaken to modify the hypothesis or theory. After revising the theory, researchers will need to repeat the cycle so as to verify the updated theory.

It is argued that the deductive approach is appropriate when a large body of well-established literature on the research topic is available. Researchers adopting the deductive approach seek research opportunities or gaps by carefully examining existing knowledge in the literature. In this case, they are usually very clear about the problems or questions that they are to investigate. Therefore, a type of 'true' or 'false' questions is often deduced from the exploration of research questions and related theories (Creswell, 1994; Ghauri and Gronhaug, 2005). As the dominant research approach employed in natural sciences, deduction is often employed in the context of the functionalist paradigm. Quantitative data are often associated with this type of research.

A deductive approach is employed in this study for the following four reasons. First, there is a large amount of existing literature covering both anchoring and behaviour in horserace betting markets. The concepts of the anchoring-and-adjustment heuristic and anchoring effects were first systematically proposed by Tversky and Kahneman in the early 1970s. A number of subsequent studies have developed the theory of anchoring from different aspects, such as the underlying mechanisms of anchoring, the various environments in which anchoring may occur, the durability of anchoring, and the measurement of anchoring. The findings of these studies provide a rich source of knowledge of anchoring which occurs in both laboratories and the real world.

Clearly, the examination of hypotheses of anchoring in a real world decision environment which has not yet been investigated can add new knowledge about anchoring or may lead to a new theory. The horserace betting market is an appropriate real world environment chosen to explore anchoring effects in this study.

Horserace betting markets have been explored in a considerable number of studies. Most of these studies focus on information efficiency in different racing markets. Hypotheses are developed through the concept of the Efficient Market Hypothesis (EMH) in financial markets, and are extended to horserace betting and other gambling markets (e.g., lottery, blackjack, football, basketball, and greyhound). Therefore, previous research exploring the accuracy of price in relation to the information available in these markets can provide well-developed knowledge to inform the current study. The investigation of anchoring effects in horserace betting markets in this study is, therefore, regarded as a combination of anchoring and betting market studies.

Second, the current study seeks to explain causal relationships between variables such as biased judgements on horses' winning probabilities and the factor on which bettors may anchor. In horserace betting, bettors' subjective judgements are influenced by different publicly available information and the impact of that information on different people varies. The aim of this study is to detect to what extent certain pieces of information (anchoring factors) affect bettors' subjective estimates of horses' winning probabilities (implied by odds of horses).

Third, the deductive approach requires sufficient numerical data and assumes that researchers are independent from what is being observed. In the current study, a large dataset from each of the two horserace betting markets (i.e., information concerning all races run in the HK and UK markets over the last ten years) is used by the researcher. The availability of a large quantitative database (the odds and other information) and a highly structured methodology (statistical methods to control and test hypotheses) are able to facilitate replication and generalisation of the study. In addition, the market data employed to conduct standard empirical tests are collected independently by the researcher. It should be noted that if the results of these tests are not consistent with the hypotheses, the hypotheses may be modified. Explanations from the researchers' subjective perspective may also help explain the inconsistencies. This will not damage the application of deduction in this study.

Finally, there will be an operationalisation process undertaken in deductive research to transfer concepts into measurable variables in a quantitative way. In horserace betting markets, the aggregate effect of all types of public information on bettors' subjective judgements is assumed to be contained in final odds. The odds information, however, cannot be directly used in the statistical models employed in this study. Therefore, an appropriate method is needed to transfer the odds information into horses' winning probabilities. Similarly, factors which may have an impact on the generation of final odds are transferred into dummy variables to meet the requirements of statistical analysis (for more details, see Section 3.6.3).

In summary, the present study applies a deductive approach, through the following stages: literature study, hypothesis construction, hypothesis testing, and outcome analysis. The literature of anchoring effects and horserace betting are reviewed in order to find the research gap and to develop research questions. Consequently, a series of hypotheses are constructed to answer these questions in depth, such as whether anchoring effects exist in real world environments. In order to test these hypotheses, an operationalisation process is undertaken to transfer public information into a range of measurable indicators such as horses' winning probabilities, post-positions of horses, and past performances of horses, jockeys and trainers. Therefore, an empirical model is employed to test whether bettors anchor their subjective judgements on certain pieces of information based upon these operationalised indicators, using large datasets of races run in the HK and UK markets.

3.3.3 Research Strategy

Like research approaches, research strategies are also based on the *social* level of research paradigm and located in the middle layer of the research 'onion'. Research strategies aim to take a further step to identify the overall plan to help answer the research questions. To do this, a research strategy should clarify what data to use, specify when, where and how to collect these data and consider the constraints that one may face when collecting data (Burrell and Morgan, 1979; Collis and Hussey, 2003; Saunders *et al*., 2003). The research paradigm and the research approach that one adopts have a significant impact on the strategy.

3.3.3.1 Interpretive Strategy

Interpretive strategies refer to the strategies associated with the inductive approach within the context of an interpretive paradigm. Under the interpretive paradigm, research strategies are often conducted using qualitative data. Representative strategies adopted in interpretive research include action research, case studies, and grounded theory. Because the paradigm adopted in the present study is the functionalistic (not interpretive) paradigm, no interpretive strategies are appropriate in this study.

3.3.3.2 Positivistic Strategy

In contrast to interpretive strategies, positivistic strategies are often employed in a deductive process under a functionalist (positivism) paradigm. Quantitative data are mainly used for these strategies. These highly specific and precise data are generally numerical and objective, and are usually collected from surveys, experiments or public information. A positivistic strategy aims to keep researchers away from the subjects being studied, to make sure that the data collected are not affected by the researchers' judgements. Within the context of functionalist paradigm, an explanatory cross-sectional strategy is therefore adopted in this thesis to conduct a naturalistic study in the real world environment.

Exploratory, Descriptive Study and Explanatory Study

In terms of the purpose of enquires, research projects can be classified into one of three categories: exploratory, descriptive or explanatory studies. Exploratory study intends to ask questions to find out what is happening and seek new insights. As an extension of an exploratory study, descriptive research seeks to develop a clear and accurate picture of the phenomena, people, or situations being studied. Explanatory studies are meant to establish causal relationships between different variables by using statistical tests (Robson, 2002; Saunders *et al*., 2003). Clearly, an explanatory study should be adopted here since the purpose of this study is to find out whether anchoring effects exist in horserace betting markets and to what extent each anchoring factor impacts the betting public's assessments of horses' probabilities of winning. If the anchoring effect does exist in horserace betting markets, bettors' subjective judgements will be affected by this decision bias and depart from the real probability of a horse winning a race. Therefore, there is a causal relationship between the impact of anchoring factors and the accuracy of betting judgements. If bettors are found to significantly anchor their judgements on certain pieces of information, the accuracy of their decisions will be damaged.

Cross-sectional Study vs. Longitudinal Study

Cross-sectional studies are conducted when researchers intend to "obtain information on variables in different contexts, but at the same time" (Collis and Hussey, 2003; p. 61). The aim is to investigate the characteristics of a large number of people or organisations (different races in different markets in this study), to seek relationships between different variables and to compare them in different organisations. Using this type of strategy, researchers are able to collect a large amount of data from different organisations in a short time so as to avoid missing data caused by chronological changes in one organisation (Collis and Hussey, 2003; Saunders *et al*., 2003). The cross-sectional strategy is appropriate for the current study for the following reasons: first, the variety of different horserace betting markets provides a good opportunity for conducting a cross-sectional study among these markets. For example, the number of racetracks (e.g., only two in HK but nearly forty in the UK), the size of races (i.e., the number of horses in a race) and different betting systems (e.g., with pari-mutuel or bookmakers) may all vary in different countries and areas. This may suggest anchoring effects at a different level or on different factors in different areas, given the same variables and hypothesis testing processes in these places. Second, the accessibility of similar data in the HK and UK horserace betting markets makes it possible to employ a cross-sectional study in these markets.

Longitudinal studies are usually used to investigate the change and development of people or social phenomena over a period of time. Data on the same variables are collected but at different time periods in order to establish valuable insights of the development of subjects being studied. Because the aim of the present research is to explore anchoring effects in horserace betting markets but not to describe the change or trend of anchoring effects in these markets, the longitudinal strategy is not employed in this study.

Experimental Study vs. Real World Study

(1) Experimental studies

As a type of explanatory study, experimental study is a classic positivistic strategy which is used by most of the studies exploring anchoring effects. These experiments are conducted either in a psychological laboratory or in a natural setting associated with real world decision tasks. By manipulating an independent variable (for example, the bid price offered in an auction), researchers are able to observe its impact on the dependent variable (for example, the deal price of the auction) so as to explore the casual relationship between these two variables.

Anchoring effects were first systematically demonstrated in laboratory experiments (Tversky and Kahneman, 1974) and then were confirmed or challenged by further studies conducting laboratory experiments and field experiments (e.g., Chapman and Bornstein, 1996; Chapman and Johnson, 1996; Carlson, 1990; Joyce and Biddle, 1981; Mussweiler and Strack; 2000; Northcraft and Neale, 1987). The main advantage of laboratory experiments over field experiments is that the former permits easy control of the interaction between variables on the experimental results. However, laboratory experiments have been criticised for using students as subjects and for not reflecting the nature of real world environment. In contrast, field experiments increase the reality of the study by conducting experiments in a real world situation, but at the cost of losing much of the control on certain factors. Some of these factors may obscure the effect of an independent variable. Some of them may have an impact on the dependent variable but are not considered the independent variables themselves (Collis and Hussey, 2002).

(2) Comparisons between experimental studies and real world studies

As discussed above, both laboratory and field-based experiments have their own advantages and drawbacks over each other. In the anchoring literature, the majority of studies are undertaken in laboratories under controlled experimental conditions; field experiments are conducted to further explore the effects detected in laboratories. However, they both lack some vital features contained in real world environments (Bruce and Johnson, 1997). Therefore, the distinctions between experimental and real world studies (also called *naturalistic* studies) and the benefits of exploring anchoring effects in a real world environment (in particular, the horserace betting markets in this study) are discussed below.

The key distinctions between experimental environments and real world decision settings refer to the nature of (1) decision tasks and (2) decision makers. In the aspect of decision tasks, three vital features are identified.

First, as discussed above, experiments are carefully determined and standardised and conducted under a set of manufactured and controlled conditions. Under these conditions, certain variables are eliminated or kept constant in order to investigate the influence and interaction of other discrete factors. Control groups are often employed to provide comparative results (Collis and Hussey, 2003; Robin, 1993). Therefore, it becomes possible, in experimental environments, to isolate particular factors for separate analysis and comparison. Even so, it is argued that experimental settings can not completely reflect or simulate the real world environment (Collis and Hussey, 2003) and "often omit vital elements which are present in a real-world decision environment" (Bruce and Johnson, 1997; p. 287). Hence to what extent the results and conclusions deduced through laboratory or field experiments can be applied in a real world environment remains unclear. However, real world settings also have their drawbacks. For example, the researchers may not be able to separate the interaction between two independent variables, and often cannot avoid the impact of variables other than the independent variable on the dependent variable. It will be difficult to separate the impact of individual factors because they all interact in real world environments.

A second distinction between experiments and real world decision tasks focuses on the nature of tasks undertaken. Experiments are often associated with low-risk tasks in stress free settings whilst real world decision makers are generally involved in high-stakes, stressful environments (Yates, 1992). It has been suggested that because the risks contained in experiments are different from those taken in the real world, individuals may behave differently within different contexts (Anderson and Brown, 1984).

A third distinction focuses on measurement of performance in experimental and real world settings. Evaluations that are used in experiments to measure the impact or performance of decision tasks are often subjective: for example, the degree of perceived risk or degree of confidence in making a correct decision. However, in naturalistic environments, people often use objective measures to evaluate decision quality and this is regarded as more reliable than subjective measures.

Another key difference between experimental conditions and real world environments centres on the decision makers. First, participants in laboratory and field-based experiments are often aware that they are involved in an experiment or study. Therefore, they may alter their behaviour. In addition, laboratory studies often use undergraduate students as experiment subjects but these students may not be familiar with constructed decision tasks or lack the experience for solving these problems (Bruce and Johnson, 1997). It is believed that decision makers in the real world often deal with similar tasks repeatedly so that they can gain experience from the decision that they make. Therefore, judgements made by 'experts' (people who have more knowledge or experience in the area) are often found to be more accurate than those made by ‘novices’ (people who do not have much knowledge or experience about the topic) (Christensen-Szalanski *et al.*, 1983). For example, when exploring the characteristics of auditors’ decision making processes, researchers found more precise and accurate results from auditors in accounting firms than from students who were undertaking accounting and financial courses at universities (e.g., Bonner, 1990; Krull, *et. al.*, 1993; Shelton, 1999).

Taken together, studies undertaken in experimental environments and in real world settings are different in many perspectives and both offer particular advantages and disadvantages.

A large body of anchoring literature is based on laboratory experiments. Consequently, it is useful to explore whether and to what extent the anchoring effects demonstrated in laboratories are really experienced in real world decision environments. In this study, a dynamic naturalistic decision environment, horserace betting markets, is selected to test this.

Horserace betting markets represent the ideal real world environment for a number of reasons.

Firstly, the features of horserace betting markets are consistent with all the criteria for a dynamic and naturalistic decision making environment (Orasanu and Connolly, 1993). It is a naturalistic environment and each element of a decision making event in this market, such as participants (horses and jockeys), location (racetracks) and conditions (surface and going of the racetrack), is unique. Hence participants’ performance is of high uncertainty. This market is also dynamic because the odds of each horse in a race are continuously changing before the race starts and bettors must make their decisions in a limited period of time, based on limited information. Even so, it has been argued that this time period (usually 30 minutes for each race at a meeting) is sufficient for bettors to make rational and reasonable judgements on horses’ winning probabilities (Johnson and Bruce, 2001).

Secondly, horserace betting markets involve an action-feedback loop, which represents the characteristic of a dynamic decision setting. In particular, bettors make explicit or implicit subjective assessments of horses’ winning probabilities based upon a variety of publicly available information (e.g., the past performance of a horse, jockey or trainer, the stall position of a horse in a race). Once the race finishes and the result is released, bettors are then able to use the feedback (updated information on the race result and performance) to update and adjust their new decisions.

In summary, this study will employ a cross-sectional strategy in a dynamic real world decision setting, the horserace betting market, to explain the relationship between certain factors on which bettors may anchor their judgements and the accuracy of their judgements when estimating the winning probability of a particular horse. The research hypotheses derived from previous literature and research questions are described in Section 3.4 respectively, followed by a description of the research data and variables in Section 3.5. The research method which is used to test these hypotheses is explained in Section 3.6.

3.4 Research Hypotheses

Hypotheses are constructed from previous literature. “A hypothesis is an idea or proposition which you test using statistical analysis (Collis and Hussey, 2003; p. 56).” The purpose of hypothesis testing is to determine whether the real world examined is in accord with the researcher’s perspective of that world and hence to answer the research questions.

As discussed in Section 3.2, three broad questions are derived in this study. The first question asks whether anchoring effects (caused by relevant and less relevant information) exist in the real world and how strong these anchors should be to lead to anchoring. The second and third questions focus on to what extent decision makers’ expertise or market differences affect the degree of anchoring effects caused by certain pieces of information.

To answer the first research question, two specific hypotheses are developed as below:

Hypothesis 1 (The anchoring factor hypothesis):

Bettors in the horserace betting markets anchor their judgements of a horse’s winning probability on the information associated with (i) the past performance of the

horse, (ii) the past performance of the horse's jockey or trainer, (iii) the post-position of the horse, and (iv) the past performance of the favourite, in the previous race.

This hypothesis relates to the influence of relevant information on the degree of anchoring effects. According to the anchoring literature (e.g., Chapman and Johnson, 2000, 2002; Mussweiler, Strack and Pfeiffer, 2000; Ritov, 1996; Shelton, 1999; Thomas and Handley, 2005), both relevant and irrelevant information have strong impacts on decision makers' judgements of decision tasks. In the horserace betting environment, relevant information refers to the core factors in determining horses' winning potential which are considered important in most racing publications (e.g., Benter, 1994): horses', jockeys' and trainers' past performances, and horses' post-positions. Previous favourites' performances are considered less relevant to the favourites' performances in later races. This is because favourites in different races at a meeting are different and the competitiveness of other horses in a race is different from that in other races. Therefore, performances of favourites in different races are difficult to compare. If bettors anchor their judgements on such information, they may overestimate the real winning probability of a similar horse in another race and therefore over-bet on this horse.

In particular, three types of information are involved in this hypothesis:

(i) Information associated with horses', jockeys' or trainers' last performance. Three individual models are constructed to test whether bettors anchor their subjective probability judgements of a horse winning a race based on the last performance of (a) that horse, (b) the jockey or (c) the trainer of the horse.

(ii) Information associated with the starting stall of the horse: the post-position. A horse's post-position is randomly determined by the racing authority before the racing day and is demonstrated to have a strong impact on the performance of the horse[14] (e.g., Beyer, 1983; Quirin, 1979). In addition, the influence of previous winner's post-position on bettors' judgements of the winning probability of the horse from the same position in the next race is also considered.

(iii) The performance of previous 'favourites'. In horserace betting markets, generally one horse cannot run more than one race at a race meeting. Therefore, the favourite horse in a previous race is different from the favourite in the next race. The

[14] The horse with inside post-position may take advantage of running less than those which start from the outside of the racetrack. This effect is robust in short distance races at certain racetracks (e.g., Beyer, 1983; Quirin, 1979).

winning probability of a favourite horse in one race is likely to have little relationship with the winning probability of a favourite in a subsequent race. Therefore, the fact that the favourite won the last race does not necessarily increase the actual chance of a favourite winning the current race. If bettors make their judgements based on this less relevant information, they are likely to overestimate the real chance of a favourite winning a subsequent race.

Note that for the information of previous winner's post-position and of previous favourite's performance, only races at the same race meeting are considered. For other information, previous races can be either at the same meeting or different meetings. This is because previous winner's post-position and the favourite's performance are vivid but less relevant information which is less likely to be reviewed or remembered by bettors when making judgements at later meetings. Whilst other information, such as horses', jockeys' and trainers' past performance, is more straightforward and relevant to the horses' performance and can be easily obtained and studied from betting publications. Therefore, even records of races at previous meetings are also included. In addition, for all the factors tested in this hypothesis, only the results of the previous race are considered. The impact of the previous two or three races on bettors' subjective judgements is examined in the following hypothesis.

Hypothesis 2 (The anchoring strength hypothesis):
Anchoring effects in the horserace betting market are fragile and they only occur if the anchor is based on consistent results in the previous (i) two races, or (b) three races (i.e., anchors based on mote than one previous race).

Previous literature has demonstrated that anchoring may not occur in certain circumstances, especially when decision makers are not explicitly asked to compare the anchor value and the target value (e.g., Brewer and Chapman, 2002; Wilson *et al.*, 1996). Moreover, it has been suggested that high-strength but low-weight information is more likely to cause overconfidence because people are more likely to be attracted by high-strength information and neglect the base-rate information (Nelson *et al.*, 2001). According to this finding, a repeated outcome in a short period of time may catch sufficient attention of bettors and therefore lead them to over-bet on this horse. This can be achieved by examining bettors' response to racing outcomes of more than one previous race. In particular, this hypothesis examines to what extent that bettors take the information of the previous two or three races into account when making decisions for the current race. If anchoring effects cannot be detected using only the previous race information, but can be demonstrated when similar results occur for two or three races, it may be argued that anchoring effects are fairly fragile in horserace betting markets. In this case it might be concluded that anchoring only occurs when the anchor is strong enough to attract bettors' attention.

Tests of this hypothesis are similar to the tests employed in the anchoring factor hypothesis. The modelling procedures are the same for testing these two hypotheses.

To answer research question two concerning the utilisation of bettors' expertise in betting judgements, the following hypothesis is developed:

Hypothesis 3 (The expertise hypothesis):
Bettors with greater expertise in the decision tasks are subject to a lower degree of anchoring than bettors with less expertise.

It is argued that decision makers with greater expertise or more experience on decision tasks can better use available information and make more accurate decisions compared to those with less expertise or experience. Consequently, experts, compared with non-experts, may be able to decrease the possibility of anchoring on certain pieces of information or to reduce the degree of anchoring when making judgements (e.g., Joyce and Biddle, 1981; Northcraft and Neale, 1987).

In horserace betting markets, expert bettors can be distinguished from non-expert bettors in different ways. For example, previous literature (e.g., Benter, 1994) suggests that expert bettors usually spend a lot of time exploring all types of information and focusing on the results of a large number of races. These bettors tend to bet throughout all days of the week because they can invest a lot of time on studying previous results and many of them do this as their jobs. In contrast, casual bettors are more likely to bet on races that run over the weekends because they regard betting more like an entertainment rather than a serious decision task. Generally these casual bettors would not spend too much time in advance studying information which may help assess the winning probability of horses. Consequently, it might be argued that casual bettors are more likely to anchor their judgements on specific information which is easy to pick up. The bets of more expert bettors are therefore likely to predominate during the weekdays, when fewer casual bettors operate.

In addition, previous literature suggests that bettors with more knowledge and experience in horserace betting will generally bet late in order to avoid their bets being followed by the general betting public (which would have the effect of reducing their returns in a pari-mutuel market) (e.g., Benter, 1994). Consequently, the odds information at different time periods before the race starts can be used to examine the judgements of bettors who have different levels of betting expertise. More specifically, the final odds and the odds at 2 and 5 minutes before the race begins are selected to explore the degree of anchoring between professional bettors and non-expert bettors. The expectation is that bets placed at earlier time from the same start will be made by more casual bettors. Similar modelling procedures to those constructed for hypotheses one and two are employed to test this hypothesis, but using various odds information.

To answer research question three which relates to the impact of decision environment and market difference on anchoring effects, the following hypothesis is developed:

Hypothesis 4 (The market hypothesis):
The degree of anchoring effects varies between the HK and UK horserace betting markets.

The aim of this hypothesis is to explore the different anchoring effects observed in different horserace betting markets. It is suggested that the degree of anchoring effects and the factors on which that bettors anchor may vary in different areas due to the market diversity. It is also argued that people in different cultures (e.g., the eastern people and western people) may contain different characteristics in risk taking preference and/or the way of processing information (Hsee and Weber, 1999). Therefore, a difference in the degree of anchoring on particular information may be explained by the characteristics in different markets: the objective features such as the features of courses, races and horses, or the subjective features such as bettors' risk preferences caused by the cultural differences, or both.

In this study, the markets in two regions, the HK and UK horserace betting markets, are selected to make this comparison. There are two reasons for choosing these two markets: one is the data accessibility, and the other is the diversity between the markets. For example, there are only two racetracks in HK whilst thirty-eight ‘flat’ racetracks are available in the UK database. In HK, the betting volume is very high for races running on each track, whilst in the UK the amount of the money that is bet at each racetrack is relatively small. There are evening races in the HK market (usually run at the Happy Valley racetrack) whilst most races in the UK are running during the daytime. Due to these differences, it is possible to assume that the behaviour of bettors may differ in these two areas and hence leads to different level or types of anchoring. The way of testing this hypothesis is to repeat the tests conducted for the previous three hypotheses, using both the HK and the UK data separately to detect differences between these markets.

In summary, this study is designed to examine the degree to which, in the real world and especially in the horserace betting market, bettors anchor their subjective judgements of a horse winning on certain pieces of publicly available information. The first two hypotheses are designed to detect bettors’ anchoring on relevant information with respect to estimating a horse’s winning probability and how strong these anchors should be to cause anchoring. Hypothesis three explores the impact of bettors’ expertise and experience on reducing or eliminating the effect of anchoring. These are implemented by following the same modelling procedures as those for hypotheses one and two, but using modified anchoring factors and specific odds information. The difference of anchoring effects between different markets is tested in the fourth hypothesis by verifying the first three hypotheses using HK and the UK horserace betting data separately.

The research data and variables are introduced in Section 3.5, followed by the description of the modelling procedures in Section 3.6. The results of hypothesis tests will be presented, explained and discussed in Chapter 4.

3.5 Research Data

The data employed to construct a positivistic research must be quantitative and highly specific and precise (Collis and Hussey, 2003). To represent and explore the main characteristics of the population considered in the research, a large data sample is needed. In this study, two large datasets from the HK and UK horserace betting markets are employed. The data are discussed in Section 3.5.1, and the variables constructed for this study are described in Section 3.5.2.

3.5.1 Data

The data employed in this study is selected from the HK and the UK horserace betting markets (flat races only). There are two reasons for choosing these two markets to conduct this study: (1) in each market, a large database containing sufficient racing information is readily accessible; and (2) the differences between the market structures of HK and the UK make it possible to detect anchoring effects in decision environments with a wild cross-section of participants. For instance, only the pari-mutuel betting system exists in the HK market whilst both the pari-mutuel and the bookmaker betting systems are available in the UK and the one which dominates the UK market is the latter one. To best reflect the behaviour of the whole market in these two regions, the pari-mutuel data for HK and the bookmaker data for the UK are employed in this study. In HK, there are only two racetracks running alternatively during the weekdays and weekends whilst in the UK, there are 38 racetracks all over the country.

Although both jump and flat races are available in horserace betting markets, in the UK only flat races are used in this study. Compared to jump races, flat races generally offer much higher prize money and it would be argued may therefore contain less insider trading. In addition, these two types of race attract a different betting public and the classification criteria for jump races are different from those for flat races (Ming-Chien Sung, 2006). Therefore, it will be difficult to examine market behaviour if both jump and flat races are maintained in one database. Consequently, to reduce the complexity of the hypothesis testing and to enable a comparison capability between the two markets, the jump races are not included in this study (there are no jump races in HK).

The data exported and formulated from the database contain two types of information: (1) general information concerning the horses and the races; and (2) the variable and the performance related information. More specifically, each record of the data contains the following information:

Table 3.5-1: Description of the data information for the HK and UK horserace betting markets

Type	Description of the information
I.	***General information concerning the horses and the races***
1	The race ID (i.e., a unique identification number for each race), the race date, and the race time
2	The horse ID (i.e., a unique identification number to represent each horse) and the horse's name
3	The number of runners in each race
4	The official rating of each horse which represents the ranking of the winning potential of the horse estimated by the racing authority
5	The jockey ID and the jockey's name for each horse in each race
6	The trainer ID and the trainer's name for each horse in each race
7	The class of the race and the winner's prize money for each race
II.	***The variable and the performance related information***
8	The odds information (e.g., the final odds and the odds 2 and 5 minutes before the race starts) of each horse in each race
9	The post-position and the finishing position of each horse in each race
10	A variable which indicates the winner of a race (the horse which won the race gets 1; 0 otherwise)
11	Variables associated with the horses' past performances
12	Variables associated with the favourite horses of different races at a meeting
13	Variables associated with the post-positions of the past winners at a meeting
14	Variables associated with the jockeys' past performances
15	Variables associated with the trainers' past performances

The detailed information of the data employed for each market is described below and the full description of each variable employed in this study is provided in Section 3.6.

3.5.1.1 The HK Data

The data for the HK horserace betting market are drawn from the pari-mutuel[15] betting markets operating at Happy Valley (HV) and Sha Tin (ST) racetracks in HK. The database consists of 66,244 horses running in 5,133 flat races from 6 September 1998 to 25 April 2007. Nearly two thirds of these observations (44,620 horses in 3,344 races) come from ST racetrack and the rest (21,624 horses in 1,789 races) are from HV racetrack. In each race, the number of runners varies from 5 to 14. All the races are started from starting stalls and each horse is allocated a stall position (i.e. the post-position) which varies subject to the number of runners in the race. An official rating is allocated to each horse before the race to represent the horse's winning potential; the rating varies for different horses from 0 to 145 with a mode of 52. The races running at HV and ST are categorised in six classes: nearly half of them are high class races (32,231 horses out of 2,523 races in class 1-3) and half of them are low class races (34,013 horses out of 2,593 races in class 4-6).

Three types of odds information are employed in this study: the final odds of each horse in a race, the odds of a horse at 2 minutes before the race starts, and the odds at 5 minutes before the race starts. The winning prize of races ranges from 0.1 to 20 million HK$ and the distance of races varies from 1,000 metres to 24,000 metres. Two types of surface are used at these two tracks: turf and synthetic. In this database, nearly 90% of the races are run on the turf (58,812 horses in 4,560 races).

3.5.1.2 The UK Data

The data employed to conduct empirical tests for the UK horserace betting market is provided by Raceform Ltd., the leading supplier of the official British Horse Racing Board's racing results. The original dataset contains 556,115 horses running in 49,993

[15] In HK, only the pari-mutuel betting system operates – no bookmaker market exists in this market. Grateful thanks to Mr. William Benter for providing data for this study.

flat races over 38 racetracks in the UK from 2 January 1996 to 1 February 2007. Due to the requirement of the model used to test the hypotheses (the conditional logit model), only one winner is allowed in a race. Therefore, 1,183 observations from 104 races are removed from the database due to the lack of the winner (79 horses from 7 races) or more than one winner (1,104 horses from 97 races – i.e. dead heats) in a race. In addition, 102 horses from 19 races are removed from the database since they were withdrawn before the race but their odds and other information were accidentally recorded in the database. If their records were maintained in the database, the over-round probability of the horses which actually run the race will be mis-specified. Finally, horses whose finishing positions were missing or which were obviously wrong (e.g., with a finishing position of 99) in the database were assumed to finish last; this affected 2,210 horses. Consequently, the final database which is analysed in this study contains 554,830 horses running in 49,881 flat races over the period of 11 years.

