The Hong Kong Polytechnic University

The Department of Building and Real Estate

Modelling Competition Intensity in Construction Market

YE Kunhui

A thesis submitted in partial fulfilment of the requirements

for the degree of Doctor of Philosophy

January, 2009

CERTIFICATE OF ORIGINALITY

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written, nor material that has been accepted for the award of any other degree or diploma, except where due acknowledgement has been made in the text.

Signature: _____

Name of student: YE Kunhui

DEDICATION

To my wife and son

ABSTRACT

Construction market worldwide is characterised by intense competition, wherein contractors' business environments are fraught with uncertainties, and challenges on contractors' viability have been becoming more serious as well. Market competition environment is a key variable determining firms' competition strategy and a major cornerstone influencing the formulation and administration of industry policies. Hence, proper analysis on the competition environment in construction market deserves close attention from both contractors and governments.

The key to market competition analysis is the measurement of competition intensity. Although competition is everlasting and all-pervading in socio-economic community, it is particularly difficult to measure the competition intensity in the construction sector due to the peculiarities of the industry. Notwithstanding many existing measures for competition intensity, the research gap of how to measure effectively the competition intensity in construction market remains unexplored. This study therefore aims to develop a new model of competition intensity to promote the effectiveness of the measurement in construction market.

The integrative application of multiple research methods including literature review, professional interview, pilot study, questionnaire survey, statistical analysis, and mathematic model analysis results in the development of "Causal-Sequential Coordinate System" (CSCS). CSCS incorporates the competition intensity variables including business diversity, market entry barriers, market growth, market size, market share

distribution, profitability, and average wage. All the variables have been quantified using statistical data under causal and sequential dimensions of the model CSCS. As demonstrated by using the data gathered from the Chinese mainland construction market, the model CSCS presents a more dynamic notion of competition intensity in construction industry. Furthermore, CSCS model can assist in identifying the competition feature of construction market. The application results of CSCS support the research findings typically including that the local construction markets in China's developed regions have higher levels of competition intensity than those in the less developed areas.

This study contributes to the development of knowledge of competition intensity in the discipline of construction management and economics. The limitations of the study are appreciated, including the limited sources of the data collected only from China's construction market. Future research is recommended to study the application of the CSCS model in other construction markets.

PUBLICATIONS

1. Journal Papers

Ye K.H., Jiang W.Y., and Shen L.Y. (2008). "Project Competition Intensity (PCI) in the Construction Market: A Case Study in China". *Construction Management and Economics*. 26(5): 463 - 470.

Ye, K.H., Lu W.S., and Jiang W.Y. (2009). "Concentration in the International Construction Market". *Construction Management and Economic*s. (Accepted).

Shen L.Y. and Ye K.H. (2007). "Measuring Competition Intensity of Construction Market in a Causal-Sequential Coordinate System". *Journal of Construction Engineering and Management*. (Under review).

Ye K.H., Shen L.Y., and Tan Y.T. (2009). "*Organisational Behaviours in Construction Market*". Construction Management and Economics. (Under review).

2. Book

Shen L.Y., Ye K.H. and Deng X.P. (2006). *Competitiveness for Contractors - Evaluation and Improvement*. Beijing: The Chinese Architect and Building Press. ISBN:

7112083370. 257 pages. (in Chinese).

3. Reviewed Papers in International Conferences

Ye K.H. (2006). "A Framework for Measuring the Intensity of Competition in General Contractor Market". *Proceedings of The 1st International CIB Endorsed METU Postgraduate Conference Built Environment & Information Technologies*, The Middle East Technical University Ankara, Turkey. pp 421-431. *(http://www.irbdirekt.de/daten/iconda/06059011837.pdf).*

Ye K.H. and Chan P.C.A. (2006). "Measuring Competition Intensity by Removal Techniques". *Proceedings of The 11th CRIOCM 2006 International Research Symposium on Advancement of Construction Management and Real Estate,* North China Electric Power University. Beijing, China.

Ye K.H., Jiang W. and Liu C. (2007). "A Case Study on Project Competition Intensity in the Construction Market". *Proceedings of the 12th International Research Symposium on the Advancement of Construction Management and Real Estate,* The University of New South Wales. Sydney, Australia.

Ye K.H. and Shen L.Y. (2007). "A Literature Review on Measuring Competition Intensity in the Construction Market". *Proceedings of Management Science and Construction Symposium*, Tianjin University. Tianjin, China.

Ye K.H., Shen L.Y. and Wong K.W.F. (2007). "A Framework of Factors for Measuring Competition Intensity (CI) in Construction Market". *Proceedings of the 11th Symposium*

on Construction Engineering and Management - TW CEM 2007, Chung Hua University. Taibei, Taiwan.

Ye K.H. and Shen L.Y. (2008). "Competition Intensity in Construction Market: Sensitivity Analysis for Conduct Factors and Performance Indicators". *Proceedings of the HKPolyU 2nd Faculty Postgraduate Research Conference*, The Hong Kong Polytechnic University. Hong Kong, China.

ACKNOWLEDGEMENTS

I am very grateful to my chief supervisor Professor Li-yin SHEN for his motivation, direction, support and patience. What I have learned from him include not only knowledge but also the attitudes towards career development and family. All these will continue to encourage me to resolve challenges ahead. I am deeply indebted to my co-supervisor Professor Wei-guo SONG for his guidance and comments on my study throughout the whole process of undertaking this research.

I would like to express special thanks to the Department of Building and Real Estate at the Hong Kong Polytechnic University for the provision of research funding. My gratitude goes to colleagues in the Department: Professor Geoffrey SHEN, Professor Albert CHAN, Dr Wilson LU, Dr Michael YAM, and Mrs Elaine Anson, for their valuable helpS and suggestions during this research study.

I have deepest gratitudes towards Hong Kong Institute of Real Estate Administrators and Hsin Chong-K.N. Godfrey Yeh Education Fund for the scholarship to support this study.

My special thanks also owe to Professor Hong REN, Mr Xiangxu XIAO, Dr Guiwen LIU, Mr Xisheng ZHU, Mr Bo XU, Mr Rongjun TANG and other colleagues in the Faculty of Construction Management and Real Estate at Chongqing University. They have been offering generous support to my study.

I would like to gratefully acknowledge those contractors in the Chinese Mainland who participated in this study for their valuable time and effort.

My very big thanks are to my wife, grandfather, parents, brothers, and parents-in-law for their understanding, patience, support and love.

Last, but not the least, my special thanks to the colleagues in Rm W606 (HKPolyU) for their friendships and experiences sharing during this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AD	Business advertising
AIC	Advanced industrialized country
BD	Business diversity
BI	Business indicators
CBI	Competition behaviour indicators
CC	Cost cutting
CCII	Casual competition intensity index
CR	Concentration ratio
CSCI	Causal-sequential competition intensity index
CSCS	Causal-sequential coordinate system
DM	Density model
EN	Entropy
EWI	The Standard & Poor's 500 equal weight indexes
FTG	First-two-group
GC	Gini coefficient
GCII	General competition intensity index
GDP	Gross domestic production
HI	Herfindahl index
HNE	Numbers- equivalent
HT	Hall-Tideman index
LDC	Less developed country
MA	Mccloughan and Abounoori approach

MC	Marginal cost
MCI	Market competition intensity
MEB	Market entry barrier
MG	Market growth
MI	Market instability
MM	Market mobility
MR	Marginal revenue
MS	Market size
MSD	Market share distribution
MU	Markup analysis
NIC	Newly industrialized country
PA	Parameterization
PCI	Project competition intensity
PI	Production innovation
PP	Product pricing
PR	Penetration ratio
PT	Profitability
QM	Qualitative measurement
RDE	Residual demand elasticity
SL	Spatial location
SOCE	State-owned construction enterprises
TPI	Tender price index
WG	Average wage

CHAPTER 1 INTRODUCTION

This chapter addresses the background, objectives, methodologies and significance of the study. The chapter ends with an overview of the structure of the thesis.

1.1 Research Background

（1） The role of construction market

A mainstream of thought in construction economics maintains that construction industry is a vital sector of socio-economy (Ofori 1990; Chan 2001; Powl and Skitmore 2005; Wu and Zhang 2005). This significant role can be manifested by the U-shaped linkage of the sector to gross domestic product (GDP) as shown in Figure 1.1. Data in the diagram demonstrate that the construction spending in GDP first grows during less developed country (LDC) status, reaches to an apex in newly industrialized country (NIC) status, and then declines as countries move to advanced industrialized country (AIC) status (Crosthwaite 2000). The data also reveal that the contribution of construction industry to socio-economy is particularly significant in newly industrialising countries such as China and Mexico. This is probably because NIC as main purchasers of construction output usually use the construction industry as an instrument to increase the overall economic output.

The significance of the construction sector is attributable to multiple reasons. Fundamentally, this sector provides physical shelter to human communities, offers employment, generates income, and facilitates economic development (Ofori 1990; Song *et al.* 2006). In the U.S., for example, the construction industry in 2000 employed 6.7 million people with an expenditure of $650 billion dollars, approximately 10 percent of the 1999 GDP (Banik 2001). In Germany, the sector accounts for 6 to 7 percent on average of GDP over the recent 30 years (Bosch and Philips 2000). In China, the sector contributes to 5 to 7 percent of GDP and nearly 4 percent of the total employment to the society (Centre for Policy Research Ministry of Construction 2007).

Construction industry underpins socio-economic development not only by providing construction products/services to but also by purchasing materials/services from other industrial sectors. Either the provision or the purchase occurs in marketplaces. It has been found that the competitiveness of a national economy has a close association with the nation's construction market (Mccloughan 2004).

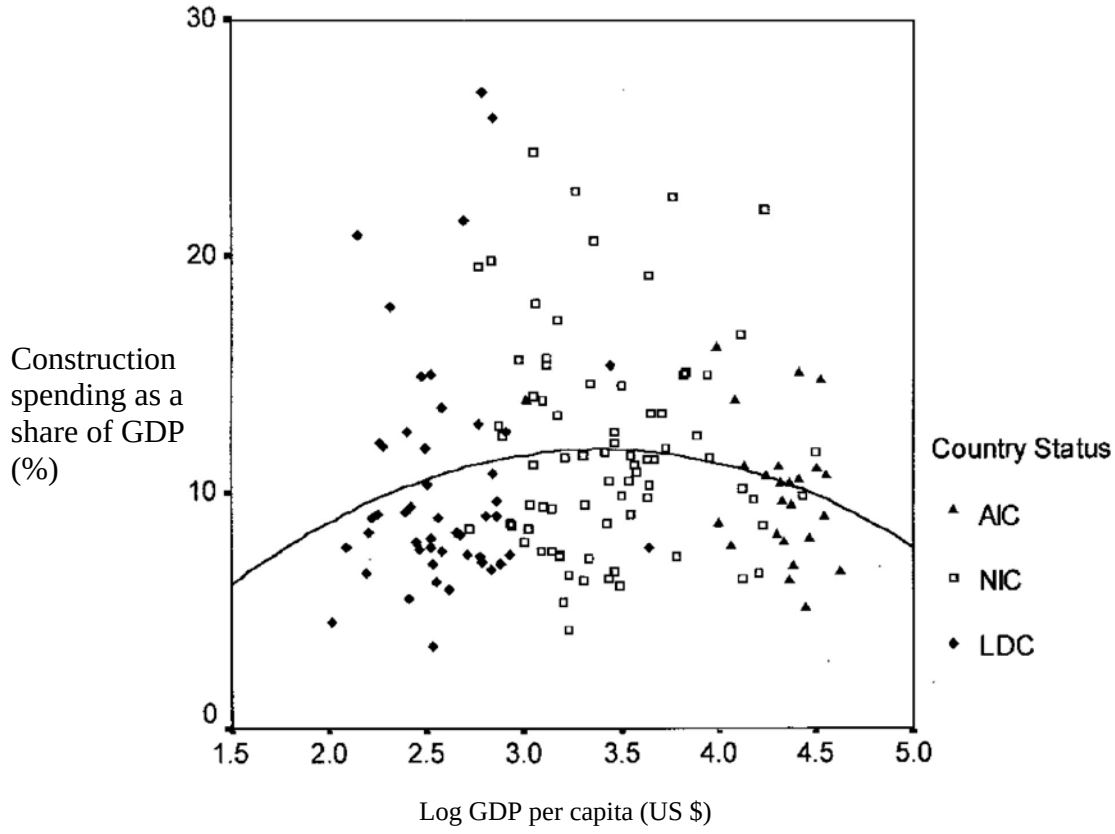


Figure 1.1 Relationships between construction spending as a share of GDP and GDP per capita (Source: Crosthwaite 2000)

According to the transaction cost theory, contractors prefer outsourcing production factors if the transaction fee is less than production cost. Empirical studies have revealed that the sizes of contractor firms have been becoming smaller (Bremer and Kok 2000; Crosthwaite 2000), suggesting that contractors rely more on construction

market to buy production factors for construction activities. Therefore, a well-developed construction market is conducive to the fulfilment of construction industry to socio-economic development.

（2） Internationalisation of construction businesses

The 21st century is characterised by advanced technology, accessible transportation, convenient communication, integrated market, and global trade. These new characteristics have accelerated the internationalisation of construction businesses (Yates 1991; Yates 1994; Sillars and Kangari 1997; Raftery *et al.* 1998; Loosemore 1999). On one hand, construction firms make due response to competition for construction businesses in across-boundary markets; on the other hand, they strive against foreign competitors in the local markets.

Clients' attitudes towards their businesses and the way they are serviced have been changing with the internationalisation of construction trade (Bennett 2000; Dulaimi 2005). However, many clients are still dissatisfied with the poor performance provided by contractors (Alarcón and Ashley 1996). Construction practitioners have to learn of the key success factors from other sectors such as lean product, total quality management, business process reengineering, benchmarking, partnering, and organisational learning (Sillars and Kangari 1997; Yates and Aniftos 1997; Kwan and Ofori 2001; Freire and Alarcón 2002; Ramírez *et al.* 2004). In the meanwhile, traditional competition practice occurring among "would-be" contractors over project tendering has been replaced by the "third way" that competition and cooperation coexist (Bennett 2000; Lemer 2001).

（3） Intense competition for construction businesses

The aforementioned new phenomenon of construction businesses mirrors a globalising tendency of construction industry (Sillars and Kangari 1997; Yates and Aniftos 1997). As found by some researchers, few construction markets in the world can nowadays stop being involved in globalisation (Dulaimi 2005; Gunhan and Arditi 2005), indicating a dynamic construction business environment.

This changing environment is represented by a high degree of business competition subject to a number of factors (Raftery *et al.* 1998; Tay and Morgan 2002). The widely used approach of tendering in construction industry has created an all-pervading competition culture (Gruneberg and Ive 2000). This environment appears to be of fierce competition, because clients usually invite too many contractors to bid for construction contracts simultaneously (Flanagan and Norman 1985; Fu *et al.* 2003). The informality of construction businesses such as temporary organisations and workforce lowers market entry barriers, which can stir more potential firms to struggle against the incumbent (Wells 2007). Furthermore, economic globalisation and technology advancement facilitate contractors' business operation worldwide (Ben 2000; Ling *et al.* 2005).

（4） Importance of moderate construction competition

The significance of construction industry to socio-economic development depends on how well construction businesses have been transacted and how important the role of competition plays in the transaction (Finkel 1997). Competition owes its importance in economics to its good capability of deploying market resources (Owen 1971). This is true in the construction sector, wherein competition occurs primarily in the domain of project contract bidding (Kim and Reinschmidt 2006). Competition works like

"invisible hand" in facilitating contractor selection, converting construction resources into project products, and determining construction bid prices (Smith 1776; Greer 1992; Neumann and Weigand 2004).

Although competition in construction market worldwide has been a dominant phenomenon, it is considered that a moderate degree of market competition deserves attention. This is because little or no competition is not good for promoting the deployment of construction resources, whereas over-intensive competition can result in serious market failure (Akintoye and Skitmore 1991; Ball *et al.* 2000). The significance of a moderate competition environment can be evidenced by the industrial case in China. China's construction industry before 1978 was well known for low productivity due to the centrally-endorsed approaches of work assignment by the government, which was characterised with no competition (Shen and Song 1998). This practice was changed since early 1980s after the implementation of reform and open-door policies. In line with the reform policies, a series of changes and new policies were introduced to the Chinese construction industry. Under the reformed business environment, construction firms have to involve market competition to obtain businesses. Recent studies have revealed that there has been a growingly intensive construction competition in the market, sometimes over-intensive. The over-intensive competition is linked to many problems such as unfair competition and improper market conducts such as bribery, shoddy work, poor construction quality, and safety incidents (Wang 2004; Wang *et al.* 2006; Zou *et al.* 2007).

1.2 Research Problem Statement

（1） How to measure the competition intensity in construction market

The preceding section ends up primarily with advocating a moderate competition in construction market. However, a critical step to the identification of a moderate competition is the measurement of competition intensity. The subject of competition measurement has been addressed in some previous studies (Bain 1968; Greer 1992; Belcher *et al.* 1995; Chiang *et al.* 2001; Mccloughan 2004; Wang 2004). There are three typical measures, namely, concentration ratio, market mobility and market instability (Hymer and Pashigian 1962; Gort 1963; Telser 1964; Straiger and Wolak 1992; Barla 1999; Bajo and Salas 2002). Concentration ratio (CR) refers to the magnitude of market shares held by a number of firms in a given market (Shepherd and Shepherd 2004). An even distribution of market shares indicates a small CR value as well as stiff competition in the market (Nelson 1960; Weiss 1963; George 1967; George 1972; Egghe 2005). Market mobility reflects the turbulence of market shares transferred from losers to winners, or the capabilities of the largest firms' in maintaining the market positions (Baldwin and Gorecki 1994; Baldwin 1995; Cable 1997). Market instability presents the impact of competition on driving one market status to another (Gort 1963; Barla 1999). A larger mobility or instability indicates a higher degree of competition intensity.

Although the subject of competition intensity has well been addressed in many disciplines, there are limited studies undertaken in construction business environment (Wang 2004; Chiang et al. 2001; Mccloughan 2004). As a result, the moderateness of construction competition keeps unexplored. To identify the moderate status in the construction competition, it demands for an effective measure of competition intensity

in the construction context.

（2） Scope of the study

The scope of this study is defined by taking into account the nature of competition in construction and data availability. Competition is a common phenomenon in socio-economy. It refers to not only the interaction between organisations or individuals in struggle for common objects (individual competition event) but also the status of general business environment (market competition status). This study focuses on construction competition at the market level, which encompasses many types of business competition in terms of contracting, marketing, pricing, costing, advertising, innovation, and strategy. As pointed out by Drew and Skitmore (1997), work divisions in construction industry have enabled a set of market sectors with different resources, skills, and management expertise. Thus, many construction firms have a diversity of businesses and are able to simultaneously compete in several sectors for construction contracts. It is quite difficult, if not impossible, to collect data per type of business competition. Therefore, the scope of this study is limited to the competition for contracting businesses in construction market. The data used for analysis were from the Chinese construction industry.

1.3 Research Aim and Objectives

This study aims to establish a model for measuring competition intensity in construction market. The research objectives are constructed accordingly as follows:

(1) To find out the characteristics of competition and competition intensity in the construction context

(2) To establish a new model for measuring competition intensity in construction market

(3) To validate the model

(4) To apply the established model to identify the competition characteristics of construction market

1.4 Significance of the Study

The significance of this study is in multi-dimensions, as presented below:

(1) A good understanding of competition intensity is a prerequisite for construction businesses to identify the feature of niches in construction market.

(2) An effective measurement of competition intensity can help contractors to develop proper strategies to adapt to business environments. With the measurement the contractors can gauge competition pressures, thus identify effective response to market challenges, and accommodate their competitiveness to various market situations.

(3) The two major roles that government plays in construction market include overseeing market operation and acting as clients for public project investment. These two roles might contradict on many occasions but they can supplement each other if governmental decisions are made based on a proper understanding of competition intensity in the market. The new model of the competition intensity from this study provides government with an effective tool for gaining the proper understanding.

(4) The study provides valuable reference in terms of competition intensity in construction management and economics to academic researchers.

1.5 Research Methodology

Methodology is a scientific term that describes documented sets of procedures, guidelines and principles for exploring new knowledge or for reinterpreting some existing knowledge towards achieving research objectives. It is an inquiry-and-solution process, but its components usually vary with various research works. In this study, a variety of research methods were designed with the intention of achieving the research objectives.

A research plan was produced to highlight the sequence and logic of the key methods adopted for research by defining research activities and exploring the issues concerning how to proceed and analyse research data. The research plan is shown in Figure 1.2, indicating that individual research objectives will be completed by addressing various research questions, and in turn, each research question will be answered by using specific research methods.

（1） Formulation of research questions

The research objectives (Section 1.3) were further developed into addressing the set of research questions listed below.

Q1: What is the meaning of competition intensity?

Q1.1 What is competition?

Q1.2 What is competition intensity?

Q1.3 What are competition and competition intensity in construction market?

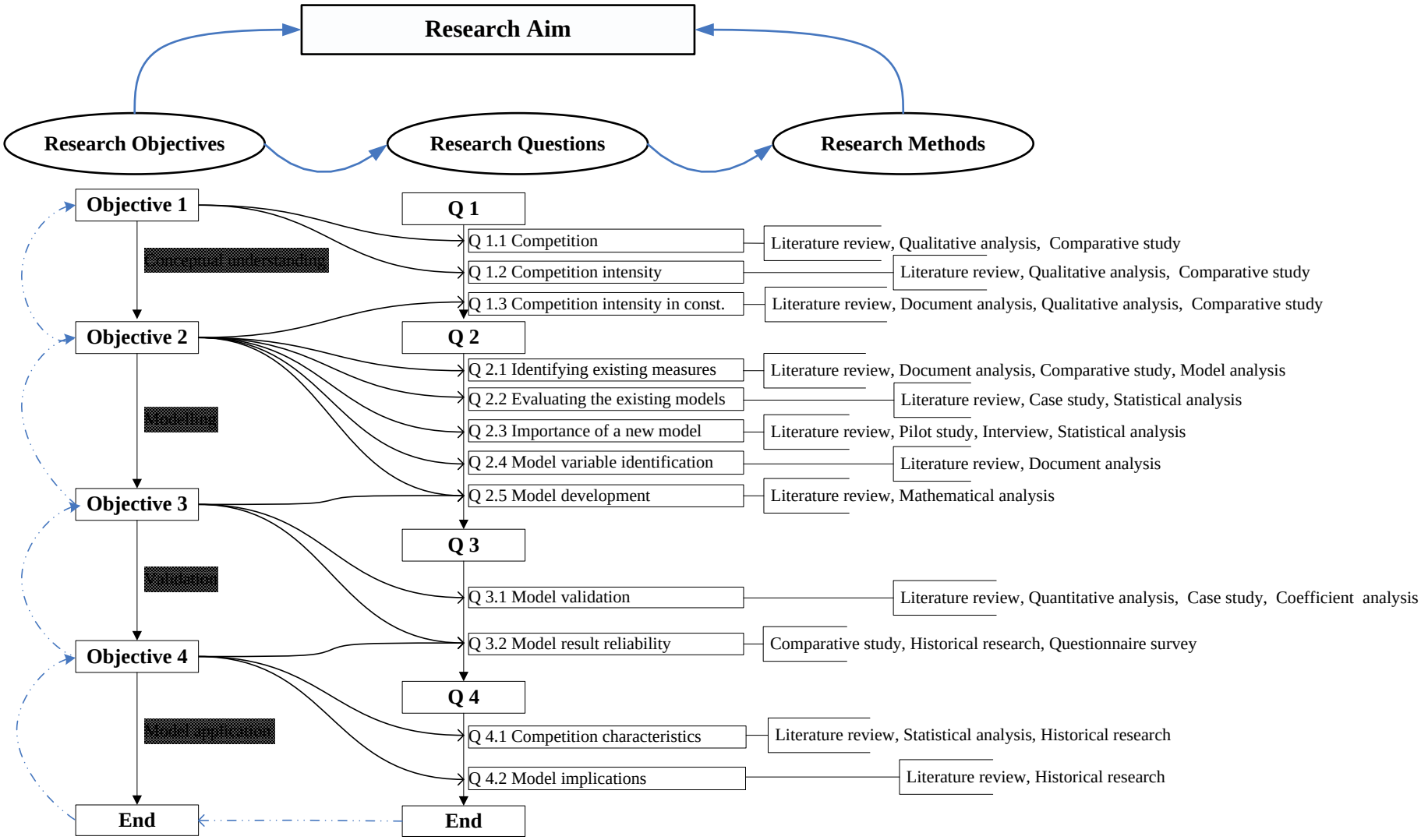


Figure 1.2 Research plan for the study

Q2: In what ways can the competition intensity in construction market be modelled better?

Q2.1 What generic models are available for the measurement of competition intensity?

Q2.2 How effective are the existing measures in the construction setting?

Q2.3 Is it necessary to develop a new model to promote the measurement in construction?

Q2.4 If yes, how can the model variables be identified?

Q2.5 How can the identified variables be developed into a new measure?

Q3: How can the established model be validated?

Q3.1 Is the model structure valid?

Q3.2 Are the model application results reliable?

Q4: What will the implications of the new model be in application to a given construction market?

Q4.1 Is it feasible to use the new model to identify competition characteristics in construction market?

Q4.2 If yes, what will the identified characteristics imply?

（2） Major research methods

The main research methods adopted in this study include literature review, document analysis, quantitative analysis, interview, questionnaire survey, and historical research as introduced below.

Literature review

Research activities in this study began with extensive literature review. Publications associated with the subject of competition intensity are the review focus. Research efforts include reviewing previous relevant research works comprehensively, using the findings of previous research works as supports, applying the proper research methodologies developed in previous studies, and utilising the results of literature review as the basis of an academic context for the study. Consequently, the literature review particularly provides insights into the concepts of competition and competition intensity (Sections 2.1 and 2.2), the measures of competition intensity (Section 2.3), and the factors of competition intensity (Section 5.3).

Document analysis

Analysis by using historical data and statistical evidence can supplement the research analysis on the information obtained by other methods such as interview and questionnaire survey (Duffy 1999). In this study, document analysis was adopted to recognise the key requirements of effective competition intensity measures (Section 4.4) and to yield a tentative list of factors of competition intensity (Section 5.3). The rationale for the choice of this method is that it can favour identifying the significant items that have been acknowledged in previous studies or considered by practitioners. Since the subject of competition intensity has been well researched, there are numerous publications of technical journal papers, enabling the method of document analysis for this study.

Quantitative analysis

Quantitative analysis was employed to examine relationships between variables of competition intensity by using mathematical techniques or statistical models, thus to

model the coherence of competition intensity variables. This method was employed in this study for a number of reasons with respect to the measurement and evaluation of competition intensity model. The factors were identified and classified into two groups: causal and sequential. An Iso-line was established for the measurement of competition intensity by integrating the grouped variables in a coordinate system. The details are presented in CHAPTER 5.

Interview

Interview serves as a brainstorming instrument for defining and resolving research questions (Freire and Alarcón 2002). It is a bridge connecting theoretical deduction to empirical study, and it can be the conversation between researchers and respondents in which questions are prepared for obtaining information from interviewees. There are several forms of interviews including: face-to-face interview vs. telephone interview, preliminary interview vs. in-depth interview, sequential interview vs. panel interview, and directive interview vs. non-directive interview. This study adopts the face-to-face interview to detail the practitioners' perception on three questions, namely, (1) "How is the concept of competition intensity understood in construction market?" (2) "How can competition intensity in construction market be measured?", and (3) "What indicators are suitable for the measurement?"

Interviewees selected are knowledgeable in construction business competition. As shown in Table 1.1, five professionals were interviewed, including three general managers, one property developer, and one government official. The managers were chosen based on their work experience in strategy management and business/enterprise planning. The interviews with the developer and the official serve to compare with the general managers' views. Each interview lasted about one hour with focal discussion on

Table 1.1 Interviewees participated in this study

Interviewee	Position	Enterprise				Particulars	
		Name	**Qualification grade**	**Type**	**Year established**	**Work year**	**Expertise**
1	General manager	Shenzhen Municipal Engineering Corp.	FTG	State-Owned Construction Enterprise	1983	12	Project management, tendering, strategy management
2	General manager	Shenzhen First Construction Engineering Co., Ltd.	FTG	State-Owned Construction Enterprise	1983	16	Civil engineering, project management, planning
3	Vice-president	Shenzhen Yuezhong Construction & Engineering Co., Ltd.	FTG	Private Construction Enterprise	2000	8	Project management, electricity, construction marketing
4	Vice-director	Shenzhen Zhujiang Real Estate Development Company	N/A	Private Property Developer	2000	20	Construction management, enterprise management, architectural
5	Associate department head	Shenzhen Municipal Construction Authority	N/A	Governmental authority	N/A	11	Construction management

Note: Names of the interviewees are not shown for the sake of privacy.

the three questions mentioned above. Notes were taken on site and edited/summarised afterwards, then sent to the interviewees for confirmation. The confirmed notes are eventually compiled into five interview minutes. The interview minutes are considered as part of evidence for supporting document analysis, presented in Section 4.3.

Questionnaire survey

Results of the interview mentioned above are the production of two sets of indicators for measuring competition intensity. To detect the possibility of modelling competition intensity on the basis of these two sets of indicators, a postal questionnaire entitled "A Survey for Understanding Competition Intensity in Construction Market" was performed in the Chinese construction market in May/June 2007 (Section 4.3). The questionnaire survey aims additionally to make comparison between local construction markets from the perspective of competition intensity (Section 7.2). The comparison can be used to demonstrate to what extent the reliability of the model results.

Good efforts have been contributed to selecting effective respondents for quality survey. According to the Regulation on Qualification Management of Construction Firms (MOC 2007), construction firms in China are classified into various grades, and only those contractors who meet rigorous requirements in terms of technology, capital, credit grade and firm size can be listed as the first-two-group (FTG) contractors. FTG contractors are allowed to conduct construction businesses nationwide, and they are considered having good knowledge of competition practices throughout the country. Thus, they have been targeted for this survey. There were about 3364 FTG contractors in China by the end of May 2007 according to the official record (PWCEI 2007), suggesting a need of 345 contractors at least to ensure a 95% confidence level and 5 confidence interval of sample size. Nevertheless, 500 contractors were selected

randomly and confirmed about their general information one by one by visiting their company websites.

The questionnaire used contains four sections under the headings of personal information, competition behaviour indicators, market performance indicators, and levels of competition intensity in local construction markets. It consists of a number of closed questions requesting respondents to indicate the significance degree through a five-level Likert scale (1 - Negligible, 2 - Less important, 3 - Average, 4 - Important, 5 - Extremely important). To ensure the suitability and good readability of the questionnaire, academic supervisors and two professionals were invited to help proofread and comment on the questionnaire. Comments were received and taken into account in the revision of the questionnaire. The scales were initially conducted and surveyed in Chinese language, but they were subsequently translated into English with the help of two construction professionals who were fluent in both Chinese and English. The translated questionnaire was sent to one reviewer who did not see the original Chinese text to ensure high face validity. The revised questionnaire is shown in the appendix for reference.

The questionnaires were addressed directly to the general managers of the 500 selected firms. 97 effective and 4 incomplete responses were finally received, giving a response rate of 20.2 percent. The respondents who participated in the survey had an average of 18.3 years of work experience, and most of them (nearly 75 percent) were high-level enterprise managers.

Historical research

Historical research is a procedure complementary to observing, testing or identifying the

authenticity of reports (McCulloch and Richardson 2000). The procedures of using this method include stating the problem, collecting source materials, evaluating/analysing source materials, and reporting findings. This method is applied in this study to identify and interpret the impacts of major economic events on competition in the Chinese construction market. The application of this method is demonstrated in Section 7.3.

（3） Data collection from the Chinese construction market

The data collected in this study are aimed at testing the applicability of the competition intensity measure developed in this study. Main reasons for collecting the data from China's construction industry include the following:

Firstly, the Chinese construction industry has become one of the largest capacities in the world and has major influence on the global construction competition practice. Therefore, the findings from the data analysis can be valuable reference to other studies on the competition intensity in other construction industries.

Secondly, the Chinese construction industry has witnessed significant changes since its reform and open-door policies in the 1980s. If an effective measure of competition intensity for this volatile industry can be established successfully, it can be tailored for other industries that have a more steady growth.

Furthermore, having the education background and work experience in China, this researcher find more confident and effective to collect good research data in China.

1.6 Outlines of the Thesis

This thesis consists of eight chapters as shown in Figure 1.3. CHAPTER 1 gives an overview of the study including research background, research gaps, research objectives, methodologies, significance and scope of the study. This chapter also presents a “bird's-eye” view of the structure between chapters. CHAPTER 2 is dedicated to the review of competition and competition intensity from the perspectives of definition and measurement. CHAPTER 3 discusses the characteristics of competition and competition intensity in the construction context. CHAPTER 4 evaluates the applicability of the existing measures of competition intensity to construction market. CHAPTER 5 presents the analysis on the factors of competition intensity. The factors are grouped into causal and sequential dimensions, which are adopted in the establishment of a new model. The established model is named Causal-Sequential Coordinate System (CSCS). CHAPTER 6 presents the analysis on the data collected from the Chinese construction market for demonstrating the applicability of CSCS model. CHAPTER 7 presents the discussion on the validation of CSCS model and the findings from the model application results. CHAPTER 8 concludes the study by addressing its contributions, merits, and limitations. Future possible research associated with the study is also recommended in this chapter.

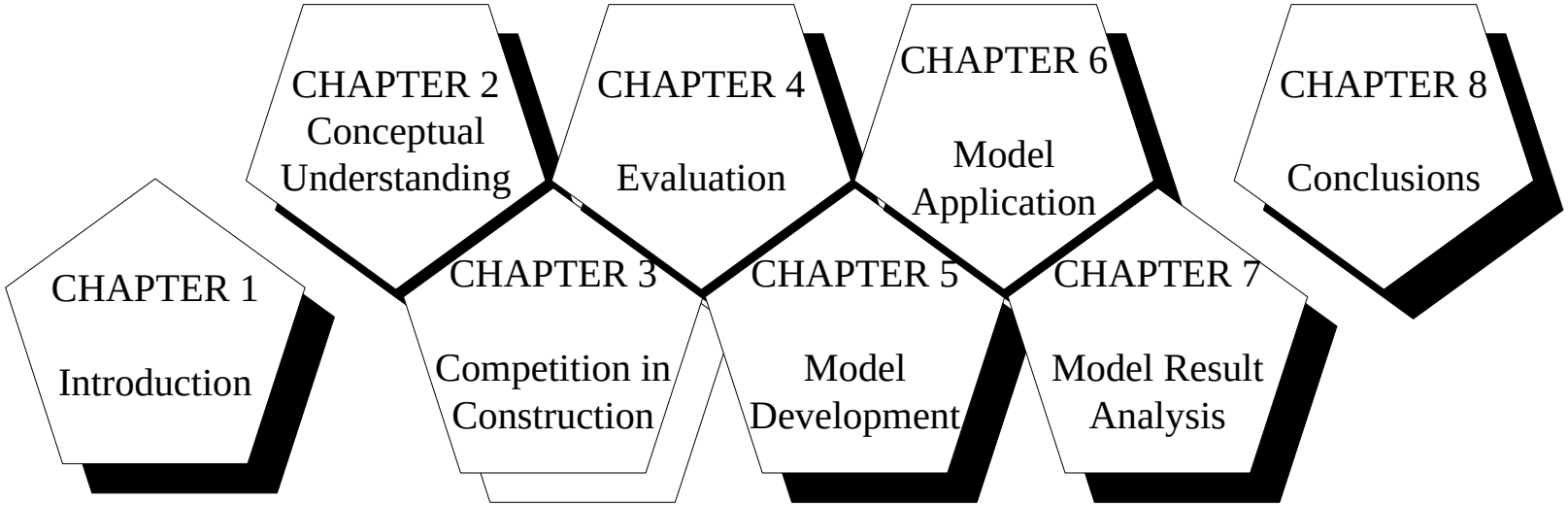


Figure 1.3 Organisation of the Thesis

CHAPTER 2 COMPETITION AND COMPETITION INTENSITY

This chapter presents the review of the literature associated with the subjects of competition and competition intensity with the focus on key terminologies, definitions and measures.

2.1 Concepts of Competition in Economics

Competition is a prevalent daily term. It fundamentally refers to a struggle of conflicting interest (Ely 1901), the action of competitors (Scherer 1980), and the mutual exertion of pressure to perform well (Shepherd and Shepherd 2004). In economics, however, this term has far more levels of meanings in connotation than in literalness. As pointed out by Martin (2004), the term competition is subject to ineffective application in the economics community, if what is intended is not laid out properly. It is beyond the scope of this study to address a whole picture of competition in the history of economics, but a few representative branches of economics such as classical economics, neoclassical economics, welfare economics, and industrial economics will be presented to give an outline of the term. The review is expected to build up proper understanding of competition intensity in the construction context.

2.1.1 A brief review of competition concepts in economic theories

Economics has many family members. However, the concept of competition did not become a scientific tool in economics and did not play a leading role in economic analysis until the era of classical economics (1750 to 1875). The notion of competition in economics can be described as indicated in Figure 2.1.

Competition in classical economics

The notion competition attracted not much academic concern in the very old days. It was Adam Smith's *The Wealth of Nations* (1776) that marked the beginning of modern economics and offered a well-known rationale for "competition" with "the invisible hand". Prior to this milestone, competition was simply a term frequently used for public

discourses. At that time, it referred more to bringing a case to court or the individuals' struggle for common objects.

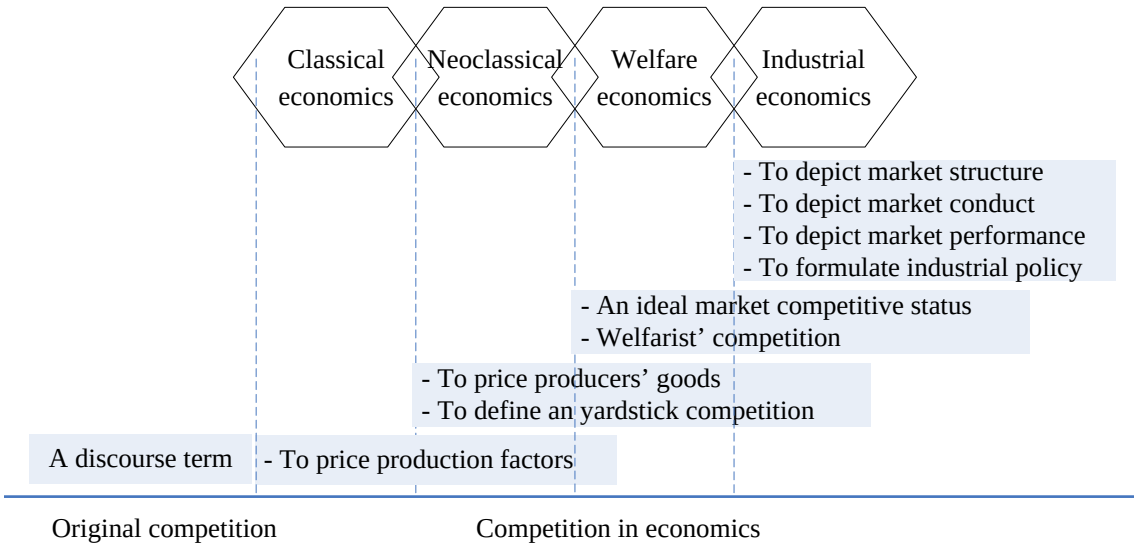


Figure 2.1 Notions of competition in economics

Smith (1776) shed light on competition through "the invisible hand", which has at least threefold meanings: (1) enabling firms to allocate scarce resources optimally, (2) providing the impetus for innovation and entrepreneurship, and (3) reducing transaction costs between exchange parties (Williamson 1985).

After the efforts of classical economists like David Ricardo (1772 -1823), Thomas Malthus (1766-1834), John Stuart Mill (1806-1873), William Petty (1623-1687), Johann Heinrich von Thünen (1783-1850), and Karl Marx (1818-1883), competition was gradually recognised as an economic force as well as a policy ideal. It was employed extensively to examine production activities and became an important economic term parallel to capital, land, machines, and labour in the discipline.

Classical economists maintain that competition is a primary regulator of wage and levels of profit (Mill 1984), and it drives the price of goods to the cost of utilising production factors. The term can be employed to explain considerable economic issues such as the incidence of taxation and its economic effect on international trade (High 2001). A tax on capital would lead to higher prices of goods, and the specialisation of countries in goods production would be due to competitive advantages. To conclude, the characteristic of competition in classical economics is its orientation for productive efficiency.

Competition in neoclassical economics

Neoclassical economics began roughly in 1870 to 1920 with the contributions by representative economists including William Stanley Jevons (1835–1882), Léon Walras (1834 -1910), Carl Menger (1840-1921), and Alfred Marshall (1842-1924). Whereas neoclassical economics experienced rapid revolution in the approaches of market price determination and marginal analysis during this time period, the nature of competition did not undergo radical changes. It basically denotes a rivalry between individuals/organisations in struggle for common objects (Stigler 1987).

In line with the main theory of neoclassical economics, competition is an important means of bridging the quantity gap between supply and demand by causing the price of goods to fluctuate around its equilibrium level. Hence, it can force production resources to flow into the production fields that can afford to give higher prices (Walras 1874). At the same time, the newly marginalised analytical technique revised the notion competition to meet the requirements of neoclassical economics (High 2001). Furthermore, one hypothesis of market competition, namely, perfect competition,

became pronounced for analysing economic issues such as labour productivity. Overall, competition has been taken into more consideration in economic life and supported the formulation of industrial policies in this branch of economics.

Competition in welfare economics

As presented above, competition was originally a discourse term and a regulator of pricing production factors in both classical and neoclassical economics, paving the way towards its being a science (Mill 1984). It is fairly difficult to conduct a comprehensive review of the competition concept along the evolution of economics, but the review would be fraught with incompleteness if the concept in welfare economics is neglected.

The remarkable role of competition in the history of economics is attributable to its capability to deploy market resources. It works like invisible hands facilitating the deployment of the resources and has thus grown into being a focal issue of welfare economics. In welfare economics, competition is fundamental to achieve a high level of market competitiveness (Neumann and Weigand 2004).