In the final database, the number of runners in a race varies from 2 to 38. A Raceform rating is assigned to the horse once it finishes its race and it varies from 0 to 136. The races in the UK fall into 7 classes (A-H) from high to low. The final odds of each horse have a range from 0 to 1000 with a mean value of 18.73[16]. The winning prize for the winner(s) of each race varies from 0 to up to 852,600 GBP often depending upon the class of the race: the higher the racing class, the more the prize money. The distance of the race varies from 1,100 metres to 4,874 metres and 55% of the races (307,413 observations in 24,948 races) were handicap races and 45% (247,417 observations in 24,933 races) were non-handicap races.

3.5.2 Variables

To test the hypotheses constructed in Section 3.4, a number of variables are formulated based on the information collected and generated from the database. If not specified, the variables and the modelling procedures for the hypothesis testing are the same for the HK and the UK horserace betting markets. The dependent and the independent variables are described below and the modelling procedures are explained in Section 3.6.

[16] The odds information employed in this study are the starting price recorded by the bookmaker betting system. This is because the bookmaker market is the dominant market in the UK (compared to the pari-mutuel market).

3.5.2.1 Dependent Variable

The betting public considers a range of publicly available information when assessing the probability of a horse winning a race. To estimate a horse's chance of winning a race, it is essential to consider the conditions of other competitors in the race. Although the competitiveness of a horse running in a race cannot be observed directly, whether it wins the race or not is recorded in the database. Therefore, a dependent variable w_{ij} is defined such that: $w_{ij} = 1$ if horse i wins race j, and $w_{ij} = 0$ otherwise. A full description of the modelling procedure of this study will be provided in Section 3.6.

3.5.2.2 Independent Variables

There are 19 independent variables employed in this study. They are categorised into three groups: (1) odds related variables; (2) performance related variables; and (3) post-position related variables. These variables are either available directly from the database (e.g., the post-position of each horse in a race), computed from available information (e.g., the odds implied probability of a horse winning a race), or created from a combination of relevant information (e.g., whether a horse won its previous race). These variables are selected in this study because: (1) they offer very important information which can be used to estimate the winning probabilities of horses; and (2) these information are easy to obtain from public resources and consequently are likely to catch bettors' attention. Therefore, it is likely that the betting public will anchor their subjective judgements of such information. The meanings and the features of these variables are described in the following sections respectively.

Odds Related Variables

The Efficient Market Hypothesis (EMH) suggests that in a semi-strong form efficient market, the market price incorporates all the publicly available information (references). In horserace betting, the odds of a horse represent its market price, and these are believed to incorporate, what many studies indicate, are the most important and comprehensive information concerning the chance of the horse winning (e.g., Asch, Malkiel and Quandt, 1984; Figlewski, 1979; Johnson and Bruce, 2001). Consequently, whether all the public information has been taken into account in odds becomes an important criterion to judge whether the betting public over (or under) estimate the contribution of certain pieces of information to the horse's winning probability (i.e. whether they anchor their judgements on certain information).

The odds employed in this study are the starting price (SP) of horses in the UK market and the pari-mutuel odds in the HK market. The reasons for choosing different betting systems in these two markets are: (1) the majority of bets placed in the UK market are with off-course bookmakers[17] and the majority of these bets are settled at SP[18]; and (2) the only legal form of horserace betting in HK is the pari-mutuel betting form (i.e., the *totalisator* model of betting), so the pari-mutuel odds are the only data which can be used in a study of the HK market.

Based on the SP (final odds information) of horses, the odds related variable employed for the UK market is the natural log of odds implied normalised probabilities. The reason for applying this logarithmic transformation is to balance the distribution of the data with small values and large values and therefore to produce an approximately normal distribution of the data (for more details, see Section 3.6.3). The final odds of horses are transformed to the natural log of odds implied probabilities as follows: (i) transform the final odds of horse *i* in a *n*-runner race *j* to its odds implied fraction (f_i) by dividing one by the odds plus one (1/(final odds + 1)); (ii) add up all the fractions of the horses in the race ($\sum_{i=1}^{n} f_i$) which may or may not equal to one; (iii) normalise the odds implied probability by dividing the fraction of each horse in the race by the sum of the fractions of all the runners in the race ($f_i / \sum_{i=1}^{n} f_i$); and (iv) take the natural logarithm of (iii) (named 'LnFinOdds' in the UK database).

The odds implied probabilities of horses running in the HK market are developed in a similar method, although these odds are those determined by the pari-mutuel

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17 In the UK, both bookmakers and the totalisator coexist in the horserace betting market. A bookmaker is an organisation or a person that takes bets and may pay winnings depending upon the results and the nature of the bets, the odds. On-course bookmakers set odds on the course or racetrack and off-course bookmakers operate off the course through telephone, betting shops or the internet. A totalisator (or *tote*) is a computerised system which runs pari-mutuel betting, calculating and displaying payoff odds, and producing tickets based on incoming bets. Pari-mutuel is a betting system in which all bets of a particular type are placed together in a pool; payoff odds are calculated by sharing the pool among all placed bets.

18 SP is the price, offered by off-course bookmakers, determined only when the race starts. Off-course bookmakers provide bettors with the choice of taking the latest betting odds (fixed-odds) on offer at the time they are placing their bets or the SP. If the bettor does not mention the bet is at the latest odds, then it is then assumed to be placed at the SP.

betting system. The odds implied probabilities at 2 and 5 minutes before the race starts are also obtained. These variables are named 'LnFinOdds', 'Ln2MinsOdds', and 'Ln5MinsOdds', respectively. This allows hypothesis tests associated with anchoring effects of experienced and non-experienced bettors to be conducted.

Performance Related Variables

(1) Horses' past performances

A horse's past performance is one of the most important pieces of information to be analysed when bettors estimate the horse's potential probability of winning its next race. In this study, three independent variables associated with horses' past performances are created to explore whether bettors overestimate the importance of this information. For example, if a horse won its last race, would bettors overestimate its chance of winning next race? The first variable related to horse's past performance (named 'H1'[19]) is a dummy variable which indicates whether the horse won its last race (1 if it won and 0 otherwise). The other two dummy variables ('H2' and 'H3' respectively) are designed to indicate whether the horse continuously won its previous (a) two or (b) three races.

(2) Jockeys' and trainers' past performances

These explanatory variables are related to jockeys' and trainers' past performances. Take jockey's performance as an example. Three variables associated with jockey's past performances are considered in this study. Dummy variable 'J1' gives a value of 1 to the horse whose jockey has won his/her previous race on another horse and 0 otherwise. Dummy variables 'J2' and 'J3' refer to jockeys' inning records in previous two or three races: gives 1 to the horse if its jockey wins previous 2 or 3 races and 0 otherwise. The continuous winning records of a jockey or trainer may be at the same[20] or different meetings.

Similarly, dummy variables ('T1', 'T2', and 'T3') are designed to test whether bettors anchor their judgements of a horse winning a race on past performances of the horse's trainer at any meeting (i.e., any previous meeting and the current meeting). The horse selected to detect anchoring effects in the current race is different from those who

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[19] If not specified, the same variables are defined and employed for both the HK and the UK markets.

[20] A jockey can ride more than once on different horses at a meeting. A trainer may have more than one horse trained by him/her running in different races at a meeting.

won previous races (up to three previous races are examined in this study) but they are trained by the same trainer.

(3) Previous favourites' performances

Previous literature suggests that decision makers tend to anchor their judgements on the information which is obvious and easy to obtain, even when such information has no relationship with the decision task (e.g., Brewer *et al.*, 2007; Cervone and Peake, 1986; Chapman and Johnson, 2002; Joyce and Biddle, 1981; LeBoeuf and Shafir, 2006; Mussweiler and Strack, 2000b; Thorsteinson *et al.*, 2008; Tversky and Kahneman, 1974). In horseracing, it is probable that whether a previous race was won by its favourite[21] has little relationship with the winning probability of the favourite in the current race. However, bettors may still anchor their judgements of the probability that the favourite wins the current race on whether the favourite(s) won previous race(s) at a meeting.

To test this, three dummy variables are designed to represent information related to the performances of favourite horses in previous races. The first variable (named 'F1') gives the favourite horse of the current race a value of 1 if the previous race was won by the favourite and 0 otherwise. All the non-favourite horses of the current race are assigned a number of 0. Similar procedures are applied to create variables which indicate the winning records of the favourites of the previous two and three races ('F2' and 'F3' respectively).

Note that whether the favourite won previous race(s) at previous meeting(s) is not regarded as an obvious piece of information which would be readily observed by the betting public (i.e. not easy to be brought to mind). Therefore, only anchoring effects associated with favourites winning races at the same meeting (not include previous meetings) are explored in this study.

Post-position related variables

Four post-position related variables are constructed in this study. The first variable represents the number of post-position[22] from which a horse starts a race ('PP'). This is

[21] A favourite is the horse which, according to the betting public, has a highest probability of wining the race (i.e., the shortest price horse in the race).
[22] Post-position is the position of stall in starting gate from which a horse starts. The position is randomly allocated to each horse by the racing authority before the race starts and horses with inner positions may

to test whether bettors over-weight the importance of a horse's post-position in winning a race and therefore anchor their subjective judgements on horses with inner post-positions, which is an obvious advantage for horses at certain tracks. Note that the number of post-positions at different tracks may be placed in different order. In HK, horses' post-positions are sorted in an ascending order from inside to outside of the track (lower position locates inside) whereas in the UK, post-positions are sorted from low to high at some tracks and high to low at other tracks (from inside to outside of the track). In addition, inside positions are favoured at tracks in HK but this is not always the case in the UK market. Due to the surface, going and configuration of the tracks, horses from outside positions may be favoured at certain racetracks.

Another three variables relate a horse's post-position in the current race to post-positions of winners in previous races. Specifically, dummy variable 'WP1' represents whether a horse's post-position in the current race is the same as (=1) or different from (=0) the winner's post-position in the previous race. Similarly, dummy variables 'WP2' and 'WP3' are created to indicate horses whose post-positions are the same as or different from those of the previous two or three winners. For example, at a meeting, if race one and race two are both won by horses from stall 6, then the horse allocated to stall 6 in race three will be assigned a value of 1 for the variable 'WP2'. If race one is won by the horse from stall 3 and race two is won by the horse from stall 6, then the horse from stall 6 in race three will be given a value of 1 to 'WP1' but 0 to 'WP2'; however, the horse from stall 3 in race three will be given 0 to both 'WP1' and 'WP2'. Note that bettors' memory of horses' post-positions is likely to remain at a given meeting, so only races at the *same* meeting are considered in this study.

3.6 Research Methods

In a positivistic paradigm, a value-free and unbiased attitude is required for researchers who explore their research topics based on the sociology of regulation. This is often approached by applying a scientific method to explore and analyse cause-effects relationships based on a large number of data rather than reasoning deductions. In

take an advantage of running inside of the track, i.e. running a shorter length than those running outside of the track.

anchoring studies, laboratory experiments and field surveys are the main methods which have been used to detect and examine the existence and durability of anchoring in decision making processes. These tests have been associated with different settings such as general decision making (e.g., Tversky and Kahneman, 1974), accounting and auditing professions (e.g., Bhattacharjee and Moreno, 2002; Joyce and Biddle, 1981), the real estate evaluation (Northcraft and Neale, 1987), political event prediction (Chapman and Johnson, 1996) and gambling (e.g., Carlson, 1990; Chapman and Johnson, 1994; Johnson and Schkade, 1989; Schkade and Johnson, 1989); an analysis of variance (ANOVA) is often used to conduct statistical analysis in exploring anchoring effects.

In studies of information efficiency in horserace betting markets, different statistical techniques are used to test the significance of odds differences between different betting systems (e.g., Bruce and Johnson, 2001; Peirson and Blackburn, 2003), to detect the relationships between different variables (e.g., Dowie, 1976; Cain *et al.*, 2001), and to explore which factors are more valuable in predicating winning probabilities of horses (e.g., Bolton and Chapman, 1986). It is noted that although different methods are employed in these two areas, data analysis and statistical techniques are involved in all these studies.

In this section, the research methods used by existing anchoring and horserace betting literature are reviewed respectively in the first two parts. Consequently, the conditional logit model – the statistical technique employed in the present study to test anchoring effects in horserace betting markets – is described in the third part.

3.6.1 Research Methods Used in Anchoring Literature

Research methods that are applied in existing studies to investigate anchoring effects include (1) laboratory experiments, (2) field studies, and (3) statistical analysis. These methods are introduced in the following subsections, respectively.

3.6.1.1 Laboratory Experiments

The majority of anchoring studies are undertaken in psychological laboratories associated with controlled experiments. As discussed in Section 3.3.3, the laboratory and real world decision environments are distinguished in two aspects: the nature of decision tasks and of decision makers. In relation to decision tasks, laboratory experiments allow the investigation of discrete factors under controlled conditions, can be conducted at low costs and in a stress free setting, and are able to involve certain number of particular type of participants (e.g., males vs. females) because they select undergraduate students as subjects. However, decision tasks undertaken in laboratory experiments may not capture the key features of real world decision tasks. In addition, subjects in this low risk and stress free environment may behave differently from those in real world environments, and the evaluation methods used in laboratories are often subjective and are not able to accurately measure task performance (Anderson and Brown, 1984; Bruce and Johnson, 1997).

From a decision makers' point of view, participants are often aware that they are involved in a controlled experiment and this may affect their behaviour (Bruce and Johnson, 1997). In addition, subjects in laboratory-based studies are often not familiar with the constructed decision tasks whereas people in the real world are more likely to be familiar with the decision tasks they face (Christensen-Szalanski *et al.*, 1983). Therefore, results generated by university students in laboratories may bias on understanding of anchoring which might be experienced in the real world.

Taken together, features of laboratory-based studies are different, in many ways, from features of naturalistic studies. To explore anchoring effects in a real world environment and answer research questions of the present study, it is necessary to examine to what extent that observed anchoring effects in laboratories can be translated to real world environments. A proper research method in investigating anchoring effects in a real world setting, in horserace betting market in particular, is therefore required (see Section 3.6.2 for more details).

3.6.1.2 Field Studies

Based on findings from laboratory experiments, researchers begin to explore anchoring effects in a real world environment outside laboratories. A common method used in the literature is to use designed experiments related to certain industries, such as auditing, auction or negation. Decision makers in these real world environments are therefore asked to give their answers to these tasks based on their knowledge and/or work experience. The extent to which these people anchor their judgements on the information provided by or generated from the tasks is explored.

Compared with laboratory studies using undergraduate students, field studies solve the subject problem by using experienced decision makers who are very familiar with the tasks provided to them. However, some disadvantages of experimental studies still remain. First, the tasks employed in these studies are designed experiments which are not directly comparable with real tasks in terms of risks, costs, amount of money involved etc. Thus, even experienced decision makers may not take these tasks seriously due to the nature of the experiment. Second, the participants, even the professionals, in these studies are aware that they are taking part in experiments so that they may behave differently. Consequently, it is still unclear whether decision makers exhibit anchoring or not in a 'pure' (i.e., decisions are made without experimental control) real world decision making environment (refer to the differences between experimental and real world studies discussed in Section 3.3.3).

3.6.1.3 Statistical Analysis

In the experimental studies a variety of statistical techniques are also employed. One is descriptive statistical figures such as the mean and standard deviation of subjects responding 'yes'/'no' to particular questions (e.g., Joyce and Biddle, 1981). Another commonly used statistical technique is the Kruskal-Wallis one-way variance analysis (e.g., Chapman and Bornstein, 1996; Joyce and Biddle, 1981). This method is used to test the null hypothesis against the alternative hypothesis when sample means are not equal. In particular, a parametric one-way analysis of variance (ANOVA) is adopted in most anchoring studies because the within-sample variances of these experiments are usually disparate. In addition, this method is more useful and powerful for multiple regression analysis when more than one independent variable is considered. However, this method is not appropriate for the analysis of horserace betting data because first, the characteristics of horserace betting data (e.g., the win/lose outcome of a horse, the competitiveness among horses in a race) require specific techniques, and second, the models developed to test anchoring in horserace betting markets are the two-variable regressions rather than multiple regressions.

3.6.2 Research Methods Used in Horseracing Literature

Three types of methods that are commonly adopted by horserace betting studies in exploring market efficiency: (1) descriptive statistical models, (2) classical regression models, and (3) logit models. These methods are reviewed below.

3.6.2.1 Descriptive Statistical Models

In horserace betting literature, descriptive statistical models (e.g., mean, mode, and standard deviation) are often used to describe the betting data and apply χ^2 tests and *t*-tests to explore differences in populations (e.g., Metzger, 1985; Bruce and Johnson, 2001; Blackburn and Peirson, 1995). These statistical techniques are easy to use, the results are very straightforward to explain, and therefore no high statistical skills are required. However, although these techniques are effective in describing the significance of differences between populations, they are incapable of estimating horses' winning probabilities. Therefore, decision making processes in horserace betting can not be facilitated using these methods (Ming-chien Sung, 2006).

3.6.2.2 Classical Regression Models

Classical regression models are also commonly used in studies exploring market efficiency. However, these regression models are only limited to and associated with continuous variables such as pari-mutuel odds and starting prices of horses (e.g., Dowie, 1976, 2003; Gabriel and Marsden, 1990, 1991). In addition, classical regressions are not capable of dealing with non-continuous dependent variables such as win or lose. Greene (2000) argues that when the independent variables increase or decrease indefinitely, the value generated by the linear regression model will extend over the range of 0 and 1. Obviously, this is inappropriate for the estimation of horses' winning probabilities. Since the five hypotheses generated in the present study are to investigate the impact of certain pieces of information on bettors' subjective judgements of horses winning, a probability related dependent variable is required in the model. Therefore, models of classical regression are not appropriate for the analysis in this study.

3.6.2.3 Logit Models

Logit models are employed by horserace betting literature to predict a binary dependent variable which has two types of mutually exclusive outputs indicating the winning or losing of a horse in a race (e.g., Asch *et al.*, 1984, 1986; Bruce and Johnson, 2000a; Sung and Johnson, 2007a, 2007b, 2008). The output of logit models falls in a range of 0 and 1 and can be identified as the probability of a horse wining a race. Independent variables in these models can be either continuous (such as odds) or discrete (such as a dummy variable). However, it is argued that these logit models do not account for the competitive nature of horses within races (Bolton and Chapman, 1986). This leads to a fact that when predicting the probability of a horse winning a race, the logit model may make the estimated probabilities for all horses in that race not equal to one.

This issue is solved by applying a conditional logit model (hereafter CL model) in the case of horse racing. The output of the dependent variable in CL model can be two or more exhaustive groups which represent the outcome of each horse within a race. For example, Figlewski (1979) predicted, using the CL model, the racing results of horses in the U.S. pari-mutuel system based on the public information concerning professional handicappers. A series of variables associated with horses, jockeys and racetrack conditions are determined, using the CL model, to estimate the winning probabilities of horses in many other studies (e.g., Chapman, 1994; Benter, 1994). Since the CL model can represent the status of competition among all runners in a race, this model is, consequently, regarded as the most appropriate model applied in the present study to explore anchoring effects in horserace betting markets.

3.6.3 Research Methods Used in This Study

To detect the existence of anchoring effects in the horserace betting market, a number of procedures are undertaken. The transformation of the explanatory variable is described below, followed by the introduction of the modelling procedure. The model fit measurements and expected model evaluations are then explained before details of hypotheses tests and results are provided. These procedures are presented as follows.

3.6.3.1 Transformation of Dependent Variable

As mentioned above, the odds information selected from the UK market is the starting price of horses in the bookmaker betting system. This price is determined by the bookmaker who offers bets to the betting public. Odds used for the HK market are, however, generated from a pari-mutuel betting system whereby the odds on horse *i* in race *j* (O_{ij}) are determined by the proportion of money bet on horse *i* in race *j*, as follows:

$$O_{ij} = \left(\frac{\sum_{i=1}^{n_j} B_{ij}}{B_{ij}} \right) (1 - d) - 1 \qquad (1)$$

where B_{ij} is the amount of money bet on horse *i* in race *j*, *d* is the pari-mutuel operator's deduction and n_j represents the number of runners in race *j*. Consequently, $\sum_{i=1}^{n_j} B_{ij}$ indicates the total amount of money bet on all the runners in race *j*. In a pari-mutuel market, the final odds of a particular horse are not determined until the race starts. It is argued that bettors will continue to put money on a horse in a race until the odds accurately reflects the market's best estimate of the horse's chance of winning that race (Asch *et al.*, 1984; Figlewski, 1979; Johnson and Bruce, 2001; Liu and Johnson, 2007). The ratio, p_{ij}^s, regarded as the subjective probability judgement of the betting public concerning horse *i*'s potentials of winning race *j*, is therefore constructed as follows:

$$p_{ij}^s = \frac{B_{ij}}{\sum_{i=1}^{n_j} B_{ij}} = \frac{\frac{1}{O_{ij}+1}}{\sum_{i=1}^{n_j} \frac{1}{O_{ij}+1}} \qquad (2)$$

In other words, p_{ij}^{s} is a normalised indicator of final odds (O_{ij}) implied winning probability of horse *i* in race *j*.

The aim of exploring p_{ij}^{s} is to assess to what extent that bettors' subjective estimate of horse *i*'s chance of winning race *j*, p_{ij}^{s}, can reflect the horse's true or objective probability of success, p_{ij}^{o}, and therefore to detect whether bettors anchor their judgements of a horse winning a race on particular pieces of information.

To develop the modelling procedure, a transformation of the explanatory variable is described in this section. In the horserace betting literature (e.g., Benter, 1994; Figlewski, 1979; Bruce and Johnson, 2001), the independent variable employed is generally the logarithmic transformation of p_{ij}^{s}, the bettors' subjective estimate of the probability of which horse *i* winning race *j*. The reasons for applying the logarithmic transformation of the subjective probability of the horse *i* wining race *j* [ln(p_{ij}^{s})] are as follows: First, taking the logarithmic form of the probability can normalise the distribution of the odds implied probabilities. For example, in the UK market, the values of the subjective probability of horse *i* wining race *j*, p_{ij}^{s}, are skewed to the right along the horizontal axis and clustered within a small range between 0.05 and 0.20. By taking the logarithmic transformation, the small values of probabilities on the left side of the axis are spread out. Consequently, the space between the values which occur most frequently is enhanced so that the significance of the variance of these values can be easily captured. Second, by taking the logarithmic transformation, the probabilities with large values on the right side of the distribution (values between 0.4 and 0.9 are only 2.5% of the whole dataset) are compressed. This can reduce the impact of high values on model estimation and increase the model fit. Finally, when the values of observations in a dataset are in an extremely wide range, the logarithmic transformation can produce a better model fit. In the dataset employed in this study, the largest value of p_{ij}^{s} in the HK market is 0.9090 (0.9852 in the UK market), whilst the smallest value is 0.0014 (0.0010 in the UK market), 636 (985) times smaller than the former one. Therefore, the logarithmic transformation is not only useful but also suitable for this study.

3.6.3.2 Conditional Logit Model

Due to the competitive conditions of a horse race, it is more likely that an efficient probability estimate of horse i winning race j is obtained if the horse's chance of winning is assessed, conditional on factors relating to other runners in race j. Two conditional logit (hereafter CL) models are developed: model one includes only those factors which bettors may anchor judgements upon and model two includes the factors in model one plus the odds information. To develop model one, a 'winningness' index W_{ij} is defined to represent the winning chance of horse i in race j:

$$W_{ij} = \alpha_k A_{ik} + \varepsilon_{ij} \tag{3}$$

where A_{ik} represents the value for horse i of the kth factor on which bettors may anchor their judgements upon (e.g. a dummy variable indicating whether horse i won its last race), α_k measures the contribution of the kth anchoring factor to the estimate of the winning chance of the horse, and ε_{ij} is the disturbance term that represents all the other information which is unobservable but has impact on the competitiveness of horse i running in race j. The real probability of horse i winning race j, p^o_{ij}, is therefore formulated as:

$$p^o_{ij} = \text{Prob}\ (W_{ij} > W_{lj},\ l = 1, 2, \dots n_j,\ l \neq i) \tag{4}$$

Equally,

$$p^o_{ij} = \text{Prob}\ (\alpha_k A_{ik} + \varepsilon_{ij} > \alpha_k A_{lk} + \varepsilon_{lj},\ l = 1, 2, \dots n_j,\ l \neq i) \tag{5}$$

Although W_{ij} cannot be observed directly from the dataset, whether horse i wins race j can be obtained after the race. As a result, a win/lose variable w_{ij} is defined as follows:

$$w_{ij} = 1 \ \textit{if}\ W_{ij} = \text{Max}\ (W_{1j}, W_{2j}, \dots W_{n_j j});$$
$$w_{ij} = 0\ \textit{otherwise}. \tag{6}$$

The probability of horse *i* winning race *j* can, therefore, be formulated such that:

$$p_{ij}^{o} = \text{Prob}\ \left(w_{ij} = 1 \mid A_{ij}, i = 1,2,...n_j\right) \tag{7}$$

It has been demonstrated that if the error terms ε_{lj} are independently and identically distributed according to the double exponential distribution, the probability of horse *i* winning race *j* can be given by a CL function as follows (McFadden, 1974):

$$p_{ij}^{o} = \frac{\exp(\alpha_k A_{ik})}{\sum_{i=1}^{n_j} \exp(\alpha_k A_{ik})} \quad , \qquad i = 1, 2, \ldots n_j \tag{8}$$

where the parameter α_k is estimated by maximising the join probability of observing the results of all *N* races in the dataset, p_{ij}^{o} subjects to $0 \leq p_{ij}^{o} \leq 1$ and $\sum_{i=1}^{n_j} p_{ij}^{o} = 1$. Consequently, assuming the results of all *N* races are independent to each other, the value of the log-likelihood function of the whole dataset, likelihood $L(\beta)$, can be maximised as follows:

$$L(\beta) = \sum_{j=1}^{N} \sum_{i=1}^{n_j} p_{ij}^{o} = \sum_{j=1}^{N} \sum_{i=1}^{n_j} (\alpha_k A_{ik}) \tag{9}$$

where *N* is the number of races in the data sample.

It is noted that equation (8) only measures the contribution of a *single* anchoring factor, A_k, to the real probability of horse *i* winning race *j*. If the coefficient of the *k*th factor, α_k, equals to 0, then p_{ij}^{o} would have a value of 1 which means the factor A_k has the full impact on the success of horse *i* in race *j*. If α_k is significantly different from 0, this indicates that factor A_k can partly but not fully contribute to the success of horse *i* in race *j* and should be taken into account when bettors estimate the probability that horse *i* wins race *j*.

In the model discussed above, the competitiveness of horse *i* in race *j*, represented by the winning index W_{ij}, only comprises two parts: one explanatory variable (A_{ik})

which is regarded as the potential anchoring factor on which bettors may anchor their judgements, and the stochastic term (ε_{ij}) which contains unobservable information in the market. The aim is to detect the importance of the potential anchoring factor on the chance of horse *i*'s success in race *j*. These factors include different aspects of information which may impact on horses' winning potentials, as discussed in Section 3.5.2.

Odds represent the bettors' estimate of the winning probability of a horse based upon the various information they have taken into account when making their judgements. Consequently, to explore anchoring effects, another model including public odds as a further independent variable is also developed as follows, given W_{ij} representing the 'winning index' of horse *i* in race *j*:

$$W_{ij} = \alpha_k A_{ik} + \beta \ln(p_{ij}^s) + \varepsilon_{ij} \qquad (10)$$

In a similar manner to that described above, this leads to a CL function as follows:

$$p_{ij}^o = \frac{\exp\left(\alpha_k A_{ik} + \beta \ln(p_{ij}^s)\right)}{\sum_{i=1}^{n_j} \exp\left(\alpha_k A_{ik} + \beta \ln(p_{ij}^s)\right)}, \quad i = 1, 2, \ldots n_j \qquad (11)$$

where A_k is the *k*th factor on which bettors may anchor their judgements, $\ln(p_{ij}^s)$ is the logarithmic form of bettors' aggregate estimate of the probability that horse *i* wins race *j*, α_k and β measure the contribution of the *k*th anchoring factor and the bettors' subjective probability of horse *i* winning race *j* to the winning index W_{ij}, respectively, and ε_{ij} is the disturbance term representing all the unobservable information in the market. Parameters α_k and β are measured by maximising the joint probability of observing the results of all *N* races in the data sample, p_{ij}^o satisfies $0 \leq p_{ij}^o \leq 1$ and $\sum_{i=1}^{n_j} p_{ij}^o = 1$. Consequently, given the results of all *N* races are independent to each other, the value of the log-likelihood function, likelihood $L(\beta)$, can be maximised as follows:

$$L(\beta)=\sum_{j=1}^{N}\sum_{i=1}^{n_j} p_{ij}^{o} = \sum_{j=1}^{N}\sum_{i=1}^{n_j}(\alpha_k A_{ik} + \beta \ln(p_{ij}^{s})) \quad (12)$$

where *N* is the number of races in the data sample.