According to welfare economics, the ideal status of resource allocation is Pareto efficiency, which means that no reallocation of resources can improve a person's well-being without worsening someone else's. The Pareto has been a benchmark used to establish many research goals in economics and as a basis to deny the market conditions that may result in inefficiency such as monopoly, oligopoly, and monopolistic competition.

Competition in industrial economics

The evolution from simply referring to production activities to indicating ideal market

efficiency has dominated the development of competition in economics for a long time. Nevertheless, no more than industrial economics has presented a practicable version of competition. Industrial economics theories are driven by economists like Edward Chamberlin (1899-1967), Edward S. Mason (1899-1992) and Joe S. Bain (1912-1991). This branch of economics is well-known for the structure-conduct-performance (SCP) paradigm that was developed from multiple understandings of competition.

Firstly, competition can indicate the status of market structure in a given industry. Four typical hypothetical models namely, perfect competition, monopolistic competition, oligopoly, and monopoly show a yardstick of competition for analysing market statuses. Secondly, within many specific market structures, firms' competition behaviours usually include rivalries for innovation, advertising, production integration, and product differentiation. In this sense, the term competition refers to competitors' competition strategies/behaviours. Furthermore, another tier of competition in this economics is its signpost for market performance in reflecting the outcomes of market operation over a period of time.

As stated in the Sherman Act (1890) and the Clayton Act (1914), competition is the key to governmental policies which serve to ensure an effective market operation. Nevertheless, governmental intervention in irregular competition and encouragement of firms' competition behaviours serve as a basis for industrial policies.

To summarise, competition basically refers to the action between two or more entities whether individuals or organisations in strife for common objectives. It is a constitutive property of market economy (Neumann and Weigand 2004), has a diversity of economic definitions (Shepherd and Shepherd 2004), and has been used for market

analysis and policy development (High 2001).

2.1.2 Development from generic competition to specific types of competition

The above section describes the evolution of competition concept in the history of economics. It can be found that the concept has been developed through various stages. Nevertheless, the unchanged aspect in this process is people's perception on competition value. Value indicates human's ideas on what is right or wrong, or what is important in the areas of economy, emotion, morality, intellect, politics, and religion. Value is usually controversial, but a well standardised and rational value is the principle upon which art and science depend for validity.

As a salient feature of a free society, people enjoy unalienable rights to pursue their own happiness, whilst competition values to economists are far beyond this. Researchers have pointed out that business competition in a market should adhere to the principles of freedom, equality, justice, fairness, welfare, happiness, and progress (Greer 1992). These abstract principles have been further developed into concrete economic objectives as shown in Table 2.1. However, it can be found that not all competition values are fully compatible to society. For instance, disclosing full company information at all cases is impracticable, and it is quite difficult to have full employment in a society.

In spite of incompatibility, competition values found their way into the legislation of the U.S. through the Sherman Act of 1890 (Neumann and Weigand 2004). As stipulated in the Act, every person who monopolises with any other person or persons and monopolise any part of the trade or commerce among the States or with foreign nations shall be deemed guilty of a felony.

Competition values underpin the development of the four market structures, namely, perfect competition, monopolistic competition, oligopoly, and monopoly as depicted in Table 2.2. Perfect competition and monopoly are two extremes of market structure. According to their definitions, perfect competition satisfies competition values best, whilst monopoly meets least. Although there is no market absolutely similar to the two extremes, it is often considered that the closer a market to perfect competition, the better the market efficiency. On the other hand, any market near to monopoly should be prohibited as far as possible.

Table 2.1 Market value and its implications

Ultimate values	**Proximate values**
Freedom	Free choice in consumption and occupation
	Free entry and investment
	Limited government intervention
	Free political parties
	National security
Equality	Diffusion of economic and political power
	Equal bargaining power for buyers/sellers
	Equal opportunity
	Limited income inequality
Justice and fairness	Prohibition of unfair practices
	Fair labour standards
	Honesty
	Full disclosure
Welfare and happiness	Allocation and production efficiency
	Full employment
	Price stability
	Health and safety
	Clean environment
Progress	Rising real income
	Technological advancement

(Source: Greer 1992)

2.1.3 Competition: status perspective vs. process perspective

The four hypothesised market structures presented in Table 2.2 differ in description of competition. The difference can be illustrated as shown in Figure 2.2.

(1) Perfect competition has a high level of competition in which numerous homogenous firms compete for common business. The competition is fuelled by no entry and exit barriers to the market, standardized products, and accessible market information.

(2) Monopoly has a negligible level of competition. Since wholly occupying the market, the monopolist can endeavour as much as possible to inhibit potential entrants through its advantages in product innovation, market entry barriers, and special government treatment.

(3) The structural factors of monopolistic competition and oligopolistic competition balance the corresponding items of the two extremes. Thus, the levels of competition can be located between perfect competition and monopoly.

The discrepancy of market structures in terms of competition intensity highlights the structuralists' understanding on market competition. In accordance with this understanding, competition in a market is rather like some economic events, indicating a status perspective of competition.

Market competition, however, is processive (Baldwin 1995; Bengtsson 1998). The Australian school of thought contends that competition is not simply an event but also a dynamic process (Reid 1987). This process refers to the way of discovering who, how, and what would serve human needs best (Hayek 1948).

Table 2.2 Basic types of market competition

Market type	Structure			Conduct			Performance		
	Number of firms	**Entry condition**	**Product type**	**Price strategy**	**Production strategy**	**Promotion strategy***	**Profits (what? who?)**	**Production efficiency**	**Progressiveness**
Perfect competition	Very large	Easy	Standardized	None	Independent	B	Normal	Good	Poor perhaps
Monopolistic competition	Large	Easy	Differentiated	Unrecognized interdependence		A	Normal	Moderately good	Fair
Oligopoly	Few	Impeded	Standardized or differentiated	Recognized interdependence		A, B, C	Somewhat excessive	Poor perhaps	Good
Monopoly	One	Blocked	Perfectly differentiated	Independent		A=B C	Excessive	Poor perhaps	Poor perhaps

* Key: A = promotion of firm's brand product; B = industry – or marketwide advertising and promotion; C = institutional or political advertising.

(Source: Greer 1992, pp 10)

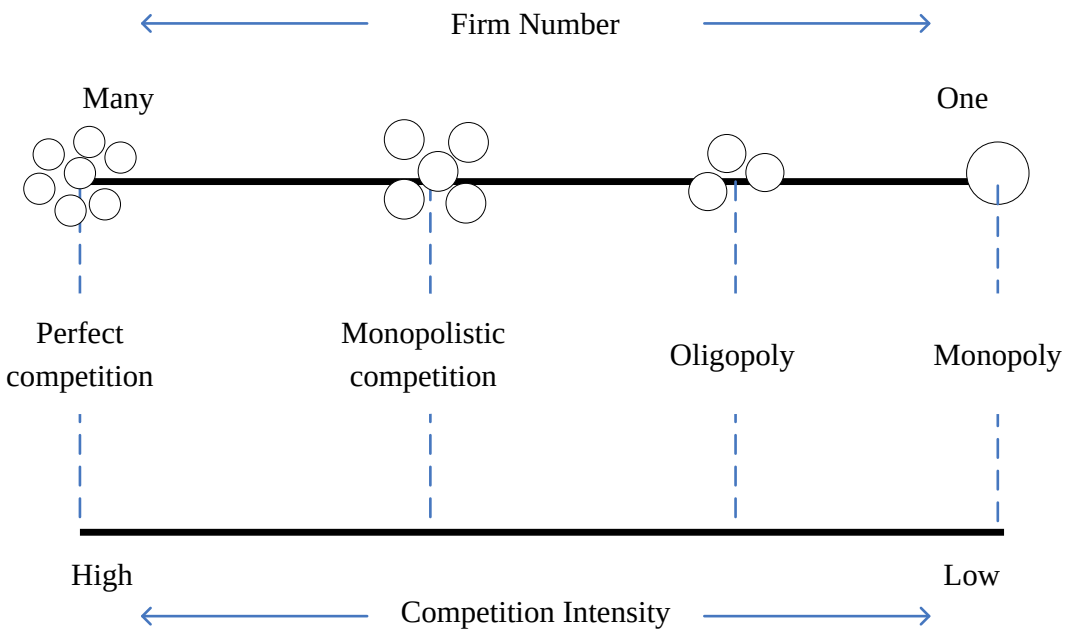


Figure 2.2 Hierarchical competition intensity

Schumpter (1949) stated that the competition process is driven by non-price behaviours such as innovation. Indeed, the process property of competition has been labelled as "creative destruction" that indicates the important role of innovation in business competition (Schumpeter 1942). Thereby, competition can revolutionise considerable economic systems by incessantly destroying the old and incessantly creating new ones (High 2001). For instance, job creation is a creative destruction to net employment, as over 10 percent jobs that exist at any point in time do not exist a year before or might not exist a year later (Davis *et al.* 1996). In addition, international competition is an important driver of creative destruction to local business competition (Trefler 2004). Furthermore, the integration of microprocessor and computer technology into the production of many products and services allows for software-based differentiation (Bettis and Hitt 1995).

To summarise, although the state and the process are two sides of market competition, they correlate with each other. Competition as a game or a competitive play occurs over a number of time periods or phases (process-based competition), whilst a special market structure (status-based competition) determines the rule of the game/play (Bengtsson 1998).

2.1.4 Two classical definitions of competition: Cournot and Bertrand

As analysed above, it seems that a processive competition can better narrate economic phenomenon in a dynamic way. To demonstrate the process feature of competition, two sorts of market competition, namely, Cournot competition and Bertrand competition are usually compared.

(1) Cournot model

Cournot competition is an economic model introduced by Antoine Augustin Cournot (1801-1877). The model assumes a market that is composed of two firms (Firm 1 and Firm 2) competing to sell homogenous products as many as possible. The two firms have constant marginal cost c and the product price reaches to the level that demand equals the total supply by the two firms. In other words, for each pair of output choices (q_1, q_2), the equilibrium price becomes $p_1 = p_2 = P(q_1 + q_2)$. The market demand curve is line DD as shown in Figure 2.3.

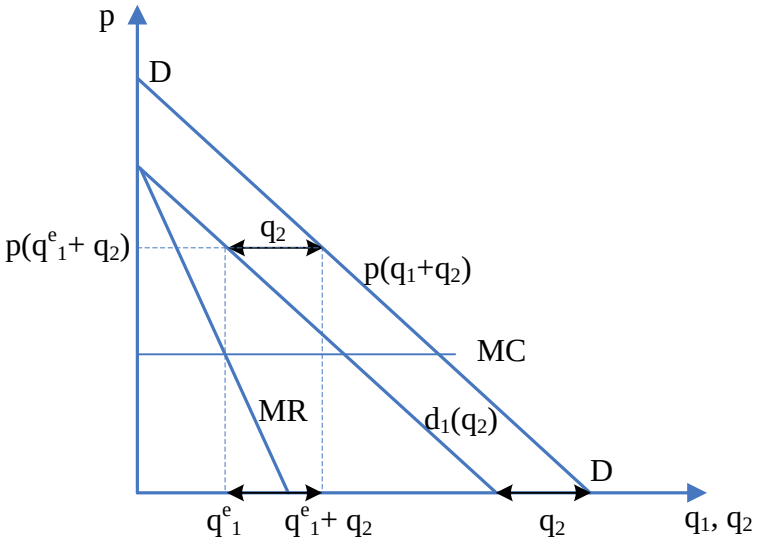


Figure 2.3 Firm 1's optimum in Cournot competition

Where, p_1 = Firm 1's price, p_2 = Firm 2's price; q_1 = Firm 1's quantity, q_2 = Firm 2's quantity; c = marginal cost (*MC*).

The process of Cournot competition is described as follows. Suppose the quantity of Firm 2's output is q_2; The curve $d_1(q_2)$ will be Firm 1's residual demand, which indicates all possible combinations of Firm 1's quantities and prices given the level q_2. Based on this curve, Firm 1 determines its marginal revenue (*MR*) like a curve with twice the slope of line $d_1(q_2)$. To maximise its profits, the optimal quantity q^e_1 enables *MR* = *MC*. Such optimum depends on the conjecture of what Firm 2 is producing. Variance of q_2 leads to a reaction curve as shown in Figure 2.4. As the symmetry of Firm 1, Firm 2 also changes its output through the conjecture of Firm 1's output. Reaction function $q_2(q_1)$ is Firm 2's optimal response given different levels q_1.

The reaction curves in Figure 2.4 are used to determine the Nash equilibrium (named

after John Forbes Nash) for Cournot competition where both firms perform optimally. As indicated by the arrows in Figure 2.4, wherever the initial point is, the equilibrium is determined at point N.

Therefore, suppose

$$P(Q) = a - b\,Q$$

$$C(q) = cq$$

Where, *q* is the firm's output; a, b > 0; and $Q = q_1 + q_2$

Firm *i*'s reaction function will be

$$R_i = q_i * (q) = (a - c) / 2b - q_j / 2$$

Where, i, j =1, 2, $i \neq j$

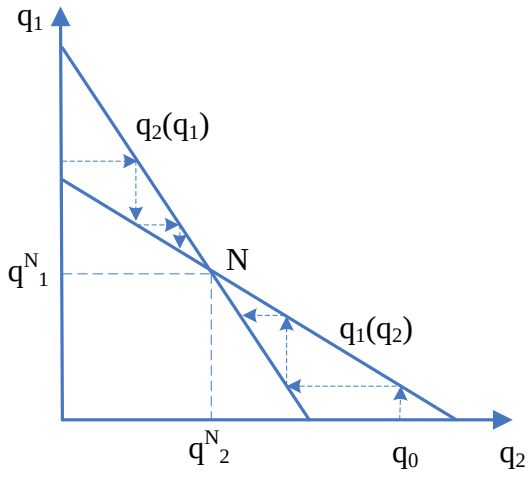


Figure 2.4 Cournot equilibrium

The point where two reaction curves intersect refers to the Cournot equilibrium composed of the following two equations:

$$q_i^c = (a - c) / 3b$$

$$p^c = (a + 2c) / 3$$

Although Cournot competition can well reflect the process feature of market competition, it has been criticised in three ways (Lipczynski and Wilson 2001). Firstly, it is based on a naive and unrealistic assumption that each firm believes its rival will never alter output (zero conjectural variation). Secondly, Cournot seems to ignore the possibility that firms may wish to seek cooperative or collusive solutions to maximise their joint profits. Thirdly, Cournot focuses on output-setting but it overlooks price-setting that might be a potential oligopolistic strategy.

(2) Bertrand model

Bertrand competition introduced by Joseph Louis François Bertrand (1822-1900) likewise consists of two firms (Firm 1 and Firm 2) in a market for a homogenous product. Its assumption indicates that firms simultaneously set their prices and have the same marginal cost *MC*. The discussion on the model is referred to Figure 2.5. *MC* is constant, and the demand *D(p)* is linear. Since the product is completely substitutable, whichever firm sets the lowest price will get all of the market demand.

Suppose that Firm 1 expects Firm 2 to price above monopoly price. Firm 1's optimal strategy is to price at the monopoly level, so it can get all of the demand and receive monopoly profits. If Firm 1 expects Firm 2 to price below monopoly price but above

marginal cost, then Firm 1's optimal strategy is to set a price just below that of Firm 2. This is because pricing above monopoly price would lead to zero demand and profits. Pricing below monopoly price brings the firm all of the market demand.

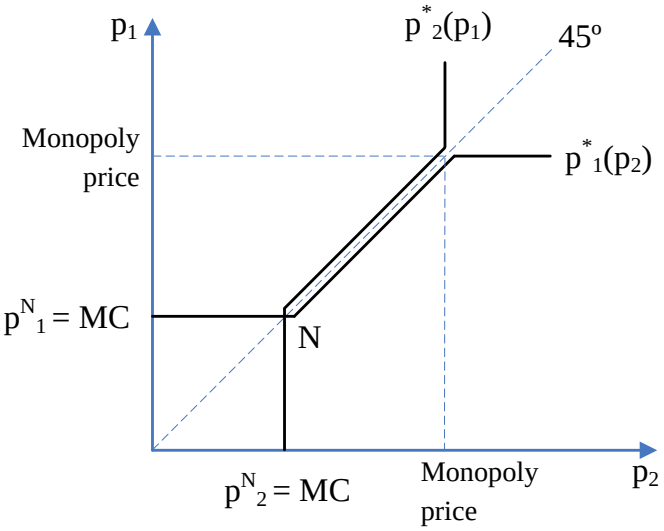


Figure 2.5 Reaction curve of Bertrand competition

Specifically, market demand P = a – b Q; Firm 1's demand curve can be described as follows:

$d_1(p_1,p_2)$ =

$D(p_1)$	if $p_1 < p_2$
$D(p_1)$	if $p_1 = p_2$
0	if $p_1 > p_2$

If $c_1 = c_2 = c$, then

Bertrand equilibrium will be $p_1 = p_2 = c$; $q_1 = q_2 = (a – c) / 2b$

If $c_1 \neq c_2$, i.e. $c_1 < c_2$, then

Bertrand equilibrium will be $p_2 = c_2$, $p_1 = c_2 - \varepsilon$, $q_2 = 0$, $q_1 = (a - c_2 + \varepsilon) / b$

Bertrand competition, however, has received three aspects of criticism (Lipczynski and Wilson 2001). Firstly, the general criticism with respect to zero conjectural variation applies to the Bertrand model as much as it does to the Cournot model. Secondly, it is arguable that where the output is not differentiated, output-setting seems a more realistic strategy than price-setting. Furthermore, the model concludes that the market will be shared equally, but such neat outcomes in practice may not be realised due to a variety of non-economic factors.

Researchers have suggested comparing industries (with same firm number, same linear demand and cost functions) under the regimes of Cournot competition and Bertrand competition. Since Cournot competition normally leads to lower output and higher prices than Bertrand competition, it is considered less intense than Bertrand competition (Bonanno and Haworth 1998).

2.1.5 Summary

This section presents a variety of competition concepts in economics. The long evolution of competition in the discipline has made the terminology multi-dimensional. The values of market competition present man’s ideas about what is right or wrong towards this term. Although there are no all-pervading competition values to base on, it is often considered that perfect competition is better than monopoly, monopolistic competition, and oligopoly. These four types of competition raise further questions concerning whether competition is a status or a process. Thus, two classical competition

models, namely, Cournot and Bertrand, are presented to illustrate the process of competition.

2.2 Definitions of Competition Intensity

On the basis of the above theoretical understandings on market competition, this section introduces the ways in which competition intensity can be defined. Prior to the introduction, a few relevant terminologies are reviewed to underpin the understanding of competition intensity.

2.2.1 Understanding relevant terminologies

Market

A market is the place where buyers and sellers exchange their goods, services, and information. It can be tangible like an antique auction market and shopping mall, and intangible like e-commerce via the Internet. Market competition occurs between market participants including buyers and sellers. The elementary rule of market is that the higher the product price, the more the supply and the less the demand, as presented graphically in Figure 2.6.

Market efficiency

Market efficiency shows the result of market competition (Boone 2001). An effective market is one in which market prices can instantaneously reflect market information, and extraordinary profit opportunities are rapidly dissipated by the individuals' action (Oster 1999).

As analysed in Section 2.1.2, there are two extremes of market competition, namely, perfect competition and monopoly, presenting dissimilar market efficiency. In a monopolistic market, the price is decided by the monopoly whilst the consumers are price-takers, suggesting that this market is not efficient. Due to the inefficiency, many antitrust laws are aimed at inhibiting the emergence of monopoly to sustain adequate competition in markets. By contrast, a market with perfect competition encourages full involvement of businesses to bring about good market efficiency.

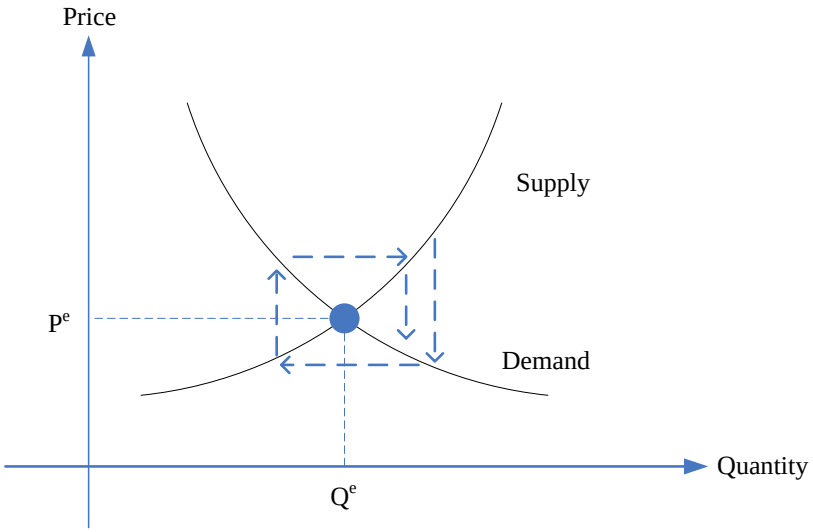


Figure 2.6 Interaction of market supply and market demand

Market competitiveness

Competitiveness is a competition-based concept demonstrating competitors' strength relative to counterparts (Fagerberg 1996; Cho 1998). Competitiveness is multi-

dimensional and it can be separated into three main levels, namely, nation competitiveness, industry competitiveness, and firm competitiveness (Shen *et al.* 2006).

The lower-grade level of competitiveness is firm competitiveness. It refers to the capability of a firm to produce better goods and services, and maintain or expand the incomes of its employees and owners at the same time (Invancevich *et al.* 1997). The middle level is industry or market competitiveness, which means the development of a higher market efficiency relative to other types of markets (Lall 1999). The upper level is nation competitiveness, referring to the ability of a country to achieve sustainable high growth rates (EI-Namaki 2002).

Competition strategy

Another terminology associated with competition is competition strategy, which describes a documented set of firms' behaviours for achieving long-term objectives (Male 1991). Competition strategy aligns an organisation's resources or capabilities either internal or external (Hofer and Schendel 1978), and it can be an outcome of a number of decisions that are made on firms' resources and market situations (Andrews 1980). Thus, competition strategy encompasses many aspects of an organisation's activities and presents the organisation's action either offensive or defensive in creating competitive position in various market environments (Johnson and Scholes 1988).

According to Porter (1980), there are three generic competition strategies, namely, focus, differentiation, and cost leadership. Specific forms of competition strategies are usually adopted in line with market competition situations as well as a set of rules to guide decision-makers about organisational behaviours (Langford and Male 2001).

2.2.2 Competition and competition intensity in biology world

Competition is prevalent in both human society and biology. High (2001) pointed out that competition is firms' attempt to outdo rivals in securing goods, customers, revenues, and profits. Keddy (2001) defined competition as the negative effects that one organism has upon another by consuming or by controlling access to a resource limited in availability. As presented by Vermeulen (2002), biology and economics have the usage of competition in common, but they differ somewhat.

Competition in biology has been studied for a very long time (Tansley 1917; Gause 1934). Charles Darwin (1809-1882) discovered the theory of evolution through natural selection, and showed the importance of natural law, which is the struggle for existence. It has been demonstrated that competition drives species to extinction, and competition together with predation and mutualism are the three fundamental forces connecting organisms in viable niches (Keddy 2001).

In biology, competition is species' struggle for scarce resources in various niches (Whittaker and Levin 1975; Milne and Mason 1989). Species will not be alive if isolated from environmental resources. Normally, there are four types of natural sources as shown in Figure 2.7.

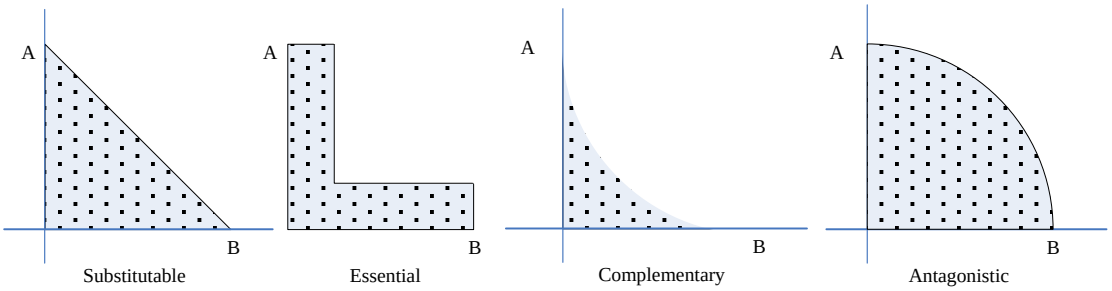


Figure 2.7 Four types of biological resources

Note: A and B denote the quantity of two types of biological resources.
(Source: Keddy 2001, pp 70)

(1) Substitutable resources – whereas species fail to win the competition for resource A, they can still survive by obtaining the substitute resource B.

(2) Essential resources – the resource that species must have by winning the competition, as without which they will die out.

(3) Complementary resources – the resources that substitute for one another and can augment one another when taken together. Thus, species require less of them if taken together than taken separately.

(4) Antagonistic resources – the resources that can substitute for one another, but some partially offset the effect of others when taken together. Thus, species require more of the resources when taken together than taken separately.

From another perspective, competition in biology presents species' interactive relationships in struggle for the above four natural resources. Such interaction can be symmetrical or asymmetrical as shown in Figure 2.8. With respect to the asymmetrical interaction, the influence of resource competition over the relationship is balanced in favour of one species rather than both; whilst for the symmetrical interaction the influence is balanced in support of both. Thus, symmetrical interaction leads to higher

level of competition than asymmetrical interaction.

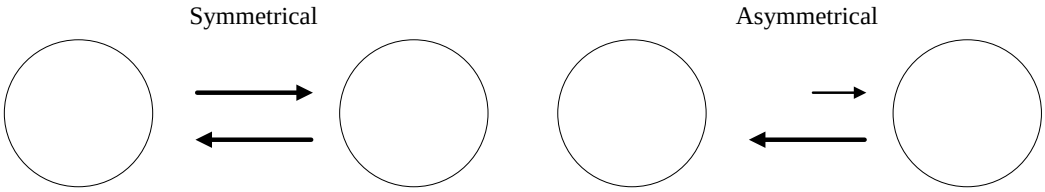


Figure 2.8 Species' interaction in biology: symmetry vs. asymmetry

In line with resource- and interaction-based competition, researchers have defined biological competition intensity in some ways. For instance, the intensity can be used to mirror the impact on a species incurred by the presence of its neighbours (Belcher *et al.* 1995). A species strives against its neighbours for survival in diffuse or monopolistic ways as shown in Figure 2.9, suggesting that competition intensity may be decomposed to embody the impact from all or partial surroundings.

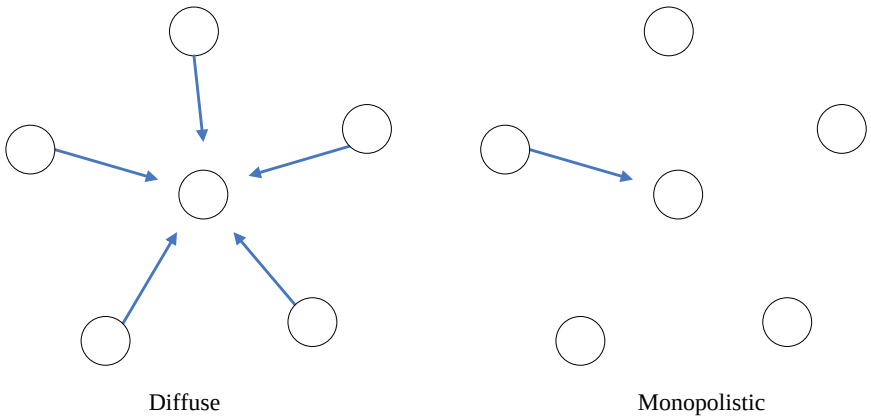


Figure 2.9 Diffuse competition intensity vs. monopolistic competition intensity in biology

Competition in biology can emerge intra-species and inter-species (Figure 2.10). The intraspecific competition intensity conveys a particular competition in which individuals of the same species strive for same resources, whilst the interspecific competition instenisty shows a form of competition in which individuals of different species compete for common resources.

Competition intensity in biology: a neighbour effect-based view

The above discussion on biological competition for natural resources favours a biological notion of competition intensity. Miller (1996) asserted that biological competition intensity can be indicated by the magnitude of competitors, whilst Aguiar *et al.* (2001) stated that the performance of an individual is determined by the amount of space that surrounds it and the density of neighbour species. Lisa and Keddy (1996) revealed that competition intensity is the effect of competition per germ, per plant, or per community. Therefore, competition intensity in biological world refers to the effects of neighbours upon the performance of a population or individual species (Wilson and Tilman 1993; Belcher *et al.* 1995; Keddy 2001).

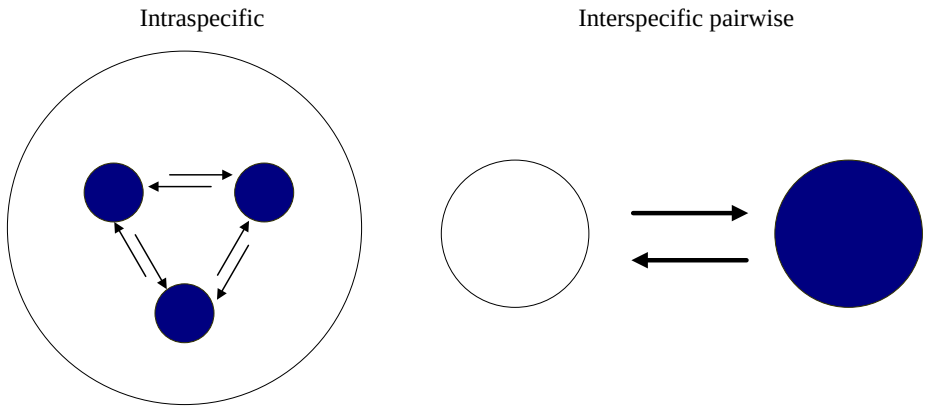


Figure 2.10 Intraspecific competition intensity vs. interspecific competition intensity in biology

(Source: Keddy 2001).

Competition intensity in biology: an environmental resource-based view

A species is difficult to survive if isolated from the natural environment or short of adequate environmental resources, suggesting that the competition for environmental resources is prevalent in nature (MacArthur 1972). According to Harper (1977), biological competition means the response of plants to the density-induced shortage of resources. In these ways, competition intensity is subject to relative resource availability that presents environmental conditions (Grace 1995; Peltzer *et al.* 1998).

A summary of biological competition intensity

It is considered that notwithstanding various understandings, biological competition intensity can be described from two perspectives: causal and sequential. The causal competition intensity refers to a species' interaction for environmental resources, whilst the sequential competition intensity is the effect of neighbours on a species' performance.

To give a better explanation, these two perspectives of competition intensity can be conceptually synthesised into a coordinate system by considering the importance of resources (antagonistic, complementary, substitutable, and essential) to the viability of species as shown in Figure 2.11. For simplicity, it is assumed that the area OB_0CD denotes the Gradient I density of substitutable resources, whilst OB_0A reflects the corresponding intensity of competition for the recourses. The areas OB_1A, OB_0A, OB_3A, and OB_2A in ranks indicate the levels of competition intensity from high to low respectively to illustrate a species' struggle for essential, substitutable, complementary,

and antagonistic resources. Thereby, this conceptual framework appears effective in presenting the four types of biological competition intensity in an integrative way.

2.2.3 Competition intensity in economics

As presented above, a causal-sequential coordinate system seems better to present the concepts of competition intensity in biology. Different from that in biology, competition intensity in economists' society has a few synonyms such as intensity of rivalry, degree of contestability, intensity of competition, and degree of competition. Although competition intensity is an economic term easy to understand, it has been viewed in diverse ways as shown in Table 2.3.

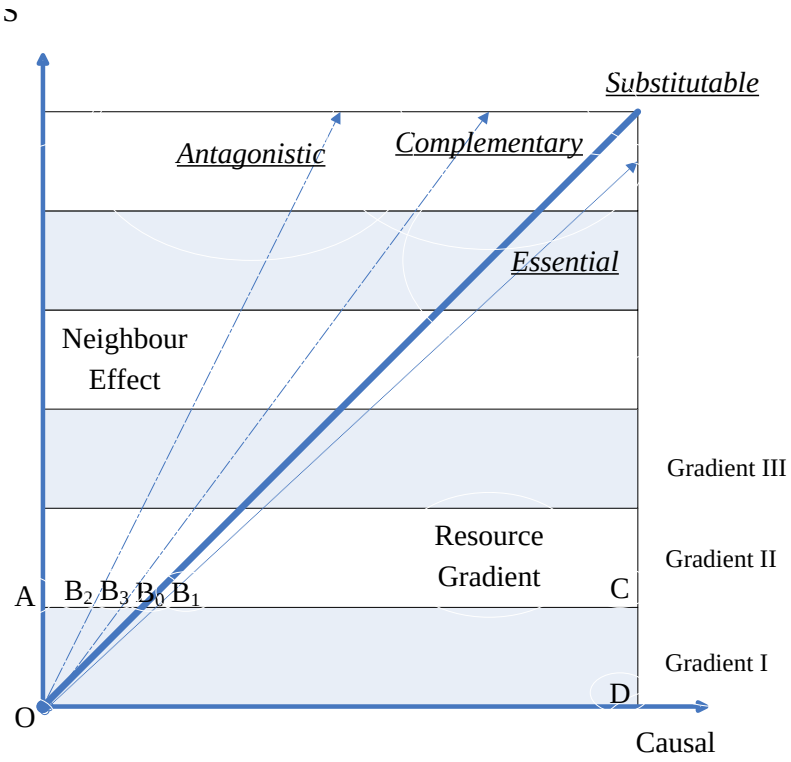


Figure 2.11 A conceptual causal-sequential framework for analysing biological competition intensity

Table 2.3 Various views on competition intensity in economics

View	Detail
***The market structure** view*	Competition intensity is a market structural variable that is determined by a number of market factors including industry growth, fixed cost, product differentiation, consumers' switching cost, competitor characteristics, and exit barriers (Porter 1980; Bird 1999; Oster 1999)
The market force view	Market forces subject to existing rivalry, the bargaining powers of buyers and suppliers, the threat of substitutes, and potential competitors can determine the intensity of competition in a collective way (Porter 1980; Oster 1999)
The firms' dominance view	The largest firm in a market has the most dominant market force that can cause market to change. The larger the force, the less the intensity of competition. Thus, the capability of the leading firms in maintaining their market positions is an indicator of competition intensity in the market (Gort 1963; Boone 2001)
The marginal analysis view	A profitable business draws more entrants to the market, resulting in fiercer competition and in turn lowering the business profitability. Therefore, the examination of using the difference between product price and production cost to measure competition intensity deserve much considerations (Goldberg and Knetter 1999). The larger the difference, the lower the level of competition
The competition uncertainty view	Competition is a dynamic process. No competitors can always outperform their rivals; instead, it is an uncertain process that competitors win the business competition at random. More firms involved in the competition lower the opportunities for competitors to win the competition (Horowitz and Horowitz 1968). In turn, the lower the randomness, the fiercer the competition

The market distribution view	Concentration is an indicator of the distributive status of market shares as a result of business competition. The more centralised the distribution, the less the competition intensity. The concentration of market share accounts indirectly for the level of competition intensity (Baldwin and Gorecki 1994; Bajo and Salas 2002)
The market instability view	Competition is a "creative destruction" to the stability of market status and it can cause firms' market shares to move from losers to winners. A cut-throat competition can induce significant changes to the market (Hymer and Pashigian 1962; Gort 1963; Telser 1964; Straiger and Wolak 1992; Barla 1999; van Kranenburg 2002)

The views on competition intensity shown in Table 2.3 can also be categorised into two groups: causal and sequential. The causal views present why and how competition occurs in the market, including the market structure view, the market force view, and the firms' dominance view. On the other hand, the sequential views reflect the results can be due to business competition, including the marginal analysis view, the competition uncertainty view, the market distribution view, and the market instability view.

2.2.4 Defining competition intensity

It has been pointed out that competition in economics basically refers not only to competitors' struggle for common objects but also to complicated economic phenomena and ideal market statuses. Competition in biology means the effect on species' viability and struggle for environmental resources. It is considered giving a definition of competition intensity with reference to the competition concepts in these two domains.

Competition intensity in biology

Competition intensity in biological experiments is a term used to describe the dynamic, interactive, divisible, and resource-based attribute of competition limited to a known population or individual species. This term is a relative measure of biological competition, which can be asymmetrical or symmetrical, diffuse or monopolistic, and can differ to a species when competing for various resources in a common niche.

Competition intensity in economics

There are various definitions of competition in economics, favouring the examination on market issues associated with structure, conduct, performance, and government policies. Competition fundamentally indicates the rivalry of businesses, either individual or organisation, for sustainability underpinned by resources, capabilities, and market shares. Furthermore, competition can be used to explain individual competition event as well as to account for dynamic process of business competition.

The review on competition concepts as presented above support the definition of competition intensity for this study. To summarise, competition intensity presents the effect of neighbour competitors, the frequency of competition interaction among competitors (Bengtsson 1998; Noh 2000), and the level of rivalry within a given environment (Ramaswamy and Renforth 1996). Therefore, this intensity can be defined as a relative notion designed to reflect the extent to which market competition is induced by homogenous competitors over a period of time.

2.3 Measurement of Competition Intensity

2.3.1 Competition intensity measurement in biology

The subject of competition intensity in biology has been examined corresponding to the framework shown in Figure 2.12 for investigating research issues such as population growth, habit productivity, and environmental conditions (Keddy 2001). Key issues of these investigations include the measurement of competition intensity. There are two measures used, namely, removal technique and environmental gradient technique, as introduced below.

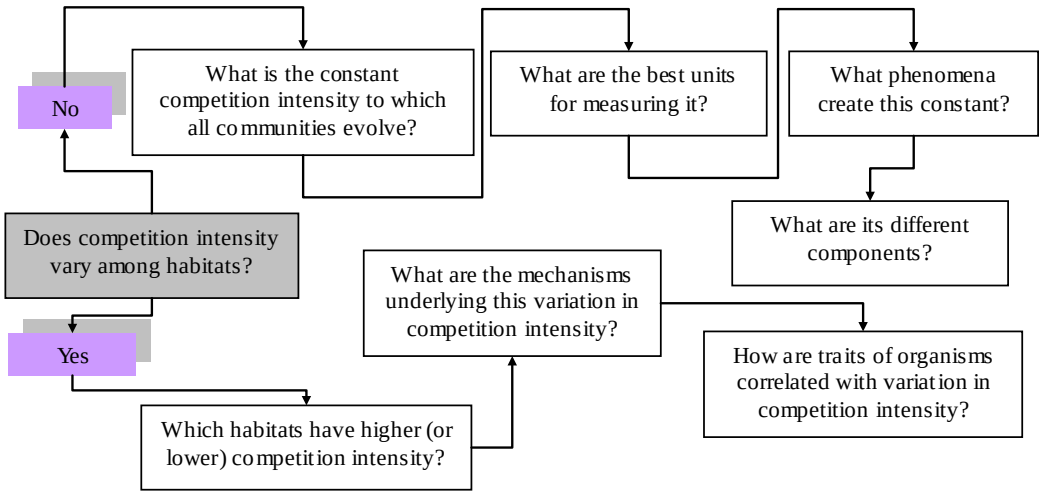


Figure 2.12 Research routes for examining competition intensity in biology

(Source: Keddy 2001, pp 331)

Removal technique

Given a pool of natural resources, species can grow to the largest density that is determined by the availability of resources. However, it will be difficult to reach the

largest density if there are other species competing for the resource at the same time. By removing little by little the amount of neighbours without altering resource gradient, the intensity of competition for the resource can be measured. This method in biology is called the removal technique and it can be illustrated by gradually removing the magnitude of Larrea or Ambrosia as shown in Figure 2.13. As presented in the figure, the competition intensity for Larrea or Ambrosia refers to the density after the removal of its counterpart.

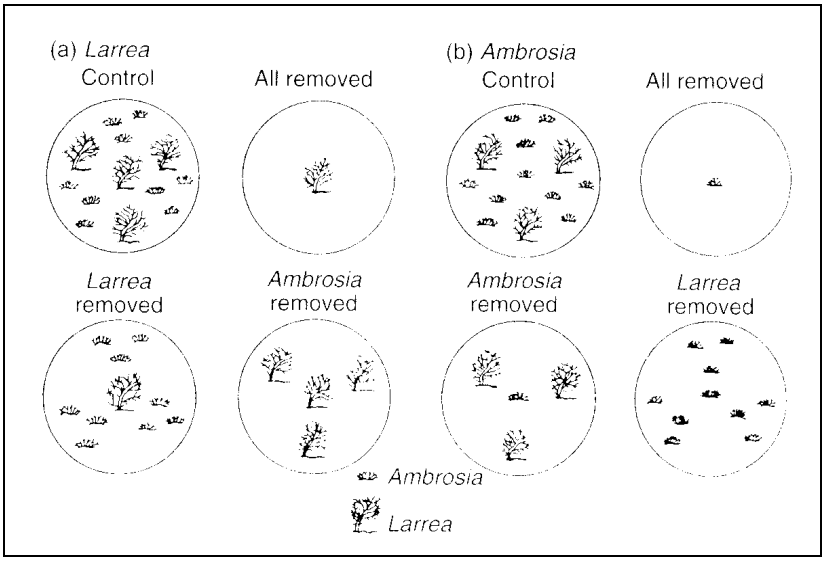


Figure 2.13 A removal experiment in desert shrubs

(Source: Fonteyn and Mahall 1981)

Resources gradient technique

The resource gradient technique is another approach for measuring the intensity of competition in biology. The rationale for this approach is that species have to own environmental resources, as without which they cannot survive. On many occasions, the density of species varies along resource gradients like soil depth, nutrient availability,

standing crop, and topography. The experiment shown in Figure 2.14, for instance, illustrates that the competition intensity ascends isochronously with the increase in fertilizer, whichever intraspecies competition or interspecies competition.