This CL model is constructed to estimate the winning probability of each horse in its race based on explanatory variables, A_k and ln(p_{ij}^{s}). Using equation (11), if α_k equals 0 and β equals 1, these indicate that bettors' subjective estimates of horses' chance of winning perfectly match horses' objective winning probabilities (i.e. p_{ij}^{s} = p_{ij}^{o}). However, if α_k is significantly different from zero and its sign in equation (11) is the reverse of its sign in equation (8), it is demonstrated that bettors' subjective probabilities are overly influenced by the *k*th factor (A_k) when they formulate the odds information. This suggests that bettors in the horserace betting market have unduly anchored on the *k*th piece of information (A_k) when forming their judgements of horse *i* winning race *j*.

It should be noted that the horserace betting markets are diverse and involve various types of races (e.g., class, distance) and racetracks. Consequently, similar tests are undertaken for each segment of the whole database. This is to explore whether bettors anchoring on different piece of information when betting on different types of races. In addition, the time and days that bettors place their bets are also considered. Comparisons between models using the odds information gathered at different times before the race starts are conducted separately. Bets placed on races running on weekdays or over the weekends are also compared. This is to explore the importance of bettors' betting experience in reducing the degree of their anchoring.

STATA 9.0 is employed to estimate the conditional lofit models developed in this study.

3.6.3.3 Model Fit Measurements: Pseudo-$\overline{R}^2$

According to Malthouse (1999), a way of judging how well the model can explain the relationship between the dependent and independent variables is to see its model fit. There are different forms of model fit measurement: the $\overline{R}^2$, the pseudo-$\overline{R}^2$, and the adjusted-$\overline{R}^2$.

The overall model fit is usually measured by $\overline{R}^2$. It represents the percent of the total sum of square which is explained by the independent variables employed in a model and can be defined as follows:

$$\overline{R}^2 = 1 - \frac{L(\theta = \overline{\theta})}{L(\theta = 0)} \quad (13)$$

where $L(\theta = \overline{\theta})$ measures the log-likelihood value of the model with the parameter estimated and $L(\theta = 0)$ indicates the log-likelihood value of a random choice model without parameter estimated. If the estimated parameter entirely explains the existence of the dependent variable, $L(\theta = \overline{\theta})$ would be zero, and hence the $\overline{R}^2$ would turn out to be 1 which indicates a perfect model fit. Consequently, the higher the $\overline{R}^2$ is, the better the model performs. Usually, the greater number of explanatory variables and observations, the higher the $\overline{R}^2$ value, and the better the model fit. However, $\overline{R}^2$ may increase when the model is less competent due to additional independent variables or observations incorporated in the model. In this case, the quality of the model estimation may not be adequately represented by the $\overline{R}^2$ value.

The adjusted-$\overline{R}^2$ takes the number of independent variables and the number of observations into account and therefore is regarded as superior to $\overline{R}^2$, especially when large databases with many explanatory variables are emplored. The adjusted-$\overline{R}^2$ is defined as follows:

$$Adj\text{-}\overline{R}^2 = 1 - \frac{L(\theta = \overline{\theta})}{L(\theta = 0)} \times \frac{\sum_{j=1}^{N} n_j - N}{\sum_{j=1}^{N} n_j - N - B} \quad (14)$$

where n_j is the number of runners in race j, N is the number or races in the whole data sample, and B is the number of parameters estimated in the model. In this chapter, B equals to 1 when the kth anchoring factor (A_k) is tested in the model on its own and will be 2 when the transformed odds implied probability of horse i winning race j ($\ln(p_{ij}^{s})$) is added into the model together with the anchoring factor. According to equation (14), if by increasing N and/or B the model fit reduces, the adjusted-$\overline{R}^2$ will decrease and hence reflects a more accurate assessment of the model efficiency. Therefore, the adjusted-$\overline{R}^2$ can be regarded as a more powerful indicator of the goodness-of-fit of the model than $\overline{R}^2$.

In this study, a pseudo-R^2 is adopted to measure the model fit. This is analogous to $\overline{R}^2$. It should be noted that the number of independent variables employed in the models (B) is not large (usually 1 or 2) but the number of observations incorporated in the study is huge. Therefore, the adjustment part of equation (14), $\frac{\sum_{j=1}^{N} n_j - N}{\sum_{j=1}^{N} n_j - N - B}$, is close to 1 and the difference between the results of equation (14) and equation (13) is minimal. Consequently, for the datasets and models employed here, there is little difference between $\overline{R}^2$, adjusted-$\overline{R}^2$, and pseudo-R^2. For convenience, the pseudo-R^2 provided by STATA 9.0 is therefore adopted as the measure of model fit.

3.6.3.4 Expected Model Evaluations

The models developed are employed to explore anchoring effects in both the HK and the UK horserace betting markets.

The definitions and expected signs for the coefficients of the independent variables are described in Appendix A. As shown in the appendix, when there is only one explanatory variable (A_k or $\ln(p_{ij}^{s})$) in the model, each of the odds related, horse's performance related, and jockey's and trainer's performance related variables is expected to obtain a positive sign for its coefficient. Among the post-position related variables, 'PP' could have a positive or negative sign for the coefficient due to the features of specific racetracks: at tracks where low/high draw numbers are favoured, the coefficients of this factor would be negative/positive.

When the odds information is included in the model, the sign for the coefficient of a variable on which bettors anchor their judgements should reverse. This implies that when the betting public attempts to incorporate this piece of information into odds, they exaggerate its contribution to the estimate of a horse's winning and anchor their judgements on it. Therefore, to obtain the real probability of the horse winning a race, the over-weighted part of the contribution must be eliminated from the odds probability.

3.7 Conclusion

In this chapter, an appropriate research paradigm, approach and methods are defined to answer the research questions derived from the literature. In particular, a positivistic paradigm has been adopted in this study. Under this paradigm, a deductive research approach is selected and five hypotheses are therefore generated to detect anchoring effects in a specific real world environment, the horserace betting market. Data from the HK and the UK horserace betting markets are described respectively and variables employed in this study are explained separately. To test these hypotheses, a CL model is developed. The modelling procedure is explained, together with an explanation of model fit measurement and the model evaluation of variables. Results and discussions of these hypotheses tests will be described in Chapter 4.

CHAPTER 4
RESULTS AND DISCUSSION:
ANCHORING EFFECTS IN HORSERACE BETTING MARKETS

4.1 Introduction

Anchoring effects in the real world are explored using HK and UK horserace betting market data. Previous literature suggests that decision makers are likely to anchor their judgements on information which they can easily obtain or generate (e.g., Brewer and Chapman, 2002; Brewer *et al.*, 2007; Cervone and Peake, 1986; Epley and Giovich, 2001; Joyce and Biddle, 1981; Mussweiler, 1997, 2001; Mussweiler and Englich, 2005; Mussweiler and Strack, 1999a, 1999b, 2000a, 2000b; Northcraft and Neale, 1987; Quattrone *et al.*, 1981; Ritov, 1996; Strack and Mussweiler, 1997; Tversky and Kahneman, 1974; Wilson *et al.*, 1996). In horseracing, the winning records of horses, jockeys and trainers are important information which indicates horses' performances in the past and their winning potential in the future. Conditions of races at different racetracks such as the post-positions of horses also have a significant impact on racing outcomes. Consequently, a number of empirical tests are conducted to detect anchoring effects based on these factors.

According to the research questions constructed in Chapter 3, four hypotheses are formulated. The first two hypotheses are related to research question one, detecting whether anchoring effects caused by both relevant information and less relevant information in horserace betting markets exist, and if they do, how strong these anchors must be to cause anchoring. The relevant information includes the past performance of the horse, the jockey, the trainer, and the post-position of the horse or the winners of previous races. These types of information are relevant to bettors' probability estimates of horses because they are widely regarded as having a direct impact on the future performance of horses. Less relevant information involves the performance of previous favourites at a meeting. This information is less relevant because the performance of favourites in previous races has little impact on the performance of the favourite in the next race since they are different horses. The second hypothesis is constructed to detect how strong the information should be to lead to anchoring in horserace betting markets. As suggested in previous literature, anchoring effects in some circumstances can be weak and fragile (e.g., Brewer and Chapman, 2002; Wilson *et al.*, 1996). However, if the anchor is strong enough, it may have a significant impact on decision makers' judgements (Bloomfield *et al.*, 2000; Griffin and Tversky, 1992; Nelson *et al.*, 2001). It is therefore argued that even if the outcome of a previous race is too weak to cause anchoring, the same result from two or three consecutive races may be strong enough.

The second research question, concerning the impact of decision makers' expertise on their judgements, is explored using hypothesis three which states that bettors with greater expertise in horserace betting are subject to a lower level of anchoring effects than those with less expertise. The anchoring factors considered in this hypothesis are the same as those employed in the previous two hypotheses.

To answer research question three, hypothesis four is constructed to explore the difference between anchoring effects in different decision making environments (i.e., the HK and UK horserace betting markets). The reasons for choosing these two markets to conduct a cross-sectional study are as follows: first, the UK horserace betting market has more diversity than the HK market as a whole in terms of the betting turnover per track and per race, the number of tracks, number of races, type of races, variety of classes and the amount of prize money. In the UK, various types of races (flat races which are either handicap or non-handicap) are run at 38 racetracks over the country and the racing days cover weekdays and weekends. Whilst in HK, races are only run on two racetracks on two or three days in each week during the racing season (usually races are run at Happy Valley racetrack on Wednesday evening and at Sha Tin racetrack on Saturday or Sunday afternoon). In total, there are approximately 4,500 races run in the UK in a season in contrast to only 600 races run in HK. Races in the UK vary from class A to class G (from high to low) and the prize money for the winner in different races varies from GBP 1,179 to 852,600. In contrast, six classes of races are run in HK and the prize money ranges from HK$ 0.1 to 20 million (approximately GBP 7,600 to 15,384,600).

Second, racetracks in the UK retain a high level of diversity in many aspects compared with the highly standardized racetracks in HK. This implies that different conditions of track surface and going may have a different impact on the racing results at different racetracks in the UK. Therefore, the physical features of each track and the influence of these features on the racing outcomes have to be considered carefully when bettors make their judgements on horses' winning probabilities at different tracks in the UK. This contrasts with the HK horserace betting market. In HK, there is not much difference in the condition of the racetracks when it comes to the same type of races. Although Happy Valley and Sha Tin racetracks in HK are not exactly the same in terms of the length, shape, and conditions of the course, they are still highly standardized when compared with the diversity of conditions at UK courses. In addition, the number of horses in a race in the UK can vary from 2 to up to 38 whilst in HK there are about 7 to 14 runners in most races. All these differences may suggest that the factors which may affect the result of a race may be accounted for differently bettors in the two markets.

The remainder of this chapter is structured as follows: Section 4.2 outlines the data, variables and the modelling procedures which are conducted for hypothesis tests. The results of the tests are presented in Section 4.3 together with the model fit measurement explanations. The results are discussed in Section 4.4. A summary of the main findings is provided in Section 4.5.

4.2 Data and Methodology

The data, variables and the modelling procedures employed to test anchoring effects in the HK and UK horserace betting markets are introduced in this section.

4.2.1 Data

As mentioned in Chapter 4, two sets of horserace betting data (from the HK and UK markets respectively) are employed to conduct anchoring tests. The HK data include records of 5,133 flat races (66,244 horses) run at Happy Valley (HV) and Sha Tin (ST) racetracks from September 1998 to April 2007. Specifically, about 33% of the total races (21,624 horses in 1,789 races) run at HV and 67% (44,620 horses in 3,344 races) run at ST. In each race, the number of runners varies from 5 to 14, and therefore the post-position number for each horse varies from 1 up to 14. The distance of the races varies from 1,000 metres to 24,000 metres and the races range over 6 class categories. In this market, only pari-mutuel betting system is operated. Three types of odds information are employed in the study: the final odds of each horse in a race and the odds 2 and 5 minutes before the race starts. The finishing position of each horse in a race and the previous performances of the jockey and trainer of each horse are recorded.

The bookmaker odds of horses are employed for the UK horserace betting market because the bookmaker rather than the pari-mutuel betting system is dominant in the UK and the money bet into the pari-mutuel 'pool' is very limited compared to the amount bet with bookmakers. Due to data accessibility, only final odds (called *Starting Price*, SP) of horses are included in this dataset. The finalised UK dataset contains details of 554,830 horses running in 49,881 flat races in the UK from January 1996 to February 2007. In this database, the number of runners in a race ranges from 2 to 38, the distance of the race varies from 1,100 metres to 4,874 metres and all the races are defined within 7 class categories.

To detect the difference of judgements between professional and casual bettors and between different markets, the datasets of the HK and UK markets are split into two sub-datasets according to the day in which races are running. Generally, the casual bettors are more likely to bet on the weekend races and consequently the bets experts can be more readily isolated on the weekdays (e.g., Benter, 1994; Kopelman nd Minkin, 1991; Saunders and Turner, 1987). In addition, the variety of racetrack configurations may also make different post-positions more advantageous. Consequently, different post-position anchoring factors may exist at different tracks. The HK dataset is split into two categories: races run at HV and races run at ST. In the UK, the data are separated into two sub-datasets: one includes all the races run at racetracks which favour high draw (post-position) horses and the other is consist of races at the racetracks favouring low draw horses. The number of horses and races of the whole market and of the market segments in the HK and UK markets are described in Table 4.2-1.

Table 4.2-1 Data description for the HK and UK horserace betting markets

	HK Market				
	Whole Market	Day of the Week		Racetrack	
		Wnd	Wk	HV	ST
Races	5,133	2,910	2,223	1,789	3,344
Horses	66,244	38,658	27,586	21,624	44,620
	UK Market				
	Whole Market	Day of the Week		Racetrack	
		Wnd	Wk	High PP	Low PP
Races	49,881	12,738	37,143	12,138	13,714
Horses	554,830	141,225	413,605	135,854	151,286

4.2.2 Variables

As explained in Section 3.5.2 in Chapter 3, the dependent variable employed in all the tests in this study is a binominal variable which equals 1 when the horse wins and 0 otherwise. The independent variables consist of the following: (1) odds-related variables such as the natural log of the odds implied probabilities of horses in each race, determined from the odds available in the market 5 and 2 minutes before the race starts, and the final odds (‘Ln5MinsOdds’, ‘Ln2MinsOdds’, ‘LnFinOdds’); (2) dummy variables which represent whether a horse has won its previous one, two or three races at any meeting (‘H1’, ‘H2’, ‘H3’) and whether the previous one, two or three races at a meeting are won by the favourite (‘F1’, ‘F2’, ‘F3’); (3) dummy variables which identify whether horses ridden/trained by the same jockeys/trainers who won the previous one, two or three races at any race meeting (‘J1/T1’, ‘J2/T2’, ‘J3/T3’); and (4) the post-position of each horse in a race (‘PP’) and dummy variables identifying the post-positions of the winners of the previous one, two or three races at a meeting (‘WP1’, ‘WP2’, ‘WP3’).

4.2.3 Modelling Procedures

It has been argued that a conditional logit (CL) model is appropriate to detect anchoring effects in the horserace betting environment (see Section 3.6.3 in Chapter 3). For each potential anchoring factor, two CL models are developed:

$$W_{ij} = \alpha_k A_{ik} + \varepsilon_{ij} \tag{15}$$

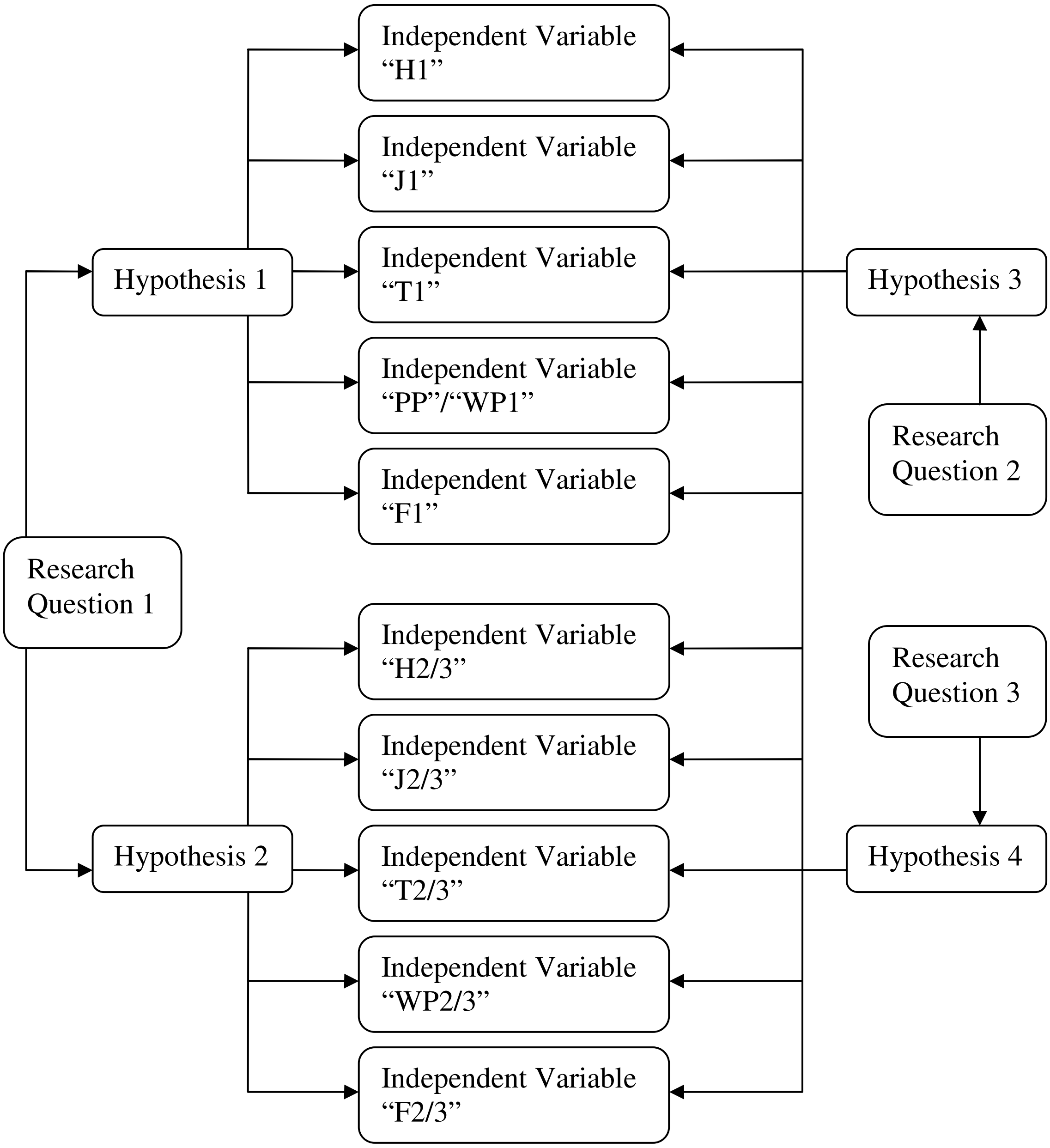
$$W_{ij} = \alpha_k A_{ik} + \beta \ln(p_{ij}^{s}) + \varepsilon_{ij} \tag{16}$$

where W_{ij} is the 'winningness' index defined to describe the winning chance of horse *i* in race *j*, A_{ik} represents the value for horse *i* of the *k*th factor upon which bettors may anchor their judgements (e.g., in the case where I investigate anchoring based on a horse's winning performance in its previous race, the anchoring factor for horse *i*, A_{ik}, will be "H1" with a value of 1 if horse *i* won its last race), $\ln(p_{ij}^{s})$ is the logarithmic form of bettors' aggregate estimate of the probability that horse *i* wins race *j* (i.e., a transform of the odds implied probability of horse *i* in race *j*), α_k and β measure the contribution of A_{ik} and bettors' subjective probability of horse *i* winning race *j* to the winning index W_{ij} , and ε_{ij} includes all the noise information which impacts the competitiveness of horse *i* running in race *j* but is not measured in the model.

The first step of the modelling procedure is to develop a single variable CL model (model 1) using equation (1). In this model, only one independent variable, A_{ik}, is involved. This is used to detect the importance and the contribution of factor A_{ik} in estimating the chance of horse *i* winning race *j*. If the coefficient of the variable, α_k , is significantly different from zero, this suggests that factor A_{ik} has an important impact on the horse winning. The second step is to develop model 2 which incorporates the odds related variables ($\ln(p_{ij}^{s})$). Odds information is generally regarded as an aggregate indicator of a horse's winning chance estimated by the betting public. Therefore, the coefficient of the odds related variable in this model should be significantly different from zero. If the coefficient of the anchoring factor in model 2 associated with the odds related variable is also significantly different to zero, this indicates that this factor has not been properly accounted for in odds. In some cases the information is undervalued (i.e., bettors do not take fully account of it), and in other cases the information is over-weighted (i.e., the betting public pay too much attention to this information, and this may indicate that they anchor their judgements on this type of information). Specifically, if the coefficient of the anchoring factor (α_k) is significant in both models and keeps the direction of the sign (positive or negative), the importance of this piece of information is underestimated by the betting public. If α_k is statistically significant in both models but changes sign when the odds information is included, this suggests that the betting public overestimate the value of this factor.

This two-step modelling procedure is repeated for each of the potential anchoring factors investigated. In each procedure, only a single anchoring factor is explored at a time to avoid results bias which may arise from interactions between anchoring factors. This approach is adopted for both the whole market dataset and different segments of the datasets. The results and discussion of these tests are provided respectively in the next section, according to the research questions and relevant hypotheses in the order shown in Figure 4.2-1:

Figure 4.2-1 Research questions, hypothesis and independent variables



4.3 Hypothesis Testing and Results

The four hypotheses developed for the three research questions are tested using the HK and UK horserace betting data. The results and analysis for each test are reported as follows.

4.3.1 Hypothesis Tests for Research Question One

Hypothesis one (the *anchoring factor* hypothesis) tests whether bettors in horserace betting markets anchor their judgements of a horse's winning probability on the information associated with the last performance of the horse, the horse's jockey or trainer, the horse's post-position, or the performance of the favourite in the previous race. Hypothesis two (the *strength* hypothesis) repeats the tests conducted in the anchoring factor hypothesis but focuses on the influence of racing outcomes of previous two or three races (e.g., the impact of the information that a horse has won its previous three races).

Results of these hypothesis tests based on CL models are displayed below in Table 4.3.1-1 – Table 4.3.1-20 according to different anchoring factors in different markets. A summary of the findings associated with the two hypotheses are provided in the last part of this section.

4.3.1.1 Horse's Past Performance

HK Market

The extent to which bettors in the HK horserace betting market anchor their subjective judgements of a horse's probability of winning on the horse's performance in its previous one, two and three races is described in the following tables: Table 4.3.1-1 displays the results of CL models associated with a single independent variable concerning the winning records of horses in their previous one, two and three races (H1, H2 and H3, respectively) and tables 4.3.1-2(1-3) report results of CL models which incorporate both bettors' subjective probability judgements *and* horses' past performances.

In Table 4.3.1-1, the coefficient of H1 derived for the whole market data is significant at the 1% level (coef. = 0.8224; Z = 19.34). This suggests that the last performance of a horse has a significant impact on its winning probability in a subsequent race. Similarly, the variables H2 and H3 are both significant at the 1% level (H2: coef. = 1.2089, Z = 13.51; H3: coef. = 1.7820, Z = 10.65), indicating the importance of horses' winning records in the past two and three races on their subsequent performance.

When the odds related variable ($\ln p_{ij}^{s}$) is added to the model (see Tables 4.3.1-2(1-3)), the influence of horses' past performances is entirely absorbed in bettors' subjective judgements (based on final odds). Take Table 4.3.1-2(1) as an example. The coefficient of H1 drops down to 0.0757 (Z = 1.63) whilst the final odds variable $\ln p_{ij}^{s}$ obtains an extremely high and significant coefficient (coef. = 0.9899; Z = 54.34). The Pseudo-R^2 of the model with final odds (0.1517) is higher than that of the model without final odds (0.0124). Results in Tables 4.3.1-2(2) and 4.3.1-2(3) suggest a similar pattern: the final odds implied probability estimates are significant at the 1% level but horses' performance variables (H2 and H3) are not.

These results suggest that (1) the odds of a horse represent an aggregate indicator of bettors' estimates of the horse's winning probability; (2) the information containing a horse's performances in its previous one, two and three races has been fully accounted by the betting public in odds; and (3) the importance of horses' past performance information has not been over-weighted. Therefore, bettors in the HK horserace betting market are not found to anchor their subjective judgements on horses' performances in their previous races.

Note that the results relating to races run on the weekdays and weekends and the results relating to bettors' subjective judgements 5 or 2 minutes before the race starts are also reported in these four tables. These results will be discussed in Section 4.3.2 when analysing the *expertise* hypothesis. A similar approach is adopted when reporting results for other anchoring factors.

Table 4.3.1-1 Results of estimating CL models with horse's past performance as independent Variable in the HK market

Variable	Whole Market	Day of the Week	
		Wnd	Wk
$H1_{ij}$ coef. [a]	0.8224**	0.9060**	0.7039**
Std. Err.	0.0425	0.0550	0.0672
Z	19.34	16.47	10.48
LL	-12937.41	-7394.66	-5540.03
Model LR (χ_1^2)	324.49	233.36	96.59
Pseudo-R^2	0.0124	0.0155	0.0086
$H2_{ij}$ coef. [b]	1.2089**	1.4203**	0.8201**
Std. Err.	0.0895	0.1089	0.1604
Z	13.51	13.04	5.11
LL	-13026.70	-7444.32	-5577.37
Model LR (χ_1^2)	145.93	134.03	21.91
Pseudo-R^2	0.0056	0.0089	0.0020
$H3_{ij}$ coef. [c]	1.7820**	1.9740**	1.4000**
Std. Err.	0.1674	0.2037	0.3022
Z	10.65	9.69	4.63
LL	-13055.45	-7474.21	-5579.96
Model LR (χ_1^2)	88.43	74.27	16.73
Pseudo-R^2	0.0034	0.0049	0.0015
No. of horses	66,244	38,658	27,586
No. of races	5,133	2,910	2,223

[a] $H1_{ij}$: A dummy variable which equals 1 for a horse if it won its last race; equals 0 otherwise.

[b] $H2_{ij}$: A dummy variable which equals 1 for a horse if it won its previous two races; equals 0 otherwise.

[c] $H3_{ij}$: A dummy variable which equals 1 for a horse if it won its previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-2(1) Results of estimating CL models with bettors' subjective probability judgements and the horse's performance in its previous race as independent variables in the HK market

Model 1	Whole Market			Day of the Week					
					Wnd			Wk	
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [a]	0.9899**	0.9736**	0.9835**	0.9955**	0.9794**	0.9887**	0.9817**	0.9649**	0.9758**
Std. Err.	0.0182	0.0183	0.0187	0.0235	0.0236	0.0241	0.0288	0.0289	0.0295
Z	54.34	53.20	52.73	42.28	41.41	41.03	34.07	33.33	33.06
$H1_{ij}$ coef. [b]	0.0757	0.1034*	0.1203**	0.0679	0.0967	0.1150 †	0.0860	0.1117	0.1269 †
Std. Err.	0.0464	0.0463	0.0463	0.0608	0.0608	0.0607	0.0718	0.0717	0.0716
Z	1.63	2.23	2.60	1.12	1.59	1.89	1.19	1.56	1.77
LL	-11112.52	-11224.82	-11254.60	-6280.60	-6348.63	-6368.13	-4831.84	-4876.11	-4886.41
Model LR (χ_2^2)	3974.28	3749.68	3690.13	2461.47	2325.41	2286.43	1512.95	1424.42	1403.81
Pseudo-R^2	0.1517	0.1431	0.1408	0.1639	0.1548	0.1522	0.1354	0.1274	0.1256
No. of horses	66,244	66,244	66,244	38,658	38,658	38,658	27,586	27,586	27,586
No. of races	5,133	5,133	5,133	2,910	2,910	2,910	2,223	2,223	2,223

Table 4.3.1-2(2) Results of estimating CL models with bettors' subjective probability judgements and the horse's performance in its previous two races as independent variables in the HK market

Model 2	Whole Market			Day of the Week					
					Wnd			Wk	
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [c]	0.9957**	0.9821**	0.9935**	0.9968**	0.9835**	0.9943**	0.9928**	0.9787**	0.9909**
Std. Err.	0.0179	0.0180	0.0184	0.0231	0.0232	0.0237	0.0285	0.0287	0.0292
Z	55.52	54.46	53.99	43.18	42.37	41.98	34.83	34.15	33.88
$H2_{ij}$ coef. [d]	0.0508	0.0522	0.0600	0.1609	0.1650	0.1744	-0.1573	-0.1616	-0.1558
Std. Err.	0.0973	0.0972	0.0973	0.1198	0.1198	0.1199	0.1694	0.1696	0.1695
Z	0.52	0.54	0.62	1.34	1.38	1.45	-0.93	-0.95	-0.92
LL	-11113.70	-11227.13	-11257.73	-6280.34	-6348.95	-6368.86	-4832.10	-4876.84	-4887.52
Model LR (χ_2^2)	3971.91	3745.05	3683.85	2462.01	2324.77	2284.97	1512.43	1422.97	1401.60
Pseudo-R^2	0.1516	0.1429	0.1406	0.1639	0.1548	0.1521	0.1353	0.1273	0.1254
No. of horses	66,244	66,244	66,244	38,658	38,658	38,658	27,586	27,586	27,586
No. of races	5,133	5,133	5,133	2,910	2,910	2,910	2,223	2,223	2,223

Table 4.3.1-2(3) Results of estimating CL models with bettors' subjective probability judgements and the horse's performance in its previous three races as independent variables in the HK market

Model 3	Whole Market			Day of the Week					
					Wnd			Wk	
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [e]	0.9946**	0.9811**	0.9928**	0.9994**	0.9865**	0.9977**	0.9872**	0.9729**	0.9851**
Std. Err.	0.0179	0.0179	0.0182	0.0229	0.0230	0.0235	0.0283	0.0284	0.0290
Z	55.94	54.91	54.45	43.67	42.90	42.52	34.92	34.23	33.97
$H3_{ij}$ coef. [f]	0.2426	0.2273	0.2271	0.2331	0.2281	0.2296	0.2547	0.2181	0.2154
Std. Err.	0.1853	0.1846	0.1849	0.2280	0.2270	0.2273	0.3187	0.3189	0.3192
Z	1.31	1.23	1.23	1.02	1.00	1.01	0.80	0.68	0.67
LL	-11113.00	-11226.53	-11257.18	-6280.70	-6349.38	-6369.39	-4832.24	-4877.08	-4887.73
Model LR (χ_2^2)	3973.32	3746.25	3684.96	2461.27	2323.91	2283.90	1512.17	1422.49	1401.18
Pseudo-R^2	0.1517	0.1430	0.1407	0.1638	0.1547	0.1520	0.1353	0.1273	0.1254
No. of horses	66,244	66,244	66,244	38,658	38,658	38,658	27,586	27,586	27,586
No. of races	5,133	5,133	5,133	2,910	2,910	2,910	2,223	2,223	2,223

[a c e] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] $H1_{ij}$: A dummy variable which equals 1 for a horse if it won its last race; equals 0 otherwise.

[d] $H2_{ij}$: A dummy variable which equals 1 for a horse if it won its previous two races; equals 0 otherwise.

[f] $H3_{ij}$: A dummy variable which equals 1 for a horse if it won its previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

† Statistically significant at the 10% level.

UK Market

The results of estimating CL models associated with horses' past performances and bettors' subjective estimates of horses' chances of winning in the UK market are reported in Table 4.3.1-3 and Tables 4.3.1-4(1-3). Due to the data accessibility, only final odds information is available in the UK market. The impact of bettors' expertise on their betting decisions concerning horses' past performance information (results associated with the weekday and weekend races) will be analysed in Section 4.3.2 (This also applies to the discussion of other anchoring factors in the UK market).

As shown in Table 4.3.1-3, taking the UK betting market as a whole, the performance of a horse in its last race has a significant impact on the horse's chance of winning in its subsequent race (H1: coef. = 0.6507, Z = 41.66). This indicates that if a horse won its previous race, it is likely to win its future races. However, when the odds information is included in a new CL model (see Table 4.3.1-4(1)), the significance of H1 disappeared. The coefficient of bettors' subjective judgements ($\ln p_{ij}^{s}$) in the whole market is significant at the 1% level (coef. = 1.2075; Z = 171.13), implying that the odds information has a significant contribution to bettors' estimation of horses' winning chances[23]. The coefficient of H1, however, turns to negative (coef. = -0.0164) and insignificant (Z = -0.99). Similarly, horses' past performances in its previous two and three races (H2 and H3) are also detected significant as independent variables in models without odds information but insignificant in models with final odds in. The signs of the coefficients of H2 and H3 also change from positive to negative when odds information is added in the model.

These results suggest: (1) the odds formulated by the betting public have entirely enclosed the impact of a horse's past performance on its winning probability in the next race; and (2) bettors in the UK market manage to fully account for the importance of horses' past performances in their probability judgements. Although the coefficients of H1, H2 and H3 change signs when the odds information is included, the Z values show that they are insignificant (i.e., the impacts of these factors have not been strong enough to be overestimated). In addition, the Pseudo-R^2 values of models with odds have largely increased compared to those of models without odds. This suggests that the odds

[23] If not different from the results reported here, all the results associated with the odds information in the subsequent tests will not be discussed. The focus of this study is the impact of anchoring factors on bettors' judgements. .

of a horse have a much greater power in explaining the horse's winning probability than the information of the horse's past performance on its own.

Table 4.3.1-3 Results of estimating CL models with horse's past performance as independent variable in the UK market

Variable	Whole Market	Day of the Week	
		Wnd	Wk
$H1_{ij}$ coef. [a]	0.6507**	0.5982**	0.6723**
Std. Err.	0.0156	0.0291	0.0185
Z	41.66	20.56	36.32
LL	-115595.24	-29425.96	-86166.97
Model LR (χ_1^2)	1580.42	388.81	1196.25
Pseudo-R^2	0.0068	0.0066	0.0069
$H2_{ij}$ coef. [b]	0.8412**	0.8128**	0.8547**
Std. Err.	0.0339	0.0600	0.0411
Z	24.82	13.55	20.80
LL	-116120.67	-29540.85	-86579.65
Model LR (χ_1^2)	529.56	159.02	370.88
Pseudo-R^2	0.0023	0.0027	0.0021
$H3_{ij}$ coef. [c]	1.0469**	0.8998**	1.1246**
Std. Err.	0.0637	0.1105	0.0781
Z	16.43	8.15	14.39
LL	-116272.78	-29592.26	-86679.12
Model LR (χ_1^2)	225.35	56.20	171.95
Pseudo-R^2	0.0010	0.0009	0.0010
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[a] $H1_{ij}$: A dummy variable which equals 1 for a horse if it won its last race; equals 0 otherwise.

[b] $H2_{ij}$: A dummy variable which equals 1 for a horse if it won its previous two races; equals 0 otherwise.

[c] $H3_{ij}$: A dummy variable which equals 1 for a horse if it won its previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-4(1) Results of estimating CL models with bettors' subjective probability judgements and the horse's performance in its previous race as independent variables in the UK market

Model 1	Whole Market	Day of the Week	
Variable		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [a]	1.2075**	1.2058**	1.2080**
Std. Err.	0.0071	0.0142	0.0081
Z	171.13	84.76	148.66
$H1_{ij}$ coef. [b]	-0.0164	-0.0268	-0.0121
Std. Err.	0.0165	0.0306	0.0196
Z	-0.99	-0.87	-0.62
LL	-96790.10	-24840.52	-71949.48
Model LR (χ_2^2)	39190.70	9559.68	29631.22
Pseudo-R^2	0.1684	0.1614	0.1708
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[a] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] $H1_{ij}$: A dummy variable which equals 1 for a horse if it won its last race; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-4(2) Results of estimating CL models with bettors' subjective probability judgements and the horse's performance in its previous two races as independent variables in the UK market

Model 2	Whole Market	Day of the Week	
Variable		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [c]	1.2071**	1.2029**	1.2086**
Std. Err.	0.0070	0.0141	0.0080
Z	172.97	85.58	150.31
$H2_{ij}$ coef. [d]	-0.0410	0.0201	-0.0693
Std. Err.	0.0358	0.0631	0.0434
Z	-1.15	0.32	-1.60
LL	-96789.98	-24840.85	-71948.38
Model LR (χ_2^2)	39191.03	9559.02	29633.41
Pseudo-R^2	0.1684	0.1614	0.1708
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[c] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[d] $H2_{ij}$: A dummy variable which equals 1 for a horse if it won its previous two races; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-4(3) Results of estimating CL models with bettors' subjective probability judgements and the horse's performance in its previous three races as independent variables in the UK market

Model 3 Variable	Whole Market	Day of the Week	
		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [e]	1.2066**	1.2047**	1.2072**
Std. Err.	0.0070	0.0140	0.0080
Z	173.61	85.99	150.81
$H3_{ij}$ coef. [f]	-0.0550	-0.1198	-0.0206
Std. Err.	0.0681	0.1170	0.0839
Z	-0.81	-1.02	-0.25
LL	-96790.27	-24840.37	-71949.64
Model LR (χ_2^2)	39190.36	9559.98	29630.90
Pseudo-R^2	0.1684	0.1614	0.1708
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[e] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[f] $H3_{ij}$: A dummy variable which equals 1 for a horse if it won its previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

4.3.1.2 Jockey's Past Performance

HK Market

The results of exploring the degree to which jockey's past performance is incorporated into bettors' subjective judgements of a horse's winning in the HK market are presented in Table 4.3.1-5 and Tables 4.3.1-6(1-3). Column 'Whole Market' in Table 4.3.1-5 presents the estimates of CL models associated with jockeys' past performances (J1, J2 and J3, respectively), for the HK horserace betting market as a whole. A positive and significant coefficient of variable J1 suggests that the performance of a jockey in his/her last race has an important impact on the performance of the horse ridden by him/her in the next race (coef. = 0.1692; Z = 3.40). However, none of the coefficients of J2 and J3 is significant in these tests. This seems to indicate that the fact that a jockey has won his/her previous two or three races has a less impact on his/her subsequent performance than when he/she has just won his/her last race. This seems to be contrary to the common sense that the more times a jockey won, the more chance he/she wins the next race due to the improvement of skills and experience. However, the results of J2 and J3 actually confirm the effect of 'regression to the mean' in judgement and decision making literature: people's performances are not always good or always bad but mixed up with good and bad and regress to the mean. Therefore, it is more likely to observe one or two good performances followed by a bad performance or a reversal sequence rather than a series of three good or three bad performances. The misconceptions of regression and neglect of base-rate will lead to a representativeness bias in judgement (Goodwin and Wright, 2004; Keren and Teigen, 2004; Montier, 2002; Tversky and Kahneman, 1974).

The results of estimating conditional models with bettors' subjective probability judgements and the jockey's performance in his/her previous race(s) are reported in Tables 4.3.1-6(1-3). Similar to previous results, when considering the UK market as a whole, the final odds implied variables are statistically significant at the 1% level. However, the coefficients of J1, J2 and J3 are all insignificant (coef. = -0.0319, Z = -0.61 in model 1; coef. = -0.1335, Z = -0.81 in model 2; coef. = -0.5210, Z= -0.86 in model 3). This indicates that bettors have fully taken the information of jockey's past performances into account in odds when assessing the horse's winning probability.

Note that although signs of anchoring factors' coefficients have changed from positive to negative but the values remain insignificant. This indicates that the betting public in this market have realised whether a horse's jockey has done well in his/her previous race(s) is important in estimating the horse's chance of winning, but do not overestimate its importance. Consequently, results from CL models with and without odds information suggest that bettors in the HK market appear not to anchor their judgements on the information concerning whether the jockey of the horse has won his/her previous race(s).

Table 4.3.1-5 Results of estimating CL models with jockey's past performance as independent variable in the HK market

Variable	Whole Market	Day of the Week	
		Wnd	Wk
$J1_{ij}$ coef. [a]	0.1692**	0.1653*	0.1742*
Std. Err.	0.0498	0.0665	0.0750
Z	3.40	2.48	2.32
LL	-13094.12	-7508.38	-5585.74
Model LR (χ_1^2)	11.08	5.92	5.17
Pseudo-R^2	0.0004	0.0004	0.0005
$J2_{ij}$ coef. [b]	0.1960	0.0996	0.3037
Std. Err.	0.1587	0.2230	0.2263
Z	1.24	0.45	1.34
LL	-13098.94	-7511.24	-5587.49
Model LR (χ_1^2)	1.45	0.19	1.67
Pseudo-R^2	0.0001	0.0000	0.0001
$J3_{ij}$ coef. [c]	-0.1602	0.1590	-0.5965
Std. Err.	0.5987	0.7430	1.0240
Z	-0.27	0.21	-0.58
LL	-13099.62	-7511.32	-5588.12
Model LR (χ_1^2)	0.08	0.04	0.41
Pseudo-R^2	0.0000	0.0000	0.0000
No. of horses	66,244	38,658	27,586
No. of races	5,133	2,910	2,223

[a] $J1_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her last race; equals 0 otherwise.

[b] $J2_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her previous two races; equals 0 otherwise.

[c] $J3_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her previous three races; equals 0 otherwise.

** Statistically significant at the 1% level. * Statistically significant at the 5% level.

Table 4.3.1-6(1) Results of estimating CL models with bettors' subjective probability judgements and the jockey's performance in his/her previous race as independent variables in the HK market

Model 1	Whole Market			Day of the Week					
					Wnd			Wk	
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [a]	0.9979**	0.9853**	0.9980**	1.0039**	0.9921**	1.0044**	0.9888**	0.9751**	0.9883**
Std. Err.	0.0177	0.0178	0.0181	0.0227	0.0228	0.0233	0.0282	0.0284	0.0290
Z	56.46	55.47	55.02	44.25	43.51	43.15	35.05	34.38	34.12
$J1_{ij}$ coef. [b]	-0.0319	-0.0667	-0.0931	-0.0641	-0.0980	-0.1221	0.0090	-0.0268	-0.0561
Std. Err.	0.0519	0.0518	0.0518	0.0696	0.0696	0.0695	0.0777	0.0776	0.0776
Z	-0.61	-1.29	-1.80	-0.92	-1.41	-1.76	0.12	-0.35	-0.72
LL	-11113.65	-11226.44	-11256.27	-6280.79	-6348.87	-6368.31	-4832.54	-4877.24	-4887.69
Model LR (χ_2^2)	3972.02	3746.45	3686.77	2461.10	2324.94	2286.06	1511.56	1422.15	1401.26
Pseudo-R^2	0.1516	0.1430	0.1407	0.1638	0.1548	0.1522	0.1352	0.1272	0.1254
No. of horses	66,244	66,244	66,244	38,658	38,658	38,658	27,586	27,586	27,586
No. of races	5,133	5,133	5,133	2,910	2,910	2,910	2,223	2,223	2,223

Table 4.3.1-6(2) Results of estimating CL models with bettors' subjective probability judgements and the jockey's performance in his/her previous two races as independent variables in the HK market

Model 2	Whole Market			Day of the Week					
					Wnd			Wk	
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p^s_{ij}$ coef. [c]	0.9977**	0.9846**	0.9967**	1.0032**	0.9907**	1.0024**	0.9892**	0.9751**	0.9878**
Std. Err.	0.0177	0.0177	0.0181	0.0227	0.0228	0.0232	0.0282	0.0283	0.0289
Z	56.49	55.50	55.05	44.27	43.54	43.17	35.08	34.41	34.15
$J2_{ij}$ coef. [d]	-0.1335	-0.1901	-0.2362	-0.1958	-0.2594	-0.3069	-0.0657	-0.1146	-0.1590
Std. Err.	0.1641	0.1639	0.1640	0.2308	0.2307	0.2308	0.2336	0.2330	0.2331
Z	-0.81	-1.16	-1.44	-0.85	-1.12	-1.33	-0.28	-0.49	-0.68
LL	-11113.50	-11226.57	-11256.82	-6280.84	-6349.21	-6368.94	-4832.51	-4877.18	-4887.71
Model LR (χ^2_2)	3972.33	3746.17	3685.67	2460.99	2324.26	2284.80	1511.63	1422.28	1401.22
Pseudo-R^2	0.1516	0.1430	0.1407	0.1638	0.1547	0.1521	0.1352	0.1273	0.1254
No. of horses	66,244	66,244	66,244	38,658	38,658	38,658	27,586	27,586	27,586
No. of races	5,133	5,133	5,133	2,910	2,910	2,910	2,223	2,223	2,223

Table 4.3.1-6(3) Results of estimating CL models with bettors' subjective probability judgements and the jockey's performance in his/her previous three race as independent variables in the HK market

Model 3	Whole Market			Day of the Week					
					Wnd			Wk	
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [e]	0.9975**	0.9841**	0.9959**	1.0028**	0.9900**	1.0014**	0.9892**	0.9749**	0.9873**
Std. Err.	0.0177	0.0177	0.0181	0.0227	0.0227	0.0232	0.0282	0.0283	0.0289
Z	56.50	55.51	55.05	44.26	43.53	43.15	35.10	34.43	34.17
$J3_{ij}$ coef. [f]	-0.5210	-0.6018	-0.6611	-0.1964	-0.2778	-0.3339	-0.9582	-1.0366	-1.0978
Std. Err.	0.6080	0.6077	0.6082	0.7602	0.7608	0.7624	1.0331	1.0319	1.0320
Z	-0.86	-0.99	-1.09	-0.26	-0.37	-0.44	-0.93	-1.00	-1.06
LL	-11113.42	-11226.70	-11257.22	-6281.18	-6349.81	-6369.79	-4831.97	-4876.61	-4887.16
Model LR (χ_2^2)	3972.49	3745.92	3684.89	2460.31	2323.06	2283.10	1512.70	1423.41	1402.31
Pseudo-R^2	0.1516	0.1430	0.1406	0.1638	0.1546	0.1520	0.1353	0.1274	0.1255
No. of horses	66,244	66,244	66,244	38,658	38,658	38,658	27,586	27,586	27,586
No. of races	5,133	5,133	5,133	2,910	2,910	2,910	2,223	2,223	2,223

[a c e] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] $J1_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her last race; equals 0 otherwise.

[d] $J2_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her previous two races; equals 0 otherwise.

[f] $J3_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

UK Market

Results of estimating the impact of jockeys' past performances on bettors' subjective judgements of horses' winning probabilities in the UK market are displayed in the following four tables. Table 4.3.1-7 reports the results of three CL models with jockeys' past performances (J1, J2 and J3) as independent variables. Similar to the results in the HK market, whether a jockey won or lost his/her last race has a significant impact on the performance of the next horse ridden by the same jockey (coef. = 0.1998; Z = 12.50), for the UK market as a whole. When bettors' subjective judgements (coef. = 1.2056; Z = 173.87) are included in the model, the coefficient of J1 remains positive (coef. = 0.0317; Z = 1.86), but only significant at the 10% level which cannot provide a strong support for over- or underestimates of this factor (see Table 4.3.1-8(1)). Therefore, no anchoring occurs in respect of jockey's last performance information.

Results associated with anchoring factors J2 and J3 do not demonstrate the existence of anchoring either. As shown in Table 4.3.1-7, these two variables are both positive and significant at the 1% level (J2: coef. = 0.3391, Z = 7.88; J3: coef. = 0.3595, Z = 3.37). When the final odds implied variable is added in the model, the coefficients of J2 and J3 both turn to insignificant although J2 with a positive sign (coef. = 0.0416, Z = 0.91) and J3 with a negative sign (coef. = -0.0669, Z = -0.59). These results indicate that the information that a jockey has won his/her previous two or three races has been fully accounted for in odds by bettors in the UK market.

Table 4.3.1-7 Results of estimating CL models with jockey's past performance as independent variable in the UK market

Variable	Whole Market	Day of the Week	
		Wnd	Wk
$J1_{ij}$ coef. [a]	0.1998**	0.2301**	0.1891**
Std. Err.	0.0160	0.0311	0.0186
Z	12.50	7.39	10.15
LL	-116310.52	-29594.31	-86715.57
Model LR (χ_1^2)	149.86	52.10	99.03
Pseudo-R^2	0.0006	0.0009	0.0006
$J2_{ij}$ coef. [b]	0.3391**	0.3666**	0.3291**
Std. Err.	0.0430	0.0827	0.0504
Z	7.88	4.43	6.53
LL	-116356.72	-29611.33	-86745.31
Model LR (χ_1^2)	57.47	18.06	39.56
Pseudo-R^2	0.0002	0.0003	0.0002
$J3_{ij}$ coef. [c]	0.3595**	0.8155**	0.1564
Std. Err.	0.1068	0.1808	0.1337
Z	3.37	4.51	1.17
LL	-116380.23	-29611.67	-86764.43
Model LR (χ_1^2)	10.44	17.38	1.32
Pseudo-R^2	0.0000	0.0003	0.0000
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[a] $J1_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her last race; equals 0 otherwise.

[b] $J2_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her previous two races; equals 0 otherwise.

[c] $J3_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-8(1) Results of estimating CL models with bettors' subjective probability judgements and the jockey's performance in his/her previous race as independent variables in the UK market

Model 1 Variable	Whole Market	Day of the Week	
		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [a]	1.2056**	1.2028**	1.2067**
Std. Err.	0.0069	0.0140	0.0080
Z	173.87	86.11	151.07
$J1_{ij}$ coef. [b]	0.0317	0.0395	0.0170
Std. Err.	0.0170	0.0405	0.0198
Z	1.86	0.98	0.86
LL	-96788.87	-24840.43	-71949.30
Model LR (χ_2^2)	39193.16	9559.86	29631.57
Pseudo-R^2	0.1684	0.1614	0.1708
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[a] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] $J1_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her last race; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-8(2) Results of estimating CL models with bettors' subjective probability judgements and the jockey's performance in his/her previous two races as independent variables in the UK market

Model 2 Variable	Whole Market	Day of the Week	
		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [c]	1.2060**	1.2029**	1.2070**
Std. Err.	0.0069	0.0140	0.0080
Z	174.02	86.19	151.18
$J2_{ij}$ coef. [d]	0.0416	0.2356	0.0152
Std. Err.	0.0460	0.1297	0.0540
Z	0.91	1.82	0.28
LL	-96790.19	-24839.32	-71949.63
Model LR (χ_2^2)	39190.52	9562.08	29630.92
Pseudo-R^2	0.1684	0.1614	0.1708
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[c] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[d] $J2_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her previous two races; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-8(3) Results of estimating CL models with bettors' subjective probability judgements and the jockey's performance in his/her previous three races as independent variables in the UK market

Model 3	Whole Market	Day of the Week	
Variable		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [e]	1.2062**	1.2034**	1.2073**
Std. Err.	0.0069	0.0140	0.0080
Z	174.10	86.22	151.27
$J3_{ij}$ coef. [f]	-0.0669	0.0612	-0.2970*
Std. Err.	0.1138	0.3353	0.1425
Z	-0.59	0.18	-2.08
LL	-96790.42	-24840.89	-71947.36
Model LR (χ_2^2)	39190.06	9558.95	29635.45
Pseudo-R^2	0.1684	0.1614	0.1708
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[e] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[f] $J3_{ij}$: A dummy variable which equals 1 for a horse if its jockey won his/her previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

4.3.1.3 Trainer's Past Performance

HK Market

The results of explaining the degree to which trainers' past performances are accounted for in bettors' subjective probability judgements in the HK market is reported in Table 4.3.1-9 and Tables 4.3.1-10(1-3). Results of CL models with trainers' past performances in their previous one, two and three races (T1, T2 and T3) as independent variables are presented in Table 4.3.1-9. For the whole market, the coefficient of each variable (T1: coef. = 0.2023, Z = 4.21; T2: coef. = 0.3080, Z = 2.01; T3: coef. = 0.7768, Z = 1.87) indicates that the information of trainers' performance is important in estimating horses' winning probabilities. However, the significance level of these three variables decreases from the 1% level for T1 to 5% for T2 and 10% for T3. This reconfirms the effect of 'regression to the mean' implicated by the performances of jockeys in their past two and three races in the HK market (see Section 4.3.1.2).

Results of CL models including bettors' subjective probability judgements and trainers' past performances are reported in Tables 4.3.1-10(1-3). For the HK market as a whole, When the HK market is considered as a whole, the anchoring factor T1 (coef. = 0.0915, Z = 1.83) is only significant at the 10% level. This result cannot provide a significant evidence of misuse of the trainer's last performance information and the positive signs of the coefficients of T1 in models with and without odds information suggest that bettors in the HK market do not tend to over-weight this piece information. Models 2 and 3 provide similar results. Trainers' past performances in their previous two and three races have been fully accounted for in odds and are not over- or underestimated. Therefore, no anchoring effects are found on the information associated with trainers' past performances. However, a decreasing of the significance level from T1 to T2 and T3 may indicate that bettors are learning from trainers' past performances: the more times a trainer won his/her race, the more likely that bettors are to pay attention to this information and adjust their judgements more properly. In other words, judgements based on the results of more races are more accurate than those based on only one race.

Table 4.3.1-9 Results of estimating CL models with trainer's past performance as independent variable in the HK market

Variable	Whole Market	Day of the Week	
		Wnd	Wk
$T1_{ij}$ coef. [a]	0.2023**	0.2016**	0.2031**
Std. Err.	0.0481	0.0641	0.0728
Z	4.21	3.15	2.79
LL	-13091.21	-7506.61	-5584.61
Model LR (χ_1^2)	16.90	9.47	7.44
Pseudo-R^2	0.0006	0.0006	0.0007
$T2_{ij}$ coef. [b]	0.3080*	0.1637	0.4549*
Std. Err.	0.1528	0.2215	0.2116
Z	2.01	0.74	2.15
LL	-13097.78	-7511.08	-5586.25
Model LR (χ_1^2)	3.76	0.52	4.14
Pseudo-R^2	0.0001	0.0000	0.0004
$T3_{ij}$ coef. [c]	0.7768 †	1.2600*	0.1085
Std. Err.	0.4151	0.5170	0.7428
Z	1.87	2.44	0.15
LL	-13098.19	-7508.99	-5588.31
Model LR (χ_1^2)	2.94	4.69	0.02
Pseudo-R^2	0.0001	0.0003	0.0000
No. of horses	66,244	38,658	27,586
No. of races	5,133	2,910	2,223

[a] $T1_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her last race; equals 0 otherwise.

[b] $T2_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her previous two races; equals 0 otherwise.

[c] $T3_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

† Statistically significant at the 10% level.

Table 4.3.1-10(1) Results of estimating CL models with bettors' subjective probability judgements and the trainer's performance in his/her previous race as independent variables in the HK market

Model 1	Whole Market			Day of the Week					
				Wnd			Wk		
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [a]	0.9966**	0.9832**	0.9952**	1.0021**	0.9894**	1.0011**	0.9881**	0.9735**	0.9861**
Std. Err.	0.0177	0.0177	0.0181	0.0227	0.0228	0.0232	0.0282	0.0283	0.0289
Z	56.42	55.41	54.94	44.22	43.47	43.09	35.04	34.35	34.08
$T1_{ij}$ coef. [b]	0.0915	0.0498	0.0207	0.0780	0.0369	0.0097	0.1089	0.0665	0.0350
Std. Err.	0.0501	0.0500	0.0500	0.0670	0.0668	0.0667	0.0755	0.0753	0.0754
Z	1.83	1.00	0.41	1.16	0.55	0.15	1.44	0.88	0.46
LL	-11112.20	-11226.78	-11257.84	-6280.55	-6349.73	-6369.88	-4831.53	-4876.92	-4887.85
Model LR (χ_2^2)	3974.92	3745.75	3683.65	2461.58	2323.22	2282.92	1513.59	1422.80	1400.95
Pseudo-R^2	0.1517	0.1430	0.1406	0.1639	0.1546	0.1520	0.1354	0.1273	0.1253
No. of horses	66,244	66,244	66,244	38,658	38,658	38,658	27,586	27,586	27,586
No. of races	5,133	5,133	5,133	2,910	2,910	2,910	2,223	2,223	2,223

Table 4.3.1-10(2) Results of estimating CL models with bettors' subjective probability judgements and the trainer's performance in his/her previous two races as independent variables in the HK market

Model 2	Whole Market			Day of the Week					
					Wnd			Wk	
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [c]	0.9972**	0.9832**	0.9957**	1.0029**	0.9904**	1.0021**	0.9886**	0.9739**	0.9861**
Std. Err.	0.0177	0.0178	0.0181	0.0227	0.0226	0.0232	0.0282	0.0283	0.0289
Z	56.48	55.41	55.02	44.26	43.53	43.16	35.07	34.39	34.12
$T2_{ij}$ coef. [d]	0.1203	0.0498	-0.0192	-0.0931	-0.1774	-0.2387	0.3457	0.2646	0.2128
Std. Err.	0.1589	0.0500	0.1586	0.2298	0.2294	0.2296	0.2201	0.2193	0.2193
Z	0.76	1.00	-0.12	-0.41	-0.77	-1.04	1.57	1.21	0.97
LL	-11113.56	-11226.78	-11257.91	-6281.14	-6349.57	-6369.32	-4831.40	-4876.62	-4887.50
Model LR (χ_2^2)	3972.20	3745.75	3683.49	2460.41	2323.54	2284.03	1513.84	1423.41	1401.63
Pseudo-R^2	0.1516	0.1430	0.1406	0.1638	0.1547	0.1520	0.1354	0.1274	0.1254
No. of horses	66,244	66,244	66,244	38,658	38,658	38,658	27,586	27,586	27,586
No. of races	5,133	5,133	5,133	2,910	2,910	2,910	2,223	2,223	2,223

Table 4.3.1-10(3) Results of estimating CL models with bettors' subjective probability judgements and the trainer's performance in his/her previous three race as independent variables in the HK market

Model 3	Whole Market			Day of the Week					
				Wnd			Wk		
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [e]	0.9972**	0.9837**	0.9954**	1.0023**	0.9894**	1.0008**	0.9891**	0.9746**	0.9869**
Std. Err.	0.0177	0.0177	0.0181	0.0227	0.0227	0.0232	0.0282	0.0283	0.0289
Z	56.48	55.48	55.03	44.24	43.49	43.12	35.09	34.42	34.15
$T3_{ij}$ coef. [f]	0.5185	0.4267	0.3617	0.5987	0.5305	0.4810	0.3675	0.2367	0.1486
Std. Err.	0.4433	0.4414	0.4413	0.5513	0.5503	0.5512	0.7640	0.7618	0.7617
Z	1.17	0.97	0.82	1.09	0.96	0.87	0.48	0.31	0.20
LL	-11113.22	-11226.84	-11257.61	-6280.68	-6349.45	-6369.54	-4832.44	-4877.26	-4887.94
Model LR (χ_2^2)	3972.89	3745.63	3684.11	2461.32	2323.77	2283.61	1511.76	1422.12	1400.77
Pseudo-R^2	0.1516	0.1430	0.1406	0.1638	0.1547	0.1520	0.1353	0.1272	0.1253
No. of horses	66,244	66,244	66,244	38,658	38,658	38,658	27,586	27,586	27,586
No. of races	5,133	5,133	5,133	2,910	2,910	2,910	2,223	2,223	2,223

[a c e] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] $T1_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her last race; equals 0 otherwise.