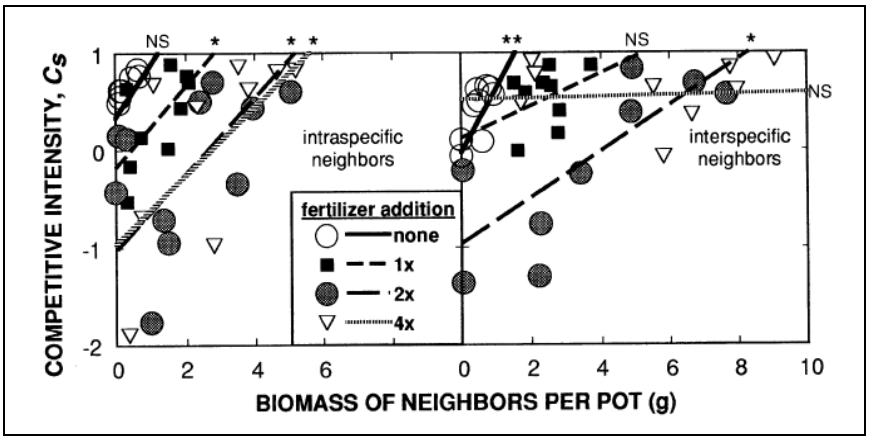


Figure 2.14 A biological experiment by using resource gradient technique

(Source: Miller 1996)

2.3.2 Competition intensity measurement in economics

The measures of competition intensity in economics were identified in this study using two ways, namely online search and traditional library research. Online resources were browsed via search engines like google.com and yahoo.com to understand the upfront research on the subject of competition intensity. The library research was executed in some major academic databases including ASCE research library Blackwell Synergy, EBSCO-HOST, Emerald IngentaConnect, Informaworld, JSTOR Search, ProQuest, ScienceDirect, Westlaw, and Wiley InterScience.

The online search led to the identification of a great deal of research particularly in the areas of biology and economics. Among the relevant literature in the economics

discipline, many research works have been conducted to promote the awareness of the impact of competition intensity on business performance. For instance, Kim (2007) presented that more competition encourages more innovation among the incumbent. Singh (2002) claimed that the intensity of competition in business market in the developing countries is no less than that in advanced countries. Koskela and Stenbacka (2005) revealed that intense product competition increases the level of negotiated wage. Nevertheless, it is found that little online research information is available for the subject of competition intensity in construction.

The keywords used for library research include “market competition”, “intensity”, and “measurement.” Over 360 relevant articles were found consequently. The relevance of the literature to this study was investigated through a preliminary review of their abstracts and keywords and further marked as significantly-related and less-relevant papers. The significant references were given further examination, leading to the identification of ten typical competition intensity measures (Table 2.4), namely,

- business indicators (BI)
- concentration ratio (CR)
- density model (DM)
- market instability (MI)
- market mobility (MM)
- markup analysis (MU)
- parameterisation (PA)
- penetration ratios (PR)
- qualitative measurement (QM)

- residual demand elasticity (RDE)

These measures have been extensively examined in the literature particularly with reference to the manufacturing and service sectors. It is noted that the causal-sequential framework for understanding of competition intensity has not been well incorporated into the formulation of the identified measures. Instead, these models reflect to some extent competition status by using resultant indicators of competition such as market share distribution, markup level (sequential aspect of competition intensity), whilst pay little attention to the factors contributing to competition intensity (causal aspect of competition intensity).

Table 2.4 Typical measures of competition intensity

Acronym	Description	Critical Model/Parameter	Reference
BI	Employing business performance indicators such as profit rate to reflect the degree of market competition	Rate of profit price level annual revenue	(Domowitz *et al.* 1986; Nickell 1996)
CR	Using the concentration of the market shares occupied by a few firms to measure the level of competition intensity	S_i, market share of firm i n, firm number	(George 1967; George 1972; Egghe 2005)
DM	An increasing density of organisations in a market will enhance the intensity of competition induced by the organisations	$p_{kj,}$ the probability that organisation j and k compete for the same resources w_j, a coefficient of proportionality	(Hannan 1986; Barnett 1997)
MI	Using the stability of one market status to indicate a level of	S_i, market share of firm i n, firm number	(van Kranenburg

	competition intensity. The larger the MI value, the more intense the competition in the market		2002)
MM	Referring to the transferring process of market shares from one firm to another. The larger the MM, the higher the level of competition intensity	*M*, Magnitude of market share shifted *P*, Patterns of market share transferred	(Baldwin and Gorecki 1994)
MU	Using the markup indicator to indicate competition intensity. The larger the MU value, the lower the competition intensity	*P*, output price *MC*, marginal cost	(Pepall *et al.* 2002)
PA	Measuring the degree of competition intensity by using single parameter	*N*, competitor number *t*, consumer travelling cost	(Boone 2001)
PR	Using this indicator to show that larger import penetration ratio indicates that local producers face huger competitive pressure from foreign firms	The percentage of imports comparative to domestic demand	(OECD 2005)
QM	Calculating the level of competition intensity by using respondents' answers on 7-scale points	Cardinal number	(Khandwalla 1972)
RDE	Being used mostly in the international trade and can be identified by the exchange rate shocks which rotate the supply relationship of the source-country export group relative to the competitors located in other countries	Market demand	(Goldberg and Knetter 1999)

2.4 Summary

This chapter presents a comprehensive review on the subjects of competition and competition intensity by addressing the relevant terminologies in economics and biology. The review shows that competition in these two domains has some common implications. For instance, the term competition fundamentally means the struggle of individuals or organisations for common objects, and it can be examined from a causal-sequential perspective. In addition, the competition of species for natural resources is closely similar to the competition of business firms for market shares.

The review of the attributes of competition in economics suggests that business competition can be either a static status demonstrating the results of market operation or a dynamic process accounting for the changes of market statuses. A perfectly competitive market has been claimed to be more efficient in resource deployment than those markets with less competition. Thus, it is good to use competition as a tool to analyse whether market structure and market policies are appropriate.

The review particularly reveals that competition intensity measures are many in the domains of biology and economics. Whilst biological competition intensity can be measured from the causal and sequential perspectives, their broad application in laboratory experiments mirrors their effectiveness in the measurement. By contrast, measuring competition intensity in economics has been conducted largely by adopting some resultant indicators of market competition. To summarise, these understandings establish an important theoretical basis for undertaking this study and stimulate the

author’s interests in considering whether the measurement of competition intensity in construction can be performed in the same methodologies adopted in biological and economic disciplines.

CHAPTER 3 COMPETITION AND COMPETITION INTENSITY IN CONSTRUCTION MARKET

CHAPTER 2 presents the theoretical understanding of competition intensity. This chapter addresses the implications of competition and competition intensity in the construction context.

3.1 Competition in Construction Market

3.1.1 Key elements of construction market

Researchers have indicated that a market is usually composed of the "5P" elements, namely, participant, place, product, price, and policy (Kotler and Keller 2009). Construction sector is no exception. The key elements of construction market can be described by using the same "5P" as shown in Figure 3.1.

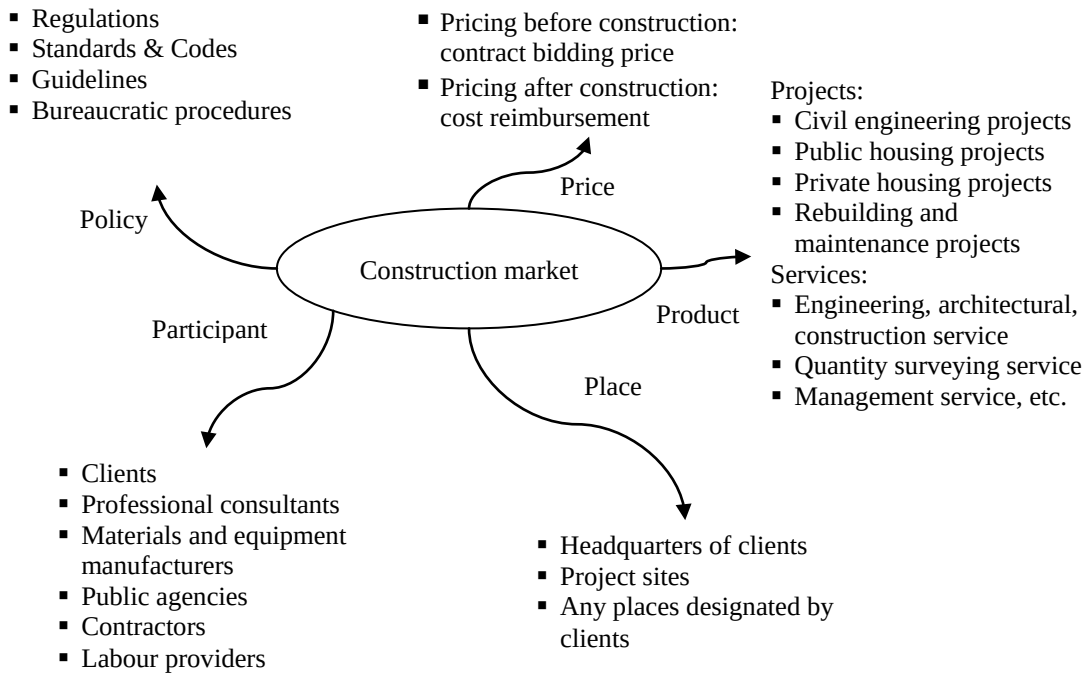


Figure 3.1 Key elements of construction market

Construction industries differ notably from each other in many respects but have business transaction process in common. Major steps of this process are described as follows. Construction clients or their consultants first lay down investment intention and

develop design drawings which specify the form, components, and size of the prospective projects. Then, they decide the choices of contracting, invite contractors to bid for the project contracts, and do examination on the qualification of contractors. Furthermore, subcontractors, management contractors, materials suppliers, specialists, and labour contractors will be determined once the main contractor is appointed.

Construction projects are built for specific purposes and fixed to the ground where they are produced. Civil engineering projects provide infrastructure facilities to the human community. Residential projects offer shelters to people. Industrial facilities are built to facilitate business activities and enlarge the capacity of productivity. Maintenance works serve to repair and rebuild old buildings. Owing to geographic features, construction products show close similarity to the products of manufacturing industry in cyclical production, service sector in customer base, agriculture in exposure to weather, and transportation and mining industries in potential dangers (Bosch and Philips 2000).

The attributes of construction products can be either physical projects or pure contracting services or a hybrid of both (Egemen and Mohamed 2006). Construction production factors including technologies, materials, labour, expertise, and managerial entrepreneur are usually assembled on project sites. The on-site assembly leads production factors to shift from factories to project sites, from project to project, and from time to time. Thereby, different assembly methods and construction components can result in different construction costs.

Another entity participating in construction market is the government with dual roles, namely, the purchaser of public facilities and the market administrator (Finkel 1997).

By using policies in regulating the operation of local construction markets, the government strives to be in the balance between the two roles.

3.1.2 Construction demand

In the construction sector, those who make the demand are clients and those who respond to clients' demand by supplying construction products are contractors (Myers 2004). Competition in construction market occurs largely among contractors who want to do business by serving clients' demand.

The term "market demand" in economics means the effective demand backed by the purchasers' affordability. It indicates the purchasers' willingness to buy homogeneous products/services at certain prices. Market demand is affected by a number of factors such as gross domestic production, population, the income and expenditure of households, consumer price index, and taxation. A higher price of good/service indicates a lower quantity demanded.

The demand in construction market is heterogeneous, project-based, and client-tailored. On the other hand, construction projects are usually huge in size, immobile, indivisible, and exposed to weather. Market demands in construction arise when clients present a project specification in terms of quality, time schedule and budget to the market. Contractors who are interested in the to-be-constructed projects then register for the competition. As not all registered contractors are always suitable to undertake construction projects, candidate contractors are carefully filtrated until the most competitive are determined. Once the list of qualified contractors is produced, project bidding competition commences. Therefore, contractors' competition stems from

construction demand and there are two tiers of competition, namely, the competition among candidate contractors who register for qualification examination and the competition among qualified contractors who are allowed to bid for project contracts.

The volume of construction demand in the long run is predictable subject to a variety of factors (Tang *et al.* 1990; Goh and Teo 2000). For instance, factors affecting the demand for owner-occupied housing include current housing price, price of other housing forms, the change of income, government incentive, demographic factors, and the price of associated goods and services (Myers 2004). By contrast, construction demand in the short term is inelastic to the changes in construction price (Rawlinson and Raftery 1997; Akintoye *et al.* 1998; Kim and Reinschmidt 2006), indicating that estimating a recent construction demand is usually fraught with difficulties (Ofori 1990).

3.1.3 Construction supply

The term “market supply” in economics refers to the effective supply backed by firms’ willingness to sell their products at certain prices. Businesses are usually reluctant to provide their products to the market if prices are not profitable. Construction supply can be indicated by the production capacity of all construction firms over a specific duration of time in a given market; whilst to a project, it can be reflected by the production capacity provided by contractors who are eligible to submit their tenders for the project bidding competition.

Construction suppliers normally do not have a finished goods inventory that can work as a buffer against demand uncertainty (Kim and Reinschmidt 2006). Like a film set, they engage in construction activities, complete the projects, and then leave for another

location for “similar” works of other clients (Myers 2004). The construction industry has low entry barriers, facilitating small- and medium-sized construction firms to do businesses (Drew and Skitmore 1997; Ball *et al.* 2000). Therefore, the production capacity of the industry is adjustable in the long run.

The price elasticity of supply measures the relationship between the supply quantity of a given product and a change in the product price. When the elasticity is less than 1, the market supply is inelastic; when greater than 1, the supply is elastic; and when equal to 1, the supply is unit-elastic. Previous research has demonstrated that the elasticity of construction supply in the short run is less than that in the long term (Ball *et al.* 2000), suggesting the changes of prices have less impact on the short-run supply than the long-run supply in construction market.

3.1.4 Determination of construction contract price

As indicated in Figure 2.6, the price of goods is determined by the downward-sloping demand curve and the upward-sloping supply curve. This is also the case in the construction sector. However, neither construction demand nor construction supply is predictable in the short run as presented above, suggesting that there is a special method of determining construction price.

First, construction markets are price competitive (Ball *et al.* 2000), as they run more like Bertrand competition (Figure 2.5). According to the Bertrand model, contractors cannot usually change the bills of quantities provided by clients to strike a good construction bargain. Instead, what contractors initially need is to design a competitive tendering price to ascertain that they can outperform their competitors.

Secondly, pricing a construction project can be a lengthy process. It is fairly difficult at the very beginning to know what the actual cost will be until the completion of the project construction. Therefore, the competition for a bidding price or bargaining price is to obtain a negotiated preliminary budget for a series of construction activities in the future.

Thirdly, clients have major influence on the pricing process as well as the competition behaviours of contractors. By establishing project bidding procedures, the roles of the clients ranging from project inception to project completion resemble the game rulers. Simultaneously, contractors act as game players to bid for project contracts by complying with the procedures.

3.1.5 Competition in construction: bidding for contract

The characteristics of construction market are subject to the type of construction work, geographical location and the nature of clients (Briscoe 1988). The interaction between construction supply and construction demand in the short term suggests that construction competition mostly refers to construction bidding activities (Kim and Reinschmidt 2006). Thus, the interaction of demand and supply, pricing methods, and project competition experienced by contractors can be the factors that affect construction competition.

Contract bidding activities are usually administrated by clients and performed by the consultants. Among various bidding procedures for project contracting, construction competition serves to determine quality project undertaker. In accordance with the

elementary market law, if considerable suppliers compete to serve a small number of demanders, there will be a drop in the price of the service provided. Nevertheless, this may not be absolutely true in construction market.

Whereas bidding activities are implemented by consultants, the complexity of construction bidding highlights the importance of clients' close involvement. The more bidders participating in the project competition, the more attention that clients have to pay. Indeed, it is an artistic process for clients/consultants to determine the appropriate number of project competitors and the intensity of project competition to lower tendering cost as much as possible. However, what constitutes the ideal number of contractors in construction contract bidding is debatable (Merna and Smith 1990; Carr 2005).

3.2 Major Elements of Construction Competition

3.2.1 Methods of construction competition

The procedure of construction bidding usually involves bidding invitation, bidder prequalification, bid submission, and post-bid negotiation. The key to the procedure is the choice of methods for understanding contractors' competitiveness. There are three methods broadly adopted in practice as presented below.

Classical method

The most commonly used method is the "lowest-best" approach, in which the contractors who submit the lowest bids are considered the best to the clients, enabling those contractors who have cost leadership to be chosen finally. This approach has

received considerable application, but the major drawbacks include schedule delays, poor quality, and increased costs due to contractors' accidental or deliberate submission of unreasonable prices (Sturts and Griffis 2005). Furthermore, overemphasis on the construction cost will be at the expense of construction quality (Grogan 1992; Ioannou and Leu 1993; Lo *et al.* 2007).

Average bid method

The average bid method was designed to soften stiff price competition and to compensate for the shortage of the classical method presented above (Ioannou and Leu 1993). By using this method, the contractor whose price is closest to the average of all bids submitted will be awarded the construction contract.

A+B bidding method

This is a bidding practice that contractors bid for contract not only on the cost (A) but also on the time (B) (EI-Rayes 2001). The lowest combination of the construction cost with the required schedule establishes the winning bid. Empirical studies have demonstrated that this method contributes to achieving substantial savings in construction time with rarely additional cost (Herbsman 1995). Another method similar to the A+B bidding method is the two-envelope bidding (Drew *et al.* 2002), in which bidders are required to submit one envelope containing the technical proposal with a second envelope containing the fee budget.

The subject of competitive bidding has been researched for decades (for example, Friedman 1956; Teo and Scott 1994; Dawood 1995). Research in this area appears to have solved two major questions about whether to bid and how to bid (Marzouk and

Moselhi 2003; Kim and Reinschmidt 2006). Numerous models including mathematical models, judgmental approaches, expert system, information technology, multi-attribute utility, analytical hierarchy, and artificial intelligence have been used to propose solutions to the above two questions (Moselhi *et al.* 1993; Teo and Scott 1994; Dawood 1995; Marzouk and Moselhi 2003; Skitmore and Runeson 2006). However, the proposed solutions seem to be of limited effectiveness in facilitating practical decision-making in construction bidding activities.

3.2.2 Decision on construction competition

Contractors' decision to bid for project works is dependent upon many factors including the need for the work, the number of competitors, experience and speciality, the size and value of the contract, the complexity of construction or managerial techniques, market conditions, bidders' workload, and the type of the client (Flanagan and Norman 1982; Drew and Skitmore 1992; Dawood 1995). Subject to the impact of these factors, construction bidding decision is therefore a very complicated process.

A good decision on bidding helps win project competition (Moselhi *et al.* 1993; Fayek 1998). Nonetheless, there is a lack of objective criteria for effective decision-making. An alternative bidding decision is to strike a balance between a bid price as competitive as possible to win the job and practically as high as possible to maximise profit (Dawood 1995; Chapman *et al.* 2000).

Once deciding to compete for project works, contractors have to price the contract bids (Singh and Shoura 1996; Lo *et al.* 2007). Guides on better pricing have been suggested to allow for contingency values according to bidders' perception and attitude towards

potential risks (Drew and Skitmore 1992). Mathematic methods such as the probabilistic approach, the neo-classical micro-economic method, and the unbalanced bidding method have been demonstrated useful to promote the performance of construction pricing activities (Ngai *et al.* 2002; Cattell *et al.* 2007). However, pricing a construction contract is not an easy task.

Pricing bids correctly means determining an optimal markup level (Dawood 1995). The optimal markup level can usually be decided by a number of exogenous factors such as works in hand, bids in hand, availability of staff, profitability, ability of architect or other supervising officer, contract conditions, site conditions, construction methods and programme, market conditions, and the identity of other bidders (Drew and Skitmore 1992). There are some methods for determining the level of markup such as using the fuzzy set theory and risk adjustment method to decide an appropriate markup (de Neufville and King 1991; Fayek 1998), but it is criticised that few of them are adequate enough to underpin decision on an optimal markup in practice (Moselhi *et al.* 1993).

3.2.3 Competitiveness of construction competitors

Since the optimal markup cannot be determined practically, researchers have pointed out that experience and intuition can promote contractors' competitiveness by facilitating contract pricing (Fayek 1998). For instance, due to experience and intuition, small bidders prefer to bid on small projects in both type and contract value, whilst large bidders are more successful in bidding for large projects (Flanagan and Norman 1982). Furthermore, contractors entering consistently low bids are considered more competitive than those entering consistently high bids, although mistakes in construction price determination might happen occasionally (Drew and Skitmore 1992;

Drew and Skitmore 1997).

Drew and Skitmore (1992) discovered the positive relationship between the competitiveness of contract bids and particular types of projects. Fu *et al.* (2003) revealed that experienced contractors are more competitive than inexperienced contractors on contract bidding. Indeed, bidders' competitiveness varies with cost estimates, markup policies, costing errors, regional market conditions, workload, and client type (Flanagan and Norman 1985; Drew and Skitmore 1997).

3.2.4 Construction market conditions and competitors' behaviour

Market analysis is not usually incorporated into the development of bidding models. However, empirical studies have shown the positive impact of market conditions on the determination of project bidders (Ngai *et al.* 2002). Kim and Reinschmidt (2006) found that the success of bidders in project competition relies on their long-term interaction with the market and their competitors. Ngai *et al.* (2002) gave a valuable explanation on the way that market conditions affect the competition behaviours of bidders as well as the effectiveness of construction bidding as presented below:

> "…the market conditions affect at least the contractors' bid prices and number of competitors for a project … (for instance) in a boom period … when there are more projects available in the construction market, contractors generally bid for projects at higher profit margins, and competition for projects is relatively less intense. In a slump period with fewer project available, contractors bid lower than in the boom period, and competition becomes more intense…" (Ngai *et al.* 2002).

3.3 Insights into the Characteristics of Competition Intensity in Construction

3.3.1 Two types of construction competition intensity

Competition is an everlasting and all-pervading theme in market economy. As presented in Section 2.2, competition intensity can describe to a certain extent the competition status in a business market from overall market competition or individual product competition. Porter (1980) stated that competition intensity is a consequence of market operation and can be affected by market structural factors such as industry growth, product differentiation and market exit barriers. This offers a view of competition intensity from the perspective of market level. Meanwhile, Bonanno and Haworth (1998) examined the intensity of individual product competition in business market and identified that the intensity can affect firms' choice between product innovation and process reengineering. This gives a product-based notion of competition intensity.

Devine *et al.* (1985) pointed out that a market is composed only of homogenous standard products. Therefore, the degree of overall market competition refers to the aggregate of considerable individual product competition over a period of time. However, this is not fully the case in construction industry, where the market is geographical, fragmented, and hierarchical, and mostly because construction projects as "products" of the market are basically unique, one-off, untransportable, and client-based (Gruneberg and Ive 2000; Langford and Male 2001). It is thus considered that competition intensity in the construction industry can be divided into two parts, namely, project competition intensity (PCI) and market competition intensity (MCI).

3.3.2 Relevance between the two types of construction competition intensity

A substantial number of studies have been devoted to examining MCI (Gort 1963; Porter 1980; Goldberg and Knetter 1999; Oster 1999; Boone 2001; Chiang *et al.* 2001; Mccloughan 2004), whereas little effort has been given to the examination on the subject of PCI. It has been pointed out that PCI attributes can be identified from three angles: tendering procedure, competitors' behaviours and results of project competition (Ye *et al.* 2008). Tendering procedure lays down the rules for the development of PCI. Competitors' behaviours therein cause the change of PCI in degrees, whilst the results of project competition show the performance of PCI. Different levels of PCI can lead to different outcomes of project competition. A low degree of PCI might enable a few contractors to control and eventually win the project competition, whilst small contractors find it difficult to survive from an extremely high level of PCI.

It can be demonstrated that there are two sorts of PCI: overt and covert, as shown in Figure 3.2. In overt aspect, PCI addresses a superficial degree of project competition that is misleading in presenting actual degree of project competition. On the other hand, the covert dimension of PCI reveals underlying degrees of project competition that can be utilised by some major project competitors. Therefore, covert PCI deserves more attention than overt PCI.

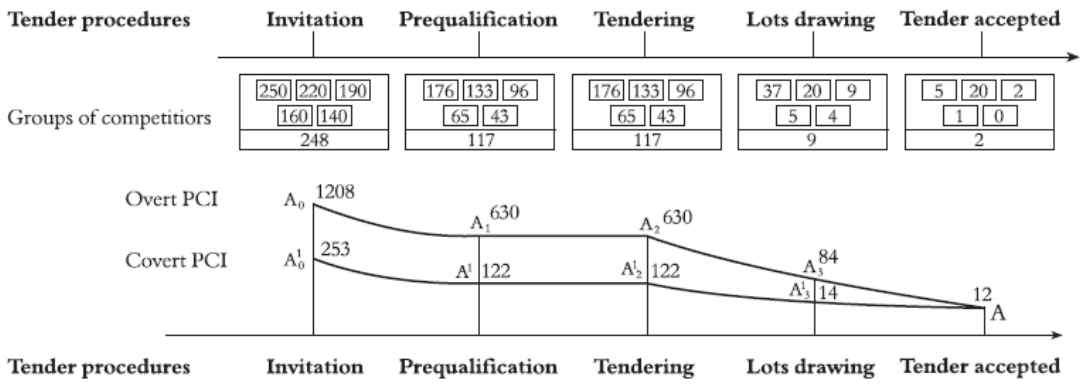


Figure 3.2 PCIs: overt and covert

Note: the data in the graph shows the degrees of PCI at various stages.

(Source: Ye *et al.* 2008)

To a certain degree, PCI reflects project competition occurring among contractors normally at earlier stages of project construction. It varies with the peculiarities of construction projects and clients' requirements of project construction. In these ways, PCI is different from MCI. For instance, the degree of competition for public projects (as PCI) may be very intensive, whereas the overall market competition (as MCI) can be very low, although the latter comprises both private and public sectors of construction competition.

3.3.3 Significance of understanding construction competition intensity

As presented above, construction competition occurs among contractors when bidding for specific project work contracts. Therefore, PCI mirrors the level of project bidding competition, and its results are the choices of project winners who are expected to satisfy the need of the clients best. PCI is attributable to competition for individual projects and seems comparable between different projects, but it makes no sense if aggregated project by project.

As an overall reflection of construction business competition, MCI is not determined by a particular type of project competition. By contrast, it can be affected by a number of market structural factors probably including market size, market demand, and tendering price index. To summarise, these two types of competition intensity in construction market can be characterised comparatively as shown in Table 3.1.

Table 3.1 Difference between PCI and MCI

Aspect	PCI	MCI
Competition definition	▪ Strife for common objects ▪ Price competitive ▪ Project bidding activities	▪ A state of competition ▪ "Invisible hand" of market force ▪ A market structural variable
Purposes	▪ To determine the appropriate number of project competitors ▪ To submit a competitive bid for winning project competition	▪ To know the status of market operation ▪ To promote the efficiency of construction resource allocation ▪ To choose competition strategies for business development
Results	▪ A final list of project contract winners	▪ Performance of market operation such as profitability and productivity
Comparability	▪ Between projects	▪ Between different construction markets at a given time ▪ Between different times for a given construction market
Potential determinants	▪ Market conditions ▪ Project characteristics ▪ Project participants	▪ Market structural variables

3.4 Summary

This chapter presents the development of competition and competition intensity in the construction context. Competition in construction specifies contractors' bidding activities for project contracts. The application of the demand-and-supply market law in construction is represented by three typical methods, namely, the classical method (lowest price), the average bid method, and the A+B method. These methods constitute major game rules of construction competition. Contractors' competition behaviours in response to these game rules are the submission of competitive bids to clients. To compete well against the competitors, contractors have to price the contract properly, highlighting the important role of pricing methods, experiences, intuition, and competitiveness. The results of construction competition lead to the determination of final contractors who are most suitable to undertake project construction.

The attributes of construction competition underpin the recognition of two types of competition intensity in the market, namely, PCI and MCI. MCI is different from PCI in describing competition meanings as well as implications in construction. PCI presents a classic, dynamic, and processive version of construction competition, whilst MCI conveys an overall state of construction competition at an interval of time. Thus, most of the competition intensity measurements are used to reflect the degree of MCI, and this study will give more weight to the study on MCI.

CHAPTER 4 MEASUREMENT OF COMPETITION INTENSITY IN CONSTRUCTION MARKET

The previous chapter has presented the implications of competition intensity in construction market. This chapter concentrates specifically on evaluating the effectiveness of existing competition intensity measures in the construction sector as well as a pilot study aimed to promote the measurement in construction.

4.1 Existing Measures of Competition Intensity in Construction

4.1.1 Applicability of general competition intensity measures to construction market

As demonstrated in Table 2.4, competition intensity can be measured in many ways. However, the applicability of the existing measures to construction market is dependent on whether they can take account of the characteristics of competition intensity in construction. Therefore, Table 4.1 gives an initial recognition of the applicability, whilst leaves the evaluation in the subsequent sections.

It seems from Table 4.1 that competition intensity in construction market can be measured by using five methods, namely, BI, CR, MI, MM, and PA. These methods in the domains of construction practice respectively refer to tender price index (TPI), concentration ratio (CR), market mobility/instability, and competitor number, as presented below.

4.1.2 Tender price index

Previous studies have revealed that tender price underpins clients' final decision on the choice of contractors in spite of a growing need for a shift from "lowest-price wins" to "multi-criteria selection practices" (Wong *et al.* 2000). The rationale behind this lowest-price method is due to its potential cost saving of money for construction clients. Therefore, tender price indices (TPIs) have been widely compiled at regular intervals to indicate construction cost level (Fitzgerald and Akintoye 1995). The base index is usually 100 for the tender price level of construction works at a past point in time.

Table 4.1 Applicability of the existing competition intensity measures to construction market

Measure	Applicability	Justification
BI	YES	Construction competition determines the performance of construction businesses directly. A high level of competition intensity increases the difficulty of obtaining project contracts and lowers the industry profitability at the same time (Porter 1980)
CR	YES	The contractors who have large market powers can be more able to overperform their competitors and control more shares of market resources, leading to the variation in the concentration of market shares
DM	NA	Since DM is a resource-based measure of competition intensity, it is more applicable to the level of individual project competition (PCI) rather than the level of market competition (MCI)
MI	YES	As a result of construction competition, the distribution of market shares among contractors keeps changing. By reflecting the stability of a particular distribution status, it is expected that the competition intensity in the construction market can be observed
MM	YES	The changing process of market share distribution can additionally be reflected by using the indicator of MM. Likewise, MM is expected to be able to measure competition intensity in construction market
MU	NA	Projects in construction market are heterogeneous, suggesting that components of construction cost per project are different. This undermines the quantification of MU variables in the construction context
PA	YES	More contractors participating in construction competition can enhance the degree of competition intensity in the market
PR	NA	PR serves to measure competition intensity in the area of international trade, whereas the model variables make no sense in

		domestic construction markets.
QM	NA	It is practical to use QM to examine the competition status in a given construction market. However, the way of data collection by using the Likert scale might not be rigorous for much research such as this study
RDE	NA	The same to the PR approach

Note: NA – Not available.

Fierce competition for construction businesses causes contractors to price their services/products as low as possible, resulting in a smaller TPI. In turn, a decrease in TPI can be a snapshot of descending project cost due to intensive competition in the market. Thus, a set of TPIs can reflect the fluctuation of market competition conditions (Ng *et al.* 2000). As shown in Figure 4.1, for instance, the markets in Points A and C can be of more competition than the market in Point B.

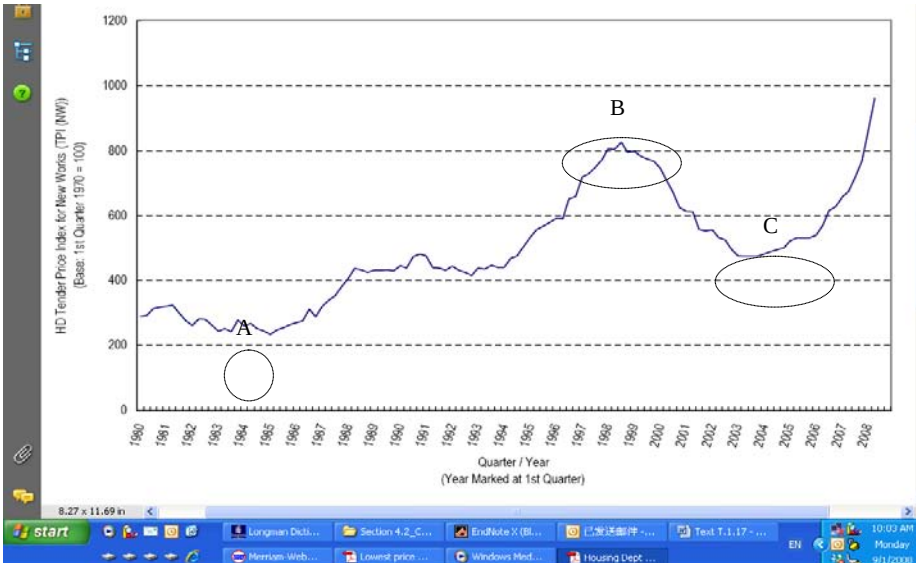


Figure 4.1 Tender price index for new works in Hong Kong

(Source: Hong Kong Housing Authority 2008)

This indicator, however, is not good enough to present competition intensity in construction market. One major reason is that the variation in TPI can be attributed to many factors including economic inflation, cyclical fluctuation of cost, and market competition. It is quite difficult, if not impossible, to identify the influence of competition on the development of TPI. As a result, this study did not take further analysis on the capability of TPI in reflecting the level of competition intensity.

4.1.3 Concentration ratio

Concentration ratio (CR) depicts the extent to which market shares allotted among existing firms in a given market (Nelson 1960; Weiss 1963; George 1967; George 1972; Egghe 2005). CR assumes a value between 0 to 1. By assuming the value of 1, it indicates a monopolistic market structure, whilst the value of 0 refers to an absolute competition (Table 2.2). For example, van Kranenburg (2002) employed the model CR_4 to address the magnitude of market shares owned by the four largest firms in an industry. It is suggested that if CR_4 is close to 0, the industry is of perfect competition. On the other hand, when CR_4 is near to 1, it means that the market has little competition.

Many research efforts have been made to develop CR measures, leading to a variety of mathematical models as listed in Table 4.1.

Table 4.2 Models of concentration ratio

Method	Description	Model Expression	Reference
CR_n	Aggregating the market shares of the *n* largest firms, where *n* can be 4, 8, 12, 16,	$CR_n = \sum_{i=1}^{n} S_i$	(Adelman 1951; Baldwin and Gorecki 1994;

	20, and 50		Wang 2004)
Herfindahl Index, HI_n	Accumulating the market shares of the *n* largest firms by weighting the market sales	$HI = \sum_{i=1}^{n} S_i^2$ Or $HI = 10000 \times \sum_{i=1}^{n} S_i^2$	(Ghosh 1975; Davies 1979; van Kranenburg 2002)
Entropy, EN	Measuring the degree of disorder, uncertainty, or randomness to reflect competition intensity	$E = \sum_{i=1}^{n} S_i \log(1/S_i)$	(Davies 1979; Sawyer 1985)
Numbers-Equivalent, HNE_n	Measuring the number of equal-sized firms which can generate similar degree of competition as indicated by HI_n	$HNE = 1/(\sum_{i=1}^{n} S_i^2)$	(Adelman 1969; White 1973; Chiang *et al.* 2001)
Gini Coefficient, GC	Measuring the extent to which business firms in a market are unequal in firm size	$(1/n)\sum_{i=1}^{n}(n-2i+1)S_i$ $V = \sum_{i=1}^{n}(\log S_i / \overline{S})^2 /(n-1)$	(Guth 1971; White 1973; Ghosh 1975; Sawyer 1985)
Hall-Tideman Index, HT	Weighting each firm by its rank and the absolute number of firms	$HT = 1/(2\sum_{i=1}^{n} rp_i^2) - 1$ Where, *n* = number of firms in the industry; *r* = the rank of each firm, and p_j = decimal fraction of the output per firm	(Hall and Tideman 1967)
MA	Estimating the concentration ratio based on publicly grouped data	$C_k = 1 - F_1(F^{-1} \times (1-(k/n))$ Where, C_k is the k-firm concentration ratio; $F_1(x_k)$ is the first moment cdf at x_k.	(Mccloughan and Abounoori 2003; Mccloughan 2004)

Note: S_i, market share of firm *i; n*, firm number

4.1.4 Market mobility and instability

Market mobility measures the transferring process of market shares from losers to winners as a result of business competition. It elaborates the industrial evolution that firms enter and exit, grow and decline. The pattern of market mobility can be measured by using Cable's (1997) model which decomposes the market mobility M_t over the time interval [0, t] as follows:

$$M_t = \sum_{i=1}^{N} (m_{i,t} - m_{i,0})^2 = \Delta H_t + 2H_0 - 2\rho\delta_t\delta_0 - 2/N$$

Where, $m_{i,0}$ and $m_{i,t}$ are the market shares of firm *i* at time *0* and *t* respectively. H_0 is the Herfindahl Index at time *0*; ΔH_t is the change in concentration measured by the Herfindahl Index at time *0* and *t*. δ_0 and δ_t denote the standard deviations of market shares at time *0* and *t* respectively. N refers to the total number of firms in the market at any point between time *0* and *t*. ρ is the correlation between market shares at successive times 0 and t; $-1 < \rho < 1$.

The parameter ρ measures the persistence of market share distribution through time (Gort 1963). It indicates the possibility that firms can maintain their relative positions in the market over time. The closer the ρ value to -1, the less the stability of the market share distribution and the larger the level of competition intensity (van Kranenburg 2002).

Entrants and existing firms are two major factors in studying special cases in market

mobility (Caves and Porter 1977), because entrants start and existing firms end with zero market share. Market mobility for the entrants and existing firms can be calculated as follows (van Kranenburg 2002):

$$M_{t,entry} = \delta^2_{entry} + \mu_{entry} \sum_{i=1}^{EN} m_{i,t} \ , \ m_{i,0} = 0, \ and \ m_{i,t} > 0$$

$$M_{t,exit} = \delta^2_{exit} + \mu_{exit} \sum_{i=1}^{EX} m_{i,t} \ , \ m_{i,0} > 0, \ and \ m_{i,t} = 0$$

Where, *EN* includes all new entrants in the time period; δ^2_{entry} is the variance in entrants' market shares, μ_{entry} refers to the mean of entrants' market shares; $\sum_{i=1}^{EN} m_{i,t}$ denotes the joint market shares of entrants in the industry; *EX* includes all existing firms in the time period; δ^2_{exit} is the variance in existing firms' market shares, μ_{entry} refers to the mean of existing firms' market shares; $\sum_{i=1}^{EX} m_{i,t}$ denotes the joint market shares of exiting firms at time 0 in the industry.

4.1.5 Number of market competitors

Competitor analysis occupies an important position in the development of business strategy (Chen 1996). As a key issue of competitor analysis, competition intensity is affected by many factors including government, history of the market, existing rivals, potential competitors, substitutes, suppliers, and buyers (Porter 1980; Oster 1999). To measure the degree of competition intensity, researchers have suggested using the indicator of competitor number, as shown in Figure 4.2.

In the discipline of economics, business markets with high levels of competition are

populated with more firms than those close to monopoly, indicating that firm number can be a surrogate for competition intensity. For instance, a larger number of firms competing for common businesses can give rise to a higher level of competition intensity. Therefore, it has been suggested in construction economics that competition intensity in the industry can be mirrored by using the likely number of potential contractors for projects (Runeson and Bennett 1983; Ngai *et al.* 2002). A larger number of potential contractors present a higher level of current rivalry in the market.

Competitor number is a fast-track indicator for knowing competition status in a given market. The inadequacy of this indicator, however, is due to its incapability of presenting the dynamics of construction competition. Different markets have different composition of competitors, and the market power which each competitor wields varies across markets (Montgomery 1985). Simply employing competitor number to illustrate the level of competition intensity is not sufficient in construction market. For instance, the competition intensity between two contractors for one project differs from that for ten projects. Therefore, this indicator has no further analysis in this study for testing its applicability to construction market.

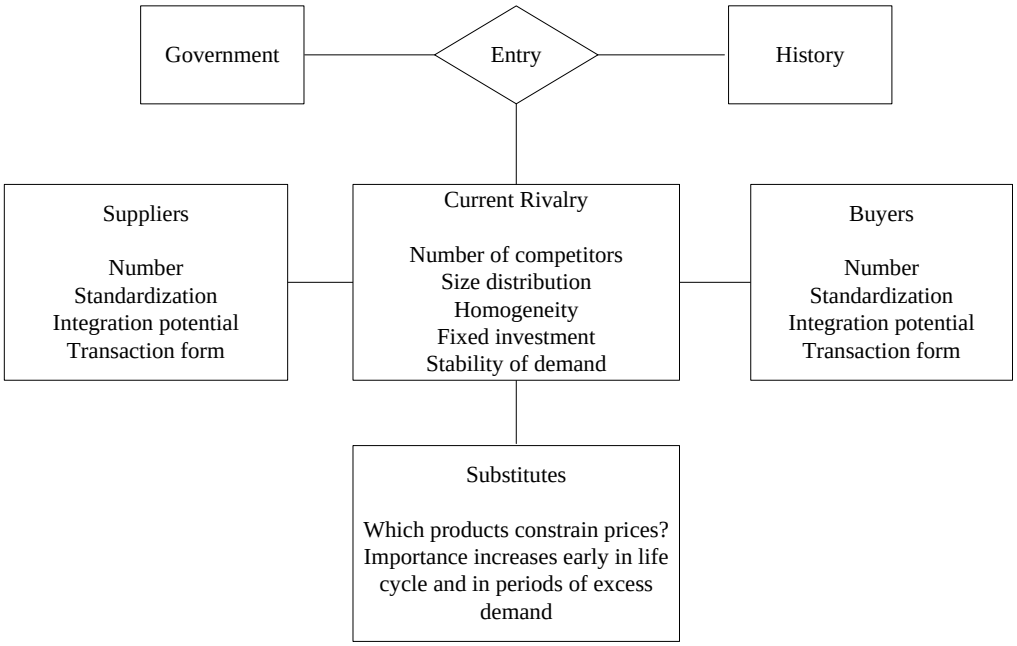


Figure 4.2 An extension of Porter's five-force model

(Source: Oster 1999)

4.2 Evaluating the Effectiveness of the Existing Measures

The study by Chiang *et al.* (2001) adopts the measure of concentration ratio to reveal that high technological and capital requirements in Hong Kong's civil-engineering market have caused a concentrated market structure. By using publicly grouped data, McCloughan (2004) demonstrated an alternative concentration approach in presenting a dynamic and fragmented structure of the British construction market. There are still other related studies conveying the parallel findings that many construction markets have become fragmented with stiff competition (Langford and Male 2001; Wang 2004).