[d] $T2_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her previous two races; equals 0 otherwise.

[f] $T3_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

UK Market

The extent to which bettors anchor their subjective judgements on the information associated with trainers' past performances in the UK markets is discussed in this section. Table 4.3.1-11 reports the results of three CL models with trainers' past performances in their previous one, two and three races as independent variables. For the UK market as a whole, all the three factors have a highly significant impact on horses' winning probabilities.

Results of models with bettors' subjective probability judgements and trainers' past performances as independent variables are reported in Tables 4.3.1-12(1-3). Similar to the HK market, bettors in the UK market do not fully account for the last performance of a trainer's horse when estimating the winning chance of the trainer's horse in the current race (T1: coef. = 0.0411, Z = 2.48; significant at the 5% level). However, when two or three horses trained by the same trainer win their races, the betting public begin to realise the trainer's performance in determining the horse's performance and take full account of it (T2: coef. = 0.0525, Z = 1.26; T3: coef. = 0.1322, Z = 1.58). Therefore, no anchoring effects are detected on the information of trainers' past performances.

Table 4.3.1-11 Results of estimating CL models with trainer's past performance as independent variable in the UK market

Variable	Whole Market	Day of the Week	
		Wnd	Wk
$T1_{ij}$ coef. [a]	0.2792**	0.2548**	0.2877**
Std. Err.	0.0156	0.0308	0.0180
Z	17.93	8.26	15.94
LL	-116233.18	-29587.87	-86644.89
Model LR (χ_1^2)	304.54	64.99	240.41
Pseudo-R^2	0.0013	0.0011	0.0014
$T2_{ij}$ coef. [b]	0.4731**	0.5098**	0.4594**
Std. Err.	0.0385	0.0736	0.0452
Z	12.28	6.92	10.16
LL	-116317.28	-29598.78	-86718.33
Model LR (χ_1^2)	136.34	43.16	93.52
Pseudo-R^2	0.0006	0.0007	0.0005
$T3_{ij}$ coef. [c]	0.7877**	0.8013**	0.7820**
Std. Err.	0.0770	0.1409	0.0919
Z	10.23	5.69	8.51
Log likelihood	-116340.28	-29606.41	-86733.86
Model LR (χ_1^2)	90.35	27.91	62.46
Pseudo-R^2	0.0004	0.0005	0.0004
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[a] $T1_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her last race; equals 0 otherwise.

[b] $T2_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her previous two races; equals 0 otherwise.

[c] $T3_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-12(1) Results of estimating CL models with bettors' subjective probability judgements and the trainer's performance in his/her previous race as independent variables in the UK market

Model 1	Whole Market	Day of the Week	
Variable		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [a]	1.2051**	1.2033**	1.2057**
Std. Err.	0.0069	0.0140	0.0080
Z	173.63	86.02	150.83
$T1_{ij}$ coef. [b]	0.0411*	0.0055	0.0536*
Std. Err.	0.0166	0.0328	0.0192
Z	2.48	0.17	2.78
LL	-96787.55	-24840.89	-71945.83
Model LR (χ_1^2)	39195.80	9558.94	29638.52
Pseudo-R^2	0.1684	0.1614	0.1708
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[a] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] $T1_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her last race; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

Table 4.3.1-12(2) Results of estimating CL models with bettors' subjective probability judgements and the trainer's performance in his/her previous two race as independent variables in the UK market

Model 2 Variable	Whole Market	Day of the Week	
		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [c]	1.2057**	1.2025**	1.2068**
Std. Err.	0.0069	0.0140	0.0080
Z	173.88	86.10	151.07
$T2_{ij}$ coef. [d]	0.0525	0.1203	0.0274
Std. Err.	0.0415	0.0792	0.0488
Z	1.26	1.52	0.56
LL	-96789.81	-24839.77	-71949.51
Model LR (χ_1^2)	39191.29	9561.18	29631.16
Pseudo-R^2	0.1684	0.1614	0.1708
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[c] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[d] $T2_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her previous two races; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-12(3) Results of estimating CL models with bettors' subjective probability judgements and the trainer's performance in his/her previous three race as independent variables in the UK market

Model 3 Variable	Whole Market	Day of the Week	
		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [e]	1.2058**	1.2028**	1.2068**
Std. Err.	0.0069	0.0140	0.0080
Z	173.97	86.16	151.14
$T3_{ij}$ coef. [f]	0.1322	0.2875	0.0676
Std. Err.	0.0837	0.1519	0.1003
Z	1.58	1.89	0.67
LL	-96789.37	-24839.19	-71949.44
Model LR (χ_1^2)	39192.16	9562.35	29631.29
Pseudo-R^2	0.1684	0.1614	0.1708
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[e] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[f] $T3_{ij}$: A dummy variable which equals 1 for a horse if its trainer won his/her previous three races; equals 0 otherwise.

** Statistically significant at the 1% level.

4.3.1.4 Post-position of the Horse

In horseracing, horses begin their races from 'starting stalls'. This device is employed to ensure that all runners in a race are released simultaneously. The stall from which a horse starts a race (i.e., its post-position) is randomly allocated and announced on the day before the race. In HK, the number of the stall starts from 1 to 40 (from inside to outside of the track) in sequence according to the number of runners in a race. Clearly, horses starting from the inside of the track can run less distance than those who start from the positions outside of the track. Due to the track configuration (e.g., a short oval racetrack with sharp bends at Happy Valley racetrack in HK) or certain racetrack topography (e.g., faster ground on the inside of the track), horses at certain post-positions may take advantages in the race. The importance of post-positions of horses must be considered carefully when bettors assess the probability of each horse winning the race. For example, the two racetracks in HK (HV and ST) are both oval circuits and the track configuration suggests that horses with low post-positions will be favoured (Schnytzer, Liu, and Johnson, 2008). However, the bends at HV are tighter than those at ST with a radius of only 91 meters at the tightest bend at HV compared to a radius of 158 meters at the tightest bend at ST. Moreover, the circumference of HV (1,454 meters) is shorter that of ST (1,933 meters). Consequently, horses with a low post-position at HV are likely to have more advantage than those that run at ST.

In the UK, flat races are run at thirty-eight racetracks across the country. Each racetrack is different from others in terms of the configuration and topography. Therefore, at some racetracks low post-positions are favoured and at other racetracks high post-positions have advantages. The way to distinguish high draw advantage racetracks (high post-positions are advantageous to horses) and low draw racetracks (horses with low post-positions are favoured) is to examine the significance and sign of the factor 'post-position (PP)' in a CL model with PP as the only independent variable. To achieve this, the data is split by racetracks. Then a CL model with post-position of horses as independent variable is employed for races at each track. A significant and positive coefficient of PP means the post-position is important in assessing the chance of a horse winning a race: the higher the post-position of the horse, the higher probability of the horse winning. Such tracks are named high draw racetracks[24]. Oppositely, if PP obtains a significant but negative coefficient, then a horse with a low post-position will be favoured in the race. Consequently, these tracks are assigned to low draw racetracks[25]. Finally, two new datasets are created with all high draw racetracks in one dataset and all low draw racetracks in another. These two datasets are then employed to examine the different relationship between horses' performances and their post-positions at different racetracks (see Table 4.2.1-1).

In this study, two aspects of horses' post-position will be explored in the HK and UK horserace betting markets. The first focuses on whether bettors anchor their judgements of a horse wining on the information of the horse's post-position. Note that whether horses are favoured by low or high post-positions can be observed from the results of previous races and/or from comments and information supplied by racing tipsters. Therefore, the post-position of a horse might be a piece of information to which bettors pay too much attention to when estimating the horse's chance of winning.

The second aspect explores whether bettors anchor their probability judgements of a horse winning on the post-position of the winner(s) of previous race(s) at a race meeting. This assumption derives from a belief that individuals tend to anchor their judgements on vivid information which is easy to obtain (Schnytzer, Liu, and Johnson, 2008). At a race meeting, the most immediate information is the result of a previous race(s). For example, if the winner of the previous race starts from stall six, bettors may take too much account of this information and anchor their probability judgements on the number of this position. Consequently, they may overestimate the winning probability of the horse from the same post-position in the current race. In this study, the influence of the post-positions of previous winners on the horse with the same post-position in the current race is explored using the previous three races at the same meeting. Whether bettors with greater expertise are less prone to anchor their judgements on horses' post-positions will be discussed when exploring hypothesis three in Section 4.3.2.

Four variables associated with horses' post-positions are employed in this study. Variable 'PP' represents the post-position of a horse in its race. Dummy variables

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[24] Racetracks with high draw advantage include: Beverley, Folkestone, Goodwood, Hamilton, Lingfield, Ripon, Southwell (A.W.), and Windsor.

[25] Racetracks low draw advantage include: Brighton, Catterick, Chester, Doncaster, Lingfield (A.W.), Nottingham, Warwick, Yarmouth, and York.

‘WP1’, ‘WP2’ and ‘WP3’ are designed to test bettors’ potential anchoring on the post-position of the previous one, two and three winners at a meeting. Specifically, ‘WP1’ equals 1 when the horse’s post-position in a race is the same as that of the winner in its previous race and 0 otherwise. Variables ‘WP2/3’ give 1 to a horse if the winners of the previous two/three races at the meeting start running from the same post-position as this horse; 0 otherwise. It is argued that if a piece of information is repeated more than once, it will be more likely to draw individuals’ attention and hence become an initial point on which decision makers may anchor their judgements (Bloomfield *et al.*, 2000; Griffin and Tversky, 1992; Nelson *et al.*, 2001). Because the chance that two or three winners in a meeting start from the same post-position is not high, once it happens, bettors are more likely to be attracted and therefore believe that the horse with the same post-position in the next race gets more chance to win the race. Consequently, if bettors anchor their judgements on this information, they would overestimate the winning probability of the horse with the same post-position.

Results and analysis for tests in the HK and UK markets are presented below. In each market, results of the whole market and for different racetracks are analysed separately. Only models with final odds implied variables and post-position related variables are discussed in this section; models involving 2 or 5 minutes odds will be discussed in Section 4.3.2 when exploring the expertise hypothesis.

HK Market

(1) Anchoring on the Information of the Current Race

The results of examining to what extent a horse’s post-position affects its finishing position are displayed in Table 4.3.1-13. It shows that for the HK market as a whole and for both HV and ST racetracks, the coefficient of PP is negative and significant at the 1% level in the model. This suggests that at these racetracks (combined and separated), a low post-position (inside of the track) is a big advantage for a horse to win the race. In addition, the Pseudo-R^2 of the model at HV (0.0159) is 30 times greater than that at ST (0.0005), suggesting that a low post-position may have a larger impact on a horse’s performance at HV than at ST.

The results of estimating CL models with bettors’ subjective probability judgements and the horse’s post-position as independent variables are reported in Table 4.3.1-14(1). For the HK market as a whole (i.e., HV+ST), the coefficient of PP is statistically insignificant, indicating that the betting public have taken the post-position information fully into account when developing their subjective probability judgements. In particular, bettors in the HK market do not appear to anchor their subjective judgements on the obvious advantage taken by low PP horses, although this advantage can be easily discerned from media comment, from observation of the racetrack configurations as well as the racetrack authority's clarification, and from the study of previous results. Consequently, it might be easily concluded that anchoring effects on post-position advantage do not exist in this market, which is clearly contrast with the wide-spread demonstration of anchoring effects in experimental studies (e.g., Mussweiler and Strack, 2000; Northcraft and Neale, 1987).

Because the influence of post-position on horses' winning probabilities and the manner in which bettors handle post-position information at the two racetracks are different, combining data from the two racetracks leads to model mis-specification in this study. A likelihood ratio test is conducted to confirm this conclusion, based on the maximum likelihood values for models incorporating (i) post-position only and (ii) post-position and odds implied probabilities. For each model, the ratio is calculated based on the maximum likelihood values modelled at HV (L_{HV}), at ST (L_{ST}), and at the combined market for the two racetracks a whole (L_{HK}), by the formula $-2[L_{HK} - (L_{HV} + L_{ST})]$. The results are 68.4754 and 20.3066 for models (i) and (ii) respectively. This suggests that for both models (either with or without odds implied probability as independent variable), the CL models conducted for the two racetracks separately, compared with models explored for the combined market, can display more information concerning the effect of post-position of horses on their winning probabilities and the manner in which bettors incorporate such information.

The difference of the impact of post-position on horse's winning probability and the way bettors handle this information between the two racetracks can also be observed from the significance and sign of the coefficient of PP in models with final odds implied probabilities and PP as independent variables. In Table 4.3.1-14(1), the coefficient of PP in the model for HV racetrack is statistically significant at the 1% level with a negative sign (coef. = -0.0250; Z = -3.36), while this coefficient for ST racetrack is positive and significant at the 5% level (coef. = 0.0116; Z = 2.45). Note that the coefficients of PP_{ij} in Table 4.3.1-13 for HV and ST are both significant and negative. These results indicate that bettors at HV/ST *under/over* use the information of post-position advantage when assessing horses' winning probabilities. In other words, they anchor their judgements on post-position advantage at ST but do not take enough account of it at HV. Therefore, the results for the HK market combined from the two racetracks as a whole mask the actual behaviour of which bettors at the two tracks use information. To some extent, this can be considered as a compromise of the conflicting effects at the two racetracks. However, the coefficients of the natural log of the odds implied probability are significant at the 1% level at both tracks, as well as at the market as a whole, indicating that bettors' subjective probability judgements reflected by the market odds are a reasonable estimator of a horse's actual winning probability.

Taken together, the results discussed above appear, concerning bettors at ST, to support hypothesis one, namely, that bettors anchor their subjective probability judgements on post-position advantage of horses, whereas the evidence regarding HV appears not to accept this hypothesis. In addition, it suggests that the sum of the information contained in CL models for the two racetracks separately is not necessarily equal to the information involved in similar models for the HK market as a whole.

(2) Anchoring on the Information of the Previous Race

If the effect of post-position advantage is recognised by bettors, throughout a racing day, by observing the outcome of the previous race(s), they may apply this consciousness into their judgements in the subsequent race(s). One way of examining this hypothesis is to observe the results of preceding race(s) and explore the influence of previous outcomes on judgements of horses with same post-positions in a subsequent race.

Table 4.3.1-13 reports the results of the post-position advantage associated with the winner(s) of previous race(s). For the HK market as a whole, the coefficients of dummy variables which represent whether a horse's post-position in a race is the same as that of the winner(s) in the previous one, two and three races (namely, WP1, WP2 and WP3), are all positive but not statistically significant. The model LR values and Pseudo-R^2 are very low, suggesting that the information of the post-position of previous winners do not have much impact on the winning chance of the horse from the same position in a subsequent race. Models for races at HV and ST racetracks separately provide similar results.

When the final odds information is included in the models, the coefficients of the factors associated with previous winners' post-positions remain insignificant (see Tables 4.3.1-14(2-4)). This suggests that, in the HK market (combined or separated), bettors do not misuse the information of previous winners' post-position in their subjective judgements of subsequent horse's winning probability. Note that when coefficients of the factors are statistically insignificant, changes of the sign of these coefficients do not support the existence of anchoring effects on these factors. These results are inconsistent with Terrell and farmer's (1996) findings in US greyhound racing. In particular, Terrell and farmer (1996) demonstrated a 9% profit by betting "the greyhound in the starting trap occupied by the previous winner" (Vaughan Williams, 2005; p. 131). This indicates that the US greyhound racing bettors tend to *underestimate* the winning probability of a greyhound if the previous race was won by the greyhound from the same starting position. However, this evidence of 'gambler's fallacy' (an effect that when an outcome occurs a few times people underestimate the chance of getting the same outcome in the next round) is not supported by the results in the HK horserace betting market. As described above, bettors in the HK market seem to fully account for the previous winners' post-position information when estimating the winning probability of the horse in the next race from the same position.

Taken together, the results of exploring the degree to which bettors, in the HK market, account for the post-position advantage according to the outcome of the previous races(s) do not support the strength hypothesis. It is clear that, for the whole market and the two separate racetracks, the post-position of the winners in previous one, two or three races does not have a significant impact on bettors' estimates of the performance of the horse from the same post-position in the subsequent race. Even if the three previous races are all won by horses from the same post-position, bettors still do not anchor their judgements on the post-position information. They may either ignore the importance of this piece of information or may have fully accounted for it when making judgements for the next race.

Table 4.3.1-13 Results of estimating CL models with horse's post-position as independent variable in the HK market

Variable	Whole Market	Racetrack	
		HV	ST
PP_{ij} coef. [a]	-0.0339**	-0.0815**	-0.0136**
Std. Err.	0.0037	0.0069	0.0045
Z	-9.05	-11.75	-3.04
LL	-13058.49	-4382.23	-8642.02
Model LR (χ_1^2)	82.35	141.56	9.26
Pseudo-R^2	0.0031	0.0159	0.0005
$WP1_{ij}$ coef. [b]	0.0656	0.1413	0.0208
Std. Err.	0.0540	0.0873	0.0688
Z	1.21	1.62	0.30
LL	-13098.94	-4451.75	-8646.60
Model LR (χ_1^2)	1.45	2.52	0.09
Pseudo-R^2	0.0001	0.0003	0.0000
$WP2_{ij}$ coef. [c]	0.0297	0.1917	-0.0987
Std. Err.	0.2086	0.3041	0.2875
Z	0.14	0.63	-0.34
LL	-13099.65	-4452.83	-8646.58
Model LR (χ_1^2)	0.02	0.38	0.12
Pseudo-R^2	0.0000	0.0000	0.0000
$WP3_{ij}$ coef. [d]	0.8058	0.3475	1.1426
Std. Err.	0.6297	1.061	0.7910
Z	1.28	0.33	1.44
LL	-13098.98	-4452.97	-8645.82
Model LR (χ_1^2)	1.36	0.10	1.64
Pseudo-R^2	0.0001	0.0000	0.0001
No. of horses	66,244	21,624	44,620
No. of races	5,133	1,789	3,344

[a] PP_{ij} : A variable which represents the number of the post-position of horse *i* in race *j*.

[b] $WP1_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as the winner's in race *j*-1; equals 0 otherwise.

[c] $WP2_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as those of the winners in race *j*-1 and *j*-2 at a meeting; equals 0 otherwise.

[d] $WP3_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as those of the winners in race *j*-1, *j*-2 and *j*-3 at a meeting; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-14(1) Results of estimating CL models with bettors' subjective probability judgements and the horse's post-position as independent variables in the HK market

Model 1	Whole Market			Racetrack					
				HV			ST		
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [a]	0.9984**	0.9836**	0.9950**	0.9223**	0.9034**	0.9141**	1.0234**	1.0099**	1.0213**
Std. Err.	0.0178	0.0179	0.0183	0.0328	0.0328	0.0335	0.0214	0.0215	0.0219
Z	55.94	54.93	54.47	28.16	27.52	0.000	47.83	47.05	46.67
PP_{ij} coef. [b]	0.0015	-0.0005	-0.0009	-0.0250**	-0.0312**	-0.0320**	0.0116*	0.0114*	0.0111*
Std. Err.	0.0040	0.0040	0.0040	0.0075	0.0074	0.0074	0.0047	0.0047	0.0047
Z	0.39	-0.13	-0.23	-3.36	-4.20	-4.32	2.45	2.40	2.35
LL	-11113.76	-11227.27	-11257.89	-3911.23	-3940.71	-3948.61	-7192.38	-7273.24	-7295.69
Model LR (χ_2^2)	3971.79	3744.78	3683.53	1083.56	1024.60	1008.81	2908.54	2746.81	2701.92
Pseudo-R^2	0.1516	0.1429	0.1406	0.1217	0.1150	0.1133	0.1682	0.1588	0.1562
No. of horses	66,244	66,244	66,244	21,624	21,624	21,624	44,620	44,620	44,620
No. of races	5,133	5,133	5,133	1,789	1,789	1,789	3,344	3,344	3,344

Table 4.3.1-14(2) Results of estimating CL models with bettors' subjective probability judgements and the previous winner's post-position as independent variables in the HK market

Model 2	Whole Market			Racetrack					
				HV			ST		
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [c]	0.9973**	0.9839**	0.9956**	0.9495**	0.9356**	0.9477**	1.0182**	1.0048**	1.0162**
Std. Err.	0.0177	0.0177	0.0181	0.0318	0.0320	0.0327	0.0213	0.0213	0.0217
Z	56.49	55.49	55.04	29.84	29.22	28.97	47.89	47.11	46.73
$WP1_{ij}$ coef. [d]	0.0376	0.0419	0.0401	0.0390	0.0488	0.0475	0.0397	0.0404	0.0384
Std. Err.	0.0563	0.0561	0.0561	0.0903	0.0901	0.0901	0.0719	0.0717	0.0717
Z	0.67	0.75	0.72	0.43	0.54	0.53	0.55	0.56	0.53
LL	-11113.62	-11227.00	-11257.67	-3916.79	-3949.43	-3957.84	-7195.22	-7275.96	-7298.31
Model LR (χ_2^2)	3972.09	3745.32	3683.98	1072.45	1007.17	990.35	2902.85	2741.37	2696.67
Pseudo-R^2	0.1516	0.1430	0.1406	0.1204	0.1131	0.1112	0.1679	0.1585	0.1559
No. of horses	66,244	66,244	66,244	21,624	21,624	21,624	44,620	44,620	44,620
No. of races	5,133	5,133	5,133	1,789	1,789	1,789	3,344	3,344	3,344

Table 4.3.1-14(3) Results of estimating CL models with bettors' subjective probability judgements and previous two winners' post-positions as independent variables in the HK market

Model 3	Whole Market			Racetrack					
				HV			ST		
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [e]	0.9974**	0.9839**	0.9956**	0.9498**	0.9359**	0.9481**	1.0181**	1.0047**	1.0161**
Std. Err.	0.0177	0.0177	0.0181	0.0318	0.0320	0.0327	0.0213	0.0213	0.0217
Z	56.49	55.50	55.04	29.86	29.24	28.99	47.89	47.11	46.73
$WP2_{ij}$ coef. [f]	-0.0322	-0.0058	-0.0024	0.0066	0.0627	0.0667	-0.0599	-0.0606	-0.0574
Std. Err.	0.2168	0.2165	0.2165	0.3133	0.3130	0.3133	0.3001	0.2998	0.2995
Z	-0.15	-0.03	-0.01	0.02	0.20	0.21	-0.20	-0.20	-0.19
LL	-11113.83	-11227.28	-11257.92	-3916.88	-3949.55	-3957.96	-7195.35	-7276.10	-7298.43
Model LR (χ_2^2)	3971.66	3744.77	3683.48	1072.26	1006.92	990.12	2902.59	2741.10	2696.42
Pseudo-R^2	0.1516	0.1429	0.1406	0.1204	0.1131	0.1112	0.1678	0.1585	0.1559
No. of horses	66,244	66,244	66,244	21,624	21,624	21,624	44,620	44,620	44,620
No. of races	5,133	5,133	5,133	1,789	1,789	1,789	3,344	3,344	3,344

Table 4.3.1-14(4) Results of estimating CL models with bettors' subjective probability judgements and previous three winners' post-positions as independent variables in the HK market

Model 4	Whole Market			Racetrack					
				HV			ST		
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [g]	0.9973**	0.9838**	0.9955**	0.9499**	0.9361**	0.9482**	1.0179**	1.0045**	1.0160**
Std. Err.	0.0177	0.0177	0.0181	0.0318	0.0320	0.0327	0.0213	0.0213	0.0217
Z	56.48	55.49	55.03	29.86	29.24	29.00	47.88	47.10	46.72
$WP3_{ij}$ coef. [h]	0.2670	0.3283	0.3692	-0.1740	-0.1150	-0.0455	0.6690	0.7328	0.7376
Std. Err.	0.6802	0.6780	0.6778	1.0867	1.0836	1.0828	0.9080	0.9046	0.9020
Z	0.39	0.48	0.54	-0.16	-0.11	-0.04	0.74	0.81	0.82
LL	-11113.77	-11227.17	-11257.78	-3916.87	-3949.57	-3957.98	-7195.12	-7275.82	-7298.15
Model LR (χ_2^2)	3971.79	3744.99	3683.75	1072.29	1006.89	990.07	2903.04	2741.65	2696.99
Pseudo-R^2	0.1516	0.1429	0.1406	0.1204	0.1131	0.1112	0.1679	0.1585	0.1560
No. of horses	66,244	66,244	66,244	21,624	21,624	21,624	44,620	44,620	44,620
No. of races	5,133	5,133	5,133	1,789	1,789	1,789	3,344	3,344	3,344

[a c e g] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] PP_{ij} : A variable which represents the number of the post-position of horse *i* in race *j*.

[d] $WP1_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as the winner's in race *j*-1; equals 0 otherwise.

[f] $WP2_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as those of the winners in race *j*-1 and *j*-2 at a meeting; equals 0 otherwise.

[h] $WP3_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as those of the winners in race *j*-1, *j*-2 and *j*-3 at a meeting; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

UK Market

(1) Anchoring on the Information of the Current Race

The results of models estimating to what extent a horse's post-position affects its finishing position in a race are reported in Table 4.3.1-15. For the UK market as a whole, the coefficient of PP is positive but insignificant. This seems to indicate that a horse's post-position has no significant impact on the horse's running performance. However, a different picture appears when the market data is split into two groups: one group is consistent of the data from racetracks with high draw advantage and the other group combines races from the low draw advantage racetracks. Respectively, the coefficient of PP is positive and significant at the 1% at racetracks with high draw advantage (coef. = 0.0283; Z = 11.00) but negative and significant at the 1% at racetracks with low draw advantage (coef. = -0.0216; Z = -8.87). Clearly, these results show that the post-position of a horse has a significant impact on the horse's performance in a race; at some tracks horses starting from high position have advantage whereas at other tracks horses with low draw positions have advantages. Consequently, the insignificance of the post-position in the model for the whole market results from the cancellation of the results from high draw and low draw racetracks.

The results of estimating CL models with bettors' subjective probability judgements and the horse's post-position as independent variables are reported in Tables 4.3.1-16(1). As shown in the table, the coefficient of the horse's post-position (PP_{ij}) is insignificant (coef. = 0.0005; Z = 0.40) for the whole market. This may suggest that (1) the post-position information has been fully accounted in odds by the betting public; or (2) this piece of information is not important in estimating the horse's probability of winning. However, results of models using separate data (where high and low draw advantages tracks are separated) provide another story. The coefficient of PP_{ij} is positive and significant at the 1% level (coef. = 0.0194; Z = 7.12) at the racetracks which favour high draw horses whilst it is negative but significant at the 1% level (coef. = -0.0152; Z = -5.95) at the racetracks with low draw advantage. Note that the significance and the sign of PP's coefficients in models with odds related variables are completely in line with those in models without the odds information, for the whole market as well as for the two racetrack groups. This consistence indicates that (1) at either high or low draw advantage racetrack, the post-position of the horse is an important piece of information in estimating the horse's winning probability; and (2) bettors in the UK market have not paid sufficient attention to the post-position information (i.e. they *underestimate* rather than *overestimate* the impact of this information when estimating the horse's chance of winning). Consequently, no anchoring effects are detected from the results discussed above.