It seems that the measurement of competition intensity in construction market has been conducted largely by using concentration approaches due to the fragmentation attribute of the market. The fragmentation of construction market can be evidenced by the fact

that a majority of contractors usually possess a very small proportion of market shares (Finkel 1997). To a large extent, the fragmentation feature further implies the substantial difficulty in collecting data about the market shares of individual construction firms, weakening the applicability of many competition intensity measures to construction market as a result. On one hand, it is quite impossible to count precisely the firm number in a given construction market with the involvement of considerable informal organisations (Wells 2007). On the other hand, the disclosure of firm information such as annual revenue can be deemed as breaching laws with respect to the protection of privacy interests.

Notwithstanding five measures, it seems that concentration ratio, market instability, and market mobility are applicable to construction market. They were evaluated as presented below to identify the efficiency in the construction setting.

4.2.1 Concentration ratio

With reference to the size of firm number (*n*) calculated, concentration measures can be divided into two groups, namely, absolute measures that account for all firms and relative measures that illustrate only a few of the largest firms. Therefore, in accordance with Table 4.1, EN, GC, HT and MA are absolute, whilst CR_n, HI_n and HNE_n are relative. These two types of concentration measures have various strengths and weaknesses in application to construction market. The identification of these strengths and weaknesses is based on studying the data collected from a large local construction market in China, the Chongqing construction market.

In Chongqing, there was an average of 1680 construction firms over the five-year period

(1997 to 2001), but only the revenues of the top 50 contractors had been published as shown in the appendix Table a. 1 (Chongqing Statistics Bureau 2002). As the full set of data for all construction firms in the market is not available, the absolute concentration measures in this case cannot be calculated. To resolve this difficulty, a random number generator was employed to generate a full set of data that can represent a complete construction market. The syntax '= RANDBETWEEN (LOW, HIGH)' (where, LOW refers to the lowest integer the function returns, and HIGH is the highest number the function generates) in Microsoft Excel 2003 is adopted as the random number generator for this purpose. This random function yields a series of numbers through a mathematical relationship by simulating "randomness." It has been demonstrated useful in simulating dice rolling in the construction discipline (Ye *et al.* 2008). Nonetheless, stochastic factors in the process of random number generation may cause data volatility and variable model results. To ascertain the effectiveness of this generator, the generation of random numbers was performed and tested for more than ten times.

The data generated per set were analysed to find out their effectiveness in presenting the fragmentation nature of construction market. In line with the definition given in previous studies (Briscoe 1988), a construction market is considered fragmented if the size of the largest firm thereof is very small in relation to the whole market. A representative random data set is cited as shown in Table a. 2, within which the largest firm has less than 0.7 percent market shares in the five years. Furthermore, the removal of the largest firm cannot impose significant change on the market shares occupied by the remainder firms. This gives the suggestion that the simulated market is of fragmentation. To illustrate, the following section is presented based on this example data set.

The absolute concentration measures including EN, GC and HT are calculated according to their equations (Table 4.1). Since the model MA can not mirror the full contents of competition intensity, it has not been analysed in this study. The variable *n* in the relative concentration models can be determined in line with various research purposes. For instance, it refers to the top three firms in the United Kingdom, and it can be the 4, 8 and 20 largest firms in the U.S.: both favour the measurement of competition intensity in manufacturing or service industries (Utton 1970). Accordingly, the 4, 8, 12, 16, 20, and 30 largest construction firms were analysed in this study to scrutinise the effectiveness of the relative measures. Results of the analysis are listed in Table 4.3, in which the lowest and highest intensity of competition are tagged respectively.

Data marked for indicating the most and least competitive years show that different concentration models can lead to different results of competition intensity. For instance, GC in the five years almost maintains a 0.3400 level, suggesting a relatively unchanged intensity of competition; whereas HT or EN shows major changes in competition intensity over the same period of time. In addition, if only the 20 or above largest construction firms are taken into account, the levels of competition intensity measured by the relative models tend to be consistent. However, there appears an obvious discrepancy in competition intensity when the 4, 8, and 12 largest construction firms are interpreted by the relative models.

Table 4.3 Test results of concentration ratio in construction market

CR	1997	1998	1999	2000	2001	Statistics			
						Mean	**Std. Dev.**	**Co. of Var.**	**CV Means**
CR_n									
4	.0205	.0208 L	.0202	.0182 H	.0183	.0196	.0013	.0645	
8	.0364 L	.0351	.0358	.0303 H	.0317	.0339	.0027	.0789	
12	.0480	.0457	.0490 L	.0404 H	.0413	.0449	.0039	.0869	.0707
16	.0570	.0548	.0583 L	.0493 H	.0499	.0539	.0041	.0763	
20	.0648	.0631	.0660 L	.0573 H	.0579	.0618	.0040	.0647	
30	.0808	.0808	.0823 L	.0732 H	.0746	.0783	.0041	.0529	
HI_n									
4	8.57 L	8.28	8.35	6.75	6.63 H	7.72	.9433	.1222	
8	46.95 L	45.18	45.32	34.35 H	36.47	41.66	5.79	.1390	
12	124.86 L	115.86	124.60	88.44 H	94.12	109.57	17.20	.1570	.0140
16	241.08	222.01	245.94 L	173.38 H	181.73	212.83	33.55	.1576	
20	394.97	366.44	406.16 L	291.60 H	302.63	352.36	52.62	.1493	
30	941.38	905.08	975.58 L	735.35 H	76.10	863.50	108.94	.1262	
HNE_n									
4	1167 L	1208	1197	1481	1509 H	1312	167.46	.1276	
8	213 L	221	221	291 H	274	244	35.87	.1470	
12	80 L	86	80 L	113 H	106	93	15.42	.1655	.1483
16	41 L	45	41 L	58 H	55	48	7.88	.1642	
20	25 L	27	25 L	34 H	33	29	4.47	.1547	
30	11	11	10 L	14 H	13	12	1.53	.1307	
EN	3.0858 L	3.1268	3.1451	3.1593 H	3.1450	3.1324	.02850	.0091	.0091
GC	.3366 H	.3424	.3400	.3440 L	.3401	.3406	.0028	.0082	.0082
MA	N/A	N/A	N/A	N/A	N/A				
HT	.6176 L	.6660 H	.6491	.6339	.6319	.6397	.0185	.0288	.0288

Note: (H) – the highest level of competition intensity; (L) – the lowest level of competition intensity.

The coefficient of variation (CV) is known for its usefulness of analysing the dispersion of points in a data series, thus enabling to differentiate the volatilities of various data series. CV was applied to this study to examine the distribution of competition intensity values derived respectively by the absolute and relative CR measures. The results can show the differences between the two types of competition intensity measures in this application. The smaller the CV value, the less the variation of data dispersion (Deep 2006), and the better the concentration model. Hence, in accordance with the CV values shown in Table 4.3, the rank of the concentration measures is GC, EN, HI_n HT, CR_n, and HNE_n. This rank reveals that the levels of competition intensity indicated by the relative measures (HI_n, HNE_n, and CR_n) are far more volatile than those measured by the absolute measures (HT, EN, and GC). For instance, variances of CR_{12}, HI_{16} and HNE_{12} are large, whilst GC values remain stable over five years. Therefore, it seems that the absolute concentration measures are more effective than the relative in measuring the degrees of competition intensity in construction market.

4.2.2 Market mobility and instability

Indices of market mobility and instability elaborate the feature of market volatility subject to firms' business competition. Nevertheless, as defined in Section 4.1.4, data for computing these two methods are particularly difficult to collect. This is because the rank of all business firms by market shares should be available for the calculation.

An alternative solution is proposed by collecting data from the US-based *Engineering News Record* (*ENR*) survey. The period spans from 2001 to 2007 considering the data availability for the top 225 international contractors. It is quite difficult, if not

impossible, to identify all contractors worldwide who operate international construction businesses, suggesting an unknown number of international contractors. As pointed out by Kaplan (1980), much of the strongest direct competition encountered by a big firm is rightly to be from other big businesses or those yet-to-be big businesses. Thus, the competition intensity between the top 225 international contractors can be a good reflection of competition statuses in the international construction market; whilst this competition intensity can be measured by examining the mobility or instability of the market shares held by the top 225 contractors.

Annual revenues of the top contractors were further transferred into relative market shares for analysis. The derived market shares were then used to calculate the indices of market mobility and instability. Results of the data analysis are shown in Figure 4.3 and Tables 4.3 to 4.7.

Based on the data shown in Figure 4.3, the market shares were concentrated at a higher level in 2000, suggesting a lower degree of competition intensity at the beginning of the analytical period of time. The competitive situation commenced to change year by year, downward by 2003 and upward until 2006. With more and more top contractors accounted for, namely, from CR_4 to CR_{20}, results of the annual concentration ratios developed at a similar pace, indicating that a few of the largest contractors, at least 20 of them, have similar competitiveness over the seven years. Thus, the competition intensity in the international market has a little impact on the concentration of this group of contractors. In the same figure, compared with the CR_{20} line, the CR_{50} line climbs to a larger extent and this indicates that a significant change in competition intensity in the market.

The contractors interpreted by CR_n are questionable in their representation of the whole market participants. Indeed, they only represent a limited number of top contractors. Therefore, the Herfindahl Indices (HI) was preferable to analysing the features of competition intensity in the international construction market. The HI values, as shown in Figure 4.3, indicate that the international construction market had a low level of competition in 2002 and high levels in both 2000 and 2006. This is quite different from the CR_n-based findings as presented above.

In line with the *HI*, the annual intensities of competition in the international construction market prior to 2002 were lower. However, as shown in Table 4.7, the market in 2001 and 2006 was less stable and more mobile in 2002, suggesting that the levels of competition intensity differ if measured by *MI* and *MM* at the same time.

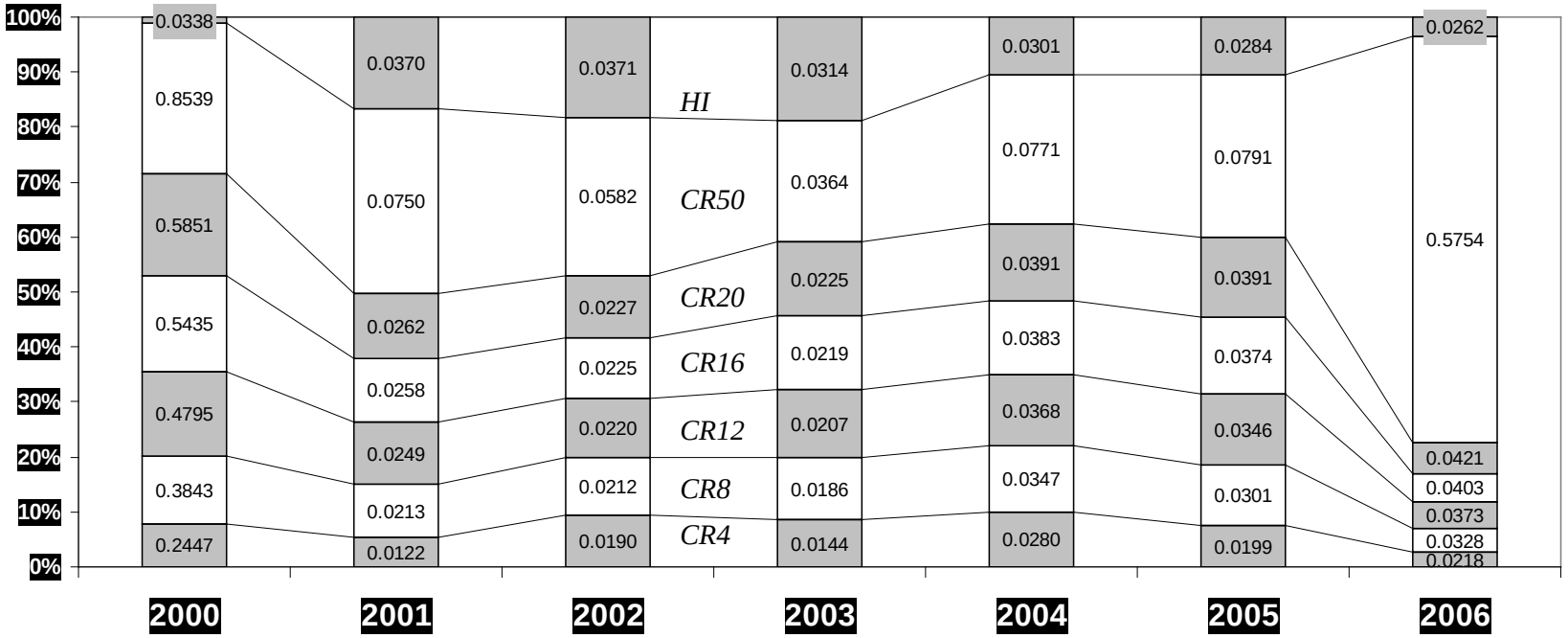


Figure 4.3 Concentration ratios of international construction market

Table 4.4 Market mobility (MM) and market instability (MI) in the international construction market

	2000	2001	2002	2003	2004	2005	2006
H_o	.03379	.03700	.03706	.03135	.03006	.02842	.0262
ΔH_t	N/A	.00321	.00006	-.00570	-.00130	-.00164	-.0022
δ_t	.01145	.01206	.01207	.01096	.01069	.01034	.0099
ρ *(market share stability)*	N/A	-.02761	.29201	.51635	.52057	.55583	-.0236
2/N	.00889	.00889	.00889	.00889	.00889	.00889	.00889
Market share mobility		.06191	.06508	.05939	.05240	.04946	.04572

Table 4.5 Numbers of entrants and exiting firms

	2000	2001	2002	2003	2004	2005	2006
EN	28	29	22	30	22	29	34
EX	32	21	28	23	32	20	N/A
EN & EX	10	13	12	10	11	14	N/A

Table 4.6 Market share mobility: entry and exiting firms

		2000	2001	2002	2003	2004	2005	2006
$M_{t,\ entry}$	σ^2_{entry}	.0000013	.0000014	.0000047	.0000012	.0000065	.0000023	.0000033
	μ_{entry}	.0006	.0009	.0009	.0006	.0015	.0012	.0013
	$\Sigma m_{i,t}$	.0231	.0367	.0323	.0256	.0486	.0504	N/A
Market share mobility		.0000153	.0000327	.0000353	.0000175	.0000781	.0000612	.0000626
$M_{t,\ exit}$								
	σ^2_{exit}		.0000399	.0000057	.0000036	.0000004	.0000021	.0000047
	μ_{exit}		.0025	.0016	.0009	.0004	.0009	.0012
	$\Sigma m_{i,t}$		.1049	.0539	.0359	.0142	.0394	.0425
Market share mobility		N/A	.0003017	.0000912	.0000358	.0000066	.0000382	.0000578

Table 4.7 Competition Intensity measured by CR, MM, and MI

Item	2000	2001	2002	2003	2004	2005	2006
HI	.03379	.03700	.03706	.03135	.03006	.02842	.0262
Changes in HI values	N/A	.00321	.00006	-.00570	-.00130	-.00164	-.0022
$M_{t,\ entry}$	.00002	.00003	.00004	.00002	.00008	.00006	N/A
$M_{t,\ exit}$	N/A	.00030	.00009	.00004	.00001	.00004	.00006
Market share mobility	N/A	.06191	.06508	.05939	.05240	.04946	.04572
Market share instability	N/A	-.02761	.29201	.51635	.52057	.55583	-.0236

4.2.3 Questions raised from the evaluation

The above data analysis shows that the values of competition intensity measured by concentration ratio, market mobility, and market instability differ in degrees. One primary reason for this difference is their discrepancy in measuring competition intensity in construction market. As suggested by the fragmentation attribute of construction market, market share per contractor is relatively negligible to the whole market size. Thus, few firms interpreted by these measures are not good enough to illustrate market competition status, which is enclosed by all competing firms (Bailey and Boyle 1971; Davies 1979; Bird 1999; Mccloughan and Abounoori 2003). Furthermore, concentration measures fail to reflect the turbulence of market share distribution entailed by the force of market competition (Parker 1991; van Kranenburg 2002). Despite the compensation of market mobility and instability for the weakness of

concentration ratio, data collection for these two methods are fairly difficult.

The analysis on the competition intensity in construction market, therefore, favours the identification of the research gap, namely, how competition intensity in construction market can be measured effectively. This research gap has already been identified in previous studies other than the construction discipline. Proposals have been given to use a synthesis of the existing measures to bridge this gap (Khandwalla 1972; Boyes and Smyth 1979).

The concentration measures in nature present a partial competition intensity as they only account for a small number of competitors (Bailey and Boyle 1971; Grossack 1972; Boyes and Smyth 1979; Davies 1979). Furthermore, there can be contradictory results by using the three measures of concentration, market mobility, and market instability. However, given the synthesis of multiple methods, what matters is their potentially breach of the disclosure rule on commercial privacy, popular unavailability of data input (Adelman 1951; Mccloughan and Abounoori 2003), and how to coordinate the contradictory measurement. Consequently, the research gap concerning how competition intensity can be measured effectively in the construction context remains unresolved.

4.3 Professional Perception on the Measurement of Competition Intensity in Construction Market - A Pilot Study

The unresolved research gap presented above does not imply that practitioners are not

aware of the subject of competition intensity in construction industry. To find out tentative solutions to the research gap as well as to investigate the perception of professionals on this subject, a pilot study was conducted through an exploratory interview.

4.3.1 An exploratory interview

As presented in Section 1.5, the five professionals were interviewed through focal discussion on three questions, namely, (1) “How is the concept of competition intensity understood in construction market?” (2) “How can competition intensity in construction market be measured?”, and (3) “What indicators are suitable for the measurement?”. The interview led to five minutes as a basis for document analysis. The results of document analysis were incorporated into an extensive questionnaire survey to validate the choices of model development for this study.

4.3.2 Two alternative measures

The interview produced two sets of indicators for competition intensity measures, namely, market performance indicators (MPIs) (Table 4.8) and competition behaviour indicators (CBIs) (Table 4.9).

It is not new to use MPI to present competition conditions. For instance, a number of indicators have been demonstrated effective in mirroring market competition condition including tender price index (McCaffer *et al.* 1983; Chan *et al.* 1996), bidder number (Flanagan and Norman 1983; Ngai *et al.* 2002), tender markup index (Chan *et al.* 1996), industrial profitability (Bassioni *et al.* 2004), concentration ratios (Chiang *et al.* 2001; Mccloughan 2004), and project performance indicators in terms of construction cost and quality (Faniran *et al.* 1999; Cox *et al.* 2003; Jin and Ling 2006). In fact, market

competition drives the changes of MPIs, which in turn show the transfer of market competition statuses. For example, a cutthroat competition in a market may foretell a reduction in the tender markup index (Shash 1993; Chan *et al.* 1996), an increase in bidder number may indicate a higher intensity of competition (Ngai *et al.* 2002), and the higher the degree of market competition, the lower the average project cost level (Ioannou and Leu 1993).

Table 4.8 Market Performance indicators (MPI) for measuring competition intensity

	Indicator
Indi1	Industrial profitability
Indi2	Rate of average construction cost below the standard quota level
Indi3	Level of project tender index
Indi4	Frequency of construction innovation
Indi5	Level of per capita wage
Indi6	Frequency of safety incident
Indi7	Frequency of delay in payment of construction fees
Indi8	Frequency of poor construction quality occurrence
Indi9	Frequency of environmental destruction/damage

Using the CBI approach to indicate competition intensity has been claimed in previous studies. For example, the studies by Barnett (1997) and Hannan (1986) measure the intensity of competition by examining the crowd of market businesses, suggesting that competitor number is a valuable competition intensity variable. Jayachandran *et al.* (1999) stated that competitors' action and reaction sharpen the intensity of competition, as they promote the frequency/speed of competitors' interaction (Bengtsson 1998).

Boone (2001) found that an increase either in competitor number or in competitors' interaction intensifies competition in market.

Table 4.9 Competition behaviour indicators (CBI) for measuring competition intensity

Indicator	**Validation**
Number of competitors (N)	More contractors bidding for the same projects complicate the interaction between competitors and intensify competition in the market (Ngai *et al.* 2002)
Competition frequency per contractor (F)	The higher the frequency, the fiercer the market competition (Bengtsson 1998)
Distribution of contractors' firm sizes (S)	Competition intensifies if contractors' firm strengths or market powers cannot be distinguished effectively (Porter 1980)
Diversity of market products/services (D)	Little diversity of products/services stirs more competition among contractors, thus promoting the level of competition intensity in the market (Porter 1990)
Importance of bidding for construction works to the viability of contractors *(W)*	The more significant the construction works for bidding, the more competition among bidders the market will have

Few studies, however, have been contributed to developing specific behaviour indicators for measuring competition intensity. Therefore, a questionnaire survey based on the items listed in Tables 4.8 and 4.9 was adopted in this study to refine the indicators of MPI and CBI. The data collected from the survey were analysed per item by calculating the mean values and standard deviations of the importance scores given by the respondents. The analysis results are shown in Tables 4.10 and 4.11. According

to these two tables, only those items with scores over 3.0 (suggesting average important) are considered effective indicators. Consequently, seven MPIs (INDI 1, 2, 3, 4, 5, 6 and 8) and five CBIs (D, F, S, N and W) were determined for further investigation.

Table 4.10 MPI statistics

		Indi1	Indi2	Indi3	Indi4	Indi5	Indi6	Indi7	Indi8	Indi9
N	***Valid***	89	89	90	89	88	88	88	89	88
	Missing	2	2	1	2	3	3	3	2	3
Mean		3.4157	3.1910	4.0778	3.1011	3.0455	3.0341	2.9659	3.2809	2.4773
Std. Dev.		1.2775	1.0647	1.0192	1.0005	0.9932	1.1592	1.1690	1.2153	1.0168

Table 4.11 CBI statistics

		N	F	S	D	W
N	***Valid***	89	89	89	89	88
	Missing	2	2	2	2	3
Mean		3.8427	3.0337	3.5618	3.5393	3.3182
Std. Dev.		0.9989	1.0163	1.0866	1.0231	1.1300

4.3.3 Univariate analysis on the alternative measures

Whilst the seven MPIs and five CBIs were demonstrated effective from the analysis in the previous section, the question is how to choose one (MPI or CBI) as an alternative for this study. According to the statistics principle (Lu 2000), if significance scores given by the respondents between two groups cannot be distinctively differentiated or can be distinguished but acceptable under a confidence level of 5 percent, they are equivalent to the same purpose. Thus, univariate variance analysis was conducted to test

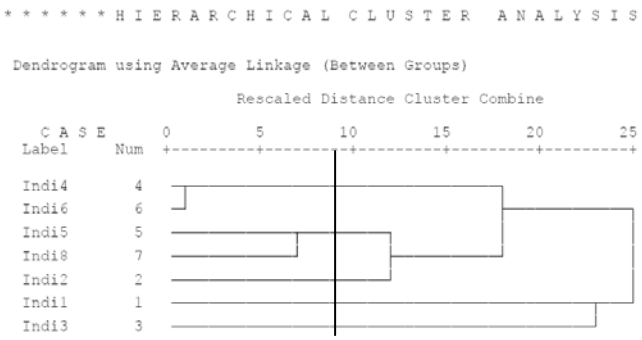
the difference between MPI and CBI.

Univariate analysis provides variance comparison for one common dependent variable, which is affected by one or more factors among subjects. It sets the null hypothesis that the relationship of the dependent variable on each subject is similar. When the statistic *F* has its significance larger than 5 percent, the null hypothesis cannot be rejected. Non-rejection of the null hypothesis means that the variable on various subjects has similar mean and variances, and these individual subjects have equivalent roles.

When the univariate analysis approach was applied to this study, the common dependent variable for the two subjects, MPI and CBI, is their effectiveness in presenting the level of competition intensity. This variable is influenced by two groups of factors (subjects), namely, the seven MPIs and the five CBIs. The univariate process was conducted by running the General Linear Model (GLM) embedded in the Statistics Package for Social Science (SPSS). Prior to the operation of the GLM, a hierarchical cluster analysis was executed to classify the MPI items, leading to the formulation of the five major MPI groups as shown in Table 4.12. This cluster analysis makes MPI consistent with CBI in terms of number of individual variables (subjects). The outcomes of the clustering results and the univariate analysis are described in Tables 4.13 and 4.14.

The results shown in Table 4.14 indicate that the statistics result of the *F* test is 13.3 percent, which is larger than 5 percent. The estimated and hypothesized difference between MPI and CBI Table 4.14 is -0.107 with standard errors of 0.071. These results suggest that the null hypothesis can not be rejected. Therefore, the approaches of MPI and CBI play equivalent roles in measuring competition intensity in construction market.

Table 4.12 Clustering market performance indicators



The variables are mainly clustered into five groups as:

Group I: Indi3

Group II: Indi1

Group III: Indi2

Group IV: Indi8, 5

Group V: Indi4, 6

Table 4.13 Tests of between-subjects effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observe Power(b
Corrected Model	98.029(b)	9	10.892	9.817	.000	.092	88.351	1.000
Intercept	10288.455	1	10288.46	9272.63	.000	.914	9272.626	1.000
Method	2.515	1	2.515	2.266	.133	.003	2.266	.324
Method * Factor	95.515	8	11.939	10.761	.000	.090	86.084	1.000
Error	965.310	870	1.110					
Total	11351.794	880						
Corrected Total	1063.339	879						

(a) Dependent Variable: Importance
(b) Computed using alpha = .05
(c) R Squared = .092 (Adjusted R Squared = .083)

Table 4.14 Contrast results (K Matrix)

Method Difference Contrast			Dependent Variable
			Importance
Level 2 vs. Level 1	Contrast Estimate		-.107
	Hypothesized Value		0
	Difference (Estimate - Hypothesized)		-.107
	Std. Error		.071
	Sig.		.133
	95 percent Confidence Interval for Difference	Lower Bound	-.246
		Upper Bound	.032

4.4 The Need for a New Measure of Competition Intensity in Construction Market

4.4.1 Limitation of the existing measures of competition intensity

Although it is relatively easy to apply the relative CR measure to construction market, a few firms explained by the measures only mirror a superficial level of competition intensity. The approaches of the absolute CR models, MM and MI reflect the resultant business competition from the perspective of the distribution or disturbance of market shares. However, the difficulty of collecting data for these approaches undermines the applicability to construction market. Therefore, the effectiveness of the existing methods in measuring the competition intensity in construction market is of obvious limitation.

4.4.2 Key requirements for an effective measure

The importance of having an effective competition intensity measure for application to construction market has been addressed in many studies (Raftery *et al.* 1998; Chiang *et al.* 2001; Tay and Morgan 2002). The results of the pilot study as well as the interview presented above provide valuable references for exploring an effective measure in accordance with some key requirements. First, the measurement should be able to mitigate the limitation of the existing measures. Second, the measure should be able to help contractors understand various market competition conditions so that competition strategies can be formulated properly. Thirdly, the measure should help clients analyse market condition to establish appropriate bidding methods. Furthermore, the measurement should enable governments to monitor local construction markets and administer effective policies when necessary to maintain a good efficiency of resource deployment across construction sectors.

4.4.3 Suggestions for the development of a new measure

The above analysis on the existing measures of competition intensity suggests that a new measure is needed for the construction sector. However, the new model should be constantly computable, and data for the model can be effectively collected to satisfy the requirements presented above. It is considered more effective for the model to use statistical data which are readily obtainable and can embody the principles of both MPI and CBI approaches. Since MPI presents good applicability of using statistical data, it is chosen as a basis for model development in this study. This is underpinned by a comprehensive understanding on main theories of competition intensity to be addressed in the next chapter.

4.5 Summary

This chapter introduces five major measures of competition intensity and their effectiveness in construction market. The research gap concerning how to effectively measure the competition intensity in construction market is recognised consequently. To further address the gap, a pilot study was conducted, leading to the identification of two alternative solutions, namely, MPI and CBI. The identification presents the basis for developing a MPI-based competition intensity measure with the expect to fill in the recognised research gap.

CHAPTER 5 MODEL DEVELOPMENT

The previous chapter has addressed the need for a competition intensity measure in construction market. This chapter presents the process of model development by integrating the variables of competition intensity in a coordinate system.

5.1 Framework of the Model Development

The discussion in previous chapters has demonstrated that (1) competition intensity is measureable in a number of ways in the discipline of economics; (2) the existing measures of competition intensity are not rigorous in application to construction market; and (3) it is important to develop a new competition intensity measure for construction practice. Furthermore, the interview and the pilot study presented in CHAPTER 4 suggest a MPI-based approach to promote the measurement.

Competition intensity in business market varies from time to time (Coyle 2001). In the construction sector, competition intensity can be characterised by the industrial fragmentation, market globalisation, and bargaining power of customers (Hastakm *et al.* 1993). However, the factors influencing competition intensity are difficult to identify (Khandwalla 1972). Therefore, the factors of competition intensity were identified by conducting a comprehensive literature review. The identified factors were grouped to support the investigation on a new measure of competition intensity in construction. Overall, the process of the model development can be described graphically in Figure 5.1.

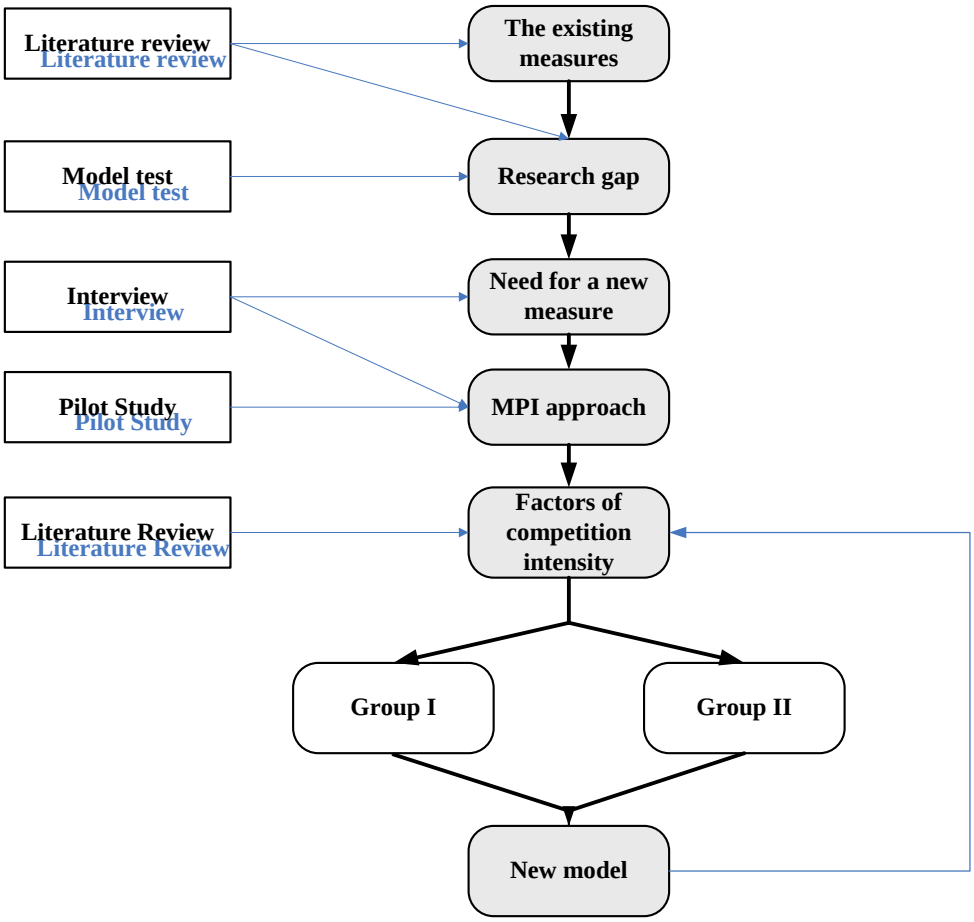


Figure 5.1 A framework of the model development

5.2 Main Theories for Identifying the Factors of Competition Intensity

In the discipline of industrial economics, the structure-conduct-performance (SCP) paradigm is a conventional approach for analysing market competition (Bain 1968; Greer 1992; Wang 2004). For instance, Hatirli (2000) used it to investigate the subsector of the U.S. potato chips and revealed a healthy price competition among the processor firms of potato chips and frozen potatoes. By using this SCP paradigm, Bonardi (2001) looked into the relationship between advertising, concentration, and profitability in the U.S. manufacturing industry and claimed that advertising intensity

can be determined by the interaction of profitability and concentration. Furthermore, Wang (2004) applied the SCP approach to study the competition phenomenon in the Chinese mainland construction market and presented some policies for promoting the market operating efficiency. In fact, the factors of competition intensity closely relate to market basic condition, market structure, market conduct, and market performance (Greer 1992).

5.2.1 Market basic condition

Market basic condition means inherent features of a market. Various markets have their own basic conditions, under which firms carry out their production and business activities. Market basic condition remains unchanged for a long period of time. For instance, the basic condition of construction market is represented with its products that are immobile, durable, costly, and large-sized (Ofori 1990). This condition retains to date coherence with before wherever in the U.S., the U.K., and China.

5.2.2 Market structure (S)

Market structure refers to the distribution status of all business firms in a given market. It can be indicated by the number and relationship of suppliers and demanders, and *inter alia* the degree of market share concentration (Gruneberg and Ive 2000). Market structure develops from market basic condition and varies in market attributes such as concentration, economy of scale, product differentiation, and market entry barriers (Porter 1980). Nonetheless, the structure of a specific market can be defined between two hypothetical extremes, namely, perfect competition (adequate competition) and monopoly (nil competition).

5.2.3 Market conduct (C)

Market conduct describes firms' competition behaviours with respect to advertising, costing, pricing, marketing, innovation, and production (Bonanno and Haworth 1998; Carlton and Perloff 2005). These behaviours are usually affected by firms' internal resources/capabilities and external market conditions.

5.2.4 Market performance (P)

Market performance presents the outcome of firms' operation efficiency over a span of time. Indicators of market performance normally include profitability, productivity, technical efficiency, and labour efficiency. These indicators provide market information that firms can use when considering the appropriateness of competition behaviours (Bonardi 2001; Shepherd and Shepherd 2004).

5.2.5 Correlations of the SCP components

The SCP components are interrelated and they interact on each other via competition intensity. Khandwalla (1972) pointed out that competition intensity determines the effectiveness of firms' behaviours in business rivalry. By examining the relationship between market structure and competition intensity, van Kranenburg (2002) identified an ongoing process of market concentration in the Dutch daily newspapers sector. Furthermore, other researchers have also explored the link between competition intensity and firms' business performance, and concluded that competition intensity is an important driver of market allocation efficiency (Porter 1980; Ramaswamy and Renforth 1996; Boone 2001).

The correlation of the SCP components contributes to studying competition issues in a specific market (Jacquemin 1987). For instance, a high level of market competition

impels firms to lower the price insofar as to lessen the overall industrial profitability as well as to force unprofitable businesses to retreat from the market (Porter 1980). This consequently leads to the reduction in competition intensity in the market. In reverse, little competition in a market encourages potential competitors to enter, causing the market to restructure. Consequently, there exist three technical paths for researching the subject of competition intensity (Figure 5.2): from structure to conduct, performance to conduct, or both (Needham 1978).

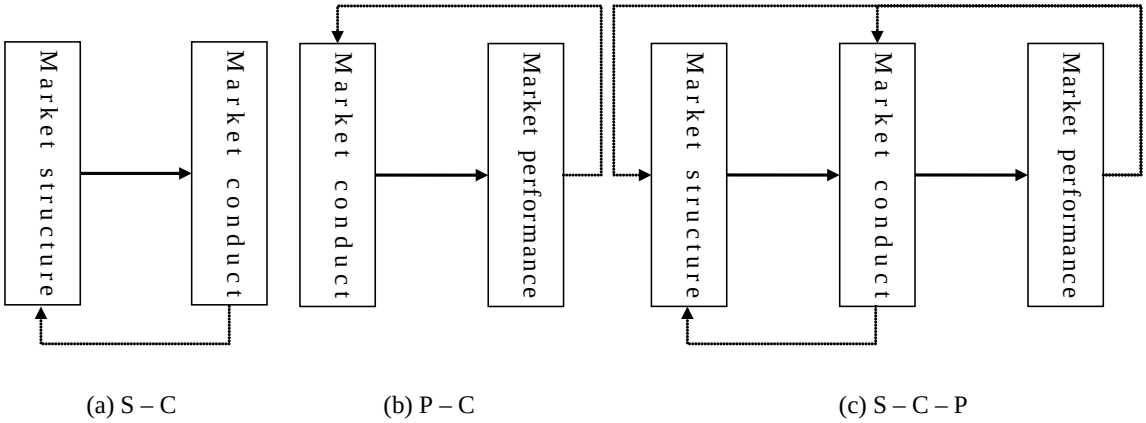


Figure 5.2 Three technical paths for researching competition intensity

The three technical paths present the necessity of re-examining the MPI approach resulted from the pilot study presented in last chapter. It can be found that the MPI approach only illustrates one aspect of the SCP paradigm, namely, market performance. Thus, it only account for a few factors of competition intensity. Research efforts in this study were thus made to examine the factors of competition intensity in accordance with the SCP framework by using an extensive literature review. The results of factor identification are presented in the following sections.

5.3 Factors of Competition Intensity

The popularity of the research on competition intensity has led to numerous relevant publications in the discipline of industrial economics. Over 105 technical papers have been identified addressing the subject of competition intensity, and 55 of them examined the factors of competition intensity, as summarised in Table 5.1. Based on the selected publications, it can be inferred that the factors of competition intensity have been researched for decades (Table 5.2). This long development process of the research on the subject has presented a number of representative factors of competition intensity, which are further classified into three groups in light of the SCP paradigm.

5.3.1 Market Structural factors

The competition intensity factors relating to market structure include the following individuals argued per item below.

- business diversity (BD)
- market entry barrier (MEB)
- market growth (MG)
- market share distribution (MSD)
- market size (MS)

Business diversity (BD)

Business diversity is the range of different businesses and it describes the heterogeneity of individual organisations in a market. The ways towards business diversity are many, including high-level commitment, well links to business strategies, sustained effort, training, benchmarking, and communication (Layne 2002). It is easy for existing firms

Table 5.1 A summary of the literature studies on competition intensity

No.	Reference	Competition Intensity Factors											
		AD	**BD**	**CC**	**MEB**	**MG**	**MS**	**MSD**	**PI**	**PR**	**PT**	**SL**	**WG**
1	*(Bailey and Boyle 1971)*							√					
2	*(Bajo and Salas 2002)*							√					
3	*(Baldwin and Gorecki 1994)*							√					
4	*(Barla 1999)*				√			√					
5	*(Berger and Hannan 1989)*							√		√			
6	*(Bonanno and Haworth 1998)*			√					√	√			
7	*(Bonardi 2001)*	√						√			√		
8	*(Boone 2001)*			√					√			√	
9	*(Bradburd et al. 1991)*							√					√
10	*(Buxton et al. 1984)*	√						√					
11	*(Chiang et al. 2001)*							√					
12	*(Collins and Preston 1966)*					√		√			√	√	
13	*(Das et al. 1993)*	√						√					
14	*(Davies 1979)*							√					
15	*(Davies and Geroski 1997)*							√					

16	*(Donsimoni et al. 1984)*						√						
17	*(Egghe 2005)*						√						
18	*(Farber 1981)*			√			√	√					
19	*(George 1967)*				√		√						
20	*(George 1972)*		√				√						
21	*(Ghosh 1975)*				√		√						
22	*(Goldberg and Knetter 1999)*			√					√				
23	*(Gort 1963)*			√	√		√						
24	*(Greer 1971; Grossack 1972)*		√				√						
25	*(Grossack 1972)*			√			√						
26	*(Gupta 1968)*			√			√						
27	*(Guth 1971)*	√		√			√						
28	*(van Kranenburg 2002)*						√						
29	*(Hatirli 2000)*		√										
30	*(Haworth and Reuther 1978)*						√				√	√	
31	*(Heggestad and Rhoades 1976)*			√	√		√						
32	*(Henley 1987)*	√					√					√	
33	*(Holtermann 1977)*	√		√	√		√			√			
34	*(Horowitz 1971)*				√		√					√	

35	*(Horowitz and Horowitz 1968)*							√					
36	*(Jenny 1978)*							√					√
37	*(Kessides 1990)*			√	√			√					
38	*(Kwoka 1981)*					√		√				√	
39	*(Lustgarten 1975)lu*	√						√					
40	*(Mann et al. 1967)*	√						√					
41	*(Miller 1969)*	√	√					√			√		
42	*(Miller 1971)*							√					
43	*(Mueller and Hamm 1974)*		√			√	√	√					
44	*(Neumann et al. 1985)*							√			√		
45	*(Newmark 1989)*							√			√		
46	*(Powell 1987)*							√					√
47	*(Qualls 1972)*				√			√					
48	*(Ramaswamy and Renforth 1996)*							√					
49	*(Scherer 1973)*		√		√		√	√					
50	*(Shepherd 1964)*					√		√					
51	*(Shrieves 1978)*							√	√				
52	*(Sleuwaegen and Dehandschutter 1986)*							√					

53	*(Vernon 1971)*	√				√		√					
54	*(Wang 2004)*							√					
55	*(Weiss 1963)*							√					
	Total	10	5	5	11	11	2	51	4	3	6	4	6

AD – Business advertising; BD - Business diversity; CC – Cost cutting; MEB – Market entry barrier; MG - Market growth; MS - Market size; MSD – Market share distribution; PI – Production innovation; PR – Product pricing; PT – Profitability; SL – Spatial location; WG – Average wage.