In addition, the difference of the impact of post-position on horses' winning probabilities and of the manner in which bettors handle post-position information at different racetracks may also confirm that the examination of the whole market data may be mis-specified and may lead to misleading conclusion. Similar as in the HK markets, a likelihood ratio test is conducted to confirm this suggestion, based on the maximum likelihood values for models incorporating (i) post-position only and (ii) post-position and odds implied probabilities. For each model, the ratio is calculated based on the maximum likelihood values modelled for the combined market with all the racetracks as a whole (L_{UK}), at racetracks with high draw advantage (L_{High}) and at racetracks favouring low draw horses (L_{Low}), by the formula $-2\ [L_{UK} - (L_{High} + L_{Low})]$. The results are 112260.86 and 93893.08 for models (i) and (ii) respectively. This suggests that for both models (either without or with odds implied probability as the independent variable), the CL models conducted for the two types of racetracks separately, compared with models for the whole market, contain more information concerning the impact of post-position of horses on their performance and the manner in which bettors incorporate such information.

In summary, the results associated with horses' post-positions and bettors' subjective judgements, shown in Table 4.3.1-15 and Table 4.3.1-16 (1), suggest that bettors in the UK horserace betting market do not anchor their subjective judgements on the post-position advantage discerned from the configuration of the racetrack. In addition, it also suggests that models conducted for the whole UK horserace betting market may not detect the real information contained by different racetracks. More specifically, the effects of the post-position on horses' performance at different racetracks may be mashed when all the data are combined together.

(2) Anchoring on the Information of the Previous Race

The manner in which bettors handle the post-position information of the winners in the previous one, two or three races in estimating a horse's winning chance in the current race is explored in this section. Three dummy variables (WP1, WP2 and WP3) are created to explain the relationship between the post-positions of previous winners and of the current horse.

Results of estimating CL models with post-position related variables are reported in Table 4.3.1-15. Results of models with bettors' subjective judgements and different post-position variables are reported in Tables 4.3.1-16(2-4), respectively. Table 4.3.1-15 shows that the coefficient of WP1 is positive and significant at the 1% level (coef. = 0.0499; Z = 2.79), WP2 is positive but insignificant (coef. = 0.0404; Z = 0.63), whereas WP3 is negative but significant at the 5% level (coef. = -0.6529; Z = -2.09), for the UK market as a whole. This may suggest that the post-position of the winner in the last race has a significant impact on the winning probability of the horse which starts from the same position in the current race. When the winners of the previous two races are both from the same post-position, there is no impact on the horse with the same position in the next race. When the number of races examined increased to three, this appears to exert a negative impact on the winning probability of the horse with the same PP in the next race. Therefore, it seems that the impact of previous winners' post-position on the performance of the horse in the next race has a negative relationship with the number of races which is explored: the more races are monitored, the less positive impact it has.

When the whole database is split into two datasets according to post-position advantages of racetracks, no significance is found for the coefficients of the three anchoring variables at the racetracks with high draw advantage (see Table 4.3.1-15). The racetracks with low draw advantage, however, provide similar results as those for the whole market: a negative relationship between the impact of previous winner(s) post-position on bettors' judgements and the number of times that horses win from the same position. This seems to indicate that at the racetrack which favours high post-position, the post-position of previous winners has no impact on the performance of the horse from the same position; at the racetrack with low draw advantage, the more previous races are examined, the less positive impact the post-position of previous winners has on the performance of the horse in the current race.

When the odds implied probability is added into the model, results for the whole market show that bettors do not appear to fully account for the information of last winners' post-position (WP1) in their judgements (significant at the 5% level for the whole market and 1% level for racetracks with low draw advantage). This is consistent with Terrell and Farmer's (1996) findings in US greyhound racing: bettors underestimate the winning probability of the greyhound which starts from the trap occupied by the previous winner. Even so, no evidence shows that the UK horseracing bettors over- or underestimate the impact of previous two or three winners' post-position (WP2 and WP3) in their judgements. For the separate datasets, racetracks with low draw advantage provide similar results to those of the whole market and bettors at tracks with high draw advantage even fully account for the impact of anchoring factor WP1. This may suggest that the UK bettors are learning from the previous racing results and are able to adjust their judgments in later races.

In summary, although the post-position of previous winner(s) may have different impacts on subsequent horses which start from the same position, bettors appear not to overestimate the importance of this information. In particular, they may underestimate its impact at tracks with low draw advantage but adjust their judgements quickly when they observe similar results from two or three races. Therefore, the anchoring and strength hypotheses of anchoring on previous winners' post-position information are not accepted.

Table 4.3.1-15 Results of estimating CL models with horse's post-position as independent variable in the UK market

Variable	Whole Market	Racetrack	
		High draw adv.	Low draw adv.
PP_{ij} coef. [a]	0.0012	0.0283**	-0.0216**
Std. Err.	0.0013	0.0026	0.0024
Z	0.98	11.00	-8.87
LL	-116384.97	-28413.19	-31841.35
Model LR (χ_1^2)	0.96	121.58	78.98
Pseudo-R^2	0.0000	0.0021	0.0012
$WP1_{ij}$ coef. [b]	0.0499**	-0.0123	0.1525**
Std. Err.	0.0179	0.0376	0.0324
Z	2.79	-0.33	4.70
LL	-116381.60	-28473.92	-31870.18
Model LR (χ_1^2)	7.70	0.11	21.31
Pseudo-R^2	0.0000	0.0000	0.0003
$WP2_{ij}$ coef. [c]	0.0404	-0.0233	0.1289
Std. Err.	0.0643	0.1394	0.1115
Z	0.63	-0.17	1.16
LL	-116385.26	-28473.96	-31880.19
Model LR (χ_1^2)	0.39	0.03	1.29
Pseudo-R^2	0.0000	0.0000	0.0000
$WP3_{ij}$ coef. [d]	-0.6529*	-0.2472	-0.1765
Std. Err.	0.3126	0.6054	0.4334
Z	-2.09	-0.41	-0.41
LL	-116382.81	-28473.89	-31880.75
Model LR (χ_1^2)	5.28	0.18	0.17
Pseudo-R^2	0.0000	0.0000	0.0000
No. of horses	554,830	135,854	151,286
No. of races	49,881	12,138	13,714

[a] PP_{ij} : A variable which represents the number of the post-position of horse *i* in race *j*.

[b] $WP1_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as the winner's in race *j*-1; equals 0 otherwise.

[c] $WP2_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as those of the winners in race *j*-1 and *j*-2 at a meeting; equals 0 otherwise.

[d] $WP3_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as those of the winners in race *j*-1, *j*-2 and *j*-3 at a meeting; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

Table 4.3.1-16(1) Results of estimating CL models with bettors' subjective probability judgements and horses' post-positions as independent variables in the UK market

Model 1 Variable	Whole Market	Racetrack	
		High draw adv.	Low draw adv.
$\ln p_{ij}^{s}$ coef. [a]	1.2061**	1.2447**	1.2089**
Std. Err.	0.0069	0.0141	0.0133
Z	174.11	88.55	90.55
PP_{ij} coef. [b]	0.0005	0.0194**	-0.0152**
Std. Err.	0.0013	0.0027	0.0026
Z	0.40	7.12	-5.95
LL	-96790.52	-23314.17	-26529.81
Model LR (χ_2^2)	39189.87	10319.64	10702.05
Pseudo-R^2	0.1684	0.1812	0.1678
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[a] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] PP_{ij} : A variable which represents the number of the post-position of horse *i* in race *j*.

** Statistically significant at the 1% level.

Table 4.3.1-16(2) Results of estimating CL models with bettors' subjective probability judgements and previous winner's post-positions as independent variables in the UK market

Model 2 Variable	Whole Market	Racetrack	
		High draw adv.	Low draw adv.
$\ln p_{ij}^{s}$ coef. [c]	1.2061**	1.2483**	1.2109**
Std. Err.	0.0069	0.0141	0.0134
Z	174.11	88.82	90.70
$WP1_{ij}$ coef. [d]	0.0481*	-0.0128	0.1478**
Std. Err.	0.0190	0.0402	0.0346
Z	2.53	-0.32	4.27
LL	-96787.43	-23339.54	-26538.68
Model LR (χ_2^2)	39196.04	10268.87	10684.31
Pseudo-R^2	0.1684	0.1803	0.1676
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[c] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[d] $WP1_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as the winner's in race *j*-1; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

Table 4.3.1-16(3) Results of estimating CL models with bettors' subjective probability judgements and previous two winners' post-positions as independent variables in the UK market

Model 3	Whole Market	Racetrack	
Variable		High draw adv.	High draw adv.
$\ln p_{ij}^{s}$ coef. [e]	1.2061**	1.2484**	1.2111**
Std. Err.	0.0069	0.0141	0.0134
Z	174.11	88.82	90.72
$WP2_{ij}$ coef. [f]	0.0551	-0.0467	0.1863
Std. Err.	0.0688	0.1502	0.1197
Z	0.80	-0.31	1.56
LL	-96790.28	-23339.55	-26546.37
Model LR (χ_2^2)	39190.34	10268.86	10668.94
Pseudo-R^2	0.1684	0.1803	0.1673
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[e] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[f] $WP2_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as those of the winners in race *j*-1 and *j*-2 at a meeting; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-16(4) Results of estimating CL models with bettors' subjective probability judgements and previous three winners' post-positions as independent variables in the UK market

Model 4	Whole Market	Racetrack	
Variable		High draw adv.	Low draw adv.
$\ln p_{ij}^{s}$ coef. [g]	1.2061**	1.2483**	1.2110**
Std. Err.	0.0069	0.0141	0.0133
Z	174.11	88.82	90.72
$WP3_{ij}$ coef. [h]	-0.6069	-0.1417	-0.0300
Std. Err.	0.3268	0.6282	0.4535
Z	-1.86	-0.23	-0.07
LL	-96788.59	-23339.57	-26547.54
Model LR (χ_2^2)	39193.72	10268.82	10666.61
Pseudo-R^2	0.1684	0.1803	0.1673
No. of horses	554,830	141,225	413,605
No. of races	49,881	12,738	37,143

[g] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[h] $WP3_{ij}$: A dummy variable which equals 1 for horse *i* in race *j* if its post-position is the same as those of the winners in race *j*-1, *j*-2 and *j*-3 at a meeting; equals 0 otherwise.

** Statistically significant at the 1% level.

4.3.1.5 Performance of Previous Favourite

Factors associated with favourites' past performances are explored in this section to examine anchoring in the HK and UK horserace betting markets. Three dummy variables concerning the performance of the favourite in the previous one, two and three races are employed to conduct these tests. In particular, variable F1 gives 1 to the favourite of the current race if the previous race was won by the favourite, and 0 otherwise. Variable F2 gives 1 to the favourite of the current race if the previous two races were both won by the favourites, and variable F3 focuses on the outcomes of previous three races. Note that under this definition, when the previous race was not won by the favourite, the favourite in the current race will obtain a value of 0, which makes all the values for horses in this race to be 0. This will cause calculation problems in CL model if the number of such races is too high. Therefore, races with 0 for all horses in a race are removed from the dataset. As a result, the number of horses and races may vary in these tests and will be presented in the results of each test.

Only races at the same meeting are concerned in this study to detect anchoring effects because favourites' performances in races at previous meetings are difficult to be retrieved to bettors' memory and therefore are not likely to serve as anchors.

HK Market

Results of exploring anchoring effects on favourites' past performances using CL models associated with the HK market data are displayed in Table 4.3.1-17 and Tables 4.3.1-18(1-3). As shown in Table 4.3.1-17, for the whole HK market, coefficients of the independent variable F1 (coef. = 1.4479; Z = 22.31) and F2 (coef. = 1.3173; Z = 9.47) are both positive and significant at the 1% level. This suggests that the information that the previous one or two races are won by the favourites has a significant impact on the performance of the favourite in a subsequent race. When the number of races won by the favourites goes up to three, the significant impact of this information on the performance of the subsequent favourite, however, disappears (coef. = 0.6258; Z = 1.64).

The results of models incorporating bettors' subjective probability judgements and favourites' past performances as independent variables are reported in Table 4.3.1-18(1-3). When the HK market is considered as a whole, the variables F1 and F2 turn to be insignificant (F1: coef. = 0.0742, Z = 0.86; F2: coef. = -0.1270, Z = -0.70). This suggests that the information that the previous one or two races are won by the favourites has been fully accounted in odds by the betting public.

However, results in model 3 show that when previous three races are all won by the favourites, it has a significant negative impact (coef. = -0.9293; Z = -2.04, at the 5% level) on bettors' subjective judgements of the favourite's winning probability in the next race. Compared with the positive but insignificant coefficient of F3 in the model without market odds (see Table 4.3.1-17), a negative but significant coefficient of F3 in model 3 indicates that the influence of favourites' performances in previous races has to be reduced from bettors' estimates of the winning chance of the next favourite horse to obtain the real winning probability of the horse. In other words, the betting public pay too much attention to this piece of information and therefore anchor their judgements on it.

Taken together, the information of favourite's last performance has been fully accounted in odds by bettors in the HK market. Therefore, the anchoring hypothesis on favourite's last performance is not accepted. However, when the HK betting public observe that previous three races at a meeting are all won by the favourites, they tend to anchor their judgements on this piece of information and *overestimate* the real chance that the favourite wins the next race. These results are inconsistent with the effect found by previous literature in racetrack betting. For example, Metzger (1985) found that bettors in US horserace betting regard a favourite less favourable if a series of races have been won by the favourites and vice versa. This is an evidence of the 'gambler's fallacy' which indicates that people tend to *underestimate* the chance that an outcome occurs if the same outcome has been repeated a series of times. Clearly, bettors in the HK horserace betting market are not subject to a 'gambler's fallacy' when favourites win previous two races but exhibit a 'hot hand' effect when the result is repeated three times. In other words, they believe that the favourite has a more chance of winning after a series of races won by the favourites (i.e., the favourite gets 'hot' in the next race). This may suggest that the strength hypothesis cannot be accepted unless similar results are repeated enough times (three times in the case of the favourite's past performance information).

Table 4.3.1-17 Results of estimating CL models with favourite's past performance as independent variable in the HK market

Variable	Whole Market	Day of the Week	
		Wnd	Wk
$F1_{ij}$ coef. [a]	1.4479**	1.4959**	1.3739**
Std. Err.	0.0649	0.0828	0.1044
Z	22.31	18.06	13.16
LL	-2939.36	-1794.84	-1144.10
Model LR (χ_1^2)	383.66	249.73	134.77
Pseudo-R^2	0.0613	0.0650	0.0556
No. of horses	15,872	9,873	5,999
No. of races	1,225	744	481
$F2_{ij}$ coef. [b]	1.3173**	1.3059**	1.3375**
Std. Err.	0.1390	0.1743	0.2307
Z	9.47	7.49	5.80
LL	-698.89	-456.01	-242.88
Model LR (χ_1^2)	69.68	43.55	26.14
Pseudo-R^2	0.0475	0.0456	0.0511
No. of horses	3,736	2,459	1,277
No. of races	286	185	101
$F3_{ij}$ coef. [c]	0.6258	0.5909	0.6867
Std. Err.	0.3806	0.4804	0.6239
Z	1.64	1.23	1.10
LL	-150.10	-96.81	-53.28
Model LR (χ_1^2)	2.32	1.31	1.03
Pseudo-R^2	0.0077	0.0067	0.0096
No. of horses	770	497	273
No. of races	59	38	21

[a] $F1_{ij}$: A dummy variable which equals 1 for the favourite if its previous race was won by the favourite; equals 0 otherwise.

[b] $F2_{ij}$: A dummy variable which equals 1 for the favourite if its previous two races were won by the favourites; equals 0 otherwise.

[c] $F3_{ij}$: A dummy variable which equals 1 for the favourite if its previous three races were won by the favourites; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-18(1) Results of estimating CL models with bettors' subjective probability judgements and the favourite's past performance as independent variables in the HK market

Model 1	Whole Market			Day of the Week					
					Wnd			Wk	
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [a]	0.9976**	0.8985**	0.8934**	0.9611**	0.9232**	0.9177**	0.8987**	0.8574**	0.8533**
Std. Err.	0.0461	0.0452	0.0451	0.0583	0.0573	0.0572	0.0754	0.0739	0.0736
Z	20.35	19.88	19.80	16.48	16.12	16.04	11.92	11.59	11.59
$F1_{ij}$ coef. [b]	0.0742	0.1317	0.1569	0.0327	0.0901	0.1156	0.1377	0.1953	0.2196
Std. Err.	0.0858	0.0859	0.0856	0.1108	0.1109	0.1106	0.1358	0.1360	0.1352
Z	0.86	1.53	1.83	0.30	0.81	1.04	1.01	1.44	1.62
LL	-2678.74	-2700.00	-2704.13	-1621.57	-1635.16	-1638.42	-1056.93	-1064.58	-1065.45
Model LR (χ_2^2)	904.89	862.38	854.12	596.28	569.10	562.57	309.09	293.81	292.06
Pseudo-R^2	0.1445	0.1377	0.1364	0.1553	0.1482	0.1465	0.1276	0.1213	0.1205
No. of horses	15,872	15,872	15,872	9,873	9,873	9,873	5,999	5,999	5,999
No. of races	1,225	1,225	1,225	744	744	744	481	481	481

Table 4.3.1-18(2) Results of estimating CL models with bettors' subjective probability judgements and the favourite's past performance as independent variables in the HK market

Model 2	Whole Market			Day of the Week					
					Wnd			Wk	
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [c]	0.9905**	0.9876**	0.9813**	1.1099**	1.1334**	1.1295**	0.7825**	0.7344**	0.7252**
Std. Err.	0.0962	0.0952	0.0943	0.1236	0.1229	0.1218	0.1545	0.1521	0.1506
Z	10.30	10.38	10.41	8.98	9.22	9.28	5.06	4.83	4.81
$F2_{ij}$ coef. [d]	-0.1270	-0.1441	-0.1388	-0.3103	-0.3580	-0.3551	0.1975	0.2388	0.2471
Std. Err.	0.1812	0.1832	0.1835	0.2276	0.2299	0.2303	0.3012	0.3058	0.3061
Z	-0.70	-0.79	-0.76	-1.36	-1.56	-1.54	0.66	0.78	0.81
LL	-631.24	-632.21	-632.71	-402.10	-400.53	-400.71	-227.71	-229.57	-229.80
Model LR (χ_2^2)	204.97	203.05	202.04	151.36	154.50	154.14	56.47	52.76	52.30
Pseudo-R^2	0.1397	0.1384	0.1377	0.1584	0.1617	0.1613	0.1103	0.1031	0.1022
No. of horses	3,736	3,736	3,736	2,459	2,459	2,459	1,277	1,277	1,277
No. of races	286	286	286	185	185	185	101	101	101

Table 4.3.1-18(3) Results of estimating CL models with bettors' subjective probability judgements and the favourite's past performance as independent variables in the HK market

Model 3	Whole Market			Day of the Week					
				Wnd			Wk		
Variable	Final	2mins	5mins	Final	2mins	5mins	Final	2mins	5mins
$\ln p_{ij}^{s}$ coef. [e]	1.0509**	1.0298**	1.0131**	1.1895**	1.1879**	1.1651**	0.8435**	0.8025**	0.7953**
Std. Err.	0.2030	0.1985	0.1946	0.2706	0.2668	0.2614	0.3111	0.3028	0.2976
Z	5.18	5.19	5.21	4.40	4.45	4.46	2.71	2.65	2.67
$F3_{ij}$ coef. [f]	-0.9293*	-0.9665*	-0.9702*	-1.1662*	-1.2626*	-1.2630*	-0.5518	-0.5151	-0.5252
Std. Err.	0.4553	0.4612	0.4628	0.5809	0.5925	0.5948	0.7372	0.7394	0.7416
Z	-2.04	-2.10	-2.10	-2.01	-2.13	-2.12	-0.75	-0.70	-0.71
LL	-132.22	-133.00	-133.22	-82.99	-83.25	-83.50	-48.86	-49.25	-49.24
Model LR (χ_2^2)	38.08	36.52	36.07	28.95	28.43	27.92	9.88	9.10	9.12
Pseudo-R^2	0.1259	0.1207	0.1192	0.1485	0.1458	0.1433	0.0918	0.0846	0.0847
No. of horses	770	770	770	497	497	497	273	273	273
No. of races	59	59	59	38	38	38	21	21	21

[a c e] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] $F1_{ij}$: A dummy variable which equals 1 for the favourite if its previous race was won by the favourite; equals 0 otherwise.

[d] $F2_{ij}$: A dummy variable which equals 1 for the favourite if its previous two races were won by the favourites; equals 0 otherwise.

[f] $F3_{ij}$: A dummy variable which equals 1 for the favourite if its previous three races were won by the favourites; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

UK Market

Tests of impact of the favourites' past performances on bettors' estimates of the favourite's winning probability in the next race in the UK market are discussed in this section. Table 4.3.1-19 reports the estimates of CL models with the favourite's performance in the previous one, two and three races as independent variables (namely, F1, F2 and F3). All the three variables are positive and significant at the 1% level. This indicates that for the UK market as a whole, the information that the previous one, two or three races have been won by the favourites increases the chance that the favourite wins the next race.

Tables 4.3.1-20 (1-3) summarise the estimates of CL models incorporating bettors' subjective probability judgements and the performance of the favourite in the previous one, two and three races. The coefficients of F1, F2 and F3 are all negative and significant at the 5% level. Compared with the positive and significant coefficients of these variables in models without odds information, these results may suggest that bettors in the UK market *overestimate* the impact of pervious favourites' performance and therefore demonstrate the existence of anchoring effects on these pieces of information.

It should be noted that although the favourites are the horses with the highest winning probabilities in their races, the performance of the favourite in one race, however, should be less relevant to the performance of the favourite in the next race (because they are different horses). Therefore, anchoring on these pieces of information seems to be consistent with the demonstration of anchoring on irrelevant information in experimental studies (e.g., Brewer *et al.*, 2007; Englich and Mussweiler, 2001; Englich *et al.*, 2006; Strack and Mussweiler, 1997; Wilson *et al.*, 1996). However, previous literature also suggests that individuals anchor not only on irrelevant but also on relevant information (e.g., Joyce and Biddle, 1981; Northcraft and Neale, 1987), and irrelevant or implausible information cause to a higher degree of adjustment (i.e., lower level of anchoring) whereas a higher level of anchoring on relevant information. This is not supported by the betting results in this study. The results of UK market seem to suggest that bettors in this market anchor on less relevant information rather than on more relevant information such as horses' and jockeys' past performance or the horse's post-position.

Table 4.3.1-19 Results of estimating CL models with favourite's past performance as independent variable in the UK market

Variable	Whole Market	Day of the Week	
		Wnd	Wk
$F1_{ij}$ coef. [a]	1.4003**	1.3458**	1.4184**
Std. Err.	0.0216	0.0434	0.0249
Z	64.94	31.02	57.07
LL	-22260.49	-5662.63	-85414.81
Model LR (χ_1^2)	3497.27	798.82	2700.56
Pseudo-R^2	0.0728	0.0659	0.0156
No. of horses	114,414	29,160	85,254
No. of races	10,293	2,597	7,696
$F2_{ij}$ coef. [b]	1.3469**	1.2551**	1.3754**
Std. Err.	0.0411	0.0852	0.0470
Z	32.75	14.73	29.29
LL	-6249.51	-1522.19	-4726.54
Model LR (χ_1^2)	891.64	181.55	711.64
Pseudo-R^2	0.0666	0.0563	0.0070
No. of horses	31,885	7,770	24,115
No. of races	2,879	6,92	2,187
$F3_{ij}$ coef. [c]	1.3932**	1.3458**	1.4076**
Std. Err.	0.0677	0.1407	0.0772
Z	20.58	9.56	18.23
LL	-2254.69	-528.06	-1726.56
Model LR (χ_1^2)	350.81	76.31	274.64
Pseudo-R^2	0.0722	0.0674	0.0737
No. of horses	11,501	2,707	8,794
No. of races	1,046	244	802

[a] $F1_{ij}$: A dummy variable which equals 1 for the favourite if its previous race was won by the favourite; equals 0 otherwise.

[b] $F2_{ij}$: A dummy variable which equals 1 for the favourite if its previous two races were won by the favourites; equals 0 otherwise.

[c] $F3_{ij}$: A dummy variable which equals 1 for the favourite if its previous three races were won by the favourites; equals 0 otherwise.

** Statistically significant at the 1% level.

Table 4.3.1-20(1) Results of estimating CL models with bettors' subjective probability judgements and the favourite's past performance as independent variables in the UK market

Model 1	Whole Market	Day of the Week	
Variable		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [a]	1.2471**	1.2286**	1.2531**
Std. Err.	0.0213	0.0427	0.0246
Z	58.57	28.76	51.01
$F1_{ij}$ coef. [b]	-0.0649*	-0.0597	-0.0666
Std. Err.	0.0300	0.0596	0.0347
Z	-2.17	-1.00	-1.92
LL	-20043.45	-5132.31	-14910.97
Model LR (χ_2^2)	39191.20	1859.46	6072.23
Pseudo-R^2	0.1684	0.1534	0.1692
No. of horses	114,414	29,160	85,254
No. of races	10,293	2,597	7,696

[a] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[b] $F1_{ij}$: A dummy variable which equals 1 for the favourite if its previous race was won by the favourite; equals 0 otherwise.

** Statistically significant at the 1% level. * Statistically significant at the 5% level.

Table 4.3.1-20(2) Results of estimating CL models with bettors' subjective probability judgements and the favourite's past performance as independent variables in the UK market

Model 2 Variable	Whole Market	Day of the Week	
		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [c]	1.2857**	1.3023**	1.2800**
Std. Err.	0.0412	0.0844	0.0472
Z	31.22	15.42	27.14
$F2_{ij}$ coef. [d]	-0.1234*	-0.1892	-0.1022
Std. Err.	0.0568	0.1153	0.0653
Z	-2.17	-1.64	-1.57
LL	-5616.13	-1369.59	-4246.29
Model LR (χ_2^2)	2158.40	486.76	1672.14
Pseudo-R^2	0.1612	0.1509	0.1645
No. of horses	31,885	7,770	24,115
No. of races	2,879	6,92	2,187

[c] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[d] $F2_{ij}$: A dummy variable which equals 1 for the favourite if its previous two races were won by the favourites; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

Table 4.3.1-20(3) Results of estimating CL models with bettors' subjective probability judgements and the favourite's past performance as independent variables in the UK market

Model 3	Whole Market	Day of the Week	
Variable		Wnd	Wk
$\ln p_{ij}^{s}$ coef. [e]	1.3873**	1.2695**	1.4251**
Std. Err.	0.0706	0.1412	0.0816
Z	19.64	8.99	17.46
$F3_{ij}$ coef. [f]	-0.1914*	-0.1285	-0.2108
Std. Err.	0.0949	0.1968	0.1084
Z	-2.02	-0.65	-1.94
LL	-1996.60	-475.63	-1520.45
Model LR (χ_2^2)	867.00	181.19	686.86
Pseudo-R^2	0.1784	0.1600	0.1843
No. of horses	11,501	2,707	8,794
No. of races	1,046	244	802

[e] $\ln p_{ij}^{s}$: Natural log of the odds implied probability of horse *i* winning race *j*.

[f] $F3_{ij}$: A dummy variable which equals 1 for the favourite if its previous three races were won by the favourites; equals 0 otherwise.

** Statistically significant at the 1% level.

* Statistically significant at the 5% level.

4.3.1.6 Discussion of the Results Related to Anchoring Factors and Strength of Anchors

The use of five pieces of information associated with horses', jockeys' and trainers' past performances, horses' post-positions and previous favourites' performances by bettors in the HK and UK horserace betting markets has been discussed in the above sections. The results demonstrate the existence of anchoring effects in these two markets, but not on most of these factors. This result is attributed to the lack of explicit comparisons between the anchoring factors and bettors' subjective judgements. As suggested by the anchoring literature, basic anchoring effects may occur in environments where no explicit comparisons between anchors and targets are required (Wilson *et al.*, 1996). However, such effect has been demonstrated to be fragile and easy to disappear due to the changes of anchors or targets (Brewer and Chapman, 2002). In horserace betting environment, although bettors make subjective judgements on horse's winning probability based on the information tested in this study, they are not explicitly asked to compare such information to their final estimates of horses' winning chance. Consequently, the impact of these anchoring factors may not be strong enough to lead to anchoring effects and therefore are hard to observe.

The only information on which bettors in the HK market are demonstrated to anchor is the horse's post-position at ST racetrack. In particular, bettors at ST tend to *overestimate* the low draw advantage of horse's post-position whereas bettors at HV appear to *underestimate* this advantage. This difference may be caused by the characteristics of HK races and the configurations of the two tracks. First, in HK, races at ST and HV are generally run in turn and bettors go to both tracks alternatively. If so, bettors' perspectives of the impact of the track configuration on horses' performance obtained at one track may be taken to the subsequent meetings run at the other track and consequently affect their judgements of the same information at the subsequent track. Second, in terms of the track configuration, both ST and HV racetracks are oval circuits and those horses with low post-position (run on the inside of the track) will be favoured. However, since the bends of HV (with a circumference of only 1454 meters and the radius of the tightest bend is 91 meters) are tighter than those at ST (with a circumference of ST is 1933 meters and an equivalent radius of 158 meters), inside runners at HV should have more advantage. Therefore, bettors at ST may be affected by their perspective of low draw advantage that they observe from previous meetings at HV and hence take too much account of it. Similarly, bettors at HV may be affected by the lower level of low draw advantage that they observe at previous ST meetings and therefore underestimate it at HV. Note that when the market is considered as a whole, no significant anchoring effect is detected. This implies that a mis-specification of the market data may mask the truth and lead to misleading perspective of the effect.

In the UK market, the only information on which bettors anchor is the performance of previous favourite(s) at a race meeting. The significant impact of performance of the favourite in the last race on bettors' subjective judgements of the winning chance of the favourite in the current race supports the anchoring factor hypothesis. Moreover, the strength hypothesis is supported by significant effect of anchoring on the favourites' performance in previous two and three races. It might be asked that why bettors in this market tend to anchor on less relevant information (such as previous favourites' performance) but not on more relevant information (such as horses' past performance, or post-position). There are several reasons which may explain this phenomenon. First, the judgemental procedure in horserace betting is often associated with information or perspectives which are generated or achieved by bettors themselves. As suggested by the previous literature, self-generated anchors have a stronger impact on individuals' absolute judgements than externally provided anchors (e.g., Davies, 1997; Mussweiler and Neumann, 2000; Mussweiler and Strack, 1999b, Tversky and Kahneman, 1974). For example, when bettors have noticed that previous three races are all won by the favourites at a race meeting, they may generate a perspective that this information is important and may affect the performance of the favourite in the next race. Therefore, they tend to anchor their judgements on this self-generated piece of information. Second, the previous favourites' performance is a piece of vivid information which can be easily retrieved from observation. This increases the accessibility of the favourite's performance information in bettors' judgements and hence makes it more likely to be anchored on (e.g., Mussweiler, 1997; Strack and Mussweiler, 1997; Mussweiler and Strack, 1999a, 1999b). Finally, the races concerning previous favourites' performance are from the same meeting whereas races concerning horses', jockeys' or trainers' past performances can be in any previous meeting. Again, the fresh and vivid information of favourites' previous information at the same meeting increases its probability to act as an anchor value. This is consistent with the model of selective accessibility of particular information (e.g., Mussweiler, 1997; Strack and Mussweiler, 1997; Mussweiler and Strack, 1999a, 1999b). Therefore, although the favourite related information is considered less relevant to horse's chance of winning compared to other relevant information, bettors still appear to anchor on this piece of information but not on others.

In summary, the anchoring factor hypothesis is not widely supported in these two markets according to the factors tested in this study. The strength hypothesis is also rejected on most of the factors because tests associated with outcomes of previous two and three races do not find significant anchoring effects except pervious favourite's performance. Consequently, bettors in these two markets seem to incorporate the information appropriately and do not over- or underestimate its impact when making judgements on horses' winning probabilities. However, some information, namely, the post-position at ST racetrack in HK and favourites' previous performance in the UK, does lead to a strong effect of anchoring due to the higher accessibility of this information. Finally, the mis-specification of data should be paid attention so as to misunderstanding of the results.

4.3.2 Hypothesis Tests for Research Question Two

The second research question of this study is to ask whether the degree of anchoring is affected by the level of expertise of decision makers. Experimental studies suggest that decision makers with greater expertise are less likely to anchor or to be subject to a lower degree of anchoring (e.g., Bonner, 1990; Mussweiler and Strack, 2000; Northcraft and Neale, 1987). It is supposed that this result also applies to naturalistic environments such as horserace betting markets.

The hypothesis formulated to answer this question is that bettors with greater expertise in horserace betting will be subject to a lower degree of anchoring than bettors with less expertise. As suggested by the previous literature (Kopelman and Minkin, 1991; Saunders and Turner, 1997), bettors who generally bet on weekday races have more knowledge and experience in betting than those who bet merely on the weekend races. Consequently, the whole market data are split into two parts, races run on the weekdays and races run at the weekends, to explore potential anchoring effects. In addition, the literature (e.g., Benter, 1994) also suggests that bettors with more betting expertise are likely to bet late in order to avoid being followed by other market players. Therefore, odds at different times before the race starts are considered to incorporate the judgements of bettors with different levels of expertise: the earlier the odds are, the less experience and expertise the bettors have. Consequently, market odds at different times (final odds, the odds at 2 and 5 minutes before the race starts[26]) are employed to test the expertise hypothesis.

The results of the hypothesis testing on bettors' expertise are displayed and are analysed in this section based on the tables displayed in Section 4.3.1. Besides the comparisons between the weekday and weekend races in each market, tests using odds at 2 and 5 minutes before the race are conducted in the HK markets. A summary of the findings will be provided in the last part of the section.

4.3.2.1 Horse's Past Performance

HK Market

The results related to an examination of the extent to which professional and casual bettors in the HK anchor their subjective judgements of horses' winning probabilities on horses' past performances are reported in Table 4.3.1-1 and Tables 4.3.1-2(1-3). The positive and significant coefficients of variables H1, H2 and H3 for weekday and weekend races (see Table 4.3.1) indicate that a horse's performance in its previous one, two and three races has a significant impact on the performance of the horse in a subsequent race.

When the final odds information is added into the model (see Tables 4.3.1-2(1-3)), the horses' performance variables (H1, H2 and H3) turn out to be insignificant for races run on weekdays and over the weekends. This seems to indicate that both weekday and weekend bettors fully account for a horse's past performance information when estimating the winning probability of the horse. No particular anchoring effects on horses' past performances are detected, no matter what bettors' knowledge and experience about the horserace betting are.

In addition, the results relating to bettors' subjective judgements at different times before the race starts show that bettors with different levels of expertise do experience

[26] Note that the information of odds at 2 and 5 minutes before the race starts is only available in the HK market. In the UK market only final odds information is available due to the data accessibility.

differences in estimating horses' winning probabilities. Take the variable H1 in the whole market as an example. The results show that the significance level of H1 changes in these three models along with the time at which the odds are taken: the earlier the odds are made, the higher level of the significance of the coefficient of H1. In other words, casual bettors tend to underestimate the impact of horses' last performance in their judgements, whereas this bias is corrected by expert bettors who enter the market in the last few minutes. These results seem to confirm the belief that bettors with more expertise bet late and their bets correctly adjust the estimates of more casual bettors and therefore accurately incorporate horses' past performance in odds. However, because none of these models provides evidence of anchoring on information H1 in this market, it cannot be concluded that expert bettors are subject to lower level of anchoring than casual bettors.

Note that the information that a horse has continuously won its previous two or three races has been fully accounted in odds (whether these are early or late odds). This may suggest that when a horse has achieved a sequence of winning (two or three races), casual bettors are able to incorporate this information into their subjective judgements properly. No anchoring effects are detected on these pieces of information, and therefore, whether expert bettors are subject to lower level of anchoring cannot be concluded.

UK Market

Whether bettors with more expertise in the UK horserace betting markets are subject to lower level of anchoring on the horse's past performance information is reported in this section.

As suggested in Table 4.3.1-3, variables of a horse's performance in its pervious one, two and three races are found significant at the 1% level with positive coefficients, for both weekday and weekend races. When the final odds information is involved into the model, the coefficients of H1, H2 and H3 all turn to insignificant (see Tables 4.3.1-4(1-3)). Therefore, both experts and non-experts in this market do not anchor their judgements on horses' past performance information.

4.3.2.2 Jockey's Past Performance

HK Market

As shown in Table 4.3.1-5, the impact of a jockey's performance in his/her last race (J1) on the probability of the horse ridden by this jockey winning a subsequent race is significant (at the 5% level) for races run on the weekdays and weekends. However, variables J2 and J3 are not significant, which may be explained by the 'regression to the mean' effect (see Section 4.3.1.2).

In models associated with bettors' subjective judgements (final odds implied probabilities) and jockeys' past performances, the coefficients of J1, J2 and J3 are all insignificant for both races run on the weekdays and weekends (see Tables 4.3.1-6(1-3)). The quality of judgements of bettors with different levels of expertise cannot be distinguished, according to the days on which they place their bets; both expert and non-expert bettors seem to incorporate jockeys' past performance information properly in their judgements without over- or under-estimations. Similarly, the coefficients of J2 and J3 for the weekday and weekend races are all negative but insignificant, indicating that all the bettors tend to pay attention to these pieces of information but manage not to over-weight their impacts. Consequently, both expert and non-expert bettors are not found to anchor their judgements on jockeys' past performances.

In addition, no significant differences are demonstrated between judgements of bettors who bet early and who bet late: the coefficients of anchoring variables (J1, J2 and J3) are all insignificant in models with bettors' subjective judgements at different times (see Tables 4.3.1-6(1-3)). Therefore, both expert and casual bettors in the HK market seem to pay appropriate attention to jockeys' past performance information.

UK Market

Jockeys' past performance in their previous one, two and three races are all significant at the 1% level in models with jockeys' performance related variables only, for the weekday races and weekend races (see Table 4.3.1-7). When bettors' subjective judgements are incorporated into the models, jockeys' performance in their past one and two races appear to be fully accounted in odds, for the market as a whole as well as for the weekday and weekend races separately (see Tables 4.3.1-8(1-2)). Therefore, both expert and non-expert bettors do not anchor their judgements on these two pieces of information associated with jockeys' past performances.

The results of J3 in models for the weekday and weekend races are slightly different. As shown in Table 4.3.1-8(3), the coefficient of variable J3 in the model for weekday races is negative and significant at the 5% level (coef. = -0.2970; Z = -2.08). This may suggest that a jockey's ability in helping a horse to win a race is overestimated by bettors who bet on weekday races, if this jockey has won his/her previous three races. In the contrast, bettors who bet on the weekend races seem to account for this piece of information properly in the final odds. This result contradicts the expertise hypothesis which suggests that expert bettors are *less* likely to conduct anchoring on certain piece of information. In particular, the results indicate that expert bettors anchor their judgements on the information of a jockey's past performance, when s/he has won his/her previous three races. In other words, the information that a jockey has won his/her previous three races is so vivid that expert bettors (i.e., those who have more time and knowledge to study the betting information) appear to anchor on such information.

4.3.2.3 Trainer's Past Performance

HK Market

The results in Table 4.3.1-9 provide a confusing image of the impact of trainers' past performances. Variables T1, T2, and T3 have a decreasing impact on the performance of the horse trained by the same trainer for weekday races (from 1% to 5% to insignificant). However, for weekend races, the significance levels of these three variables are 1%, insignificant and 5% level.

When bettors' subjective judgements (measured by final odds) are included into the models (see Tables 4.3.1-10(1-3)), the coefficients of T1, T2 and T3 for races run on the weekdays and weekends are all insignificant. This indicates that trainers' past performances have been fully accounted by both expert and non-expert bettors. Therefore, both groups of bettors do not over- or underestimate the impact of trainers' performance information in their judgements.

Models involving bettors' subjective judgements at different times throughout the betting market, suggest that expert and non-expert bettors handle trainers' past performance information appropriately. Consequently, no anchoring effects are detected on the trainer's past performances, for both expert and non-expert bettors.

UK Market

In the UK market, trainers' past performance information has a significant impact on horses' performance. As shown in Table 4.3.1-11, coefficients of variables T1, T2 and T3 are all significant at the 1% level, for both weekday and weekend races. When the final odds information is included in the models (see Tables 4.3.1-12(1-3)), the coefficients of T1 remain significant (but at a 5% level) for weekday races and for the market as a whole. However, it becomes insignificant for the races run over the weekends. This seems to suggest that casual bettors (i.e., those who bet on weekend races) are able to incorporate trainers' last performance information appropriately in their judgements whereas expert bettors tend to underestimate the value of this piece of information. Clearly, this result is in contrast with the expertise hypothesis. However, the results suggest that neither expert nor casual bettors anchor on information associated with trainers' past performances.

4.3.2.4 Post-position of the Horse

HK Market

Differences in the extent to which expert and non-expert bettors in the HK market anchor on a horse's post-position are explore using odds on offer at different times throughout the betting market. The races run at HV and ST racetracks are examined separately.

(1) Anchoring on the Information of the Current Race

As shown in Table 4.3.1-13, a horse's post-position is highly significant at both HV and ST racetracks in determining a horse's winning probability. At both racetracks, horses with low post-positions are favoured, as suggested by a negative but significant coefficient of PP. When the final odds information is added in the model, the results suggest that the betting public underestimate horses' post-position information at HV racetrack and overestimate it at ST racetrack, as discussed in Section 4.3.1.4 (see Table 4.3.14(1)). In addition, the results of models associated with 2 and 5 minutes odds provide a similar picture as models with final odds (see Table 4.3.1-14(1)). Therefore, both expert and non-expert bettors anchor their judgements on horse's post-position information at ST but underestimate this information at HV. The hypothesis that bettors with greater expertise are subject to a lower level of anchoring on the post-position information cannot be confirmed in relation to the HK market.

(2) Anchoring on the Information of the Previous Race

For races at HV and ST racetracks as well as the HK market as a whole, none of the previous winners' post-position information (WP1, WP2, and WP3) has significant impact on the performance of the subsequent horse starting from the same position. When bettors' subjective judgements at different times (implied by final odds, 2 and 5 minutes odds) are included into the models, the results indicate that bettors have fully accounted for previous winners' post-position information in their judgements (see Tables 4.3.1-14(1-3)). Once again this suggests that bettors in the HK horserace betting market, regardless of their level of expertise, do no anchor on the winning post-position for the previous race.

UK Market

As suggested in Section 4.3.1.4, bettors in the UK market underestimate (not overestimate) the impact of a horse's post-position information on the horse's winning probability when making judgements, when the racetracks with high/low draw advantages are considered separately. Bettors are found to anchor their subjective judgements on the independent variable WP1, at racetracks with high position advantage, but no such anchoring is found at the racetracks with low draw advantage. However, because only final odds information is available at the UK horserace betting market, the degree of anchoring between expert and non-expert bettors cannot be examined in this market.

4.3.2.5 Performance of Previous Favourite

HK Market

Results displayed in Table 4.3.1-17 and Tables 4.3.1-18(1-3) show that bettors anchor their subjective judgements of favourite horses' winning a race on the performance of the favourites in the last three races at a race meeting over the weekends. This is suggested by an insignificant coefficient of F3 in the model with out odds but a negative but significant (at the 5% level) coefficient of F3 in models with odds in. This suggests that when non-expert bettors notice that continuous three races are won by the favourites, they tend to overestimate the probability of the next favourite horse winning the race. In this situation, they forget that previous favourite horse's performance is actually less relevant to the performance of the favourite horse in the next race. Bettors who bet on the weekend races are not found to anchor on this or other piece of information concerning favourite horses' past performance.

However, the results of models concerning odds at different times show no difference in the way that expert and non-expert bettors incorporate the information of the favourites' performance in the previous three races.

UK Market

Table 4.3.1-19 and Tables 4.3.1-20(1-3) show that although favourite horse's performances in the past one, two and three races have significant impacts on the favourite horse's performance in the next race, bettors are not found to anchor their judgements of the favourite horse winning on these pieces of information. The coefficients of the independent variables F1, F2 and F3 are all insignificant when races run on the weekdays and over the weekends are considered separately, indicating that both expert and non-expert bettors are able to fully incorporate the influence of the favourite's performance in the previous one, two and three races. Note that these results are inconsistent with those of models when the market is considered as a whole (see discussion in Section 4.3.1.5). Therefore, another evidence of mis-specification of market data has been demonstrated.

4.3.2.6 Discussion of the Results Related to Bettors' Expertise

The results exploring the extent to which bettors with different levels of expertise in the HK and UK horserace betting markets anchor their subjective judgements of horses' winning probabilities on horses', jockeys' and trainers' past performances, horses' post-positions and favourites horses' past performances are reported in the previous sections. Given the strong evidence, in previous laboratory and field studies (e.g., Bhattacharjee and Moreno, 2002; Mussweiler and Strack, 2000b; Northcraft and Neale, 1987; Wilson, *et al.*, 1996), of the use of decision makers' expertise in reducing the effect of anchoring observed, bettors with more expertise in the horserace betting market are expected to be accounted with a lower level of anchoring. However, the tests conducted in these markets provide conflicting results on different factors and therefore do not entirely support this hypothesis.

First, expert bettors' judgements on the information on which anchoring effects have been demonstrated may be or may not be the same as those of not-expert bettors. For example, for the horse's post-position information in the HK market, bettors have been demonstrated to anchor their judgements on this piece of information at ST whereas underestimate its importance at HV in HK. When the market odds 2 and 5 minutes before that race starts are included into the CL models, the results are similar to those of models with final odds information, for both races at ST and at HV. This seems to indicate that both expert and casual bettors incorporate the horse's post-position in the same way (i.e., overestimate its impact at ST and underestimate its impact at HV). However, when concerning the performance of the favourites' previous three races (F3), bettors who bet on weekend races (casual bettors) show a significant anchoring effect on this piece of information whereas those who bet on weekday races (expert bettors) appear to fully account for this information. This may suggest that expert bettors are better at incorporating information than casual bettors. Finally, UK bettors who bet on weekday races (experts) are demonstrated to anchor their judgements on a jockey's performance in his/her previous three races (J3) whereas those who bet on weekends do not appear to anchor on this piece of information. This may suggest that expert bettors in this market perform worse than casual bettors when concerning particular anchoring information.

Second, the previous favourites' performance information in the UK market provides an interesting result. In particular, the strong impact of anchoring on these pieces of information (implied by variables F1, F2, and F3) is demonstrated when the market is considered as a whole. However, when the whole dataset is split into two groups including weekday and weekend races, these factors are still significant at the 1% level in models without odds, but turn to be insignificant in models with final odds in. This indicates that when consider the races run on weekdays and over the weekends separately, bettors seem to fully account for the favourite(s)' performance(s) in previous race(s) and do not appear to anchor on any of these pieces of information. Similar as the horse's post-position information in the HK market, this is another example of the effect of mis-specification of market data. Even so, no evidence has shown that expert bettors are subject to a lower level of anchoring than casual bettors.

Third, for the information on which anchoring effects are not demonstrated, tests in the HK and UK markets also provide inconsistent results. For example, when considering the HK market as a whole, casual bettors seem to underestimate the impact of horse's last performance (H1) in their judgements: the earlier the bets are placed, the higher the level of the under-estimation of their probability judgements. This suggests that bettors who bet late (experts) are better at incorporating the horse's last performance information than those who bet early (non-experts). However, in some other occasions, professional bettors appear to perform worse than casual bettors. For example, experts in the UK market turn to anchor on the performance of a jockey's pervious three races (J3) whereas casual bettors fully account for this information. Expert bettors in the UK are also found to underestimate the impact of a trainer's last performance (T1) on horse's winning probability whereas casual bettors incorporate this information properly.

Taken together, the results associated with the examination of the impact of bettors' expertise on their subjective judgements do not support the expertise hypothesis developed in Chapter 3. The impacts of bettors' expertise on their judgement accuracy are complex. Clearly, this is not in line with the findings of previous anchoring literature which suggest that experts are less likely to encounter anchoring effects or are subject to a lower level of anchoring than navies (e.g., Bhattacharjee and Moreno, 2002; Northcraft and Neale, 1987; Wilson *et al*., 1996).

4.3.3 Hypothesis Tests for Research Question Three

The third research question, to what extent the degree of anchoring in the real world is affected by different environments or markets in which decisions are made, is answered in this section by comparing the results of tests for the previous four hypotheses in the HK and UK markets.

The discussion in Section 4.3.1 and 4.3.2 suggests that only limited anchoring effects are detected in the HK and the UK horserace betting markets. However, the results suggest that judgements of bettors in the HK and UK horserace betting markets are different in two aspects. First, bettors in these two markets anchor on different factors. For example, bettors at the ST racetrack in HK anchor their subjective judgements on the horse's post-position, due to general low draw advantage of the racetrack. In the UK, bettors do not anchor their judgements on the horse's post-position information, no matter whether the racetracks have a high or low draw advantage, but appear to anchor on the favourite' performance in previous one, two and three races, when the market is considered as a whole. This anchoring effect is eliminated when the market data is split into two groups (the weekday and weekend races). No anchoring effects are found on the other factors in either HK or UK markets.

Second, factors which are not fully accounted for in odds are not consistent in the two markets. For example, bettors in the HK market seem to fully account for all the anchoring factors tested in this study, expect the *overestimate* of the horse's post-position information at ST racetrack. However, bettors in the UK markets have been demonstrated to *underestimate* the impact of the trainer's performance in his/her last race (T1) for the whole market as well as for the weekday races (both significant at the 5% level). Similarly, the impact of the winner's post-position in the previous race (WP1) is *underestimated* for the whole market and the races at tracks with low draw advantage (both significant at the 5% level). Other information is all fully accounted.

There might be three reasons to explain these differences between the two markets. First, the reason why anchoring effects occur on horse's post-position information in HK rather than in the UK may be due to the differences between track configuration (e.g., short/long oval racetracks with sharp/modest bends) or other racetrack topography (e.g., faster/slower ground on the inside/outside of the track) in the two markets. For example, the racetracks in HK, the HV and ST racetracks, are both oval circuits and the track configuration suggests that those horses with post-positions on the inside of the track (low PPs) will be favoured, since they will be required to run less distance. HV has a circumference of only 1454 meters, whereas the circumference of ST is 1933 meters. The bends at HV are therefore tighter than those at ST; the tightest bend at HV having a radius of only 91 meters, whereas the equivalent bend at ST has a radius of 158 meters. Consequently, the configuration of both these tracks suggests that horses with a low PP will be favoured and more so at HV (Schnytzer, Liu, and Johnson, 2008). Although the comparisons between the two tracks indicate a larger advantage of low post-position at HV, results show that bettors anchor their subjective judgements on horses' post-positions at ST racetrack. This might be that bettors in assessing the post-position advantage at ST may be unduly influenced by the results of the previous meeting run at HV earlier in the market. Therefore, bettors appear to over-weight the impact of low post-position of horses at ST and anchor on it. In contrast, the impact of horse's post-position on the horse's running performance has been fully accounted for by bettors in the UK market. This may be due to the larger variety of racetracks in the UK market than the tracks in the HK market, in terms of the track configuration and other topographies. For example, the number of racetracks in the UK (38 flat racetracks in the database) is much greater than that in HK (only two racetracks). Consequently, no clear trend or evidence of anchoring effects on horses' post-position information in the UK market is detected.

Second, the reason why bettors in the UK market anchor their subjective judgements on less relevant information of pervious favourites' performance has been discussed in Section 4.3.1.6. In particular, a self-generated judgemental procedure may strengthen the impact of this piece of information on bettors' judgements because previous literature has suggested that self-generated anchors have more impacts on individuals' judgements than externally provided anchors (e.g., Davies, 1997; Mussweiler and Neumann, 2000; Mussweiler and Strack, 1999b, Tversky and Kahneman, 1974). In addition, the previous favourites considered in this study are associated with races run at the same meeting. Obviously, such information is more vivid and easier to be retrieved by the betting public than the information which occurred in previous meetings. This effect can be supported by the selective accessibility model in explaining the underlying mechanism of anchoring (e.g., Mussweiler, 1997; Strack and Mussweiler, 1997; Mussweiler and Strack, 1999a, 1999b). That is, a piece of information which is easy to be assessed will provide an increasing knowledge about such information to bettors and bettors are therefore more likely to pay attention to this information and anchor their judgements on it.

However, if this is the case, one may argue that why bettors in the HK market do not anchor on the previous favourite's performance which is demonstrated to be refresh and vivid. This might be explained by the differences of market characteristics and market efficiency between the two markets. These differences can also be used to explain why bettors in the HK market are able to fully account for more pieces of information than bettors in the UK market (related to the second difference between these two markets, presented above). First, the betting volume for each race in the HK market is much greater than that for UK races. This may indicate that HK market is more efficient than the UK market and hence bettors in HK are able to better incorporate the publicly available information than those in the UK. Second, the betting public in the HK market has been widely-spread in all over the world. This world generalisation of bettors may attract more professional bettors to bet in the HK market and in return, the market efficiency in HK is increased. Third, the number of runners in each race in the HK market ranges from 5 to 14, whereas this number in the UK market varies from 2 to 38 in each race. Consequently, a large variety of races and track conditions in the UK reduce the efficiency of bettors' information incorporation in this market. Therefore, bettors in the UK are less likely to fully account for the information and more likely to over- or underestimate it.

In summary, the similarities and distinctions between the results of HK and UK horserace betting data show that the anchoring effects in a real world environment are far more complicated than what has been revealed by laboratory-based research. There is no clear trend or hint indicating that bettors in certain markets or market segments anchor their subjective judgements on certain pieces of information on horserace betting. Bettors in different markets show their own characteristics in decision making and information handling when faced with the same type information. In terms of the tests employed and analysed in this study, the theory of anchoring developed from the laboratory experiments is not strongly and systematically supported in either of these two markets in the real world.

It appears that factors which have not yet been incorporated in the previous studies, such as the cultural differences of decision makers and the complexity of decision tasks, may affect the degree of anchoring which occur in real world environments. However, the cultural differences between these two markets are difficult to measure. Generally, the markets selected to explore cultural differences should be either equal in the market size or identical in the products examined by the decision makers. Due to the data limitation, the two markets explored in this study are in low similarities and therefore, further research is required to explore the cultural differences in horserace betting markets.

4.4 Conclusion

To conclude, a summary of main findings of empirical tests are highlighted in section 4.4.1 and implications of the study are discussed in section 4.4.2.

4.4.1 Main Findings of the Study

This chapter provides the empirical evidence of anchoring effects developed in a real world decision making environment – the horserace betting market. The main findings of hypothesis tests using the HK and UK horserace betting market data are described as follows:

First, bettors in the HK and UK horserace betting markets are found to appropriately incorporate available information into their subjective judgements, implied by the market odds, of horses winning a race. The five groups of information selected to conduct hypothesis tests are considered fairly important in estimating the winning probabilities of horses. However, bettors in both two markets are not detected to significantly anchor their judgements on these core factors. Only two pieces of information are associated with a weak anchoring effect: that is when the same outcome occurs three times (jockeys' past performances for weekday races in the UK and favourite horses' past performance for weekend races in HK). However, the anchoring detected on these two pieces of information is not strong (significant at the 5% level), and, consequently, these results cannot support a highly significant anchoring effect in this real world environment. The only factor which may attract too much attention of bettors is the post-position information of horses at ST racetrack in HK. Similar effects of anchoring do not occur on low position horses at the other racetrack in the same market, HV. Consequently, from the whole markets' point of view, anchoring effect is not a phenomenon which appears to exist widely in horserace betting markets.

Second, to some extent, the number of times that a piece of information is repeated influences the degree of attention paid by bettors. The more times that a phenomenon occurs, the more likely bettors are to over-weight this piece of information. This only applies to certain information such as jockeys' past performance in the UK market and favourite horses' past performance in HK. For other information, no significance difference is observed between bettors' judgements on one race and on two or three similar races.

Third, the results demonstrated that expert bettors in these two markets are able to better incorporate some information than the non-expert bettors. However, there is little evidence that expert bettors are subject lower levels of anchoring. Comparisons of results between weekday and weekend races show that for some information, bettors with more expertise and experience (those who bet on weekday races) are able to better use some of the information than the non-experts who usually bet on the weekends. Similarly, the models associated with odds at different times indicate that early odds contain less accurate information about the horses' winning chance; casual bettors who often bet early tend to over or underestimate the value of certain pieces of information than those who bet late. Note that for some information, such as horses' and trainers' past performances, both casual bettors and expert bettors are able to fully account for in their judgements. However, anchoring only appears to arise in relation to a few pieces of information, and even so the significance levels are not high. Consequently, the results do not support a general conclusion that expert bettors in these two markets are less likely to be subject to anchoring and more casual bettors to anchoring. Further studies are needed to explore this.

Consequently, a number of conclusions emerge from the study:

First, the caution must be exercised when anchoring effects are examined in a real world environment, since mis-specification of the problem can easily occur by combining data inappropriately. For example, in this study, no anchoring effects are observed on the post-position information of horses in HK when the market data is analysed as a whole. However, when the whole market data are split into two datasets according to the racetracks, bettors are found to anchor their subjective judgements on horses' post-position information at ST racetrack, but not do so at HV. The false conclusion of 'no anchoring' arose because bettors, when making their probability judgements, under-valued the advantage of a low post-position at one track and over-valued it at another. Therefore, the effects of anchoring at one track were 'cancelled out' by the underestimates of information at another track and theses effects were masked when examining the market as a whole.

Second, tests conducted in this study demonstrate that anchoring in real world environments is a complex phenomenon. For example, bettors in the UK market do not anchor their judgements on jockeys' performances in their *last* race, whilst they tend to anchor on the jockey's performance information when the success of the jockey was repeated in a *series* of races. For anchoring to be observed in this real world environment, it appears to require a strong stimulus to attract bettors' attention (see Section 4.3.1). Although this confirms the *strength hypothesis*, similar phenomena are not found on many other factors. This may suggest that for most public information, bettors have realised the impact of a series of racing outcomes and are able to fully account for this information in their judgements. However, note that the anchoring detected in this study only appears on certain pieces of information for certain races (e.g., jockeys' past performances in their last three races for the weekday races in the UK). No strong evidence shows that the influence of a race series is significant on all of the key factors detected in this study.