Table 5.2 Time dispersion of the publications selected to analyse competition intensity factors

Decade	**1960-1969**	**1970-1979**	**1980-1989**	**1990-1999**	**2000-**
Number of publications	9	19	10	9	8

to become diversified in terms of business structure. Nevertheless, business diversity can be a factor affecting competition intensity. This is because new entrants are normally difficult to possess a set of diversified businesses in a rapid way, so that they cannot compete well against the incumbent (Miller 1969).

The effect of business diversity on competition intensity can be identified in a specific way. It stimulates firms' innovation and differentiation, while the success of innovation or differentiation yields new products/services, and in turn relieves the firms' competition against their preceding counterparts. Therefore, fiercer competition in market leads to more new products/services, resulting in a higher degree of diversity. This has been echoed by the study by Wang (2004), suggesting that the stiff competition in the Chinese construction market has forced contractors to diversify businesses to avoid strong competition within the narrow scope of construction businesses.

Market entry barrier (MEB)

The factor of market entry barrier is a major variable affecting market structure and competition intensity (Johns 1962; Wenders 1971). As addressed by Porter (1980), competition in a market encompasses two parts, namely, the existing competition among established firms as well as the potential competition imposed by new entrants. The existing part can be changed by the potential if the market entry barrier fails to inhibit any business from entering into the market effectively. Therefore, the existing level of competition intensity can be determined by the magnitude of market entry barriers.

Market entry barrier is determined by the attributes of industry such as economy of scale, product differentiation, requirement of capital and marketing access, and government policy (Bain 1956; Porter 1985). The presence of market entry barriers indicates that not all businesses can penetrate the market successfully. Higher entry barriers hold back more entrance of new competitors; thus, the competition intensity imposed by possible entrants will be lessened. On the other hand, lower entry barriers induce more facile entrance for new firms, which will give rise to the increase in firm number as well as the intensity of competition at the same time (Jacquemin 1987).

Market growth (MG)

Market growth denotes the speed of market expansion. A fast growing industry causes the interests from potential entrants into the businesses, driving the market to become less concentrated in terms of market share distribution and the competition intensity to increase (Baumol 1962; Shepherd 1964). However, it has widely been recognised that market growth can weaken competition intensity, as it presents business firms with larger market places to operate and lowers the level of competition intensity (Owen 1971). Hence, the rate of industry growth offsets the level of competition intensity (George 1967).

Market size (MS)

Market size affects the level of competition intensity because a larger market in size yields more business opportunities that reduce firms' competition pressure in struggle for market shares. This effect is generally considered tiny, given the equilibrium between demand and supply in any markets (Mueller and Hamm 1974). Nonetheless, many studies have implied that considerable fiercer competition phenomena occur with

the markets become larger (Asplund and Sandin 1999). One main reason is that a larger market in size lowers market entry barriers to a larger extent, facilitating more competition in the market as a consequence (Bain 1956). I has been echoed in the study by Neumann *et al.* (2001) who found that an expanding market causes the concentration of market share to decline and the intensity of competition to ascend.

Market share distribution (MSD)

Researchers have pointed out that market structure can be represented by the market share distribution between the incumbents, because the distribution signifies the difference of market power between existing firms (Horowitz and Horowitz 1968; Shepherd and Shepherd 2004). The distribution of market shares is extremely concentrated in a monopoly market, wherein only one firm occupy all customer resources. By contrast, this distribution in a perfect-competition market is rather even, where all businesses have similar powers in controlling market shares. Hence, an uneven distribution in market share can be a result of little competition in the market (Alexander 2001).

5.3.2 Market conduct factors

Typical factors used to explain the conducts or behaviours of the competing firms were identified as follows:

- business advertising (AD)
- cost cutting (CC)
- production innovation (PI)
- product pricing (PP)
- spatial location (SL)

Business advertising (AD)

The academic debate on the relationship between business advertising and market competition has been continuing for more than 80 years (Chamberlain 1933; Friedland 1977). Advertising is an important means of business competition to promote distinction in products among incumbents and to induce market entry barriers against potential competitors (Bonardi 2001). It assists individual firms with the differentiation from rivals and it has become a major factor influencing market concentration ratio as well as the level of competition intensity (Miller 1969; Guth 1971). However, some researchers opined that advertising helps businesses to cut down competition due to the potential creation of buyers' loyalty (Shepherd and Shepherd 2004). Other researchers claimed that advertising lessens firms' market power by increasing the quantity of information available to consumers in terms of prices and alternative products, thus increases the rivalry between extant firms and latent firms (Eckard 1987).

Cost cutting (CC)

Firms need to know how much it costs to produce their products if they are to compete well against their competitors (Carlton and Perloff 2005). Cutting unnecessary production cost as much as possible lets firms possess more bargaining power with buyers and achieve more cost advantages (Porter 1980). For the attainment of cost advantage, competitors have to behave radically, leading to keen competition in the market as a consequence (Cernikova 2002). It is commonly considered that cost cutting results in the decrease in product price, thereby contributing to the amplification of market shares (Boone 2001). However, firms that fail to shave off redundant production cost may be outperformed by their competitors, thus leading to the decrease in firm

number and lessening the competition intensity in the market consequently.

Production Innovation (PI)

Competing by innovation has become a prevalent strategy for firms to run businesses (Bengtsson 1998). The relationships between competition intensity and innovation activity are intricate and range in product types (Shrieves 1978; Boone 2001). Competition is rigorous in the markets with homogenous products, whereas it is lesser in the markets with heterogeneous products. Intense competition forces businesses to conduct innovation for new products. The emergence of new products further creates new platforms for business competition, and therefore weakens the intensity of competition in the original product market. However, an opposite view advocates that competition stimulates innovation, and innovation increases the degree of competition in the market (Vickers 1986; Geroski and Pomroy 1990).

Product pricing (PP)

Pricing is one of the most important means of organisational marketing. Price-based competition is popular in many markets (Khandwalla 1972). Economic theory explains that the fluctuation of market price around the equilibrium between supply and demand is a result from market competition (High 2001). Therefore, adjusting the product price is major business behaviour for firms to make response to the changes of market competition. For instance, lowering the price has traditionally been one of the most effective and direct approaches to gain competitive advantages when confronted with intense competition.

The empirical study by Yamawaki (1984) indicates that competition intensity is a key

variable of market structure that determines the choice of pricing products. In reverse, there are two ways in which pricing choice affects the intensity of competition. One is to build market entry barriers, by which the incumbent can price artistically to deter the entrance of potential competitors, thus the current intensity of competition will not be changed (Bagwell and Ramey 1990; Albak and Overgaard 1994). The other is to price competitively to compel unprofitable businesses to retreat from the market, leading to the decrease in both firm density and competition intensity.

Spatial location (SL)

The location of business in geography is usually subject to two major intentions, namely, better utilisation of resources and immediate adjacency to consumers (Ellinger 1977). Spatial location decided by business firms has an effect on the level of competition intensity (Kwoka 1981; Boone 2001). However, such effect is inexplicit. On one hand, fierce competition mobilises firms to spread their businesses spatially as far as possible, thus comforting the competition as a consequence. On the other hand, the advancement of the techniques of communication, transportation, logistics and information technology have made firms' geographic predominance vanished rapidly. Therefore, it is quite difficult, if not impossible, to detect the relationship between competition intensity and spatial location.

5.3.3 Market Performance factors

The mostly commonly adopted performance factors as identified in this study are profitability (PT) and average wage (WG) as introduced below.

Profitability (PT)

Profitability is a principal indicator of market performance used to indicate the variation in market competition. According to Bain (1951; 1956), a market moving towards a highly concentrated status (low degree of competition intensity) has a high level of profitability. This has been demonstrated in many studies, suggesting that profitability in the markets with little competition is better than that in other markets with fierce competition (Collins and Preston 1966; Holtermann 1977; Bonardi 2001; Chiang *et al.* 2001; Mccloughan 2004; Wang 2004). However, there are some different opinions questioning the influence of competition intensity on profitability. For instance, Neumann *et al.* (1985) opined that the relationship between profitability and competition intensity might be weak occasionally.

Average wage (WG)

Average wage is a surrogate for labour productivity. Previous studies have identified a negative relationship between market competition and wage level, suggesting that the cost of labours descends when competition in the market becomes intensive (Jenny 1978; Bradburd *et al.* 1991; Ramaswamy and Renforth 1996). However, in accordance with the demand-and-supply rule and Porter's (1980) five-force model, average wage is most dependent on the equilibrium status of labour market. When labour supply lags behind labour demand, it results in the promotion of average wage in the construction sector.

5.4 Integration of Competition Intensity Factors from the SCP Paradigm to a New Approach – the Causal-Sequential Coordinate System

5.4.1 Rereviewing competition intensity factors in causal and sequential dimensions

In light of the definitions/measures of competition intensity (Sections 2.2 and 2.3) and the literatures in the discipline of biological research on competition intensity (Section 2.4), the factors of competition intensity can be re-compiled from the SCP framework to a causal-sequential system. Among these factors, some items cause the competition intensity to change, called the "causal factors" of competition intensity, including AD, CC, MEB, MG, MS, PI, PP, and SL. Other factors called the "sequential factors" of competition intensity including BD, MSD, PT, and WG indicate the consequence of competition intensity.

5.4.2 Impacts of the causal factors on competition intensity

According to the above examination in Section 5.3, the effects of causal factors on competition intensity can be summarised in Table 5.3. The higher the MS values and/or the lower the values of MEB and MG, the higher the level of competition intensity. However, according to the discussion given in Section 5.3.2, the relationships between the conduct factors (AD, CC, PI, PP, and SL) and competition intensity can be either positive or reverse.

Table 5.3 Impacts of causal factors on competition intensity

Causal Indicators	**AD**	**CC**	**MEB**	**MG**	**MS**	**PI**	**PP**	**SL**
Direction of changes	↑	↑	↑	↑	↑	↑	↑	↑
Competition intensity	↑↓	↑↓	↓	↓	↑	↓↓	↓↓	↑↓

Note: "↑↓"indicates dual relationships between the factors and competition intensity.

5.4.3 Impacts of competition intensity on the sequential factors

The above discussion in Section 5.3 shows that the impact or consequence of competition intensity can be measured by the sequential factors (BD, MSD, PT and WG). As shown in Table 5.4. A higher level of competition intensity will result in larger values of BD, MSD, and WG, and a lower PT value.

Table 5.4 Impacts of competition intensity on sequential factors

Directions of change in competition intensity	**Sequential factors**	
↑	***BD***	↑
↑	***MSD***	↑
↑	***PT***	↓
↑	***WG***	↑

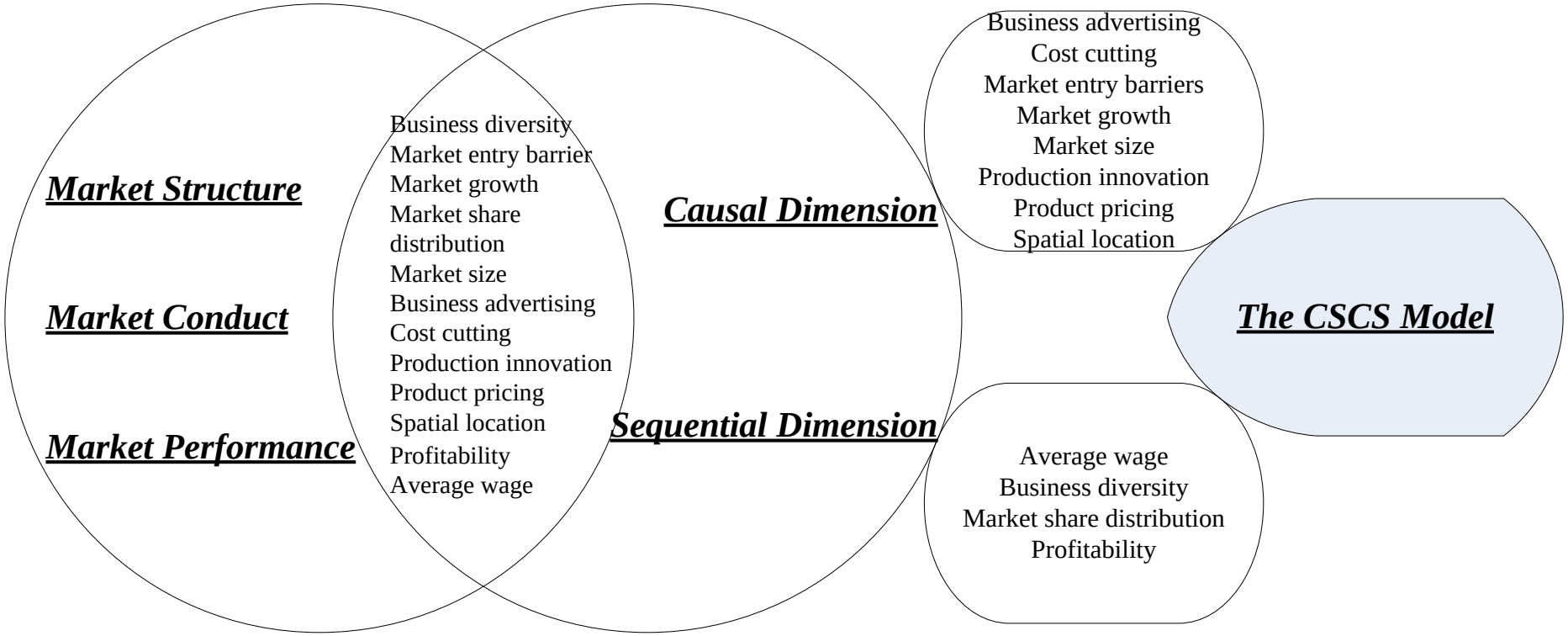


Figure 5.3 Revision on the factors of competition intensity

5.5 Competition Intensity in a Causal-Sequential Coordinate System

5.5.1 Definition of causal-and-sequential competition intensity

As discussed in the previous sections, the factors for measuring the level of competition intensity have been differentiated into causal and sequential dimensions, denoted as X_C and X_S respectively. The two dimensions are mutually exclusive, and it is considered that the causal-sequential factors of competition intensity can be integrated in a coordinate system called a Causal-Sequential Coordinate System (CSCS), as shown in Figure 5.4.

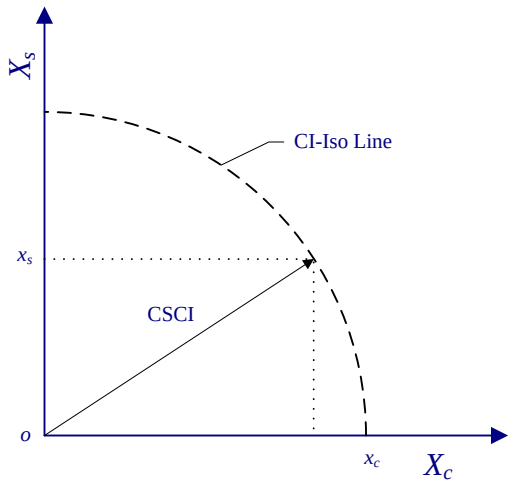


Figure 5.4 Causal-and-sequential competition intensity, CSCI

The value of the competition intensity in CSCS is called Causal-Sequential Competition Intensity (CSCI) as written below.

$$CSCI = \sqrt{X_C{}^2 + X_S{}^2} \qquad (5.1)$$

In CSCS model, the origin "*O*" denotes the status of nil competition that emerges when a market is monopoly. The level of competition intensity in a given market represents the deviation of the current competition status from the monopoly to satisfy the definition of competition intensity given in Section 2.2.4. As shown in Figure 5.5, the distance between point A and point o can reflect the degree of competition intensity. Thereby, point A has a higher level of competition intensity than points B and C. Furthermore, it can be noted from equation 5.1 that the same values of CSCI could be obtained from various combinations of X_C and X_S. These combinations form a competition intensity Iso line, called the CI-Iso line, as shown in Figure 5.4. The curve indicates that more than one market status present equal level of competition intensity, although they have different situations defined by the causal and sequential factors. For instance, point A (Figure 5.5) has same level of competition intensity as point C, both having different values of causal and sequential factors.

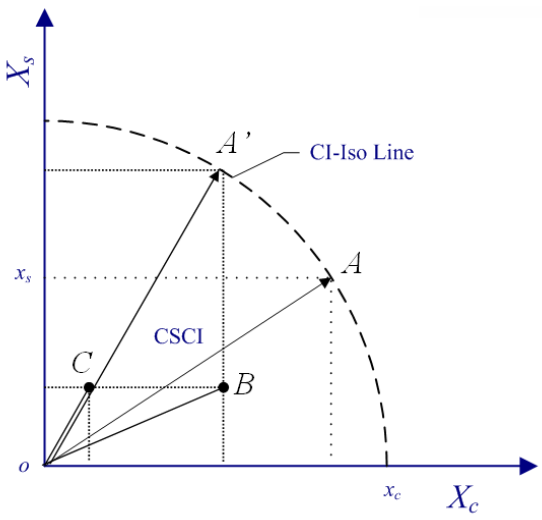


Figure 5.5 Rationale of the CSCS model

CSCI appears more effective than the MPI approach which was derived from the pilot study presented in Section 4.3. As shown in Figure 5.6, competition works like a black box that transforms products/services (inputs) for exchange into the competition process which may involve many interactions and uncertainties, reflected by competition intensity. Then it produces the results of market exchange (outputs), indicated by MPI. Although measuring the outputs of competition process purely from the sequence can generate useful information, its effectiveness is unavoidably impaired subject to the reliability and completeness of MPI.

CSCS synthesises the bi-dimensional factors of competition intensity into the model framework. It is thus expected to be able to even out the contingency errors in MPI methods owing to the variation in competition intensity factors.

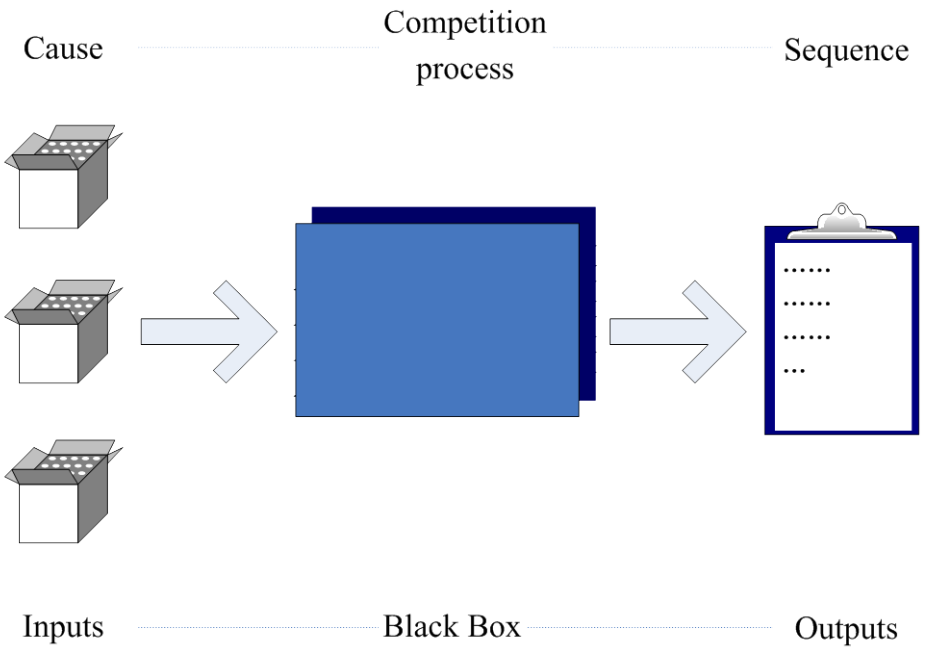


Figure 5.6 Rationale for CSCS model

5.5.2 Causal dimension of competition intensity

As discussed above, the causal factors of competition intensity (X_C) include business advertising (AD), cost cutting (CC), market entry barrier (MEB), market growth (MG), market size (MS), production innovation (PI), product pricing (PP), and spatial location (SL). Among these factors, AD, CC, PI, PP, and SL are conduct factors describing firms' behaviours. Since they can not be measured accurately in quantitative terms and they also have uncertain relationships with competition intensity, the calculation for the causal dimension X_C in formula 5.2 only accounts for the variables of MEB, MG, and MS. The value of X_c is considered as weighted aggregation of three factors as written below:

$$X_C = \alpha_1 MEB + \alpha_2 MG + \alpha_3 MS$$
$$\sum_{i=1}^{3} \alpha_i = 1, \quad 0 \le \alpha_i \le 1 \qquad (5.2)$$

Where, α_i is the weighting value of the corresponding factors.

5.5.3 Sequential dimension of competition intensity

The sequential factors of competition intensity (X_S) encompass business diversity (*BD*), market share distribution (*MSD*), profitability (*PT*), and average wage (*WG*). The value X_S is similarly calculated as the weighted aggregation of the four sequential factors written as follows:

$$X_S = \beta_1 BD + \beta_2 MSD + \beta_3 PT + \beta_4 WG$$
$$\sum_{i=1}^{4} \beta_i = 1, \quad 0 \le \beta_i \le 1 \qquad (5.3)$$

Where, β_i is the weighting value of the corresponding factors.

It should be noted that the variables for calculating X_C and X_S in formulas 5.2 and 5.3 assume different units in practice in measuring their values. Since competition intensity is a relative measure, the term is meaningful only when measuring two or more markets for comparison. Therefore, the units of these variables for calculation should be normalised into relative indices.

Given *m* markets for comparison in the relative competition intensity, the normalisation for these causal factors can be performed by comparing the data gathered from the different markets through the transformers indicated in formula 5.4:

$$\begin{aligned} X_{MEB} &= (\underset{i=1}{\overset{m}{Max}}\, MEB_i - MEB) \Big/ (\underset{i=1}{\overset{m}{Max}}\, MEB_i - \underset{i=1}{\overset{m}{Min}}\, MEB_i) \\ X_{MG} &= (\underset{i=1}{\overset{m}{Max}}\, MG_i - MG) \Big/ (\underset{i=1}{\overset{m}{Max}}\, MG_i - \underset{i=1}{\overset{m}{Min}}\, MG_i) \\ X_{MS} &= (MS - \underset{i=1}{\overset{m}{Min}}\, MS_i) \Big/ (\underset{i=1}{\overset{m}{Max}}\, MS_i - \underset{i=1}{\overset{m}{Min}}\, MS_i) \end{aligned} \tag{5.4}$$

The sequential variables can likewise be normalised by using the following transformers (formula 5.5):

$$\begin{aligned} X_{BD} &= (BD - \underset{i=1}{\overset{m}{Min}}\, BD_i) \Big/ (\underset{i=1}{\overset{m}{Max}}\, BD_i - \underset{i=1}{\overset{m}{Min}}\, BD_i) \\ X_{MSD} &= (MSD - \underset{i=1}{\overset{m}{Min}}\, MSD_i) \Big/ (\underset{i=1}{\overset{m}{Max}}\, MSD_i - \underset{i=1}{\overset{m}{Min}}\, MSD_i) \\ X_{PT} &= (\underset{i=1}{\overset{m}{Max}}\, PT_i - PT) \Big/ (\underset{i=1}{\overset{m}{Max}}\, PT_i - \underset{i=1}{\overset{m}{Min}}\, PT_i) \\ X_{WG} &= (WG - \underset{i=1}{\overset{m}{Min}}\, WG_i) \Big/ (\underset{i=1}{\overset{m}{Max}}\, WG_i - \underset{i=1}{\overset{m}{Min}}\, WG_i) \end{aligned} \tag{5.5}$$

In models 5.4 and 5.5, variables X_{MEB}, X_{MG}, X_{PT}, and X_{WG} are the normalised values of

the variables *MEB*, *MG*, *PT*, and *WG*, respectively. The increase in these normalised values represents a decrease in competition intensity. On the other hand, the variables X_{BD}, X_{MS}, and X_{MSD} are respectively the normalised values of the variables *BD*, *MS*, and *MSD*, and the increase in these normalized values indicates an increase in competition intensity.

In line with the above normalisation, the calculations for formulas 5.2 and 5.3 can be rewritten as formulas 5.6 and 5.7.

$$X_C = \alpha_1 X_{MEB} + \alpha_2 X_{MG} + \alpha_3 X_{MS}$$
$$\sum_{i=1}^{3} \alpha_i = 1, \quad 0 \le \alpha_i \le 1 \tag{5.6}$$

$$X_S = \beta_1 X_{BD} + \beta_2 X_{MSD} + \beta_3 X_{PT} + \beta_4 X_{WG}$$
$$\sum_{i=1}^{4} \beta_i = 1, \quad 0 \le \beta_i \le 1 \tag{5.7}$$

5.6 Summary

This chapter presents the process of developing a new model for measuring the competition intensity in construction market. Twelve major factors of competition intensity have been analysed under the framework of the structure-conduct-performance (SCP) framework. The identified factors are classified and examined in two groups: causal factors and sequential factors. With reference to the methodology of competition intensity in the biology discipline, a model called CSCS has been established to

measure competition intensity in construction market in a causal-sequential coordinate system. CSCS model is composed of a main formula, two weighting equations, and two transformer equations. The application of this model will be presented in the next chapter.

CHAPTER 6 APPLICATION OF CSCS MODEL

CSCS model assumes a generic form that is adaptable to various construction markets. This chapter presents the application of CSCS model with the data collected from the Chinese construction industry for the period of 1990 to 2006.

6.1 Weight Setting on CSCS Coefficients

In general, the weight of Factor *i* in a model can be defined in line with equation 6.1, which describes the significance of each factor relative to the other (Dash and Loggie 2008). The *exponent* in the equation serves to amplify the role of a particular factor if necessary.

$$Weight_i = Factor_i^{Exponent} / \sum_{i=1}^{n} Factor_i^{Exponent} \quad (6.1)$$

Where, *n* is the magnitude of factors in the model.

For demonstrating the applicability of CSCS model with reference to equations 5.1, 5.4, 5.5, 5.6, and 5.7, assumptions are made. It is considered that individual causal coefficients (α1, α2, α3) or sequential coefficients (β1, β2, β3, β4) in the model assume equal weights, namely,

$\alpha 1 = \alpha 2 = \alpha 3 = 1/3$

$\beta 1 = \beta 2 = \beta 3 = \beta 4 = 1/4$

Equal weight is a choice that gives no underweight or overweight to any factor in a theoretical model. This choice might have a limitation because it can not precisely reflect the relative importance between factors in the model. In this study, however, equally weighting CSCS variables is acceptable because of a couple of typical reasons.

Firstly, equal weight is an indifferent factor choice that randomises potential factors affecting competition intensity in a construction market over its long evolution. This allows all CSCS variables to be considered on an equally weighted basis at any point of the evolution process. Secondly, the Chinese construction market is composed of 31 local markets, per market having a variable level of competition intensity. An equal weight offers a common basis for the comparison of competition intensity under different market situations. Thirdly, equal weight has been demonstrated useful in developing indexes similar to CSCI. A good example is the well-known S&P 500 EWI (The Standard & Poor's 500 Equal Weight Indexes) issued by the McGraw-Hill Companies for stock exchange markets *(www.indices.standardandpoors.com*). The index weights the performance of 500 leading companies equally to meet the need for benchmarking, investing and trading strategies that require a size-neutral index.

6.2 Quantification of Causal Factors

The quantification of CSCS variables includes developing the implication of the variables in quantitative ways as well as collecting proper data in the Chinese construction market.

6.2.1 Market entry barrier

Market entry barrier (MEB) is a key feature of an industry that brings the incumbent inherent advantages over potential entrants (Porter 1980). Previous studies have demonstrated that the entry barriers to domestic construction markets are low to local contractors, whilst they are high to foreign entrants (Gruneberg and Ive 2000; Wang

2004; Chen 2005). This is because the barriers to international construction usually comprise some bothering facets such as legal limitation, permit/approval system, rating/qualification system, capital requirement, and expatriation of profit/tax condition (Chen 2005).

A number of methods have been employed to measure market entry barriers. Based on the indicators of capital requirement and advertising intensity, the study by Orr (1974) measured market entry barriers to reveal that the barriers to some Canadian manufacturing industries including smelting and brewing were substantial. Bain (1951) adopted the total market shares held by the eight largest firms to reflect market entry barriers and found a statistically significant relationship between the barriers and industry profitability. Mathis and Koscianski (1996) claimed that the excess production capacity is a good indicator of a market that has major entry barriers. Furthermore, other studies suggest measuring market entry barriers by the plant capacity required for business operation in manufacturing industries (Holtermann 1977; Farber 1981).

It is arguable that the methods mentioned above are effective in the construction context. For instance, owning a scale of construction plants does not necessarily constitute entry barriers to potential competitors, because contractors usually rent the plants upon their need. Therefore, capital requirement in this case cannot constitute an entry barrier to construction market.

According to Stigler (1968), “a barrier to entry may be defined as a cost of producing (at some or every rate of output) which must be borne by firms which seek to enter an industry but is not borne by firms already in the industry (p.67).” In line with this

discussion, it is considered appropriate to use the average registered capital among existing construction firms to measure entry barriers to construction market. A larger size of average registered capital indicates more difficult for potential entrants to become the dominating firms and a lower level of competition intensity in the market.

6.2.2 Market size

Market size (MS) is measureable by market capacity from the perspective of either supply or demand (Mueller and Hamm 1974; Noh 2000). A number of indicators have been suggested to reflect market size such as geographic boundary, product quantity, and types of production techniques (Stekler 1961). Campbell and Hopenhayn (2005) adopted regional population, geographic population density, and overall industrial turnover to examine the effect of market size on the distribution of retail firms in some U.S. cities. Thereby, it was found that larger cities have larger retail firms and higher levels of competition intensity in the retail markets.

As discussed early in Section 3.1, the volumes of construction demand or supply are difficult to predict in the short run, complicating the measurement of market size from either construction demand or construction supply. However, since the size of construction market is closely associated with the magnitude of businesses undertaken by construction firms, it is suggested using the average annual construction works committed by individual firms as an alternative measure. This measurement can be indicated by average annual building area under construction. As defined by NBSC (2007), this indicator is an important statistics reflecting real demand of construction works, namely, the larger the average volume of the construction works, the larger the market size.

6.2.3 Market growth

There are multi-form ways to quantify market growth (MG). George (1967) measured an employment-based market growth and detected a negative relationship between the growth and the changes in market concentration. By using the indicators of firm number and total asset value to reflect market growth, Ghosh (1975) revealed a number of rapidly growing industries in India including engineering, chemical plants, and woollen. The study by Heggestad and Rhoades (1976) employs the annual percentage change in deposits to measure the growth of a commercial banking market, and concludes that the less the competition intensity between commercial banks, the greater the stability of the market.

A commonly used measure for market growth is by estimating the growth of market demand (Collins and Preston 1966; Holtermann 1977). Therefore, the growth rate of the building works under construction, which is a surrogate for market demand, is adopted to measure the growth of construction market. The higher the growth rate, the less intense the competition in the construction market.

6.3 Quantification of Sequential Factors

6.3.1 Business diversity

Business diversity (BD) can be measured in a number of ways. With reference to the U.S. manufacturing industry, Fuchs (1961) measured business diversity by using the average percentage of value added among all types of businesses held by existing firms.

It was found thereby that the higher the percentage, the more diversified the market. Miller (1969) adopted the ratio of employment allotted to various plants owned by the largest firms to present the degree of business diversity, indicating that a larger ratio of employment represents a more diversified industry.

Owing to the intense competition in the market, construction firms have become aware of the importance of diversity practice (2001; Fiori 2003). This awareness is represented by the diversity of work forces in terms of age, culture, background, race, and gender (Layne 2002; Fleming 2008; James 2008). Accordingly, the composition structure of various work forces has been developed to measure construction diversity (Layne 2001). However, this measurement seems ineffective to interpret the impact of competition on construction business diversity.

Contractors' businesses can be extended to many areas such as main contracting and auxiliary activities concerning specialist contracting, labour contracting, design, consultant, equipment letting, and construction material provision. A construction firm may simultaneously do businesses in several areas to minimise market risks. Thus, the firm's income is sourceable from its diversified business structure. The income composition structure of individual construction firms presents the business diversity among the incumbent, and this structure can be indicated by the proportion of auxiliary revenue to total business revenue. The higher the proportion, the more diversified the firms' business.

6.3.2 Market share distribution

A particular status of market share distribution (MSD) is a consequence of market

competition, presenting a key variable of market structure. This distribution can be measured by means of concentration ratio (CR) or Gini coefficient （GC）(Adelman 1951; Egghe 2005). Technically, CR demonstrates the extent to which market shares are controlled by business firms, and GC reflects the deviation of the whole MSD picture from a current status to the ideal situation under which each firm has an identical market share. Nonetheless, CR can describe the competition occurred only between a limited number of competitors, whilst GC has limitations in application due to the difficulty of collecting the full scope of data.

A substitute to these two measures is a new method called MA approach, which has been demonstrated applicable to the Britain construction market (Mccloughan and Abounoori 2003; Mccloughan 2004). The MA approach requires the data that all firms in a market should be categorised into equal classes in terms of firm size. Nevertheless, as discussed early in Chapter 4, MA is not adequate to mirror the consequence of business competition in construction market. It is considered therefore to replace the MA approach with the indicator of the market shares owned by major firms. The major firms in the Chinese construction industry are China's state-owned construction enterprises (OSCE), as they play a leading role in the industry development. The larger the indicator value, the less the MSD degree.

6.3.3 Profitability

There are many approaches for measuring profitability (PT). As a key market performance indicator, it denotes a profit rate of turnover, the return on a capital investment, or the rate of return (Phillips 1976; Akintoye and Skitmore 1991). Considerable research on the subject of profitability has provided a number of methods

for measuring the profitability of construction businesses. For instance, the study by Yee and Cheah (2006) adopted the indicators of “earnings before interest and taxes” and “net profit margin” to measure industrial profitability in construction, and found that there is no significant correlation between firm size and profitability. It has been revealed that construction market usually has a low profitability due to high competition (Choi and Russell 2005). However, the measurement of profitability has some weaknesses due in nature to its calculation based on returns to an investment within a span of future time (Martin 1988).

Whilst profitability is commonly described by profit rate, the difficulty lies in collecting the relevant data from all individual firms in a market (Bonardi 2001). In China’s construction industry, however, data on industrial profit rate are publicly available in the annual compilation of statistics. It is suggested using publicly available data on the profit rate to measure profitability in the construction market.

6.3.4 Average wage

Labour is an important production factor of construction activities. In spite of the increasing dependence on equipment and machinery, considerable construction activities cannot be conducted without the involvement of labour. Hence, the competition for labour resources in construction market is closely associated with the situation of labour market. For instance, a high demand for construction labour resources can result in the imbalance between demand and supply in the labour market, leading to the raise in the level of average wage.

The level of wage has commonly been measured by either hourly wage rate for

construction workers or annual wages for established staff (Horowitz 1971; Haworth and Reuther 1978). Therefore, the annual average wage is calculated for all employees working in the Chinese construction market.

6.4 Results of CSCS Model Application

The results of CSCS model application are generated from the process of data collection, data quantification, transformation of raw data, and calculation according to models 5.1, 5.4, 5.5, 5.6, and 5.7.

6.4.1 The data collection

As shown in the appendix tables, the data collected from the Chinese construction industry present the values of the three causal factors, namely, MEB (Table a. 5), MG (Table a. 6), and MS (Table a. 7) and the values of four sequential factors, namely, BD (Table a. 4), MSD (Table a. 8), PT (Table a. 9), and WG (Table a. 10). There are 31 samples per factor, representing 31 local construction markets (provinces). The data were published by the National Bureau of Statistics of China (NBSC, 1990-2007).

6.4.2 Outputs of CSCS model application - CSCI

The output of the CSCS model application is a set of indexes including the general competition intensity index (GCII), causal competition intensity index (CCII), and sequential competition intensity index (SCII). By entering the data into CSCS model, the study derives all indexes of GCII (Table 6.1), CCII, and SCII (Table 6.2) for the 31 Chinese local construction markets. GCII shows the overall degree of the intensity of competition in a local Chinese construction market. The values of both CCII and SCII

vary from 0 to 1 in addressing the intensity of competition from causal and sequential perspectives respectively.