Third, the results do not show very clear and strong evidence to support the hypothesis that UK bettors with greater expertise will display lower anchoring effects, whereas bettors in the HK market with greater expertise use information more appropriately and are less prone to anchoring effects. This might be caused by the characteristics of the market and bettors in these two markets. In the UK, the market information is much more than that in HK because a large number of racetracks with high variety make it far more complicated to incorporate the information of each race; the starting price employed in this study is not the only odds information in this market. In contrast, the HK market is highly concentrated and there is less variety due to the large betting volume and high similarity between the two tracks; more highly skilled bettors are involved in this market due to the simplicity of the market and of the betting system. However, whilst this is true for anchoring based on a recent *series* of previous races, no differences were detected between those with greater and less expertise in terms of the degree to which they anchor on the results of the *last* race encountered. This, to some extent, accords with expectations in betting markets, since expert bettors are widely regarded as being distinguished from those with less expertise by the considerable resources they spend in overcoming the complexity of analyzing the outcomes of previous *series* of races (Benter, 1994).

In summary, this study presents evidence of subtle, complex anchoring effects in a real world environment. Most previous anchoring studies have been conducted in the laboratory on individuals. An important feature of the current study is that it examines behaviour in a financial market. In many ways one might expect markets to eliminate individual anchoring effects, as some individuals seek to exploit the biases of others. The odds, reflecting the betting behaviours of those subject to the biases and the behaviours of those who seek to capitalize on the biases, should, in theory, be driven to a point where no bias exists. Remarkably, it is determined that these markets still exhibit the effects of anchoring. Clearly, the anchoring effects observed here are complex and more research is needed to identify the factors which influence the degree and nature of anchoring in real world contexts.

4.4.2 Implications of the Study

The implications of the tests explored and analysed in this chapter lie in the complexity of the anchoring effect displayed in a real world decision making environment – the horserace betting market.

Firstly, anchoring effects detected on certain pieces of information such as horses' post-positions at ST racetrack and favourites' performances in the previous three races in the HK market indicate that some information in this market has not been properly used and there are some chances of making profits if aware of these biases. A strategy which can be used in this speculative financial market to make abnormal returns is to find out in what circumstances what information is overestimated (anchored) by the betting public and therefore try to avoid these circumstances and bet on alterative horses. For example, since the results in this study show that bettors over-bet the horses with low draw positions at ST racetrack in HK, to bet on horses with high draw positions at this track will be a good strategy to obtain abnormal returns. Another example of anchoring is the 'hot hand' effect demonstrated on previous favourites' performances. Bettors are found to anchor their subjective probability judgements on the next favourite if previous three races are all won by the favourites. Therefore, to bet on non-favourites after a series of favourites winning will have a higher chance of making profits. This strategy can also be generalised to other speculative financial markets. For example, if financial investors are found to overestimate the probability that a company produces high earnings in a financial year after a series of high earnings in previous years, it will be a good strategy to *not* to invest in this company or to reduce the investment in this company.

Secondly, the findings demonstrate that human beings' decision making process and behaviour in the real world are far more complicated than those detected from laboratory experiments. Although in laboratories, experiments are designed to search for the influence of every single factor on decision making process and outcome, they cannot completely duplicate real world situations in terms of the risk or pressure that participants are facing, and the experience of participants in solving similar tasks.

Thirdly, the behaviour of the whole market is not simply an aggregation or duplication of that of individuals. It is believed that "the market represents the aggregated decisions of individual bettors and will to some extent reflect individual decision making biases" (Liu and Johnson, 2007; pp. 74). However, it is also argued that market behaviour may differ from that of many individuals due to interactions between market participants. In particular, although bettors do experience anchoring effects in horserace betting markets in certain circumstances, the information on which they focus and to what extent they take such information into account into their decisions vary. When taking the market as a whole, the influences of different individuals may interact with each other and therefore compromise the aggregate degree of anchoring effects in the whole market.

Finally, the effectiveness of using whole market data to detect potential behavioural biases of market participants should be considered carefully. From the results discussed above, anchoring effects may exist in certain segments of the market but do not show in the whole market. For example, anchoring effects are found on horses' post-positions at ST racetrack but not at HV in HK. This is because bettors seem to overestimate the low position advantage at ST and underestimate it at HV due to the configuration and trophy of the racetracks. Therefore, anchoring at ST racetrack cannot be observed until the counterpart influence from HV is removed from the whole market data. Therefore, market behaviour may be misunderstood if such differences between the whole market and its segments are not distinguished.

CHAPTER 5
SUMMARY, CONTRIBUTIONS, AND SUGGESTIONS

5.1 Introduction

This thesis provides empirical evidence related to the exploration of anchoring effects in a real world environment, the horserace betting market in HK and the UK. The study starts with an extensive review of judgement and decision making literature, particularly focusing on studies on the anchoring and adjustment heuristic and anchoring effects, in Chapter 2. As a result of this review, three broad research questions emerge in Chapter 3. The first research question investigates whether the anchoring effects caused by relevant or less relevant information exist in real world environments and how strong the anchors must be to lead to these effects. The second research question is concerned with whether the degree of anchoring is affected by the degree of expertise of decision makers in real world environments. The third research question in concerned with to what extent the degree of anchoring is affected by the environment or market in which decisions are made. To explore these research questions, *positivism* is considered as the most appropriate research paradigm for this study, a *deductive* research approach is therefore justified, and an empirical method using a large market database is eventually adopted. Consequently, four hypotheses are developed to help explore the research questions; each of these hypotheses is tested by a number of empirical tests fully outlined in Chapter 3. The results of each of these tests are presented, analysed and discussed in Chapter 4.

The remainder of this chapter is structured as follows: In Section 5.2, a brief review of this research is provided by first highlighting the research questions derived from the existing literature and the specific research hypotheses developed to answer these questions. Second, a summary of the main findings and a brief discussion of the results are presented to explain to what extent these research questions are answered. In

Section 5.3, contributions of this study are presented, in terms of the theoretical and methodological contributions. Subsequently, the limitations of this study are described in Section 5.4, followed by a number of recommendations for further study on anchoring effects. A final conclusion is drawn in Section 5.5.

5.2 Overview of the Research

This section provides an overview of the research. First, the research questions which are proposed from the previous anchoring literature are reviewed, together with the research hypotheses developed to answer these questions. The second part of this section provides a summary of the main findings of this study, followed by a brief discussion on how these findings explain or challenge the hypotheses and original research questions.

5.2.1 Summary of Research Questions and Hypotheses

This study investigates the extent to which bettors in the HK and UK horserace betting markets anchor their subjective judgements of horses' winning probabilities on particular pieces of information which are publicly available in the market. The study is conducted by exploring three broad research questions which are derived from the existing literature.

The first research question is concerned with whether the anchoring effects caused by relevant or less relevant information exist in real world environments and how strong the anchors must be to lead to these effects. To answer this question, two specific hypotheses are developed. The first hypothesis (the *anchoring factor* hypothesis) states that bettors in the horserace betting market anchor their judgements of a horse's winning probability on the information associated with (i) the past performance of the horse, (ii) the past performance of the horse's jockey or trainer, (iii) the post-position of the horse, and (iv) the past performance of the favourite, in the previous race. Furthermore, the strength of anchoring factors is examined by the second hypothesis (the *anchoring strength* hypothesis) which states that anchoring on these pieces of information (the ones identified in hypothesis one) occurs only when similar results are repeated two or three times.

Based on the study of the existence and strength of anchoring effects, the second research question asks whether the degree of anchoring is affected by the degree of expertise of decision makers in real world environments. This is associated with the third hypothesis (the *expertise* hypothesis). In particular, this hypothesis states that bettors with greater expertise in the decision tasks are subject to a lower degree of anchoring than bettors with less expertise. The identification of expert and non-expert bettors is undertaken by separating weekday (with more expert bettors) and weekend (with more casual bettors) races and by examining final odds (which include experts' judgements) and odds 2 and 5 minutes (mainly resulting from casual bettors' judgements) before the race starts.

Finally, the third research question is to explore to what extent the degree of anchoring is affected by the environment or market in which decisions are made. To explore this question, the fourth hypothesis (the *market* hypothesis) is generated; this states that the degree of anchoring effects varies between the HK and UK horserace betting markets. Similar modelling procedures are repeated for each of the anchoring factors investigated in previous three hypotheses, using HK and UK horserace betting data.

To test all these hypotheses, conditional logit (CL) models are developed. The CL model is employed because it is appropriate for analysing the horserace betting data. Specifically, the CL method enables the competitiveness among horses according to the category of each single race to be accounted for, and its probability-scale outputs are most appropriate for the requirements of horserace outcomes. The results of estimating CL models associated with anchoring factors are compared with the results of estimating CL models with anchoring factors and bettors' subjective probability judgements of horses winning (implied by odds information). A significant coefficient of an anchoring factor which changes sign in models with and without odds related variable is regarded as the evidence of anchoring on this particular information.

5.2.2 Summary of Main Findings and Discussions

The main findings of this study in testing the degree to which bettors in the HK and UK horserace betting markets anchor their subjective probability judgements on publicly available information are summarised as below.

One of the key findings of this study is both new and surprising in relation to existing anchoring literature. The empirical results suggest that overall, no significant anchoring effects exist in the HK and UK horserace betting markets on the information associated with horses', jockeys' and trainers' past performances in the previous race, or on the information concerning previous winners' position positions and the favourite winners in the previous race. Clearly, this finding challenges results of previous studies which suggest that anchoring is a widely-spread decision bias. In fact, anchoring effects have been demonstrated in a range of both laboratory-based studies (e.g., Chapman and Johnson, 1994, 1996, 1999, 2002; Mussweiler, 1997, 2001; Mussweiler and Englich, 2005; Mussweiler and Strack, 1999a, 1999b, 2000a, 2000b; Strack and Mussweiler, 1997; Tversky and Kahneman, 1974; Wilson *et al.*, 1996; Wong and Kwong, 2000) and field studies (e.g., Black and Diaz, 1996; Blount, 1996; Brewer *et al.*, 2007; Cervone and Peake, 1986; Chapman and Bornstein, 1996; Northcraft and Neale, 1987; Poucke and Buelens, 2002; Ritov, 1996; Rutledge, 1993; Whyte and Levi, 1994).

It appears that the only factor on which bettors may anchor is the post-position information of horses at ST racetrack in HK. Similar effects of anchoring do not occur on low position horses at the other racetrack in the same market (i.e., HV). Since the factors selected in this study are generally considered as the key factors in assessing the winning probabilities of horses and therefore are believed to be heavily accounted for by the betting public, the absence of anchoring effects on these factors may suggest that anchoring effects in real world environments are weak, fragile, and difficult to observe. In other words, from the whole markets' point of view, the anchoring effect is not a phenomenon which appears to widely exist in horserace betting markets and the *anchoring factor* hypothesis is not accepted.

Although previous, largely laboratory-based research suggested that people tend to be overconfident about their judgements when having high-strength (more frequent) and low-weight (small sample) information (Bloomfield *et al.*, 2000; Nelson *et al.*, 2001), factors associated with horses', jockeys', or trainers' winning records of previous two or three races do not appear to act as anchors for bettors in either the HK or UK markets. This may suggest that the strength of these factors is still not sufficient to cause anchoring effects. However, jockeys' past performances in the UK market and favourite winners' past performances in the HK markets do appear to act as anchors if there is a consistent recent pattern of results. For example, if a jockey has won his/her previous three races, bettors in the UK anchor their subjective judgements on this piece of information and over-bet on the horse ridden by this jockey in the current race. However, no strong evidence shows that this can be generalised to the whole market on other factors: the anchoring detected on these two pieces of information is not strong (only significant at the 5% level). Consequently, these results cannot support a generalised significant anchoring effect on the information associated with wining records of more than one race. Therefore, the *anchoring strength* hypothesis is not supported in this study.

In terms of the expertise of decision makers, this study *does* provide strong evidence that professional bettors (those who bet on weekday races or bet late in a race) are better at incorporating publicly available information than casual bettors (those who bet on weekend races or bet late in a race). This is consistent with the horserace betting literature (e.g., Kopelman and Minkin, 1991; Saunders and Turner, 1987). However, little evidence has been provided to support the *expertise* hypothesis since none of professional bettors and casual bettors are found to strongly anchor their judgements on particular information examined in the study. Therefore, it cannot be generalised that expert bettors in these two markets are subject to a lower level of anchoring effect than casual bettors. Consequently, whether the experience and expertise of decision makers help reducing the degree of anchoring effects in real world environments still remains unclear.

Finally, the *market* hypothesis, which expects differences in the degree to which bettors in the HK and UK markets anchor their judgements on particular information, is not supported. This is because anchoring effects are not found to be salient and significant in either of these markets. The only difference is that there does appear to be a strong anchoring effect on post-positions of horses at ST racetrack in the HK market but not at HV or racetracks in the UK market. This may be caused by the discrepancies between the configuration and going of the racetracks in HK. Further studies are needed to explore whether bettors' judgements on horses' post-position information are affected by the information that they obtain from the previous race meetings at the same and different racetracks.

The reasons for not detecting strong anchoring effects in the horserace betting market might be as follows. First, this may be caused by the features of naturalistic environments. As discussed in Chapter 3, naturalistic environments differ from experimental settings in a number of aspects, including: (i) higher level of complexity; and (ii) greater stress and personal stakes facing real world decision makers which suggest that individuals may take their real world (c.f. laboratory-based) decision making more seriously (Bruce and Johnson, 1997; Collis and Hussey, 2003; Yates, 1992). Consequently, individuals in the horserace betting market may account for the public information more carefully and more seriously when making betting decisions, and therefore, anchoring effects are avoided by careful incorporation of available information in the market.

Second, the tests conducted in this study actually do not require explicit comparison between bettors' subjective probability judgements and specific anchoring information. This is the situation in which basic anchoring effects may occur (Brewer and Chapman, 2002; Wilson *et al.*, 1996). According to Brewer and Chapman (2002), anchoring effects in such situations are fragile and easy to eliminate by changing dimensions of anchors or changing anchors. The results presented in this study are consistent with Brewer and Chapman's (2002) study: there is no significant or clear trend of anchoring on any specific information; anchoring can be detected on certain pieces of information (e.g., the post-position at ST racetrack in HK) but not on others.

Third, the data employed in this study to explore anchoring effects are the aggregate market data rather than that gathered from individuals. As discussed in Chapter 3, the market data, on the one hand, provides a large scale data sample; on the other hand, it is difficult to distinguish effects caused by different individual decision biases. In particular, the market data are the final judgements of the betting public based on the incorporation of all the publicly available information. All these information come up at different time and may be presented in different ways (e.g., in a sequence or in a table format); these may lead to different levels of impacts on bettors' probability judgements. Therefore, anchoring effects in the horserace betting market may have been eliminated by the interactions between the effects caused by different factors, as suggested by the literature (e.g., Krull *et al.*, 1993). In addition, although the market consists of all the market participants and represents the behaviour of market participants, individuals' behaviour may vary and interact with each other. In the markets, each individual has his/her own procedure of gathering and incorporating information which may make them anchor on different pieces of information. Eventually, the effects caused by anchoring on different information may be cancelled out in the whole market.

Fourth, the environment employed in this study to examine real world anchoring effects, the horserace betting market, facilitates accurate calibration of subjective judgements (Bruce and Johnson, 1997, 200a, 2001; Johnson and Bruce, 2001). The involvement of instant feedback for the outcomes of previous races is a unique characteristic which favours decision makers in this market to make more accurate judgements. As people can learn from their experience (Rabin, 1998; Shiller, 1999), it is more likely that bettors learn to adjust their judgements of horses' winning probabilities from observing the outcomes of previous races at a meeting and therefore, are subject to a lower or zero anchoring effects.

In summary, bettors in the HK and UK horserace betting markets are found to appropriately incorporate available information into their subjective judgements, implied by the market odds, of horses' winning probabilities. It is suggested that the characteristics of real world environments, the situation in which judgements are made, the employment of aggregate market data, and the features of the horserace betting market contribute to the absence of anchoring effects in this study. Remarkably, anchoring effects *do* appear to exist in relation to particular pieces of information (e.g., post-positions of horses at ST racetrack in HK) in the markets. Therefore, the effects observed in this study are complex and clearly more research is needed to identify the factors which influence the degree and nature of anchoring in real world contexts.

5.3 Contributions of the Research

This study finds that anchoring effects in real world environments, the HK and the UK horserace betting markets in particular, are fairly weak and difficult to detect. A number of specific contributions are made in this study, which help understand the use of anchoring and adjustment heuristic. These contributions are divided into two groups: theoretical and methodological contributions. Each of them is discussed below.

5.3.1 Theoretical Contributions

This study theoretically contributes to the study of anchoring in two aspects: those relating to the literature review and those relating to the findings of the hypothesis tests.

Contributions from the Literature Review

1. Although anchoring effects have been widely demonstrated in laboratory experiments and in a number of field experiments associated with real world decision tasks, no study has ever provided a systematic review of relevant literature. This study, however, contributes to the current anchoring literature by providing an extensive and systematic review of anchoring effects in both laboratory and real world settings. This helps to develop a betting understanding and a broader picture of anchoring effects, in terms of the types of anchoring, the underlying mechanisms of anchoring, and most importantly, the influential factors which may have strong impacts on people's judgements.

2. Based on the systematic review of the literature, this study identifies gaps between laboratory-based and real world studies. Although anchoring effects have been widely demonstrated by a large number of laboratory studies and delicately designed field studies, only one previous study has used records of decisions in an actual event (rather than via a designed experiments) to analyse potential anchoring (Whyte and Levi, 1994, the case of the Cuban missile crisis). Consequently, the current study contributes to the existing literature as it provides the first extensive anchoring study using direct and instant data of probability judgements in a real world environment.

3. Finally, the literature makes clear that this is the first study which explores anchoring in the horserace betting market. Although numerous studies have been conducted on the market efficiency of horserace betting markets, few of them has paid sufficient attention to the market behaviour and bettors' decision making. This study starts a judgement and decision making research in this market by exploring anchoring effects.

Contributions from the Findings

1. The first and the most important contribution of the current study is that the results challenge the existing anchoring literature by finding no significant anchoring effects in a real world environment, the horserace betting market. In particular, although a number of vivid factors which are considered important in assessing horses' winning probabilities have been examined, expected anchoring effects are not detected. The impact of the strength of the anchoring factors is also investigated and similar results are observed, based on the HK and the UK horserace market data. These findings are entirely inconsistent with the existing literature which suggests significant anchoring effects in real world environments (based on field experiments). Therefore, the findings of this study may help better understand anchoring effects in real world environments: in particular, in which situations anchoring effects may or may not occur.

2. The findings of this study confirm the belief that judgement and decision making in the real world is far more complicated than that in controlled laboratory conditions. In the real world, it is difficult to control the influences of other factors so it is difficult to distinguish various effects from each other. Therefore, further study on judgement and decision making, particularly on the anchoring effect, in real world environments is essential.

3. Despite the 'unexpected' results, the current study also demonstrates that the horserace betting market is a well-calibrated market in which bettors' subjective judgements of horses' winning probabilities are highly consistent with the horses' actual winning probabilities, in terms of anchoring bias, at least but not the last.

5.3.2 Methodological Contributions

1. This is the first study using empirical models (the CL model in particular) to explore anchoring effects on people's probability judgements in a real world environment. The commonly used method in analysing anchoring effects in experiment-based studies is the one-way ANOVA analysis. Although this statistical analysis is appropriate in exploring the variance of independent variables from the dependent variable, it is not suitable for the analysis in this study due to the characteristics of the horserace betting market.

2. This is also one of only a few studies which employ a very large dataset containing various market data to test anchoring biases. For the two horserace betting markets examined in this study, the data cover a long time period (9 years for the HK market and 11 years for the UK market). Compared with at most hundreds of participants in experimental studies, the horserace betting data provides 44,620 observations in the HK market and 556,115 observations in the UK market, together with a large variety of information concerning horses' winning probabilities. This huge dataset is not only unique in anchoring studies, but also distinct in horserace betting studies. Consequently, the sample size bias which is easily encountered in experimental studies is avoided. In addition, the number of factors (16 in total) explored in this study is large, compared with 2 or 3 factors examined in most experimental studies. In addition, this study explores anchoring effects in the horserace betting market from multiple-perspectives (i.e., the existence of anchoring, the strength of anchoring factors, the expertise of decision makers, and the influence of market difference on anchoring), whereas previous papers only focuses on one of these perspectives of anchoring. All these unique factors associated with the current study contribute to the existing anchoring literature, by providing an extensive and deep investigation of anchoring effects in the real world.

3. Finally, this study highlights the importance of appropriate model specification in the empirical analysis. For example, the results find no significant anchoring effects on horses' post-positions in the HK market when the data are analysed as a whole. However, when the data are split into two racetracks, it is found that bettors who bet at ST racetrack behave differently from those who bet at HV. In other words, the combination of the market data actually hides the evidence that bettors anchor their judgements on the low post-positions at ST racetrack. Consequently, the study simply demonstrated that model mis-specification may lead to misleading conclusions.

5.4 Limitations and Suggestions for Future Research

A number of limitations which may affect the generalisation of the findings of this study are discussed in this section. Consequently, some suggestions and recommendations for future anchoring research are generated.

5.4.1 Limitations of the Study

A number of limitations of this study are explored in this section, concerning the data employed, the methodology adopted, and the markets on which the study focuses.

1. This study employs aggregate market data (a secondary database from the racing authority and publicly available information). Although the examination of market data avoids the weaknesses of laboratory studies such as the lack of reality, the complexity of the real world environment makes it more difficult to distinguish the influences of different factors and to discern the effects caused by different judgemental biases. Compared with highly controlled and manipulated experimental conditions, the influences of various factors in a real world setting are more likely to interact and it is difficult to discern their individual effects.

2. Although, as indicated earlier, a large database is employed in the study for both the HK and the UK horserace betting markets, when races are divided according to certain criteria they can result in relatively small samples. For example, there are 66,244 horses run in 5,133 races in the nine-year period of horseracing in HK, whereas only 770 horses were left in the sample when examining anchoring on the favourite given that the previous three races were all won by the favourites. This may bias the results of analysis and dismiss potential effects due to the small sample size.

3. In testing the impact of bettors' expertise on reducing the degree of anchoring in their subjective probability judgements, the way in which expert and non-expert bettors are defined (weekday vs. weekend bets, and late vs. early bets) may not be accurate. Data concerning the number of bets amd the amount of each individual bet on a horse may also contain valuable information in distinguishing expert and casual bettors, but unfortunately this is not available in the current database.

4. The markets on which this study concentrated are also limited. Only HK and the UK horserace betting markets are explored and no significant evidence was found due to market differences in susceptibility to the anchoring effect. In addition, the betting system employed in the HK market is the pari-mutuel system whist the dominant betting system in the UK market is the bookmaker system. Because the later contains interactions between both buy-side (bettors) and sell-side (bookmakers) of the market participants, the influences of anchoring factors may be different on these two markets.

5.4.2 Suggestions for Future Research

As the first study exploring anchoring effects in the horserace betting market, this thesis provides preliminary result to help understand anchoring effects in real world environments associated with 'pure' market data. This research can be extended in the following ways:

1. To conduct questionnaire surveys or interviews among bettors at racetracks or betting shops to clarify, in practice, what factors are the most likely to be anchored on by bettors in the market. Bettors' answers may or may not be the same as those suggested by the horseracing literature and researchers. This would be a useful assistance in selecting of potential anchoring factors in future studies.

2. More specific investigations can be conducted on particular pieces of information. For example, in this study, bettors in the HK market are found to anchor on horses' post-positions at ST racetrack but this effect is not found at HV. Since ST and HV race meetings generally alternate, but not always, it will be interesting to explore, for example, whether bettors at a given race meeting anchor on the results of the previous race meeting.

3.In this study, only a single anchoring factor is investigated in a CL model at a time. However, it might be possible that bettors' judgements are merely affected by the interaction of certain factors. For example, a horse which has won its previous three races may not cause over-betting on this horse, but if its jockey has also performed well in his/her previous two or three races, this information may provide a distinct hint of an extremely high winning probability of the horse and therefore be strong enough to attract bettors' attention. Consequently, this may lead to anchoring. Therefore, the combination of certain (highly related) factors may be considered in future study.

4. This work has involved a large cross-sectional study. The data employed carry a long period (nine years in the HK market and eleven years in the UK market). Consequently, further analysis can be conducted to examine potential anchoring factors in each single year so as to explore the changes and trends of the way in which the betting public utilise information. It may be found that anchoring has increased and decreased over the period.

5. Finally, the study of anchoring effects in real world environments can also be extended to other markets or settings which involve numerical assessments and/or probability judgements, such as the online betting, the horserace betting market in other regions, or in wide financial markets.

5.5 Conclusion

Overall, this study has suggested an effective method of exploring anchoring effects in a real world setting, the horserace betting market. New evidence is presented which challenges the degree to which anchoring effects observed in laboratory and field experiments influence the subjective judgements of decision makers in naturalistic environments. In particular, bettors in the HK and UK horserace betting markets are not found to anchor their subjective probability judgements on certain information, which is generally regarded as the most important information in favouring horses winning a race, such as horses', jockeys' and trainers' past performance. Although significant anchoring effects have been observed on post-positions of horses in the HK market, they may merely arise because of the specific track configurations in HK and no evidence is found that these results generalise to the UK market. Consequently, these findings may suggest that anchoring in real world decision making environments is not as strong as researchers have expected. In fact, in the environment examined, anchoring effects appear to be weak, fragile, difficult to observe, and easy to eliminate. Reasons to explain these discrepancies could be features of real world environments which distinguish them from experimental conditions, and, in particular, aspects of the horserace betting market which facilitate good calibration.

The findings presented here represent a beginning to the study of anchoring in horserace betting markets. Only a limited number of potential anchoring factors have been examined and these need to be expanded in future studies before it can be concluded that anchoring does not exist in the horserace betting market. The fact that bettors are not explicitly required to compare their probability judgements of a horse winning with the information they use to make assessments may also contribute to the fact that anchoring is not detected. This may occur, because these are the conditions for basic (rather than traditional) anchoring and previous results have suggested that basic anchoring effects are more fragile than traditional anchoring effects. Consequently, further analysis is currently being undertaken to examine the extent to which anchoring effects differ between casual and expert bettors.

In summary, the results reported here challenge the consensus to emerge from laboratory based studies, and suggest that anchoring effects may not be as widespread in real world decision making environments as previously thought. Further studies on anchoring effects in real world environments, and in horserace betting markets in particular, are necessary and encouraged.

APPENDIX

Description and Sign of Independent Variables

No.	Type	Ind. Variable	Description of the independent variable	Without Odds			With Odds		
				Exp. Sign	Real Sign HK	Real Sign UK	Exp. Sign	Real Sign HK	Real Sign UK
1	Horse	H1	Give 1 to a horse if the horse won its last race; 0 otherwise	+**	+**	+**	−**	+	−
2		H2	Give 1 to a horse if the horse won its previous two races; 0 otherwise	+**	+**	+**	−**	+	−
3		H3	Give 1 to a horse if the horse won its previous three races; 0 otherwise	+**	+**	+**	−**	+	−
4	Jockey	J1	Give 1 to a horse if its jockey won his/her last race; 0 otherwise	+**	+**	+**	−**	−	+
5		J2	Give 1 to a horse if its jockey won his/her previous two races; 0 otherwise	+**	+	+**	−**	−	+
6		J3	Give 1 to a horse if its jockey won his/her previous three races; 0 otherwise	+**	−	+**	−**	−	
7	Trainer	T1	Give 1 to a horse if its trainer won his/her last race; 0 otherwise	+**	+**	+**	−**	+	+*
8		T2	Give 1 to a horse if its trainer won his/her previous two races; 0 otherwise	+**	+*	+**	−**	+	+

No.	Type	Ind. Variable	Description of the independent variable	Without Odds			With Odds		
				Exp. Sign	Real Sign		Exp. Sign	Real Sign	
					HK	UK		HK	UK
9		T3	Give 1 to a horse if its trainer won his/her previous three races; 0 otherwise	+**	+	+**	−**	+	+
10	Post-position	PP	The post-position of a horse in a race	+** −**	−**	+	−** +**	+	+
11		WP1	Give 1 to a horse if its post-position is the same as that of the previous winner; 0 otherwise	+**	+	+**	−**	+	+*
12		WP2	Give 1 to a horse if its post-position is the same as that of the winners of previous two races; 0 otherwise	+**	+	+	−**	−	+
13		WP3	Give 1 to a horse if its post-position is the same as that of the winners of previous three races; 0 otherwise	+**	+	−**	−**	+	−
14	Favourite	F1	Give 1 to the favourite of a race if its previous race was won by the favourite; 0 otherwise	+**	+**	+**	−**	+	−*
15		F2	Give 1 to the favourite of a race if its previous two races were won by the favourites; 0 otherwise	+**	+**	+**	−**	−	−*
16		F3	Give 1 to the favourite of a race if its previous three race were won by the favourites; 0 otherwise	+**	+	+**	−**	−*	−*

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