Table 6.1 Values of CSCI for China's 31 local construction markets

Place	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Max	Min	Mean
Anhui	.7252	.7071	.7637	.6943	.7333	.6829	.6915	.7244	.7966	.6013	.7025	.5787	.7215	.7659	N/A	.7606	.7553	.7966	.5787	.7128
Beijing	.7567	.8093	.8737	.5574	.7975	.7182	.8143	.7255	.8129	.8382	.7633	.7328	.7994	.8090	N/A	.6122	.6966	.8737	.5574	.7573
Chongqing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.7504	.7576	.7984	.7632	.6423	.7546	.8040	N/A	.8236	.7145	.8236	.6423	.7565
Fujian	.5846	.6767	.9368	.6024	.8112	.7429	.8116	.7305	.8190	.7006	.7307	.6752	.7419	.7597	N/A	.7376	.7012	.9368	.5846	.7352
Gansu	.5869	.6452	.7948	.6257	.7288	.7191	.6474	.6180	.7913	.6470	.8518	.7057	.6434	.7251	N/A	.6621	.6872	.8518	.5869	.6925
Guangdong	.7789	.7837	.7067	.6322	.8218	.6448	.8579	.8160	.8909	.8753	.8719	.7859	.8315	.7268	N/A	.9033	.8209	.9033	.6322	.7968
Guangxi	.5800	.6498	.6927	.6091	.8507	.7500	.7496	.7634	.8059	.7986	.6302	.6082	.5633	.6493	N/A	.7439	.7307	.8507	.5633	.6985
Guizhou	.6178	.6369	.6766	.6039	.8065	.6969	.7640	.6511	.7317	.7103	.7542	.7369	.7176	.7678	N/A	.8529	.7822	.8529	.6039	.7192
Hainan	.4714	.5670	.7009	.7727	.8891	.8070	.8255	.6706	.7556	.7590	.7273	.4451	.6255	.4807	N/A	.5753	.6086	.8891	.4451	.6676
Hebei	.6536	.6308	.6731	.5729	.6705	.6045	.7139	.6138	.7168	.6543	.6972	.6398	.5999	.6920	N/A	.7207	.7396	.7396	.5729	.6621
Heilongjiang	.7346	.5704	.6004	.6114	.7212	.6663	.7038	.6020	.6578	.6836	.6456	.5911	.7013	.7135	N/A	.6989	.7282	.7346	.5704	.6644
Henan	.7045	.5238	.6718	.5849	.7145	.6334	.6885	.6812	.7873	.7548	.7363	.6309	.6394	.7101	N/A	.6803	.6102	.7873	.5238	.6720
Hubei	.7192	.6459	.7051	.6103	.7756	.6596	.7694	.7062	.7489	.6730	.7057	.6862	.6604	.5733	N/A	.7561	.6498	.7756	.5733	.6903
Hunan	.6047	.6467	.7082	.5907	.7478	.6784	.7300	.7178	.7738	.8185	.8191	.6471	.6724	.6300	N/A	.7264	.6966	.8191	.5907	.7005
Jiangsu	.7060	.8410	.6718	.6697	.8081	.7179	.8511	.8578	.9010	.8964	.8663	.8711	.8393	.8977	N/A	.8815	.8303	.9010	.6697	.8192
Jiangxi	.5256	.5788	.6532	.6609	.7870	.8205	.7499	.7058	.7744	.6969	.7487	.6712	.6137	.6203	N/A	.6688	.7696	.8205	.5256	.6903
Jilin	.6112	.4522	.6350	.5563	.7234	.7677	.8136	.6537	.7764	.6694	.5424	.6617	.7701	.7547	N/A	.6696	.7638	.8136	.4522	.6763
Liaoning	.6828	.6436	.5814	.5890	.7929	.7914	.7577	.6818	.7956	.6446	.6262	.6775	.7235	.7577	N/A	.7227	.7073	.7956	.5814	.6985
Neimenggu	.5890	.5886	.6512	.6497	.8216	.7993	.7692	.7192	.7692	.6455	.6865	.7068	.7816	.8133	N/A	.6553	.5466	.8216	.5466	.6995
Ningxia	.4882	.5052	.6400	.6010	.7984	.7532	.8097	.7148	.6967	.6830	.6725	.6506	.8143	.9322	N/A	.9283	.7983	.9322	.4882	.7179
Qinghai	.5465	.7571	.7754	.6254	.7207	.6724	.6708	.5654	.5642	.8683	.7255	.6331	.5288	.6326	N/A	.7910	.7645	.8683	.5288	.6776

Shandong	.6223	.7113	.6141	.5512	.6875	.6501	.6229	.7346	.7727	.7267	.7362	.7189	.7061	.7167	N/A	.7435	.7136	.7727	.5512	.6893
Shanghai	.7975	.8288	.9009	.8626	.7379	.7320	.8581	.7840	.8414	.7914	.6783	.7498	.8475	.7599	N/A	.7816	.7827	.9009	.6783	.7959
Shanxi	.5769	.6827	.7069	.6046	.6550	.5929	.7373	.6386	.7036	.7306	.7428	.6623	.6640	.7073	N/A	.6770	.6666	.7428	.5769	.6718
Shan-xi	.6747	.5269	.7183	.5072	.6005	.6112	.7124	.5739	.7410	.6709	.6312	.5643	.4708	.7186	N/A	.6469	.6673	.7410	.4708	.6273
Sichuan	.5921	.6359	.6662	.6059	.7362	.6036	.7206	.7567	.7856	.7636	.7360	.6716	.6190	.6921	N/A	.8104	.7375	.8104	.5921	.6958
Tianjin	.5274	.5824	.4706	.5340	.5893	.6181	.6124	.5046	.5894	.6621	.6129	.7414	.5501	.6984	N/A	.6900	.6318	.7414	.4706	.6009
Xinjiang	.6330	.6365	.7453	.6520	.8321	.7801	.8107	.7474	.8056	.8076	.7626	.7936	.8502	.9252	N/A	.8969	.8276	.9252	.6330	.7816
Xizang	.6332	.6615	.6925	.5853	.6051	.5085	.4241	.5979	.3851	.3451	.4605	.6038	.3097	.4678	N/A	.4771	.4072	.6925	.3097	.5103
Yunnan	.5757	.6327	.7113	.7507	.5300	.7182	.7280	.6797	.7601	.6327	.7264	.6688	.7587	.6907	N/A	.7518	.7148	.7601	.5300	.6894
Zhejiang	.7516	.8224	.6744	.7043	.9837	.8319	.8881	.8857	.9398	.8129	.7980	.8200	.9038	.8907	N/A	.9939	.9048	.9939	.6744	.8504

Table 6.2 Indices of Xc and Xs in China's local construction markets

Place	1990		1991		1992		1993		1994		1995		1996		1997	
	Xc	**Xs**	**Xc**	**Xs**	**Xc**	**Xs**	**Xc**	**Xs**	**Xc**	**Xs**	**Xc**	**Xs**	**Xc**	**Xs**	**Xc**	**Xs**
Anhui	.5481	.4749	.4933	.5067	.6672	.3716	.5006	.4812	.5784	.4509	.4876	.4781	.5968	.3493	.5691	.4482
Beijing	.6010	.4598	.7313	.3466	.7135	.5043	.4532	.3244	.6075	.5167	.5368	.4772	.6567	.4814	.4697	.5530
Chongqing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.5442	.5166
Fujian	.4694	.3484	.5439	.4027	.6252	.6977	.3578	.4846	.6570	.4757	.5538	.4952	.6703	.4575	.5347	.4976
Gansu	.5287	.2548	.5309	.3667	.6484	.4597	.5052	.3693	.6213	.3810	.5412	.4736	.5869	.2734	.5400	.3005
Guangdong	.6359	.4498	.5675	.5406	.5057	.4937	.4288	.4645	.6527	.4993	.4925	.4162	.7523	.4124	.5487	.6039
Guangxi	.4701	.3397	.4593	.4596	.5257	.4510	.4540	.4061	.6131	.5898	.5748	.4817	.6574	.3603	.5381	.5415
Guizhou	.5423	.2960	.5288	.3549	.5789	.3502	.4429	.4104	.6988	.4026	.6119	.3334	.6595	.3858	.5213	.3901
Hainan	.3680	.2947	.5207	.2244	.5925	.3745	.5227	.5691	.5666	.6853	.6438	.4865	.6856	.4598	.3804	.5522
Hebei	.5547	.3457	.4947	.3914	.5534	.3832	.4802	.3125	.6000	.2994	.4898	.3543	.6350	.3262	.5015	.3539
Heil.J.	.6588	.3251	.4571	.3412	.4701	.3735	.4781	.3810	.6513	.3098	.5790	.3296	.6105	.3502	.4548	.3944
Henan	.5270	.4676	.3664	.3743	.6060	.2898	.4613	.3595	.6487	.2996	.5442	.3241	.6463	.2372	.6125	.2983
Hubei	.5464	.4676	.5119	.3939	.6333	.3101	.4600	.4011	.6168	.4702	.4769	.4557	.6347	.4348	.5202	.4776
Hunan	.4060	.4482	.4904	.4217	.5900	.3918	.4789	.3457	.6039	.4411	.5141	.4426	.5992	.4169	.5157	.4993
Jiangsu	.3389	.6193	.5085	.6698	.4378	.5096	.4359	.5084	.5728	.5701	.3589	.6217	.6768	.5161	.5768	.6350
Jiangxi	.3904	.3519	.4440	.3714	.5648	.3282	.5038	.4277	.7006	.3585	.6578	.4905	.6790	.3182	.5744	.4102
Jilin	.5456	.2753	.3695	.2607	.5090	.3797	.4825	.2769	.6566	.3036	.6708	.3733	.6232	.5231	.4826	.4409
Liaoning	.5489	.4061	.5022	.4025	.4388	.3815	.4562	.3726	.6298	.4816	.6006	.5153	.6057	.4552	.4695	.4944
Neimenggu	.4816	.3390	.4405	.3904	.5236	.3871	.5087	.4041	.6714	.4736	.6394	.4797	.6264	.4464	.5003	.5167
Ningxia	.4186	.2513	.3772	.3360	.5034	.3953	.3972	.4510	.6930	.3965	.6059	.4474	.6204	.5204	.4548	.5515

Qinghai	.4669	.2841	.6582	.3742	.6489	.4244	.5171	.3518	.6166	.3731	.4533	.4967	.5684	.3563	.4398	.3553
Shandong	.4568	.4225	.5376	.4657	.5532	.2665	.4499	.3184	.5827	.3649	.5156	.3961	.5448	.3020	.5835	.4463
Shanghai	.5850	.5421	.6568	.5055	.6419	.6321	.6257	.5938	.3121	.6687	.4106	.6059	.5949	.6184	.3669	.6928
Shanxi	.4606	.3474	.5701	.3755	.6411	.2979	.4957	.3462	.4823	.4432	.4362	.4015	.6150	.4068	.4980	.3997
Shan-xi	.5384	.4066	.4428	.2856	.6682	.2636	.4879	.1386	.4996	.3331	.4661	.3953	.6037	.3783	.4606	.3422
Sichuan	.4343	.4024	.4949	.3993	.5679	.3482	.4747	.3764	.5907	.4394	.4591	.3919	.6115	.3813	.6131	.4434
Tianjin	.4452	.2827	.5114	.2786	.2263	.4125	.4785	.2371	.4508	.3796	.4469	.4270	.4958	.3596	.3262	.3850
Xinjiang	.3516	.5263	.3996	.4954	.6068	.4327	.5020	.4161	.6186	.5566	.5604	.5426	.6274	.5134	.4566	.5917
Xizang	.3934	.4962	.5741	.3286	.5533	.4164	.5770	.0979	.5448	.2633	.4160	.2924	.4039	.1292	.5608	.2074
Yunnan	.4354	.3766	.5177	.3638	.6033	.3768	.6653	.3478	.3563	.3924	.5626	.4463	.6178	.3853	.5252	.4314
Zhejiang	.5650	.4956	.5414	.6190	.4962	.4567	.3603	.6052	.6637	.7261	.3555	.7521	.6208	.6350	.5329	.7075

	1998		1999		2000		2001		2002		2003		2005		2006	
Place	Xc	Xs	Xc	Xs	Xc	Xs	Xc	Xs	Xc	Xs	Xc	Xs	Xc	Xs	Xc	Xs
Anhui	.6888	.4001	.4791	.3634	.6460	.2760	.4747	.3310	.5774	.4326	.5768	.5038	.5724	.5009	.4692	.5919
Beijing	.5521	.5967	.5641	.6200	.5939	.4795	.4744	.5585	.4904	.6314	.4547	.6691	.2957	.5360	.3071	.6253
Chongqing	.6049	.4561	.6382	.4796	.6747	.3567	.5022	.4004	.6079	.4470	.6252	.5054	.5964	.5680	.5678	.4338
Fujian	.5792	.5790	.5473	.4373	.6257	.3773	.5206	.4299	.5479	.5003	.5242	.5499	.3883	.6272	.3944	.5798
Gansu	.7014	.3664	.5585	.3267	.7907	.3166	.6364	.3049	.5165	.3837	.5490	.4737	.5334	.3922	.4992	.4722
Guangdong	.6811	.5743	.6621	.5726	.7599	.4275	.6323	.4667	.6014	.5742	.5217	.5060	.6239	.6532	.5632	.5972
Guangxi	.6534	.4717	.6046	.5216	.5033	.3792	.4886	.3622	.3219	.4622	.4375	.4797	.5446	.5067	.4962	.5363
Guizhou	.6263	.3784	.5538	.4448	.7012	.2776	.6731	.3000	.5185	.4960	.5926	.4883	.5740	.6309	.5770	.5281
Hainan	.6667	.3557	.7233	.2298	.6988	.2015	.3860	.2216	.6091	.1420	.4425	.1878	.5477	.1760	.5320	.2956
Hebei	.6396	.3236	.5767	.3090	.6420	.2721	.5307	.3574	.4835	.3552	.5310	.4437	.5603	.4532	.5184	.5275
Heil.J.	.5323	.3864	.4958	.4707	.5215	.3807	.4856	.3369	.5110	.4803	.4849	.5234	.4895	.4988	.4623	.5626
Henan	.6985	.3632	.6738	.3402	.6760	.2917	.5660	.2787	.5247	.3654	.5597	.4371	.4993	.4621	.3742	.4819

Hubei	.6083	.4368	.5545	.3813	.6437	.2894	.6288	.2747	.5112	.4182	.3984	.4122	.5733	.4930	.4140	.5009
Hunan	.6321	.4463	.6308	.5215	.6914	.4393	.5160	.3905	.5260	.4189	.4368	.4539	.5879	.4265	.5172	.4666
Jiangsu	.6783	.5930	.6502	.6171	.7249	.4745	.7179	.4934	.6287	.5560	.6190	.6502	.6070	.6392	.5684	.6053
Jiangxi	.6702	.3879	.5965	.3604	.7088	.2413	.6169	.2645	.5295	.3103	.4781	.3951	.5467	.3853	.5529	.5354
Jilin	.6141	.4751	.4918	.4542	.3702	.3964	.5267	.4006	.5837	.5024	.5444	.5227	.4538	.4924	.4601	.6097
Liaoning	.5942	.5290	.4030	.5031	.4855	.3956	.5479	.3986	.5542	.4651	.5310	.5404	.5398	.4806	.4632	.5345
Neimenggu	.6182	.4577	.4575	.4554	.5828	.3628	.5499	.4441	.5542	.5511	.5209	.6246	.4696	.4571	.4186	.3516
Ningxia	.4864	.4988	.3843	.5646	.6108	.2814	.4435	.4760	.4693	.6655	.5014	.7859	.6940	.6165	.4705	.6449
Qinghai	.3526	.4404	.6811	.5385	.6438	.3346	.5216	.3588	.4477	.2814	.4938	.3955	.6518	.4481	.6118	.4584
Shandong	.6580	.4052	.6119	.3921	.6621	.3219	.6142	.3736	.5855	.3947	.5709	.4333	.5897	.4529	.5353	.4720
Shanghai	.4680	.6993	.4737	.6340	.4985	.4600	.4606	.5917	.4635	.7095	.1816	.7378	.4246	.6562	.4630	.6310
Shanxi	.5689	.4141	.5753	.4503	.6676	.3257	.5487	.3709	.4694	.4696	.4935	.5067	.5123	.4426	.3979	.5348
Shan-xi	.6542	.3480	.4936	.4544	.5803	.2485	.4925	.2755	.2255	.4133	.4698	.5438	.4441	.4703	.4038	.5312
Sichuan	.6363	.4608	.6340	.4257	.6630	.3196	.5817	.3357	.4962	.3700	.5333	.4411	.6245	.5165	.5304	.5124
Tianjin	.4176	.4159	.4646	.4718	.5320	.3045	.5959	.4410	.3035	.4588	.4405	.5420	.5405	.4289	.3883	.4983
Xinjiang	.5372	.6004	.5315	.6080	.3646	.6697	.3752	.6992	.4191	.7397	.5905	.7122	.6374	.6309	.5515	.6171
Xizang	.3383	.1841	.3038	.1637	.4283	.1693	.5694	.2009	.2157	.2222	.4274	.1902	.3875	.2784	.3411	.2224
Yunnan	.6039	.4617	.4779	.4146	.6598	.3040	.5694	.3508	.6427	.4031	.5259	.4477	.5613	.5002	.4695	.5390
Zhejiang	.6650	.6641	.5339	.6130	.6284	.4919	.5966	.5626	.6252	.6526	.6158	.6436	.7709	.6274	.6675	.6108

6.5 Summary

Using the empirical data collected from China, this chapter has demonstrated the application of CSCS model. The discussion in this chapter presents the ways in which the causal factors and sequential factors are quantified. The output from running CSCS model has three components including the general index of competition intensity, the causal competition intensity, and the sequential competition intensity. These three indexes can be applied to examine the structural features of construction market and construction competition as discussed in the next chapter.

CHAPTER 7 ANALYSIS TO THE RESULTS OF THE CSCS APPLICATION

This chapter presents the analysis to the CSCS application results. The objectives of the analysis are to validate the CSCS model and to address the ways in which the model results can be utilised to improve business performance.

7.1 Validity of the Application Results

Model validation is an essential part of model development process. It refers to an iterative process of “building an acceptable level of confidence that an inference about a simulated process is a correct or valid inference for the actual” (van Horn 1971). To examine whether a developed model can satisfy its intended requirements with respect to the methods employed and the results derived, model validation contributes to understanding the advantages, limitations, and appropriateness of the model in addressing a diversity of questions.

There is a widely applied three-stage approach for model validation as follows (Naylor and Finger 1967):

- *Rationalism* – to test a model that should be simply a system of logical deductions from a series of synthetic premises of unquestionable truth.
- *Empiricism* – to subject assumptions, parameters and distributions of the model to empirical testing.
- *Positive economics* – to compare the model input-output transformations with corresponding input-output transformations for the real system.

As an "objectivist" approach to validation in simulation (Kleindorfer *et al.* 1998), this three-stage method is adopted in this study to validate CSCS model. The model validation includes the test of model structure, the methods of factor quantification, and

the factor interaction as presented below.

7.1.1 Effectiveness of the structure of CSCS model

The CSCS structure is composed of the variables of BD, MEB, MG, MS, MSD, PT, and WG as defined in CHAPTER 5. The functional relationships between the structure variables and the objective variable CSCI have been discussed in CHAPTER 5. This section presents validity analysis on these functional relationships. The validity is examined by calculating the correlation coefficients between CSCI and individual model variables. Data used for the correlation analysis are the mean values of CSCI and model variables for the 1990-2006 periods, as shown in Table 7.1. The correlation coefficients are presented graphically in Figures 7.1 – 7.7.

Table 7.1 Mean values of CSCI and model variables (1990-2006)

Place	BD	MEB	MG	MS	MSD	PT	WG	CSCI
Anhui	.3305	.7987	.5513	.3236	.5276	.6745	.2076	.7128
Beijing	.5519	.3889	.6169	.5884	.4276	.3749	.7405	.7573
Chongqing	.1732	.7835	.5396	.4640	.8401	.6023	.2348	.7565
Fujian	.3700	.8056	.4937	.3019	.6088	.5083	.4980	.7352
Gansu	.2149	.7718	.6350	.3346	.4379	.6129	.2131	.6925
Guangdong	.5354	.5140	.6100	.6816	.6375	.3242	.5658	.7968
Guangxi	.6198	.6629	.5761	.3253	.3059	.5645	.3471	.6985
Guizhou	.4539	.8980	.6033	.2614	.2497	.7216	.1916	.7192
Hainan	.2934	.8416	.6258	.1988	.4140	.4569	.1999	.6676
Hebei	.2363	.6638	.5910	.3936	.4783	.5329	.2047	.6621
Heilongjiang	.1480	.7969	.6511	.1162	.5096	.5975	.3560	.6644
Henan	.3193	.8551	.5420	.2875	.4060	.5752	.1172	.6720
Hubei	.4673	.7067	.5942	.3364	.3514	.5799	.2559	.6903
Hunan	.3541	.7437	.5374	.3570	.5520	.5735	.2631	.7005
Jiangsu	.5233	.6348	.4371	.6344	.7999	.4979	.4985	.8192
Jiangxi	.2652	.9483	.5251	.2543	.4342	.6707	.1141	.6903
Jilin	.2754	.7995	.5819	.1907	.3469	.6902	.3592	.6763
Liaoning	.2978	.7669	.6058	.1967	.6267	.5399	.3746	.6985

Neimenggu	.2163	.8643	.5735	.1679	.6565	.5722	.3404	.6995
Ningxia	.5208	.9359	.5090	.0796	.4328	.6713	.3458	.7179
Qinghai	.3788	.8329	.7138	.0982	.1249	.8128	.2514	.6776
Shangdong	.3058	.8434	.5416	.3122	.6819	.3292	.2401	.6893
Shanghai	.7077	.2868	.5559	.5875	.5618	.3597	.8655	.7959
Shanxi	.3944	.6669	.5920	.3222	.2500	.7264	.2625	.6718
Shan-xi	.3285	.6573	.6104	.2194	.1895	.7113	.2278	.6273
Sichuan	.2849	.7522	.5807	.3444	.5250	.5862	.2449	.6958
Tianjin	.1730	.2252	.5955	.5038	.1890	.6597	.5591	.6009
Xinjiang	.7499	.6679	.5855	.2710	.3608	.5722	.6552	.7816
Xizang	.1081	.8340	.4659	.0192	.3109	.1378	.4089	.5103
Yunnan	.3115	.8139	.6046	.2304	.4723	.5573	.2941	.6894
Zhejiang	.3846	.7044	.4342	.5938	1.0000	.4016	.6796	.8504

Note: the mean values are derived based on Tables 6.1, and Tables a.4 - a.10 in the attachment.

7.1.2 Variables having negative relationships with CSCI

Market entry barriers

Barriers to market entry block potential competitors from entering a given market. Entry barriers matter because they can impel new firms to enter the market at costs and protect the existing competition among the incumbent unchanged. By contrast, the competition in the industries that are characterised by low entry barriers can be intensified and changed quickly by the new entrance. Thus, as discussed in Section 5.4, a higher level of entry barriers contributes to a lower degree of competition intensity in construction market. This is supported by the correlation analysis results shown in Figure 7.1, suggesting that MEB has a negative impact on CSCI. In particular, the larger the MEB value, the more significant the negative relationship between MEB and CSCI.

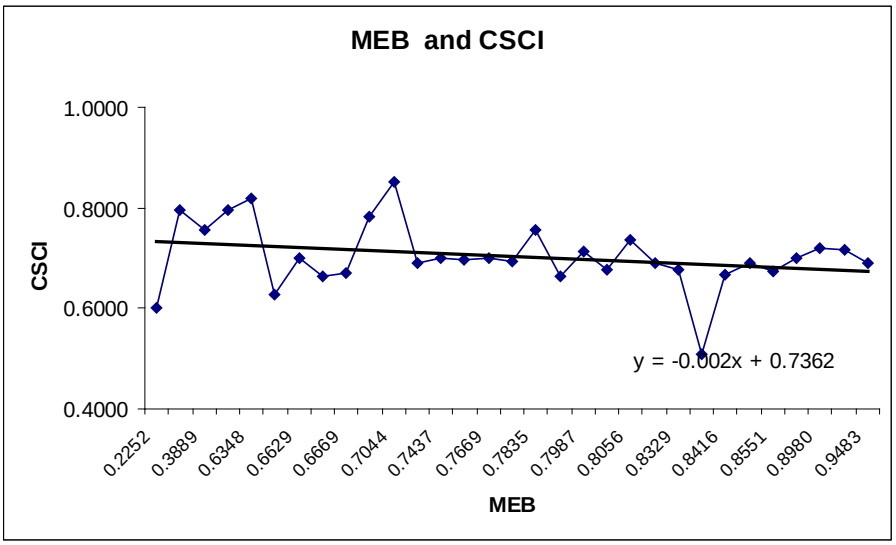


Figure 7.1 Relationships between MEB and CSCI

Market growth

Market growth means an increase in market size. As considered in CSCS model, market growth is a causal factor that can lessen the degree of competition intensity. This is supported from the findings presented in Figure 7.2. In fact, a larger market presents contractors with more opportunities of construction works, thus contractors do not need to compete against counterparts radically for businesses. For instance, competition pressure on contractors in a booming economy will be smaller than that in a slumping period.

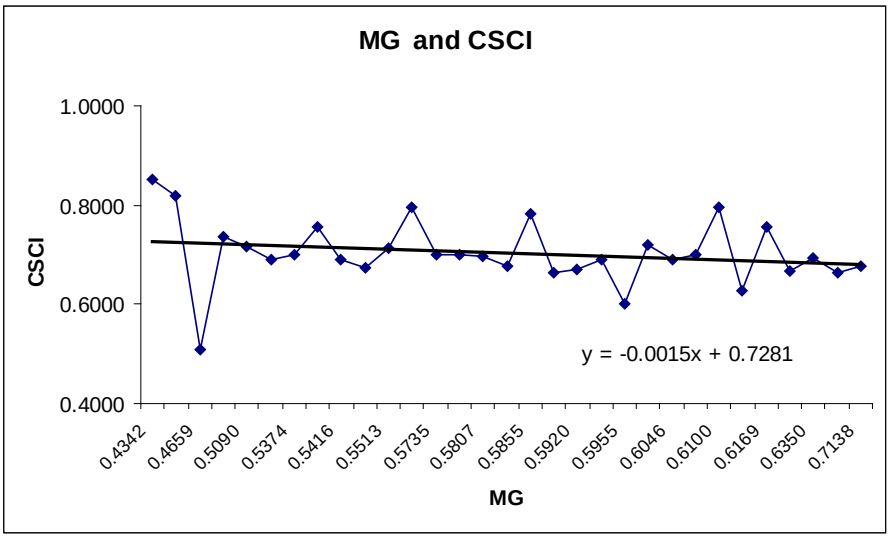


Figure 7.2 Relationships between MG and CSCI

Profitability

A profitable business attracts new entrance into the market, resulting in stiffer competition and decrease in the level of profitability. It is assumed in CSCS model that the interactive relationship between competition intensity and profitability in construction market is no exception. Although the profitability is determined by multiple factors such as market condition, innovation, and cost level, fiercer competition in a construction market can lower the level of profitability in the industry. This is supported by the correlation analysis results shown in Figure 7.3, which echoes the early discussion over the negative relationship between CSCI and PT as presented in Section 5.5.

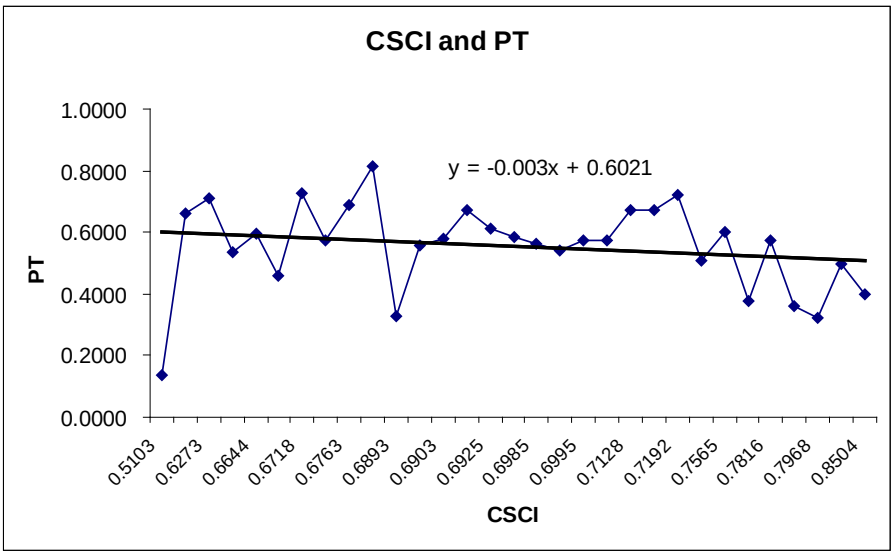


Figure 7.3 Relationships between CSCI and PT

7.1.3 Variables having positive relationships with CSCI

Market size

The argument in CSCS model suggests that a larger size of construction market gives rise to fiercer competition in the market. This is supported by the findings shown in Figure 7.4. It is primarily because the barriers to enter construction market are usually minor, thus contractors can start their businesses effortlessly in a newly emerging market and new competitors can enter the market without serious trouble. More contractors entering the market incur the upswing of the competition intensity.

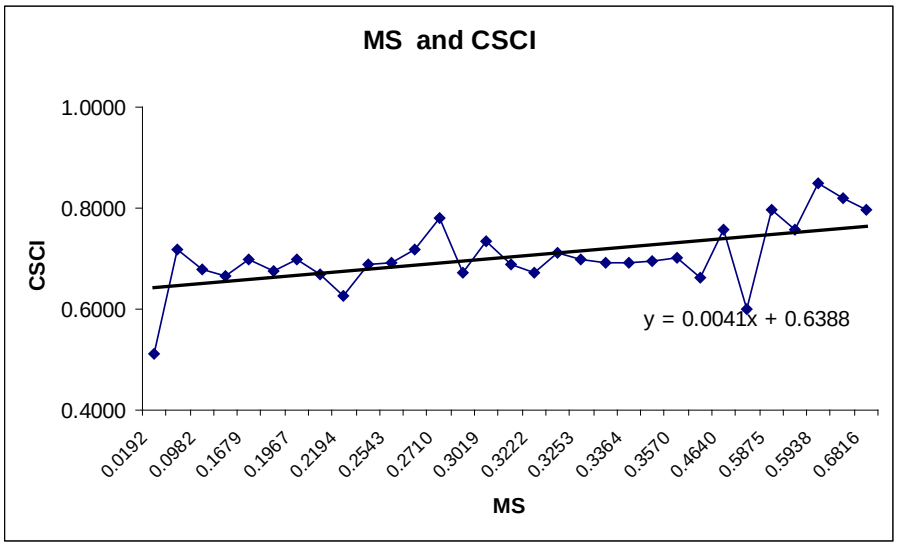


Figure 7.4 Relationships between MS and CSCI

Business diversity

Business diversity helps firms to serve customers in different markets. There are a number of factors that lead to business diversity. For instance, business diversity can support organisational leadership, strategic responsiveness, and management effectiveness. By diversifying business structure, the effectiveness of the linkages in the firm's value chain can be promoted. As demonstrated above, fierce competition lowers the level of profitability, and consequently, firms have to explore other promising businesses. Such kind of the impact of market competition on business diversity has been described in CSCS model by using the positive correlation between CSCI and BD. This correlation is supported by the trend line in Figure 7.5, indicating that the higher the level of competition intensity, the more diversified the type of construction businesses in the market.

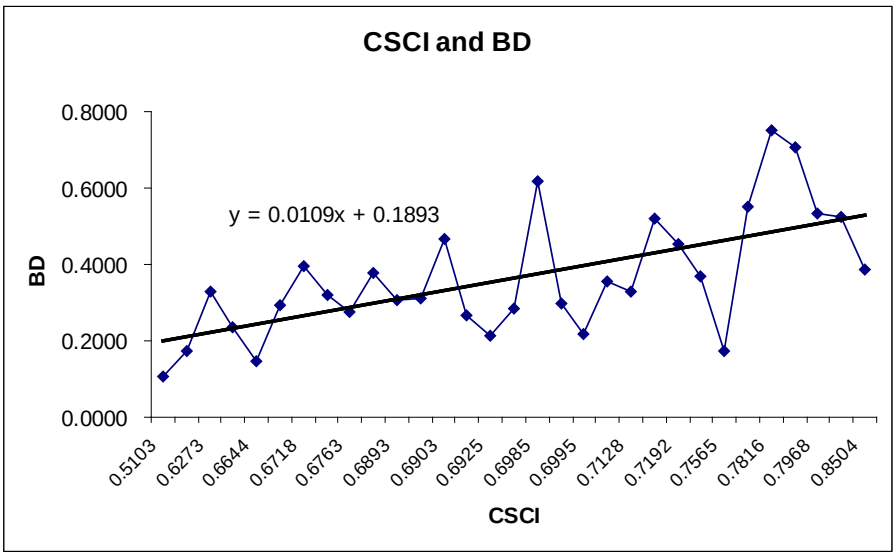


Figure 7.5 Relationships between CSCI and BD

Market share distribution

Market competition can result in more concentration of market shares if the market is dominated by a few large firms. In the meanwhile, it can lead to more even distribution when all the existing firms have similar market powers in controlling product prices. The competition in construction market appears when more similar powers exist in the market. It is considered that the relationship between CSCI and MSD is positive. Data analysis as presented graphically in Figure 7.6 supports this analogy, indicating that a higher level of competition contributes to an even distribution of market shares among contractors.

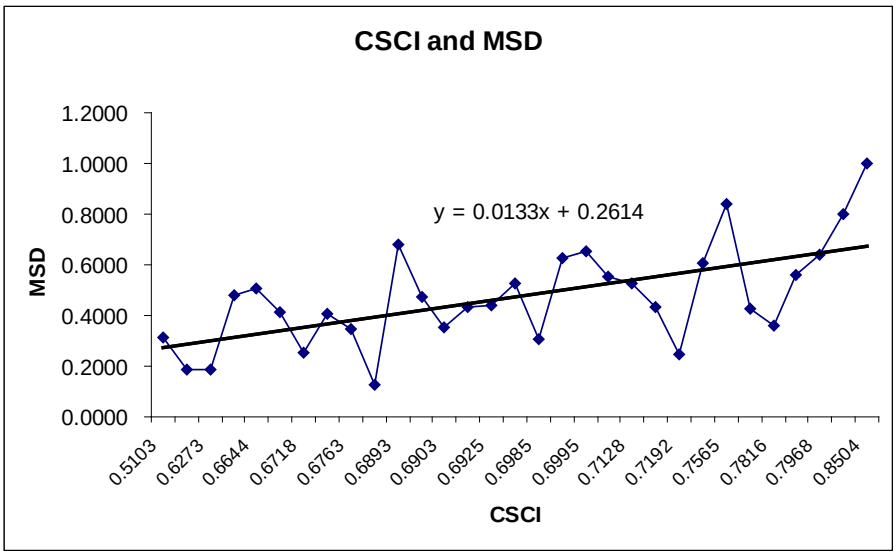


Figure 7.6 Relationships between CSCI and MSD

Average wage

Wage means the reward to labour productivity. Labour with higher productivity usually gets more rewards. Nevertheless, the average rate of wage at the industry level is determined by multiple factors such as market forces, skills, and education backgrounds. Contractors' competition for labour resources is all-pervading in construction practice. CSCS model assumes the positive relationship between competition intensity and WG. This can be supported in the analysis presented in Figure 7.7, indicating a fiercer construction competition can lead to a higher level of wage.

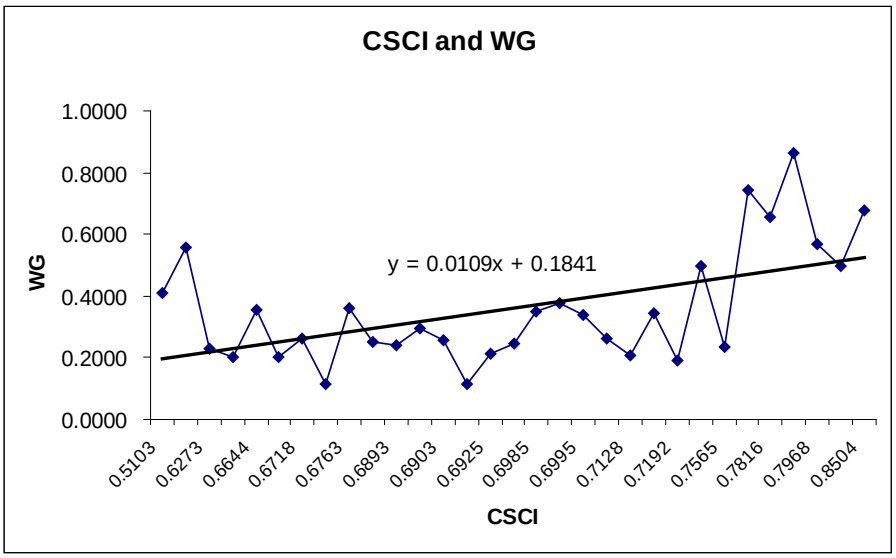


Figure 7.7 Relationships between CSCI and WG

7.2 Reliability of the Application Results

The discussion in the above section demonstrates the proper establishment of the rationale for the relationships between the objective variable CSCI and the causal/sequential factors in the model CSCS. This gives the validity of the model structure. This section will further discuss the validity of CSCS by comparing the results from the model application with the results from a practical investigation through a survey.

7.2.1 Practical investigation using questionnaire survey on competition intensity between local construction markets

To understand the reliability of the CSCS application results, a survey on the professionals' view about competition intensity is conducted with reference to local

construction markets in China. As shown in the attached questionnaire, this survey is a part of the whole survey, namely, “A Survey for Understanding Competition Intensity in Construction Market”. The survey method and procedure have been addressed in CHAPTER 1. In this part of survey, respondents were invited to gauge the construction markets in terms of competition intensity by marking a scale in five-level Likert system. The survey results are presented in Table 7.2.

Table 7.2 Descriptive statistics on the survey

Place	Min.	Max.	Mean	Std. Dev.	Var.	N	Missing
Zhejiang	2	5	4.4074	0.7379	0.5444	89	2
Guangdong	2	5	4.1954	0.8189	0.6707	89	2
Jiangsu	1	5	4.0370	1.2293	1.5111	89	4
Shanghai	1	5	3.8659	1.1414	1.3028	89	3
Chongqing	1	5	3.8046	1.3880	1.9265	89	2
Beijing	2	5	3.7738	0.8118	0.6591	89	5
Tianjin	1	5	3.3976	1.0469	1.0961	89	6
Ningxia	1	5	3.3816	1.3463	1.8125	89	6
Guizhou	1	5	3.2658	1.0341	1.0695	89	7
Fujian	1	5	3.1786	1.1103	1.2328	89	5
Shandong	1	5	3.1625	0.9865	0.9733	89	6
Yunnan	1	5	3.0000	1.0000	1.0000	89	8
Gansu	1	5	2.9241	0.9026	0.8147	89	10
Anhui	1	5	2.9241	0.9442	0.8916	89	10
Sichuan	1	5	2.8354	0.8833	0.7803	89	10
Liaoning	1	5	2.7949	1.0365	1.0743	89	11
Neimenggu	1	5	2.6835	0.9680	0.9370	89	10
Hunan	1	5	2.6500	1.1374	1.2937	89	9
Heilongjiang	1	5	2.6410	1.0928	1.1941	89	11
Jilin	1	5	2.6026	0.9581	0.9179	89	11
Jiangxi	1	5	2.5513	0.9349	0.8740	89	11
Shan-xi	1	5	2.5190	0.9318	0.8682	89	10
Shanxi	1	4	2.4430	0.9302	0.8653	89	10
Henan	1	5	2.3671	0.8796	0.7738	89	10

Qinghai	1	5	2.3291	1.2166	1.4800	89	10
Hubei	1	5	2.2169	1.0482	1.0987	89	6
Xinjiang	1	5	2.2169	1.0247	1.0500	89	6
Hebei	1	5	2.1667	0.9591	0.9199	89	11
Guangxi	1	4	2.0241	0.8111	0.6579	89	6
Hainan	1	4	1.9351	0.8482	0.7194	89	12
Xizang	1	4	1.9157	0.8440	0.7123	89	6

7.2.2 Difference between the survey results and the model results

In referring to the CSCS application results shown in Table 7.1, the mean values of competition intensity for the 31 local markets over the 2000 to 2006 period are used to compare with the rank results in Table 7.2, and the comparison is shown in Table 7.3.

From Table 7.3, it can be seen that apart from Tianjin and Xinjiang, an average difference in rank order between the two types of analysis results is 1.6897, representing 5.83% of the rank range which is 29. Furthermore, the ranking correlation coefficient between the CSCI results and the survey results is 0.7597. If not taking into account the special two cases, Tianjin and Xinjiang, the correlation coefficient will be 0.9610. Therefore, it is considered a minor difference between the model calculation results and the survey results, suggesting that the model results are reasonably reliable. This further supports the validity of CSCS model. The two special cases in Tianjin and Xinjiang will be discussed in detail later.

Table 7.3 Rank comparison on the 31 local markets between empirical data and survey results

Place	CSCI mean value	Ranks by CSCI	Ranks by survey result	Absolute difference
Anhui	.7141	13	14	1
Beijing	.7356	9	6	3
Chongqing	.7503	8	5	3
Fujian	.7244	10	10	0
Gansu	.7126	14	13	1
Guangdong	.8234	4	2	2
Guangxi	.6543	27	29	2
Guizhou	.7686	6	9	3
Hainan	.5771	30	30	0
Hebei	.6815	22	28	6
Heilongjiang	.6797	23	19	4
Henan	.6679	26	24	2
Hubei	.6719	25	26	1
Hunan	.6986	17	18	1
Jiangsu	.8644	2	3	1
Jiangxi	.6821	21	21	0
Jilin	.6937	19	20	1
Liaoning	.7025	16	16	0
Neimenggu	.6984	18	17	1
Ningxia	.7994	5	8	3
Qinghai	.6792	24	25	1
Shandong	.7225	11	11	0
Shanghai	.7666	7	4	3
Shanxi	.6867	20	23	3
Shan-xi	.6165	29	22	7
Sichuan	.7111	15	15	0
Tianjin	.6541	28	7	21
Xinjiang	.8427	3	27	24
Xizang	.4544	31	31	0
Yunnan	.7185	12	12	0
Zhejiang	.8852	1	1	0

7.3 Discussion on the Application Results

The discussion in the previous section supports that CSCS model is effective in measuring competition intensity between China's local construction markets. The results of the model application are presented with three types of indexes as shown in Tables 6.1 and 6.2, indicating general competition intensity, causal competition intensity, and sequential competition intensity respectively. This section discusses the ways in which the application results can be utilised. The implication of the CSCS application results for the Chinese construction sector will be examined at the same time. To support this discussion, the data shown in Table 6.1 are transformed into graphics as indicated in Figure 7.8. The mean values of competition intensity in a construction market during the analysed period of time are used to represent the overall level of competition intensity relative to other construction markets.

7.3.1 Higher level of competition intensity in the developed regions

The results of the CSCI values shown in Figure 7.8 and Table 7.4 present levels of competition intensity in China's local construction markets. It can be found that the differences in competition intensity between local markets are considerable. These differences are closely associated with the gaps of development socially and economically between different regions. In accordance with the geographic location shown in Figure 7.9, the coastal areas are more developed, which usually refer to nine provinces, namely, Beijing, Fujian, Guangdong, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, and Zhejiang. According to GDP per capita (Table 7.5), economies in the coastal areas are more developed than those in the inland provinces. As indicated by the CSCI indexes (Figure 7.8), the competition intensity in the coastal is high, underpinning

the conclusion that construction markets in the developed regions are subject to larger intensity of competition than those in the undeveloped regions.

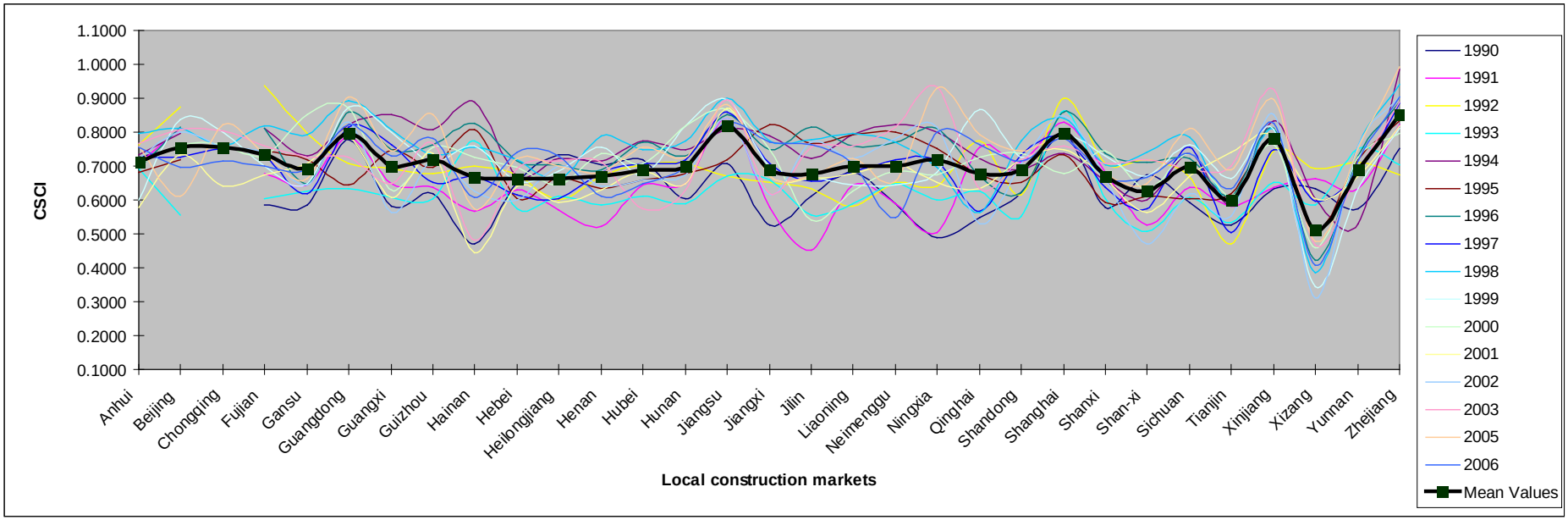


Figure 7.8 Values of CSCS in China's local construction markets

Table 7.4 Ranks of the regional construction markets by CSCI values (1990-2006)

Place	CSCI	Rank	Place	CSCI	Rank	Place	CSCI	Rank
Zhejiang	.8504	1	***Hunan***	.7005	12	***Jilin***	.6763	23
Jiangsu	.8192	2	***Neimenggu***	.6995	13	***Henan***	.6720	24
Guangdong	.7968	3	***Liaoning***	.6985	14	***Shanxi***	.6718	25
Shanghai	.7959	4	***Guangxi***	.6985	15	***Hainan***	.6676	26
Xinjiang	.7816	5	***Sichuan***	.6958	16	***Heilongjiang***	.6644	27
Beijing	.7573	6	***Gansu***	.6925	17	***Hebei***	.6621	28
Chongqing	.7565	7	***Jiangxi***	.6903	18	***Shan-xi***	.6273	29
Fujian	.7352	8	***Hubei***	.6903	19	***Tianjin***	.6009	30
Guizhou	.7192	9	***Yunnan***	.6894	20	***Xizang***	.5103	31
Ningxia	.7179	10	***Shandong***	.6893	21			
Anhui	.7128	11	***Qinghai***	.6776	22			

Table 7.5 GDP per capital at province level (2000-2006)

Plance	2000	2001	2002	2003	2004	2005	2006	Mean	Rank
Beijing	1.7936	2.0576	3.0431	3.4494	4.0591	4.4833	4.9780	3.4092	2
Tianjin	1.6377	1.8328	2.1358	2.5492	3.0381	3.5468	4.0550	2.6851	3
Hebei	.7546	.8326	.8936	1.0224	1.2451	1.4752	1.6904	1.1306	12
Shan-xi	.4986	.5440	.7058	.8615	1.0709	1.2469	1.4082	.9051	16
Neimenggu	.5897	.6503	.8159	1.0037	1.2756	1.6326	1.9989	1.1381	11
Liaoning	1.1017	1.2001	1.2986	1.4258	1.5822	1.8628	2.1660	1.5196	8
Jilin	.6676	.7553	.8702	.9846	1.1525	1.3334	1.5700	1.0476	13
Heilongjiang	.8818	.9344	.9539	1.0635	1.2446	1.4436	1.6189	1.1630	10
Shanghai	2.7187	3.0674	3.5329	3.9125	4.6342	5.1542	5.7115	4.1045	1
Jiangsu	1.1539	1.2933	1.4370	1.6801	2.0185	2.4512	2.8669	1.8430	6
Zhejiang	1.2906	1.4629	1.7223	2.0739	2.4679	2.7458	3.1611	2.1321	4
Anhui	.5076	.5199	.5553	.6120	.7366	.8791	1.0063	.6881	27
Fujian	1.1294	1.2365	1.2890	1.4288	1.6415	1.8598	2.1401	1.5322	7
Jiangxi	.4838	.5198	.5804	.6599	.8069	.9420	1.0764	.7242	24
Shandong	.9409	1.0439	1.1314	1.3236	1.6364	2.0042	2.3716	1.4932	9
Henan	.5551	.5903	.6278	.7104	.8803	1.1298	1.3305	.8320	18
Hubei	.7094	.7803	.7035	.7927	.9364	1.1425	1.3317	.9138	15
Hunan	.5733	.6039	.6263	.6994	.8423	1.0303	1.1935	.7956	20
Guangdong	1.1181	1.3681	1.7181	1.9920	2.2718	2.4351	2.8165	1.9599	5
Guangxi	.4567	.4660	.5234	.5808	.7023	.8756	1.0232	.6611	28
Hainan	.6588	.6859	.7746	.8553	.9767	1.0826	1.2594	.8990	17
Chongqing	.5143	.5650	.6405	.7261	.8625	1.0965	1.2434	.8069	19
Sichuan	.4815	.5118	.5448	.6130	.7312	.8997	1.0574	.6913	26

Guizhou	.2819	.2856	.3241	.3686	.4298	.5313	.6074	.4041	31
Yunnan	.4559	.4840	.5338	.5842	.6981	.7818	.8938	.6331	29
Xizang	.4483	.5275	.6238	.6999	.8042	.9066	1.0356	.7208	25
Shanxi	.4607	.5040	.6133	.7014	.8571	1.0147	1.2112	.7661	23
Gansu	.3838	.4165	.4751	.5377	.6447	.7462	.8736	.5825	30
Qinghai	.5089	.5754	.6440	.7310	.8647	1.0015	1.1708	.7852	22
Ningxia	.4725	.5300	.6594	.7675	.9135	1.0189	1.1768	.7912	21
Xinjiang	.7088	.7918	.8465	.9754	1.1254	1.2968	1.4855	1.0329	14

Figure 7.9 Developed and undeveloped regions in China

Note: The four-digit data indicate GDP per capita (10, 000 Yuan/per person) in 2006, whilst the ordinal numbers on the right refer to the ranks of the 31 provinces based on GDP per capita.

In fact, construction plays important roles in socio-economic development within these developed regions. According to the statistics (NBSC 2007), there were 31,441 construction firms in 2006 in the Chinese coastal regions, accounting for 52.3 percent of all construction firms in China, and the construction output contributed by these places was RMB 0.248 trillion, taking 59.77% of the total output of the industry at the national level. On the other hand, market sizes in these developed regions are generally large, where a number of large construction organisations have emerged. For example, among the 49 Chinese contractors listed in the top 225 global construction companies (ENR 2007), 37 were from the developed provinces. This supports the previous discussion that a larger market size might induce more intense competition. It also indicates that international competition has already been introduced in these developed regional

markets.

In another example, according to the report from the Xinhua Newspaper (Xinhua Website-a 2004), the construction investment triggered by the Beijing 2008 Olympic Games generated “a big cake” valued over RMB1.5 trillion for construction firms in Beijing construction market. As stated by the same newspaper, the competition induced by this “big cake” was fiercer in the local construction market. Similarly, the construction markets in the more developed local markets, generally in coastal regions, have been growing in size dramatically, accompanying with the increase in competition intensity for construction businesses over the previous years.

7.3.2 Lower intensity of competition in the less developed regions

The analysis results also show that the competition of the construction markets in the less developed regions is less intensive. As indicated in Figure 7.8, the competition in construction markets in Yunnan, Qinghai, Jilin, Henan, Shanxi, Hainan, Heilongjiang, Hebei, Shan-xi, and Xizang are relatively less intensive. These places are inland provinces. They are relatively undeveloped from perspectives of GDP outcomes, infrastructure facilities and other aspects, and the construction outputs in these provinces are much lower than those in the coastal areas. In fact, the construction markets in these regions still engage the practice of localism and protectionism to a certain extent.

Construction markets in less developed provinces are less open than those in the developed areas, presenting more entry barriers particularly for foreign firms to enter. In the early 1980s, reform and open-door policies were implemented from some coastal

cities gradually to the inland. Subject to governmental decision, local construction markets in the coastal provinces opened to foreign investments much earlier than in the inland provinces. The presence of foreign investment brought more economic opportunities to those coastal areas, leading them to be more developed than that in the inland construction markets. As a consequence, construction markets in the developed areas have lower entry barriers than those in the less developed areas. This further echoes the previous discussion that lower entry barriers induce the increase in competition intensity.

7.3.3 Special cases: Shandong, Tianjin and Xinjiang

There are three special cases worth of note. Shandong and Tianjin are two coastal provinces with developed economies. Xinjiang is located in the less developed parts of northwest China. Results from the data analysis in Table 7.4 reveal, however, that the competition intensity in these three construction markets differs from what was expected. To gain deep understanding on such special characteristics, comparison can be made between Zhejiang (the most intensive in competition) with these three cases.

As shown in Tables a.5 and a.6 in the appendices, Shandong has lower market entry barriers (*MEB*) and smaller market growth (*MG*) than Zhejiang. According to the principles built in CSCS, these two causal factors should lead to higher intensity in competition in Shandong construction market. However, according to the performance of the sequential factors including *BD*, *WG*, and *MSD*, the competition in Shandong should be less intensive than that in Zhejiang. This suggests that the performance of sequential factors is more significant than the performance of causal factors in Shandong construction market. This can be further illustrated in Figure 7.10, from

which it can be seen that the typical characteristics of Shandong construction market in terms of *MS*, *MSD*, and *WG* contribute to the lower intensity of competition than expected.

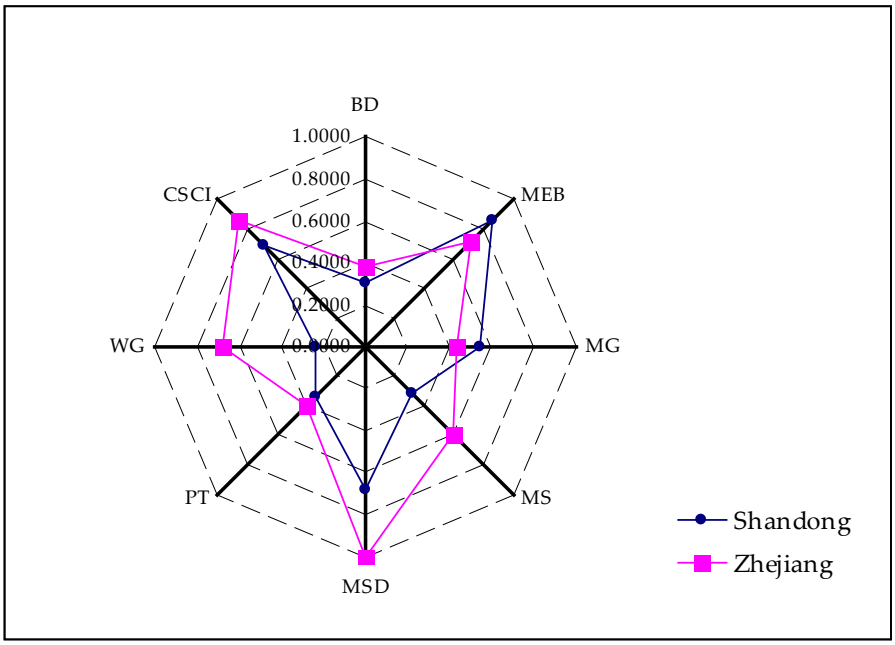


Figure 7.10 Value differences in CSCI, X_c (MEB, MG, MS) and X_s (BD, MSD, PT, WG) between Shandong and Zhejiang

Likewise, the factors *MEB* and *MSD* dominate the calculation for the measurement of competition intensity in Tianjin construction market, as shown in Figure 7.11. $MEB_{Tianjin}$ is 1.954 times than $MEB_{Zhejiang}$, whilst $MSD_{Tianjin}$ is 0.417 smaller than $MSD_{Zhejiang.}$ The performance values of these factors contribute to the decrease in CSCI values in Tianjin as shown in Table 7.4.

For the case of Xinjiang, as a less developed region, its competition intensity was expected lower according to the discussion that less developed economies have lower

intensity of competition in construction markets. However, this is not the case in Xinjiang, which has a high level of CSCI. As presented in Figure 7.12, the values for Xinjiang on the factors *BD*, *MSD* and *MS* are different from those of Zhejiang, but the values of all other factors are similar to those of Zhejiang. Therefore, the over performance of *MEB*, *MG*, *PT* and *WG* factors has led to a high level of $CSCI_{Xinjiang}$.

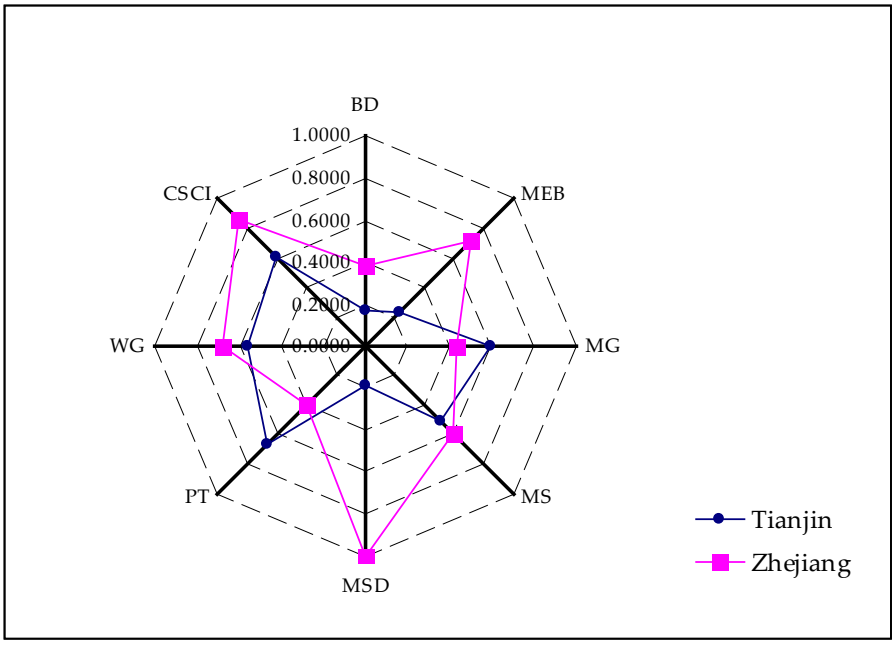


Figure 7.11 Value differences in CSCI, X_c (MEB, MG, MS) and X_s (BD, MSD, PT, WG) between Tianjin and Zhejiang

In summary, the reasons for the special cases in Shandong, Tianjin, and Xinjiang are largely due to the over performance of some individual causal/sequential factors in the local construction markets. The influence of some individual factors has dominated the calculation measurement of competition intensity, leading to the results different from expected. In fact, these specific cases further demonstrate the effectiveness of CSCS model in measuring competition intensity in construction markets, which incorporate

the influences of individual causal/sequential factors.

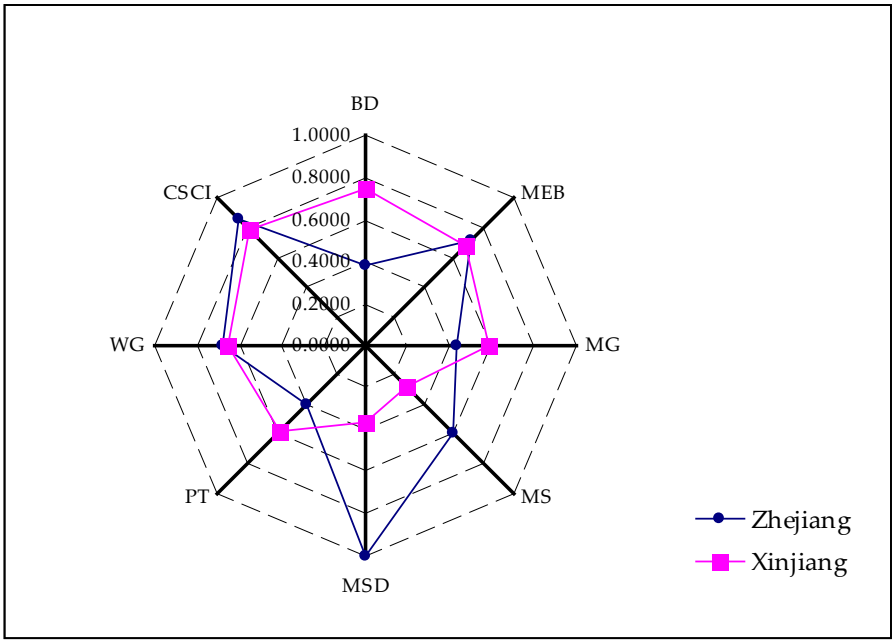


Figure 7.12 Value differences in CSCI, X_c (MEB, MG, MS) and X_s (BD, MSD, PT, WG) between Xinjiang and Zhejiang

7.4 Summary

The application results of CSCS model provide a foundation for validating CSCS and for examining the competition characteristics of local construction markets in China. It has been demonstrated that CSCS has good efficiency in measuring competition intensity in the Chinese construction market, and construction markets in the developed regions in China are of more competition than those in less developed provinces.

CHAPTER 8 CONCLUSIONS

This chapter presents the conclusions from conducting this research, the contribution of the research to knowledge, appreciation to the research limit, and the recommendation for further research.

8.1 Major Conclusions

Competition is an important subject in the discipline of economics and a prevalent phenomenon in socio-economic community. Although competition exists in any markets, it concerns two fundamental issues in construction market, namely, the process during which contractors bid for construction contracts and the status in a given construction market. This study concentrates specifically on the market level of competition. The study opines that neither no competition nor excessive competition would help effective market operation, and effective market status shall arrive at a moderate degree of competition.

This study develops a measure of competition intensity in construction market with the purpose of guiding the market in deriving a moderate intensity of competition therein. The defined research objectives have been achieved, including (1) the identification of the factors of competition intensity within the construction context; (2) the establishment of a model for measuring competition intensity in construction market; and (3) the demonstration of the model applicability. By pursuing these research objectivities, the following major conclusions can be drawn:

- ***There is a need for better measurement of competition intensity in construction market***

The measurement of competition intensity plays an important role in the area of industrial economics, and it can be executed through several established methods such

as concentration ratio, market mobility, and market inequality. Among these measures, it appears that only concentration ratio have been used in construction market. However, the concentration approach has been found to have limitations in application to construction market, whilst employing other existing measures to compensate for the ineffectiveness of the concentration approach is impracticable. Therefore, there is a need for a new model for better measurement of competition intensity in construction market.

Better measurement of competition intensity can assist contractors in understanding the changing market competition situations, thus they can promote firms' competitiveness by integrating internal organisational resources with external market environment. Furthermore, a proper measurement of competition intensity contributes to governmental decision on market administration when necessary to ascertain the vital role of the industry to the socio-economic development.

- ***Understanding and recognising the implication of competition intensity in construction market***

Whereas competition has been defined in various ways by economists and biologists, the term competition in economic and biological literature has some features in common. It basically refers to the struggle of individuals/ organisations for common objects, illustrates market competition status, and presents the dynamic process that competitors strike to achieve their objectives. Nevertheless, competition in construction industry portrays contractors' action and reaction in bidding for contracts. The prices of construction products/services are determined by competition and the organisational competitiveness is affected by the level of competition intensity.

Competition intensity is conceptualised to quantify the extent of competition in a given market. In biology, this concept presents the effect of neighbours on the viability of species or competitors' effort in struggle for environmental resources. In economics, competition intensity addresses a key variable of market structure and has many determinants such as market entry barriers, number of competitor, product differentiation, and market share distribution. Likewise, competition intensity in construction market reflects the characteristics of market structure, the efficiency of market resource allocation, and individual business competitiveness.

- ***Understanding the factors which contribute to competition intensity in construction market in a causal-sequential system***

Competition intensity can be analysed from various perspectives, for example, market structure, organisational dominance, the uncertainty of business success, and market share distribution. These perspectives should be integrated. In adopting this integrative approach, factors contributing to the competition intensity in construction market are identified as business advertising (AD), business diversity (BD), cost cutting (CC), market entry barrier (MEB), market growth (MG), market size (MS), market share distribution (MSD), production innovation (PI), product pricing (PP), profitability (PT), spatial location (SL), and average wage (WG). These factors are classified into two groups: causal and sequential. The causal competition intensity factors include AD, CC, MEB, MG, MS, PI, PP, and SL, and the sequential factors consist of BD, MSD, PT, and WG.

The causal competition intensity indicates why and how the intensity of competition is

formed. The sequential factors interpret that a market status is a consequence of certain degree of competition intensity. The classification of causal and sequential competition intensity factors lays the foundation for the development of a new competition intensity measure in a causal-sequential system.

- ***Development of the causal-sequential coordinate system (CSCS) for measuring competition intensity in construction market***

The understanding on the limitation of the existing competition intensity measures in application to construction market results in the development of an alternative. This new measure should be able to assist in detecting market competition status by incorporating the factors that contribute to competition intensity. The measure developed in this study incorporate the effects of both causal and sequential factors on competition intensity in a coordinate system, which is called the Causal-Sequential Coordinate System (CSCS). The causal factors in CSCS model include MEB, MG, and MS; whilst the sequential factors are BD, MSD, PT, and WG. CSCS has been demonstrated effective in measuring competition intensity by using the data collected from the 31 local construction markets in China. The calculations on CSCS model generate a set of competition intensity indexes for examining the competition characteristics of construction market.

- ***Application of CSCS model to examine the competition characteristics among various construction markets***

The application of CSCS includes three steps: (1) to quantify the causal and sequential factors by employing the data collected from a given market; (2) to calculate the value of competition intensity; and (3) to examine and interpret the calculation results. The

model provides a comprehensive tool in assessing the competition intensity in construction market as well as a toolkit for construction professionals to gain better understanding of competition status in different construction business markets. The application of CSCS model in this study particularly reveals that construction markets in the developed provinces in China are conducive to more intensive competition than those in the relatively undeveloped regions.

8.2 Contributions

This research has made valuable contributions to the development of the literature in the disciplines of construction market and competition intensity in construction market.

- ***The study provides in-depth understanding of competition intensity.*** Notwithstanding various views for competition intensity in different disciplines, the term in construction market is considered as the reflection of the extent of the intensiveness of construction competition in the market. This new perspective allows to examine the attributes of competition intensity at a different time or different markets.

- ***The study presents an alternative philosophy of competition intensity in construction market.*** Competition for construction businesses is mainly in the form of bidding activities among contractors. This study promotes the understanding of competition intensity in the construction context by examining the competition attributes from the perspectives of causal and sequential factors. This new philosophy of understanding competition intensity indicates the

complexity of competition intensity in the industry and supports the need of an integrative approach to measure the competition intensity.

- **This study contributes to the body of knowledge by establishing CSCS model for measuring competition intensity in construction market.** CSCS model integrates the causal and sequential factors of competition intensity into an analytical framework that makes it possible to account for the interactions within and beyond market competition factors. The model interprets multi-dimensional factors such as business diversity, market entry barriers, and profitability. Thus, it is more efficient in measuring competition intensity in construction market. CSCS model is distinct from existing measures such as concentration ratio (CR). It bears the advantage of mitigating the difficulty of data collection as it bases public survey data. Furthermore, the application results of CSCS model can help understand the effects of major socio-economic events on the competition characteristics of construction market. Whilst the data used in this study were collected from the Chinese construction industry, the method introduced provides an alternative in analysing competition intensity in other overseas construction industries.

8.3 Limitations and Recommendation for Future Research

（1） Limitations

The limitations of this study are appreciated, which are largely due to data availability and complication of data processing.

Firstly, data collection and analysis in this study are referred to the Chinese construction industry. Thus, the analysis in this study is limited to the Chinese construction sector. Secondly, competition intensity is a relative concept. The relativity is presented by making comparison between different markets at a particular span of time or between different periods of time for a same construction market. However, due to limited time, the analysis in this study has not been extended to the examination of the competition intensity between different periods of time in a same construction market. Furthermore, the assumption is given in the application of CSCS model that causal and sequential factors carry on equal weighting values. It is appreciated that these weighting values should be allowed to change according to various market environments.

（2） Recommendation for further study

This study has opened a new research area in the discipline of construction market and competition. It should be followed by further studies or extended to the following areas:

- To study competition intensity in other construction markets by using CSCS model.
- To generalise the CSCS model using Analytic Hierarchy Process (AHP)
- To examine how competition policies can be formulated to manipulate competition status in a particular construction market by investigating the effect of governmental polices on the intensity of competition.
- To investigate how contractors determine competition strategies by using CSCS model to examine the match between contractors' internal resources or capabilities and external market conditions.

- To study the strategies which enable moderate competition in construction market, as neither over-intensive nor monopoly in a market would contribute to the healthy development of construction industry.

APPENDICES

Table a. 1 Annual incomes of Chongqing Top 50 contractors

Top 50 \ Year	1997	1998	1999	2000	2001	Top 50 \ Year	1997	1998	1999	2000	2001
1	14090	10050	13893	11907	16337	26	3334	3217	3481	3411	4909
2	10071	9946	11803	11055	14408	27	3303	3194	3475	3309	4837
3	9651	9840	10809	9952	13550	28	3286	3037	3437	3289	4819
4	9337	9185	9371	8078	12671	29	3225	3007	3404	3286	4724
5	9300	7809	9144	7641	12031	30	3219	3004	3253	3102	4684
6	8160	6819	8838	6985	10669	31	3196	2895	3171	3011	4674
7	7976	6177	8797	6745	10083	32	3121	2888	3055	2985	4634
8	7853	5995	8569	6059	8940	33	2960	2854	3033	2866	4562
9	7522	5717	8475	5881	8168	34	2925	2789	3020	2855	4546
10	5886	4859	7568	5605	7447	35	2889	2691	2969	2845	4526
11	5655	4683	6966	5583	7366	36	2879	2679	2951	2835	4460
12	5491	4599	6855	5494	6911	37	2811	2679	2893	2744	4352
13	5471	4507	5903	5297	6860	38	2795	2663	2787	2690	4247
14	4537	4320	5357	5039	6766	39	2762	2595	2781	2638	3724
15	4498	4169	4927	4997	6652	40	2750	2560	2730	2565	3721
16	4433	4046	4854	4734	6442	41	2741	2422	2725	2561	3672
17	4275	4041	4818	4608	6325	42	2676	2409	2655	2486	3663
18	4261	3948	4296	4582	6239	43	2668	2403	2587	2421	3537
19	4033	3928	4266	4510	6193	44	2589	2401	2583	2418	3478
20	3699	3774	4158	4428	6148	45	2576	2192	2530	2373	3462
21	3595	3604	4092	4182	6097	46	2554	2184	2487	2353	3437
22	3520	3601	4018	4038	5622	47	2549	2178	2441	2351	3399
23	3494	3554	3952	3948	5539	48	2544	2138	2400	2333	3392
24	3415	3532	3871	3652	5392	49	2429	2111	2306	2293	3215
25	3393	3456	3783	3590	5258	50	2427	2006	2282	2262	3209

Source: Chongqing Statistics Bureau (2002)

Table a. 2 An example of random data for another 50 construction firms

Year / Cons. firm	1997	1998	1999	2000	2001	Year / Cons. firm	1997	1998	1999	2000	2001
1	2043	1564	7987	2078	2633	26	2001	1529	5905	1407	1718
2	997	1151	3352	146	2241	27	827	351	1297	214	516
3	1845	1281	4313	2133	1993	28	1333	1235	2329	997	2055
4	695	115	6811	153	128	29	2194	382	3976	1984	2394
5	1249	805	5784	1276	258	30	1709	759	7247	1194	1782
6	755	1603	3933	311	336	31	1128	1103	2953	1124	141
7	1575	1258	2541	537	2368	32	936	320	8237	1497	2505
8	1065	427	7683	1561	1906	33	1036	1657	8037	1194	182
9	1017	1065	7292	711	586	34	858	587	3792	2091	778
10	2027	1235	5968	1793	701	35	1316	1919	4962	573	1527
11	1585	1625	287	878	1727	36	1882	631	1377	1418	664
12	218	723	5959	1314	2509	37	2367	1719	143	2144	2377
13	874	1529	7161	1092	2402	38	1058	821	9040	247	2918
14	1925	953	8458	600	188	39	1234	1211	8451	977	955
15	208	1052	1523	677	539	40	1465	1021	4917	890	859
16	1932	712	6918	1935	1590	41	681	1948	6321	1449	2983
17	1418	681	5791	1192	2917	42	1175	2001	8687	264	2000
18	141	841	7576	1361	906	43	1486	448	7294	829	692
19	1368	243	6697	1334	2105	44	1722	1505	8109	426	294
20	1838	475	3465	2210	741	45	2105	520	7619	278	2210
21	2131	1688	490	725	920	46	1294	1392	4773	1902	2960
22	2332	1990	8709	1524	1293	47	2314	1717	2155	1502	2368
23	548	1011	7336	106	656	48	2045	1497	4910	1588	1114
24	2027	1236	3722	128	917	49	1708	934	8073	1168	1730
25	1494	1970	3620	284	2315	50	2335	1312	5591	1957	1471
Firm number	1501	1655	1735	1785	1721	Total incomes	2102607	1875804	2266077	2254517	3111861

Note: (1) A random data generator RANDBETWEEN (Bottom, Top) embedded in Microsoft Excel is applied to generate data for assuming the incomes of the remainder contractors, including RANDBETWEENs (100, 2426), (100, 2005), (100, 2281), (100, 2261) and (100, 3208) respectively for the five years (1997 – 2001). (2) The largest data generated for the remainder should be lower than any sizes of the top 50 construction firms. (3) Total incomes refer to the sum totals of all construction firms in each year.

Table a. 3 A survey on two approaches for measuring competition intensity in construction

FACTORS		SCALES							
		1	2	3	4	5	MISSING	MEANS	No. of Respondents [@]
PERFORMANCE©	Indi1	6	19	20	20	24	2	3.4157	91
	Indi2	4	21	28	26	10	2	3.1910	91
	Indi3	1	7	16	26	40	1	4.0778	91
	Indi4	4	21	33	24	7	2	3.1011	91
	Indi5	4	23	32	23	6	3	3.0455	91
	Indi6	10	19	25	26	8	3	3.0341	91
	Indi7	9	15	21	30	14	2	3.2809	91
	Indi8	12	17	29	22	8	3	2.9659	91
	Indi9	16	29	31	9	3	3	2.4773	91
	N	3	6	16	41	23	2	3.8427	91
	F	7	18	34	25	5	2	3.0337	91
	S	4	11	23	33	17	2	3.5618	91
	D	3	11	25	35	15	2	3.5393	91
	W	5	17	25	27	14	3	3.3182	91

@ 91 respondents are analysed due to their complete answers.

Table a. 4 Data for BD, the average auxiliary income proportion between individual construction firms

Places	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Mean
Anhui	.0474	.0373	.0369	.1409	.1000	.0818	.0484	.0467	.0248	.0326	.0342	.0415	.0512	.0510	N/A	.0388	.0556	.0543
Beijing	.0541	.0143	.0234	.1477	.1294	.1143	.1159	.1090	.0969	.0964	.1101	.0848	.0750	.0793	N/A	.0533	.0536	.0848
Chongqing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.0562	.0366	.0477	.0378	.0303	.0294	.0404	N/A	.0338	.0229	.0372
Fujian	.0268	.0191	.1117	.1200	.0687	.0603	.0560	.0484	.0525	.0511	.0671	.0591	.0641	.0592	N/A	.0653	.0359	.0603
Gansu	.0250	.0249	.0244	.1088	.0360	.0229	.0211	.0136	.0417	.0275	.0620	.0346	.0437	.0606	N/A	.0351	.0564	.0399
Guangdong	.0285	.0227	.0134	.1332	.0735	.1024	.1042	.1177	.0968	.1090	.0947	.0927	.0947	.0746	N/A	.0695	.0697	.0811
Guangxi	.0545	.0465	.0475	.2009	.1139	.0798	.0624	.1237	.0942	.1077	.0854	.0789	.0988	.0784	N/A	.0707	.0550	.0874
Guizhou	.0171	.0141	.0115	.0951	.0703	.0477	.0612	.0785	.0548	.0809	.0642	.0644	.1105	.1190	N/A	.1155	.0862	.0682
Hainan	.0130	.0123	.0112	.1376	.1471	.1041	.1173	.1745	.0625	.0386	.0486	.0575	.0273	.0138	N/A	.0178	.0238	.0630
Hebei	.0346	.0265	.0269	.0969	.0718	.0605	.0635	.0406	.0360	.0340	.0421	.0554	.0278	.0287	N/A	.0294	.0437	.0449
Heilongjiang	.0249	.0218	.0206	.0413	.0283	.0254	.0196	.0254	.0310	.0530	.0678	.0268	.0249	.0202	N/A	.0364	.0367	.0315
Henan	.0447	.0379	.0273	.1396	.0772	.0590	.0394	.0455	.0494	.0497	.0572	.0528	.0492	.0488	N/A	.0336	.0327	.0527
Hubei	.0556	.0322	.0303	.1606	.1140	.1067	.1167	.0987	.1050	.0710	.0656	.0418	.0730	.0330	N/A	.0372	.0425	.0740
Hunan	.0418	.0249	.0232	.0961	.0626	.0776	.0644	.0764	.0516	.0833	.1025	.0639	.0524	.0406	N/A	.0290	.0349	.0578
Jiangsu	.0661	.0495	.0445	.2050	.1310	.1125	.0748	.0814	.0734	.0737	.0674	.0465	.0522	.0634	N/A	.0526	.0473	.0776
Jiangxi	.0322	.0253	.0229	.1602	.0551	.0956	.0260	.0777	.0612	.0466	.0323	.0407	.0373	.0366	N/A	.0281	.0397	.0511
Jilin	.0303	.0172	.0152	.0862	.0512	.0549	.0720	.0435	.0840	.0646	.0823	.0494	.0617	.0406	N/A	.0174	.0294	.0500
Liaoning	.0320	.0183	.0170	.0897	.0666	.0621	.0698	.0572	.0702	.0745	.0710	.0532	.0426	.0459	N/A	.0260	.0464	.0527
Neimenggu	.0219	.0149	.0148	.1054	.0500	.0582	.0408	.0814	.0531	.0543	.0450	.0427	.0529	.0393	N/A	.0295	.0209	.0453
Ningxia	.0144	.0252	.0170	.1524	.0970	.1191	.1021	.1144	.0833	.0808	.0395	.0826	.1046	.1109	N/A	.0885	.0699	.0814
Qinghai	.0224	.0204	.0198	.0584	.0454	.0864	.1031	.0504	.0702	.0736	.0826	.0903	.0478	.0667	N/A	.0812	.0560	.0609
Shandong	.0475	.0348	.0315	.1166	.0708	.0541	.0527	.0646	.0536	.0481	.0449	.0464	.0412	.0378	N/A	.0394	.0363	.0513
Shanghai	.0646	.0353	.0319	.2771	.1809	.1848	.1819	.1519	.1161	.0721	.0722	.0855	.0785	.0860	N/A	.0645	.0516	.1084
Shanxi	.0552	.0132	.0120	.0999	.0724	.0769	.0833	.0650	.0707	.0771	.0698	.0749	.0736	.0656	N/A	.0564	.0415	.0630
Shan-xi	.0368	.0195	.0156	.1056	.0880	.0934	.0698	.0498	.0349	.0796	.0501	.0362	.0616	.0665	N/A	.0505	.0433	.0563
Sichuan	.0424	.0276	.0287	.1088	.0704	.0539	.0541	.0480	.0664	.0562	.0407	.0407	.0350	.0432	N/A	.0463	.0347	.0498
Tianjin	.0204	.0146	.0226	.0704	.0513	.0358	.0281	.0417	.0560	.0548	.0558	.0376	.0393	.0248	N/A	.0189	.0336	.0379
Xinjiang	.0626	.0338	.0324	.1839	.1232	.1023	.1001	.1503	.1456	.1021	.1319	.1404	.1081	.0787	N/A	.0907	.0755	.1038
Xizang	.0328	.0184	.0150	.0705	.0438	.0047	.0072	.0649	.0150	.0073	.0365	.0429	.0340	.0304	N/A	.0333	.0095	.0291
Yunnan	.0385	.0263	.0227	.1414	.0863	.1073	.0520	.0520	.0625	.0526	.0504	.0345	.0413	.0401	N/A	.0468	.0360	.0557
Zhejiang	.0446	.0377	.0325	.1791	.1165	.1252	.0712	.0639	.0615	.0577	.0537	.0476	.0506	.0429	N/A	.0259	.0279	.0649

Source: Yearbooks (2000-2004) of National Bureau of Statistics in China.

Table a. 5 Data for MEB, the average individual firms' registered capital (10, 000 YUAN/firm)

Places	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Mean
Anhui	187.37	198.56	129.57	377.96	518.86	609.36	386.59	398.25	385.48	479.01	551.67	895.22	1155.73	1412.53	N/A	1109.69	1339.24	633.44
Beijing	1039.59	1171.30	1270.08	571.18	421.84	446.89	623.69	766.25	777.01	867.70	1042.79	1348.01	1432.06	2190.70	N/A	2992.91	2882.48	124.28
Chongqing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	464.54	422.63	479.21	548.50	948.11	1160.25	1460.92	N/A	1116.63	1217.05	868.65
Fujian	223.80	232.34	262.00	298.90	305.56	381.18	353.95	396.74	489.90	516.94	605.36	867.38	1076.87	1679.64	N/A	1419.96	1496.00	662.91
Gansu	242.51	271.71	244.05	435.41	380.19	468.32	553.80	542.82	443.86	450.64	573.37	951.52	1134.99	1530.73	N/A	1370.19	1410.14	687.76
Guangdong	322.36	362.54	404.07	426.97	728.49	887.70	859.55	878.92	780.77	842.41	917.51	1146.22	1184.14	2124.03	N/A	1357.00	1489.04	919.48
Guangxi	248.31	258.51	315.35	655.15	544.67	568.24	437.68	467.27	485.30	484.47	1037.36	1298.68	1629.05	1848.61	N/A	1381.49	1439.23	818.71
Guizhou	75.82	79.29	91.51	218.25	244.98	364.60	371.55	393.74	336.70	367.03	393.84	611.43	1083.65	1529.53	N/A	1278.23	1289.96	545.63
Hainan	153.05	157.99	212.53	100.19	398.09	408.18	410.44	238.55	326.63	324.46	423.79	628.13	750.58	2738.68	N/A	1392.91	1407.52	629.48
Hebei	240.25	251.80	282.95	453.07	491.97	612.42	497.51	552.64	504.71	626.11	768.28	1128.92	1582.80	2005.01	N/A	1395.04	1518.44	807.00
Heilongjiang	109.09	118.77	140.94	256.09	258.04	362.48	406.62	457.18	447.46	539.48	612.84	1006.95	1339.19	1665.59	N/A	1498.99	1516.36	671.01
Henan	210.72	203.68	224.68	294.14	275.63	355.55	310.48	295.26	341.62	411.42	479.84	817.80	1276.50	1609.34	N/A	1291.34	1427.87	614.12
Hubei	165.42	168.85	189.66	422.05	443.05	555.20	431.42	467.60	424.11	508.87	628.83	1076.27	1451.98	2226.11	N/A	1545.54	1802.14	781.69
Hunan	152.21	164.39	192.69	376.67	430.50	524.16	393.52	487.82	451.29	491.49	571.07	1044.70	1325.84	1866.53	N/A	1489.74	1681.05	727.73
Jiangsu	405.96	443.24	478.36	611.73	614.10	874.40	564.31	619.70	615.37	639.26	754.98	1046.17	1171.97	1617.63	N/A	1168.55	1295.19	807.56
Jiangxi	85.43	86.83	107.79	208.39	251.35	340.74	276.83	292.43	250.21	289.42	333.91	535.29	968.47	1337.50	N/A	1190.33	1346.54	493.84
Jilin	190.54	206.89	216.17	271.45	289.77	320.19	404.87	449.14	430.04	450.43	716.90	1139.84	1170.12	1688.17	N/A	1302.52	1463.05	669.38
Liaoning	191.32	213.54	249.66	293.89	322.94	427.83	526.68	555.09	544.29	601.99	728.47	984.02	1180.84	1519.73	N/A	1231.39	1266.89	677.41
Neimenggu	128.30	143.24	167.10	238.67	244.23	287.39	327.83	370.28	351.99	378.56	434.55	715.88	1194.55	1635.08	N/A	1590.31	1569.10	611.06
Ningxia	193.10	171.53	200.79	289.81	226.16	268.52	287.17	357.85	344.06	376.09	424.14	635.13	967.34	1134.10	N/A	1041.38	1117.23	502.15
Qinghai	179.11	284.79	292.20	389.31	334.06	540.50	405.13	433.76	392.56	485.61	533.68	797.01	928.26	1259.24	N/A	1154.73	1353.44	61.21
Shandong	444.02	483.85	482.55	401.03	433.74	534.68	342.74	368.69	335.82	367.02	395.24	626.25	896.51	1299.97	N/A	1100.87	1174.46	605.46
Shanghai	1099.23	1173.76	936.91	4477.89	792.98	859.03	830.98	836.86	865.10	1033.22	1216.02	1373.08	1348.10	2480.80	N/A	1601.80	1736.11	1416.37
Shanxi	265.42	282.65	320.12	638.77	672.90	755.14	430.52	451.85	410.66	517.19	559.23	948.20	1222.13	1911.91	N/A	1861.66	1922.07	823.15
Shan-xi	280.18	263.13	181.14	476.92	593.69	641.34	470.16	442.10	471.85	549.97	728.27	1241.33	1651.60	1882.98	N/A	1573.36	1687.53	82.97
Sichuan	132.55	157.72	195.26	407.89	467.62	595.46	444.64	501.92	476.37	555.44	574.15	927.69	1205.96	1901.85	N/A	1272.20	1293.22	694.37
Tianjin	1481.25	1918.83	1653.51	3354.96	596.79	489.82	1145.31	963.63	960.82	1242.70	1375.68	1843.94	1433.79	1899.80	N/A	1377.98	1828.16	1472.94
Xinjiang	253.82	294.38	271.28	540.94	363.78	397.15	465.48	475.45	462.66	489.56	1295.71	1776.99	1951.67	1496.96	N/A	1259.54	1310.61	819.12
Xizang	216.94	214.82	199.16	239.72	412.47	388.13	336.56	468.92	384.55	373.77	477.07	715.55	1174.40	1838.27	N/A	1293.01	1052.18	611.59
Yunnan	150.17	167.17	257.44	191.79	346.28	412.77	375.68	366.64	422.81	557.68	656.97	970.48	1101.62	1648.05	N/A	1251.97	1284.49	635.13
Zhejiang	199.21	211.20	268.35	298.59	390.58	626.41	520.79	559.64	568.29	630.20	720.05	943.09	1164.60	1832.44	N/A	1438.92	1690.74	753.94

Source: Yearbooks (2000-2004) of National Bureau of Statistics in China.

Table a. 6 Data for MG, the growth rate of the building works under construction (percent)

Places	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Mean
Anhui	-.0851	.1289	.1514	.1580	.0935	.1215	1.0221	-.0949	-.0102	.1800	.0914	.2937	.0588	.1597	N/A	.2323	.2276	.1705
Beijing	-.0588	-.0720	.1120	.2613	.1532	.1404	.1579	.0888	.1224	.0480	.0619	.2308	.1482	.1690	N/A	.1842	.0509	.1124
Chongqing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.1853	.0391	.1107	.3078	.0936	.1202	N/A	.1771	.0746	.1385
Fujian	-.0053	.0625	.1768	.7287	.3210	.1952	.1951	-.0104	.0753	.0662	.0239	.2070	.1237	.1623	N/A	.5010	.3493	.1983
Gansu	-.0881	.0355	.1039	.0688	.1282	.0877	.8555	-.0017	.0019	.1841	-.0959	.1065	.1653	.1053	N/A	.1706	.1014	.1206
Guangdong	-.1412	.0750	.3832	.5518	.1645	.1949	-.0443	.0134	.0589	.0538	-.0235	.1548	.0780	.0623	N/A	.1231	.0741	.1112
Guangxi	-.0216	.1555	.3153	.3347	.1382	.0825	.3843	-.0571	-.0182	.0190	-.0417	.0594	.2158	.2648	N/A	.2164	.1762	.1390
Guizhou	-.0870	.0577	.2260	.3801	-.1055	.0198	.0643	.0524	.1407	.1466	.0728	.0854	.1870	.0911	N/A	.1909	.0685	.0994
Hainan	.0651	.0370	.1602	.0184	.5944	-.0669	-.3138	.7749	.0060	-.0896	-.1285	.3598	.1150	-.1606	N/A	.2125	.1272	.1069
Hebei	-.0935	.1223	.2953	.2074	.0704	.1265	.2595	.0259	.0622	.0682	.0521	.1970	.1074	.0743	N/A	.1871	.1151	.1173
Heilongjiang	-.2309	.1154	.3449	.1726	-.0141	-.0137	-.0349	-.0025	.1001	.0586	.1403	.1262	-.0032	.1255	N/A	.1562	.0849	.0703
Henan	-.0671	.2769	.1978	.2803	.1979	.1417	.5756	-.0659	.0154	-.0089	.0582	.1860	.1307	.1275	N/A	.2764	.3385	.1663
Hubei	-.0864	.0919	.1568	.2711	.0510	.1550	.3851	.0122	.1532	.0919	.0790	.0651	.0848	.2360	N/A	.1279	.1974	.1295
Hunan	.0472	.1066	.2115	.2030	.1134	.1071	1.0231	.0124	.0737	.0224	-.0179	.2302	.1432	.4047	N/A	.2022	.1538	.1898
Jiangsu	.1057	.0861	.4248	.4167	.5087	.4499	.8055	.0281	.1062	.0697	.1369	.1304	.1586	.2233	N/A	.3061	.2086	.2603
Jiangxi	.0657	.1696	.2598	.1290	.0883	-.0312	.1907	-.0203	.0915	.0992	.0509	.1503	.1933	.4572	N/A	.2857	.1264	.1441
Jilin	-.1222	.2265	.2905	.1648	-.0943	-.1411	-.0014	-.0146	.0008	.1214	.5266	.1198	.0006	.0255	N/A	.3187	.1491	.0982
Liaoning	-.1208	.0620	.3889	.2846	.0552	-.0805	-.0124	-.1171	-.0454	.1685	.2554	.1003	.0380	.1331	N/A	.1795	.1836	.0921
Neimenggu	-.0507	.1419	.2702	.0619	-.0762	-.0496	.2117	.0389	.0486	.1703	.1557	.1596	.0408	.1453	N/A	.2425	.2162	.1079
Ningxia	-.0017	.2052	.2747	.5339	-.2898	.0196	.1593	.1159	.2218	.2110	-.0092	.2463	.1894	.3417	N/A	-.0818	.1790	.1447
Qinghai	-.0395	-.1433	.0610	-.0344	-.0766	.0582	.3609	.1324	.5147	-.0977	-.1228	.0996	.2093	.2333	N/A	-.0884	-.1491	.0573
Shandong	-.0024	.0686	.2628	.3142	.3054	.0953	1.8085	-.1782	.0623	.0533	.1256	.1573	.1517	.2325	N/A	.1803	.1513	.2368
Shanghai	-.0966	.0393	.2228	-.4306	1.8603	.1236	.0166	.1401	.0591	.0029	-.0144	.1755	.1476	.5991	N/A	.3775	.1224	.2091
Shanxi	-.0030	.0169	.1321	.0833	.1654	.0681	.4004	.0140	.1766	.0581	.0263	.1569	.1993	.1721	N/A	.1396	.1932	.1250
Shan-xi	-.1006	.1597	.0793	.1220	.0388	.0323	.1991	.1620	-.0623	.1065	.0523	.0976	.3211	.0710	N/A	.2263	.1480	.1033
Sichuan	.0201	.0987	.2329	.2173	.1921	.1948	.8479	-.3215	.0917	.0201	.0789	.1689	.2038	.0441	N/A	.0905	.1476	.1455
Tianjin	-.1276	-.1374	.5473	-.0731	.5291	.1833	.0323	.1225	.1753	.0135	.0800	-.0506	.3167	.2052	N/A	.1467	.1560	.1324
Xinjiang	.0884	.2183	.1755	.0389	-.0124	.0460	-.0042	.1598	.1872	.1087	.2162	.1866	-.0327	.0570	N/A	.0155	.0441	.0933
Xizang	.0123	-.0576	.1929	-.2749	-.1822	.2182	3.4142	-.6636	.3970	.2518	.2500	.0126	.4154	.0513	N/A	.3292	.3502	.2948
Yunnan	.0048	.0544	.1734	-.5985	2.6276	.1054	.7972	.1509	.1297	.1483	-.0665	.0684	-.0837	.0706	N/A	.1210	.1484	.2407
Zhejiang	-.1229	.0283	.3294	.7661	.2699	.5018	.9092	-.0286	-.0200	.1265	.2434	.3182	.3054	.3844	N/A	.1967	.1747	.2739

Source: Yearbooks (2000-2004) of National Bureau of Statistics in China.

Table a. 7 Data for MS, the average work loads for individual firms (10, 000 m^2)

Places	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Mean
Anhui	3.6094	4.1159	4.7071	3.7737	3.7269	4.1536	2.7162	2.4751	2.4599	2.7918	2.9593	3.8188	3.7474	4.3357	N/A	5.1345	6.1064	3.7895
Beijing	17.9220	16.8568	18.4953	3.1868	3.2052	3.4549	4.1241	4.4729	4.3968	4.2974	4.2704	4.9251	4.9761	5.7529	N/A	5.9003	6.1511	7.0243
Chongqing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.9654	3.1877	3.1853	3.5052	4.7255	5.1160	5.6710	N/A	4.8783	4.8556	4.2322
Fujian	4.0670	4.3212	4.9005	3.0353	3.2140	3.7013	2.4695	2.1999	2.2847	2.3637	2.4145	3.2721	3.5451	4.4630	N/A	6.0295	7.8010	3.7551
Gansu	3.1358	2.9571	3.2937	2.7615	2.8720	3.1755	3.4686	3.5246	3.1953	3.9540	3.7806	4.2335	3.8567	3.4547	N/A	3.8769	4.1060	3.4779
Guangdong	6.8776	7.1729	7.6432	6.0028	8.8002	8.8841	7.3344	6.4901	5.8705	5.7964	5.4701	5.6982	4.8603	5.9577	N/A	6.5115	7.0197	6.6494
Guangxi	3.5779	4.0182	5.2605	5.1699	5.0837	5.2542	3.1593	2.6448	2.5658	2.3788	2.1591	2.5446	3.2656	4.2508	N/A	5.5515	6.6367	3.9701
Guizhou	1.8682	1.9919	2.3290	2.5466	2.1634	2.6775	2.1677	2.1950	2.4867	2.8512	2.8911	3.0736	3.9142	4.6577	N/A	5.4359	5.7490	3.0624
Hainan	1.5969	1.4810	2.0333	1.1558	3.0953	2.9341	2.3064	1.3984	1.8266	1.7328	1.5038	2.0363	2.6711	4.3562	N/A	5.6752	6.5036	2.6442
Hebei	4.1597	4.4102	5.6319	3.5732	3.8048	4.3134	2.9567	3.0332	3.2200	3.4635	3.6186	4.4577	5.1668	5.6279	N/A	5.6111	6.4333	4.3426
Heilongjiang	0.9456	1.0510	1.4507	1.5497	1.4398	1.4157	1.3188	1.3047	1.4618	1.5586	1.7933	2.1470	2.3307	2.5693	N/A	2.5900	2.7216	1.7280
Henan	3.7191	3.6950	4.2322	2.5293	2.2270	2.4469	2.3424	2.5237	2.5206	2.6500	2.8161	3.5428	4.4657	4.6474	N/A	4.3992	5.8738	3.4144
Hubei	3.1913	3.3151	3.7939	3.0127	3.4550	3.6011	2.6821	2.6145	2.9613	2.8211	3.1932	4.0700	4.5773	5.1165	N/A	5.8355	6.5424	3.7989
Hunan	2.6165	2.7824	3.5238	2.9257	3.1301	3.4968	2.8152	2.7000	2.8153	2.8831	2.9009	4.2990	5.0465	6.3420	N/A	7.8579	9.0611	4.0748
Jiangsu	5.2195	5.3983	6.4126	5.0641	6.1409	8.6762	5.1793	4.9298	5.0386	4.7234	5.3919	6.3962	6.7956	7.9939	N/A	8.8411	9.9106	6.3820
Jiangxi	1.9517	2.2561	2.9866	2.4504	2.8475	2.8393	2.0619	2.0120	2.0948	2.3810	2.5595	2.6776	3.4958	4.8630	N/A	5.9197	6.9503	3.1467
Jilin	1.6495	1.8774	2.3789	1.8352	1.8037	1.4893	1.6058	1.6836	1.7162	1.9505	2.9382	3.3526	3.0338	3.2300	N/A	3.5612	4.2204	2.3954
Liaoning	1.8977	2.0513	2.6097	2.2050	2.0466	1.9593	2.1475	1.8953	1.8253	2.0948	2.6606	2.7583	2.9958	3.1924	N/A	3.3491	3.7573	2.4654
Neimenggu	1.2460	1.4951	1.8697	1.7264	1.5597	1.4483	1.4669	1.5729	1.6393	1.7488	1.9704	2.4450	3.1388	3.8147	N/A	4.4968	5.3156	2.3096
Ningxia	1.2889	1.0979	1.3432	2.3295	1.2287	1.2581	0.9641	0.9798	1.0838	1.1889	1.1085	1.4682	1.9233	2.5984	N/A	2.2338	2.6393	1.5459
Qinghai	1.6734	2.3526	2.3179	1.4351	1.5096	1.5974	1.1792	1.4015	1.9944	1.8336	1.2570	1.4693	1.4465	1.6516	N/A	1.0956	0.9580	1.5733
Shandong	6.2323	6.5285	6.6849	2.9285	3.1947	3.5213	2.7449	2.1456	2.2674	2.3614	2.7189	3.1310	3.7016	4.4200	N/A	4.5519	5.3893	3.9076
Shanghai	15.9175	17.5670	14.9899	26.9614	6.1139	5.5905	4.2223	3.4336	3.1516	3.1001	3.1234	4.0188	3.7166	4.9669	N/A	5.9254	5.9056	8.0440
Shanxi	4.2328	4.2832	4.7780	3.5136	3.7933	4.1404	2.3237	2.0980	2.4576	2.6872	2.8261	3.4102	3.8528	5.1756	N/A	5.8213	6.6820	3.8797
Shan-xi	3.4512	3.4000	2.7430	2.6763	2.7153	2.9143	2.0560	1.9632	2.0807	2.3051	2.5359	2.8968	2.7737	2.7676	N/A	2.8856	3.4351	2.7250
Sichuan	2.4559	2.6314	3.1657	3.0546	3.5641	4.2049	3.1253	3.1721	3.2272	3.2539	3.2195	4.0593	4.4837	4.5769	N/A	5.1213	6.0786	3.7121
Tianjin	11.8509	10.0466	12.8800	15.4759	2.9377	2.3627	4.6594	3.6732	4.1184	4.2766	5.0538	5.2580	3.1379	3.8415	N/A	3.6588	4.1867	6.0886
Xinjiang	3.1560	3.8448	3.9926	2.5685	2.1708	2.1768	2.1257	2.1543	2.4375	2.6032	3.2533	4.4776	3.7832	3.8846	N/A	3.7655	3.9049	3.1437
Xizang	1.0000	0.9147	1.0027	0.6256	0.5789	0.7053	2.7512	0.5606	0.6465	0.5194	0.6170	0.7163	0.7994	0.8093	N/A	0.9008	1.3354	.9052
Yunnan	1.9532	2.1006	3.5797	1.0724	2.8887	3.1931	2.6528	2.4494	2.6691	2.7303	2.4816	2.6234	2.6282	3.0014	N/A	3.0047	3.0760	2.6315
Zhejiang	2.7082	2.6527	3.6952	3.9503	4.4684	5.9774	3.9667	3.4237	3.3419	3.6885	4.6131	6.4814	9.1008	11.6372	N/A	15.1950	17.1030	6.3752

Source: Yearbooks (2000-2004) of National Bureau of Statistics in China.

Table a. 8 Data for MSD, the market shares owned by state owned enterprises (percent)

Places	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Mean
Anhui	.4432	.4483	.4417	.3381	.1646	.1842	.4712	.5173	.5046	.5094	.5528	.6210	.7027	.7444	N/A	.7040	.6847	.5020
Beijing	.4017	.3921	.3885	.1901	.2630	.2952	.2778	.3080	.4239	.4278	.4766	.5499	.6113	.6655	N/A	.6250	.6680	.4353
Chongqing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.6822	.7278	.7417	.7627	.8296	.8538	.8593	N/A	.8334	.8362	.7919
Fujian	.3928	.4260	.4503	.4679	.3796	.4173	.5024	.5268	.5745	.5489	.5323	.6432	.6650	.7474	N/A	.7513	.8201	.5529
Gansu	.2449	.2568	.5246	.2007	.2055	.2451	.4678	.4246	.4670	.5071	.5094	.5496	.6379	.6512	N/A	.6293	.6467	.4480
Guangdong	.5469	.5498	.5273	.4835	.4363	.4886	.4284	.5062	.5650	.5636	.5825	.6334	.6701	.7206	N/A	.6306	.6955	.5643
Guangxi	.2762	.2904	.3034	.2686	.2642	.2580	.3575	.3852	.3841	.3613	.3904	.4122	.4261	.4404	N/A	.4989	.4994	.3635
Guizhou	.5153	.4992	.5368	.2883	.2333	.1718	.2170	.2114	.2711	.2740	.2995	.3380	.3380	.2968	N/A	.3137	.2575	.3164
Hainan	.5339	.4287	.4113	.6417	.4460	.4562	.4405	.4692	.2815	.2670	.3102	.3711	.3901	.4419	N/A	.4591	.4438	.4245
Hebei	.4318	.4450	.4262	.2551	.2195	.2457	.3578	.3721	.4277	.4308	.4906	.6062	.6752	.7489	N/A	.6732	.6769	.4677
Heilongjiang	.4414	.4057	.4312	.4973	.3055	.3308	.3506	.3547	.4079	.4424	.4627	.5667	.7099	.7501	N/A	.6821	.6546	.4871
Henan	.5417	.3492	.3487	.2192	.1994	.2290	.3359	.2899	.4243	.4126	.4131	.4138	.5784	.5985	N/A	.6725	.7335	.4225
Hubei	.3585	.3432	.3748	.2312	.1484	.1952	.2966	.3193	.3162	.3809	.3855	.4660	.5457	.6181	N/A	.6110	.6594	.3906
Hunan	.4472	.4642	.4919	.2850	.2403	.2662	.5106	.5441	.5691	.5617	.5519	.6384	.6663	.6986	N/A	.6607	.6573	.5158
Jiangsu	.5860	.5751	.5659	.3711	.4725	.4665	.6016	.6539	.7012	.7265	.7486	.7845	.7719	.8805	N/A	.8848	.9072	.6686
Jiangxi	.4342	.4689	.4959	.2822	.2364	.2567	.3715	.3843	.4023	.4057	.4437	.4289	.5286	.6009	N/A	.6368	.6596	.4398
Jilin	.3058	.3186	.3268	.2448	.2152	.2215	.2335	.2322	.2577	.2909	.3168	.5389	.5711	.6208	N/A	.6751	.8273	.3873
Liaoning	.5478	.5422	.5416	.5152	.4409	.4636	.4435	.4380	.4685	.5033	.5603	.6105	.6570	.7187	N/A	.7176	.7467	.5572
Neimenggu	.4589	.4666	.4484	.4055	.3548	.3923	.4602	.4590	.5266	.5553	.6454	.6575	.7771	.8752	N/A	.9090	.9095	.5813
Ningxia	.2498	.2865	.3043	.2992	.2746	.3209	.3874	.3756	.4516	.5144	.5212	.5649	.6121	.6719	N/A	.6441	.6390	.4448
Qinghai	.2422	.1850	.2180	.1353	.1213	.1141	.1657	.1733	.2450	.2398	.2465	.3242	.3726	.4041	N/A	.4160	.3828	.2491
Shandong	.5071	.5125	.5325	.3155	.3050	.3406	.6403	.6202	.6265	.6521	.6908	.7401	.7551	.7694	N/A	.7676	.7854	.5975
Shanghai	.3827	.4388	.4444	.0000	.3918	.3771	.3693	.3944	.5725	.6041	.6166	.6555	.7346	.7772	N/A	.7653	.7755	.5187
Shanxi	.2521	.2700	.2865	.1102	.1065	.1276	.2367	.2638	.2797	.3374	.3710	.4519	.5724	.5617	N/A	.5323	.4854	.3278
Shan-xi	.3958	.1855	.2771	.0944	.0544	.0585	.1094	.1405	.1811	.1882	.2013	.3563	.4890	.6599	N/A	.5503	.6683	.2881
Sichuan	.3730	.3870	.3794	.2584	.2655	.2615	.5066	.4703	.5110	.5797	.6477	.6374	.7104	.7337	N/A	.6434	.6519	.5011
Tianjin	.1078	.1046	.1077	.0203	.1057	.1237	.1212	.1729	.2154	.2446	.3196	.4496	.6152	.6519	N/A	.6397	.7017	.2939
Xinjiang	.3442	.3180	.3599	.2641	.2317	.2949	.2637	.2592	.3338	.3429	.3110	.4152	.5482	.7144	N/A	.6642	.6606	.3954
Xizang	.1495	.1850	.1712	.1838	.1046	.0731	.1169	.1240	.1777	.4537	.5092	.6668	.6554	.6876	N/A	.8260	.8373	.3701
Yunnan	.2250	.2135	.2378	.3403	.1851	.2181	.4569	.5053	.5662	.5453	.5947	.6824	.6687	.7311	N/A	.7227	.7077	.4750
Zhejiang	.6099	.6381	.6597	.6864	.5706	.6705	.8311	.8321	.8302	.8411	.8787	.9135	.9258	.9445	N/A	.9464	.9563	.7959

Source: Yearbooks (2000-2004) of National Bureau of Statistics in China.

Table a. 9 Data for PT, the level of profitability in percentage in the market (percent)

Places	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Mean
Anhui	-.0031	-.0069	.1164	-.0009	.0042	.0007	.0121	.0043	.0003	.0057	.0093	.0172	.0172	.0177	N/A	.0187	.0219	.0147
Beijing	.0342	.0266	.0774	.0292	.0313	.0210	.0190	.0201	.0199	.0199	.0225	.0211	.0239	.0236	N/A	.0323	.0446	.0291
Chongqing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	.0111	.0114	.0131	.0141	.0208	.0199	.0235	N/A	.0255	.0316	.0190
Fujian	.0215	.0242	.1088	.0198	.0171	.0150	.0113	.0125	.0106	.0103	.0095	.0241	.0228	.0211	N/A	.0225	.0266	.0236
Gansu	.0163	.0093	.0917	.0080	.0055	-.0089	.0123	.0103	.0127	.0142	.0160	.0135	.0117	.0148	N/A	.0276	.0284	.0177
Guangdong	.0255	.0316	.1468	.0226	.0264	.0300	.0230	.0194	.0195	.0228	.0229	.0330	.0279	.0377	N/A	.0321	.0348	.0347
Guangxi	.0334	.0269	.0910	.0267	.0075	.0086	.0092	.0066	.0119	.0089	.0061	.0125	.0195	.0167	N/A	.0159	.0204	.0201
Guizhou	.0144	.0011	.1129	.0014	.0004	-.0028	-.0044	-.0004	.0008	.0018	.0090	.0115	.0144	.0214	N/A	.0141	.0106	.0129
Hainan	.0204	.0365	.1270	.0277	.0161	.0064	.0055	.0174	.0010	.0193	.0129	.0190	.0345	.0364	N/A	.0433	.0231	.0279
Hebei	.0178	.0171	.1115	.0180	.0124	.0101	.0120	.0130	.0103	.0143	.0137	.0206	.0205	.0232	N/A	.0228	.0217	.0224
Heilongjiang	.0158	.0214	.1229	.0232	.0187	.0149	.0021	.0013	.0040	.0079	.0093	.0144	.0112	.0124	N/A	.0091	.0110	.0187
Henan	.0081	.0166	.1222	.0108	.0101	.0114	.0148	.0088	.0070	.0120	.0088	.0130	.0142	.0148	N/A	.0240	.0243	.0201
Hubei	-.0048	.0073	.1275	.0130	.0119	.0095	.0096	.0053	.0111	.0130	.0129	.0167	.0204	.0219	N/A	.0197	.0242	.0199
Hunan	.0069	.0158	.1389	.0127	.0082	.0071	.0127	.0100	.0060	.0052	.0124	.0177	.0187	.0189	N/A	.0236	.0257	.0213
Jiangsu	.0202	.0208	.1531	.0184	.0173	.0149	.0141	.0106	.0115	.0091	.0134	.0142	.0161	.0196	N/A	.0256	.0303	.0256
Jiangxi	.0112	.0151	.1477	.0080	-.0006	-.0058	.0026	-.0020	-.0029	.0033	.0053	.0092	.0165	.0163	N/A	.0275	.0202	.0170
Jilin	.0261	.0309	.0892	.0233	.0128	.0048	-.0096	-.0110	-.0113	.0005	.0072	.0135	.0101	.0068	N/A	.0051	.0124	.0132
Liaoning	.0270	.0266	.1437	.0246	.0164	.0045	.0071	-.0020	-.0102	.0063	.0112	.0195	.0151	.0162	N/A	.0367	.0328	.0235
Neimenggu	.0113	.0078	.1123	.0143	.0107	.0021	-.0026	-.0062	.0032	.0112	.0106	.0107	.0186	.0216	N/A	.0426	.0609	.0206
Ningxia	.0009	.0135	.0662	-.0003	.0166	.0018	-.0048	.0005	-.0016	.0115	.0244	.0197	.0147	.0144	N/A	.0186	.0162	.0133
Qinghai	.0091	-.0056	.0477	-.0079	-.0042	-.0041	-.0024	-.0026	-.0044	-.0098	.0085	.0097	.0188	.0182	N/A	.0064	.0082	.0054
Shandong	.0369	.0344	.1617	.0295	.0197	.0159	.0260	.0250	.0232	.0230	.0223	.0266	.0271	.0277	N/A	.0346	.0370	.0357
Shanghai	.0235	.0362	.0562	.0216	.0258	.0218	.0186	.0229	.0223	.0250	.0296	.0266	.0286	.0342	N/A	.0354	.0452	.0296
Shanxi	.0216	-.0258	.0947	.0127	.0021	.0031	.0012	.0021	-.0019	.0027	.0060	.0089	.0101	.0106	N/A	.0153	.0146	.0111
Shan-xi	.0065	.0038	.1151	.0352	.0027	.0000	-.0014	-.0004	-.0047	-.0004	-.0002	.0057	.0084	.0088	N/A	.0110	.0102	.0125
Sichuan	.0057	.0133	.1248	.0130	.0076	.0054	.0090	.0098	.0098	.0117	.0141	.0183	.0199	.0212	N/A	.0189	.0191	.0201
Tianjin	-.0256	-.0077	.0246	.0233	.0052	.0065	.0081	.0112	.0139	.0099	.0118	.0130	.0181	.0186	N/A	.0226	.0262	.0112
Xinjiang	-.0395	.0010	.0961	.0165	.0075	.0034	-.0093	-.0038	-.0041	.0085	-.0204	-.0173	-.0035	.0210	N/A	.0130	.0143	.0052
Xizang	-.0035	.0396	.0783	.0394	.0160	.0092	.0237	.0611	.0465	.0373	.0439	.0610	.0659	.0643	N/A	.0694	.0631	.0447
Yunnan	-.0058	.0077	.0744	.0191	.0112	.0127	.0104	.0156	.0143	.0170	.0189	.0136	.0130	.0202	N/A	.0348	.0278	.0191
Zhejiang	.0319	.0181	.1760	.0192	.0163	.0168	.0198	.0194	.0206	.0209	.0230	.0259	.0266	.0266	N/A	.0281	.0270	.0323

Source: Yearbooks (2000-2004) of National Bureau of Statistics in China.

Table a. 10 Data for WG, the average annual wage among employees (Yuan/person)

Places	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Mean
Anhui	1819.28	1807.21	2215.69	3160.03	4560.22	6210.25	5458.31	5418.54	6168.58	5967.14	6173.47	7460.41	8458.54	10307.47	N/A	9531.32	12144.95	6053.84
Beijing	2667.81	2862.98	3394.48	4765.58	6175.13	6922.94	8536.41	8567.45	10599.00	13134.39	12871.95	16910.61	16992.50	20045.95	N/A	13975.63	21931.09	10647.12
Chongqing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5858.06	6062.88	6988.29	7126.30	8375.14	9511.71	10775.32	N/A	12492.19	8095.75	8365.07
Fujian	2496.26	2854.01	3372.03	6043.71	5189.70	7006.34	7104.39	7074.27	9830.35	7266.94	8146.34	11401.23	11397.87	12839.16	N/A	12491.88	13782.74	8018.58
Gansu	2243.16	2479.60	2597.71	3793.16	4802.98	6044.32	4750.41	4431.80	6223.26	6734.38	7101.40	7868.10	7616.19	8425.51	N/A	7630.12	6956.73	5606.18
Guangdong	2755.62	3450.45	4014.17	5213.96	5727.20	5732.70	6974.50	7760.22	8621.22	9145.25	9176.76	11139.55	11426.58	12964.45	N/A	17907.70	13085.71	8443.50
Guangxi	2121.24	2479.01	2904.12	4235.19	5476.33	6701.96	5649.46	6066.52	7066.90	7596.21	7765.58	8674.07	9204.40	11801.22	N/A	9240.46	12519.33	6843.87
Guizhou	1689.26	1883.67	2149.20	3418.10	3958.38	4137.72	5258.30	5054.21	6479.99	7087.09	7547.17	8570.59	10025.46	11051.99	N/A	13357.89	8050.42	6232.47
Hainan	1941.88	2238.01	3134.56	7493.16	5609.36	4458.59	4969.93	4671.89	5444.69	6542.75	5677.46	5674.08	7347.26	8423.13	N/A	5259.05	5496.00	5273.86
Hebei	1869.81	2167.99	2546.97	3420.78	3810.22	5147.00	5322.11	5338.67	5521.46	6598.36	7355.87	8142.17	9114.59	11247.40	N/A	9770.78	10581.91	6122.26
Heilongjiang	1992.54	2282.90	2758.36	5621.16	4663.85	5507.05	5729.79	6019.88	6860.25	9247.93	10052.36	10282.60	12899.67	14579.45	N/A	8193.72	11697.52	7399.31
Henan	1759.49	1807.12	2157.35	2663.99	3661.51	4909.36	4774.31	4214.82	5552.86	6138.25	6720.17	7310.47	7609.56	9181.57	N/A	9920.41	9376.87	5484.88
Hubei	1740.54	1984.27	2248.20	3539.59	5143.98	6130.85	6077.01	5915.77	6217.84	6363.05	6915.54	7845.56	8469.11	11440.71	N/A	11517.16	10247.74	6362.31
Hunan	2089.14	2356.99	2860.34	3270.57	4989.40	5810.20	6177.63	5765.56	6029.16	6329.91	6487.05	7682.39	8632.97	10161.68	N/A	8809.47	10142.03	6099.66
Jiangsu	2365.08	2711.91	3370.63	4785.36	4677.73	7608.58	7449.61	7867.44	8033.00	9010.76	10452.32	11368.01	12319.90	14894.95	N/A	12687.05	12079.37	823.11
Jiangxi	1822.33	1946.52	2389.24	2936.28	3681.95	4792.66	4818.55	4007.14	4731.54	5601.49	5807.71	6984.91	8025.58	8690.37	N/A	8038.69	11900.27	5385.95
Jilin	2217.21	2477.33	2863.73	3670.30	4243.28	5196.72	6885.58	6459.22	6320.96	8321.62	11893.71	11521.05	11553.77	13076.98	N/A	9773.28	12734.55	745.58
Liaoning	2262.98	2572.25	2769.78	3684.51	4939.14	5762.30	6471.67	6245.21	6436.51	7436.75	8464.38	10341.98	11561.19	13615.66	N/A	13692.32	12129.23	7399.12
Neimenggu	2028.44	2385.83	2782.85	3701.52	5141.45	5458.57	5624.21	5386.40	6358.04	7705.53	8399.10	11466.37	12332.78	17576.56	N/A	9082.16	10157.64	7224.22
Ningxia	2188.61	2262.50	2705.92	2342.54	4402.44	3835.35	5540.86	6219.03	6137.73	9839.81	10702.98	12121.46	13184.69	20001.59	N/A	10188.62	11937.98	7725.76
Qinghai	2414.02	2582.47	2993.98	2989.29	4291.93	6398.04	4077.78	5391.53	6998.57	9274.54	9586.22	8665.14	8682.75	9540.00	N/A	4390.09	6277.23	5909.60
Shandong	2229.54	2543.92	1670.61	4213.86	4587.13	6036.12	5158.06	5545.01	6225.03	6928.43	7525.75	8067.57	8674.07	9973.36	N/A	8827.86	10542.30	6171.79
Shanghai	2734.17	3097.44	3830.17	10067.06	5838.62	6969.13	8699.39	9772.11	11098.82	14285.75	16588.79	17144.93	18436.95	23583.90	N/A	16583.21	20431.35	11822.61
Shanxi	1926.10	2104.24	2427.57	5244.38	5071.11	5642.66	5696.58	5534.35	6238.02	6909.77	7227.81	8077.23	8522.02	10801.51	N/A	6904.90	13910.81	6389.94
Shan-xi	2143.82	2254.15	2376.92	2326.28	4004.33	5268.43	6031.59	5548.45	6956.37	8267.32	8016.58	9169.23	8882.90	10117.25	N/A	7921.00	7678.28	606.18
Sichuan	1953.35	2259.25	2582.63	4211.42	4680.01	5333.90	5246.50	6084.11	6665.27	6279.25	6972.46	7610.03	8084.27	8722.50	N/A	10659.30	11329.47	6167.11
Tianjin	2075.28	2392.17	2928.84	5594.56	5004.57	7565.36	8167.46	7494.02	9365.92	12121.69	11229.64	17077.56	12966.70	19172.28	N/A	10562.77	11604.73	9082.72
Xinjiang	2493.73	2727.47	3175.39	3052.57	5370.79	6208.35	6649.70	6273.85	7363.43	11755.58	23776.16	19196.79	17865.38	21132.93	N/A	15278.85	21752.08	10239.59
Xizang	3891.96	3581.20	3704.50	1861.98	4726.00	6596.15	6329.19	6949.40	9419.77	7756.80	8932.52	6762.17	10041.04	7758.04	N/A	6307.91	6480.48	6318.70
Yunnan	2206.13	2496.81	2809.12	2212.35	4595.73	6142.15	5938.61	5839.02	6833.06	7646.05	6824.56	7324.02	8416.36	9401.15	N/A	11366.30	14098.16	6509.35
Zhejiang	2399.25	2632.67	3112.17	5233.62	5929.68	8358.77	9185.98	9425.62	10161.24	10871.70	13416.12	14051.15	15589.48	17930.53	N/A	14924.60	14466.62	9855.58

Source: Yearbooks (2000-2004) of National Bureau of Statistics in China.

A Survey for Understanding Competition Intensity in Construction Market

INSTRUCTION

A preliminary list of items is included in this questionnaire for understanding competition intensity in construction market with particular reference to the Chinese construction industry. We are going to identify professionals' views about the competition intensity. There may be other items missed in this list. Please identify them as you go through the list.

SECTION I: PERSONAL INFORMATION

Name：_____
Title：_____
Position: _____
Years of work：_____
Company Name：_____
Qualification Type：_____
Contact No.：_____
Email address：_____
Postal Address：_____
Postal Code：_____

SECTION II: COMPETITION INTENSITY INDICATORS

Competition intensity refers to the degree of competitors' competition actions in strife for common objects. Please use the following scale to indicate whether the following five indicators are applicable to what extent for reflecting competition intensity.

5 – Extremely important; 4 – Important; 3 – Average; 2 – Less important; 1 – Negligible

(1) Number of competitors（N）	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
(2) Competition frequency per contractor（F）	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
(3) Distributive status of contractors' firm sizes（S）	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
(4) Diversification of products/services in the market（P）	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
(5) Significance of construction works（W）	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1

SECTION III: PERFORMANCE INDICATORS

Please indicate the degree of importance of each indicator for reflecting competition intensity by selecting one of the five alternatives:

5 – Extremely important; 4 – Important; 3 – Average; 2 – Less important; 1 – Negligible

Indicators	Importance Levels
P1: Industrial profitability	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
P2: Rate of average construction cost below the standard quota	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
P3: Level of project tender index	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
P4: Frequency of construction innovation	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
P5: Level of per capita wage	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
P6: Frequency of safety incident	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
P7: Frequency of delay in payment of construction fees	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
P8: Frequency of poor construction quality occurrence	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
P9: Frequency of environmental destruction/damage	○ 5.... ○ 4.... ○ 3.... ○ 2.... ○ 1
Please add more indicators under this category if necessary:	

SECTION IV: LEVELS OF COMPETITION INTENSITY IN LOCAL CONSTRUCTION MARKETS

Please indicate the degree of competition intensity in local construction markets by using the following five levels:

5 – Strongest; 4 – Stronger; 3 – Average; 2 – Weaker; 1 – Weakest

Place	Level of competition intensity
Anhui	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Beijing	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Chongqing	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Fujian	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Gansu	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Guangdong	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Guangxi	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Guizhou	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Hainan	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Hebei	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Heilongjiang	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Henan	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1

Hubei	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Hunan	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Jiangsu	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Jiangxi	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Jilin	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Liaoning	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Neimenggu	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Ningxia	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Qinghai	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Shandong	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Shanghai	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Shanxi	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Shan-xi	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Sichuan	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Tianjin	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Xinjiang	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Xizang	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Yunnan	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1
Zhejiang	○ 5..... ○ 4..... ○ 3..... ○ 2..... ○ 1

<End>

REFERENCES

Adelman, M.A. (1951). "The Measurement of Industrial Concentration". *Review of Economics and Statistics* 33(4): 269-296.

Adelman, M.A. (1969). "Comment on the H Concentration Measure as a Numbers-Equivalent". *Review of Economics and Statistics* 51(1): 99-101.

Aguiar, M.R., Lauenroth, W.K. and Peters, D.P. (2001). "Intensity of Intra- and Inter-specific Competition in Co-existing Shortgrass Species". *The Journal of Ecology* 89(1): 40-47.

Akintoye, A., Bowen, P. and Hardcastle, C.H. (1998). "Macro-economic Leading Indicators of Construction Contract Prices". *Construction Management and Economics* 16(2): 159-75.

Akintoye, A. and Skitmore, M. (1991). "Profitability of UK Construction Contractors". *Construction Management and Economics* 9(4): 311-325.

Alarcón, L.F. and Ashley, D.B. (1996). "Modelling Project Performance for Decision Making". *Journal of Construction Engineering and Management* 122(3): 265-273.

Albak, S. and Overgaard, P.B. (1994). "Advertising and Pricing to Deter or Accommodate Entry when Demand is Unknown: Comment". *International Journal of Industrial Organisation* 12(1): 83-87.

Alexander, A.M. (2001). "The Role of Market Power in the Spatial Location of Industry". PhD Dissertation. The University of Wyoming.

Andrews, K.R. (1980). "The Concept of Corporate Strategy" Irwin, Homewood, IL.

Asplund, M. and Sandin, R. (1999). "The Number of Firms and Production Capacity in Relation to Market Size". *Journal of Industrial Economics* 47(1): 69-85.

Bagwell, K. and Ramey, G. (1990). "Advertising and Pricing to Deter or Accommodate Entry when Demand is Unknown". *International Journal of Industrial Organisation* 8(1): 93-113.

Bailey, D. and Boyle, S.E. (1971). "The Optimal Measure of Concentration". *Journal of the American Statistical Association* 66(336): 702-706.

Bain, J.S. (1951). "Relation of Profit Rate to Industry Concentration in American Manufacturing 1936-1940". *Quarterly Journal of Economics* 65(3): 293-324.

Bain, J.S. (1956). "Barriers to New Competition, Their Character and Consequences in Manufacturing Industries" Harvard University Press. Cambridge.

Bain, J.S. (1968). "Industrial Organization" (2nd edn). John Wiley. New York.

Bajo, O. and Salas, R. (2002). "Inequality Foundations of Concentration Measures: An Application to the Hannah-Kay Indices". *Spanish Economic Review* 4(4): 311-316.

Baldwin, J.R. (1995). "The Dynamics of Industrial Competition" Cambridge University Press. Cambridge, England.

Baldwin, R.J. and Gorecki, P.K. (1994). "Concentration and Mobility Statistics in Canada's Manufacturing Sector". *Journal of Industrial Economics* 42(1): 93-103.

Ball, M., Farshchi, M. and Grilli, M. (2000). "Competition and the Persistence of Profits in the UK Construction Industry". *Construction Management and Economics* 18(7): 733-745.

Banik, G.C. (2001). "Construction Productivity Improvement: Current US Perspective". *Journal of Construction Procurement* 7(2): 60-71.

Barla, P. (1999). "Market Share Instability in the US Airline Industry". *Journal of Applied Business Research* 15(4): 67-79.

Barnett, W.P. (1997). "The Dynamics of Competitive Intensity". *Administrative Science Quarterly* 42(1): 128-160.

Bassioni, H.A., Price, A.D.F. and Hassan, T.M. (2004). "Performance Measurement in Construction". *Journal of Management in Engineering* 20(2): 42-50.

Baumol, W. (1962). "On the Theory of Expansion of the Firm". *American Economic Review* 52(5): 1078-1087.

Belcher, J.W., Keddy, P.A. and Twolan-Strutt, L. (1995). "Root and Shoot Competition Intensity Along a Soil Depth Gradient". *The Journal of Ecology* 83(4): 673-682.

Ben, M.S. (2000). "Innovative Supply-based Strategies in the Construction Industry". *Construction Management and Economics* 18(6): 643-650.

Bengtsson, M. (1998). "Climates of Competition" Harwood Academic Publishers.

Bennett, J. (2000). "Construction - The Third Way" Butterworth - Heinemann. Oxford.

Berger, A.N. and Hannan, T.H. (1989). "The Price-Concentration Relationship in Banking". *Review of Economics and Statistics* 71(2): 291-299.

Bettis, R.A. and Hitt, M.A. (1995). "The New Competitive Landscape". *Strategic Management Journal* 16(Special Issue): 7-19.

Bird, K. (1999). "Concentration in Indonesian Manufacturing, 1975-93". *Bulletin of Indonesian Economic Studies* 35(1): 43-73.

Bonanno, G. and Haworth, B. (1998). "Intensity of Competition and the Choice between Product and Process Innovation". *International Journal of Industrial Organization* 16(4): 495-510.

Bonardi, L. (2001). "Analysis of the Relationship between Advertising, Concentration and Profitability in the U.S. Manufacturing Industry". PhD Dissertation. Fordham University. New York.

Boone, J. (2001). "Intensity of Competition and the Incentive to Innovate".

International Journal of Industrial Organization 19(5): 705-726.

Bosch, G. and Philips, P. (2000). "Building Chaos - An International Comparison of Deregulation in the Construction Industry" Taylor & Francis Group. ROUTLEDGE.

Boyes, J.W. and Smyth, J.D. (1979). "The Optimal Concentration Measure: Theory and Evidence for Canadian Manufacturing Industries". *Applied Economics* 11(3): 289-302.

Bradburd, R., Pugel, T. and Pugh, K. (1991). "Internal Rent Capture and the Profit-Concentration Relation". *Review of Economics and Statistics* 73(3): 432-440.

Bremer, W. and Kok, K. (2000). "The Dutch Construction Industry: A Combination of Competition and Corporation". *Building Research & Information* 28(2): 98-108.

Briscoe, G. (1988). "The Economics of the Construction Industry" B.T. Batsford Ltd. London.

Buxton, A.J., Davies, S.W. and Lyons, B.R. (1984). "Concentration and Advertising in Consumer and Producer Markets". *Journal of Industrial Economics* 32(4): 451-464.

Cable, J.R. (1997). "Market Share Behaviour and Mobility: An Analysis and Time-Series Application". *The Review of Economics and Statistics* 79(1): 136-141.

Campbell, J.R. and Hopenhayn, H.A. (2005). "Market Size Matters". *Journal of Industrial Economics* 53(1): 1-25.

Carlton, D.W. and Perloff, J.M. (2005). "Modern Industrial Organisation" (4th edn.). Pearson Addison Wesley. New York.

Carr, P.G. (2005). "Investigation of Bid Price Competition Measured through Prebid Project Estimates, Actual Bid Prices, and Number of Bidders". *Journal of Construction Engineering and Management* 131(11): 1165-1172.

Cattell, D.W., Bowen, P.A. and Kaka, A.P. (2007). "Review of Unbalanced Bidding Models in Construction". *Journal of Construction Engineering and Management* 133(8): 562-573.

Caves, R.E. and Porter, M.E. (1977). "From Entry Barriers to Mobility Barriers: Conjectural Decisions and Contrived Deterrence to New Competition". *Quarterly Journal of Economics* 91(2): 241-261.

Centre for Policy Research Ministry of Construction, P.R.C. (2007). "Reform and Development - A Report on Construction Industry and Market in China" China Architecture & Building Press. Beijing.

Cernikova, R. (2002). "Factors Influencing Intensity of Competition in the Czech Dairy Industry". *Agriculture Economics* 48(7): 315-320.

Chamberlain, E.H. (1933). "The Theory of Monopolistic Competition" Harvard University Press. Cambridge, Mass.

Chan, M.S., Runeson, G. and Skitmore, M. (1996). "Changes in Profit as Market Conditions Change: An Historical Study of a Building Firm".

Construction Management and Economics 14(3): 253-264.

Chan, S.L. (2001). "Empirical Tests to Discern Linkages between Construction and Other Economic Sectors in Singapore". *Construction Management and Economics* 19(4): 355-363.

Chapman, C.B., Ward, S.C. and Bennell, J.A. (2000). "Incorporating Uncertainty in Competitive Bidding". *International Journal of Project Management* 18(5): 337-347.

Chen, C. (2005). "Entry Strategies for International Construction Markets". PhD Dissertation. The Pennsylvania State University.

Chen, M.J. (1996). "Competitor Analysis and Interfirm Rivalry: toward a Theoretical Integration". *Academy of Management Review* 21(1): 100-134.

Chiang, Y.H., Tang, B.S. and Leung, W.Y. (2001). "Market Structure of the Construction Industry in Hong Kong". *Construction Management and Economics* 19(7): 675-687.

Cho, D.S. (1998). "From National Competitiveness to Bloc and Global Competitiveness". *Competitiveness Review* 8(1): 11-25.

Choi, J. and Russell, J.S. (2005). "Long-Term Entropy and Profitability Change of United States Public Construction Firms". *Journal of Management in Engineering* 21(1): 17-26.

Chongqing Statistics Bureau (2002). Chongqing Yearbook of Statistics (1998-2002).

Collins, N.R. and Preston, L.E. (1966). "Concentration and Price-Cost Margins in Food Manufacturing Industries". *Journal of Industrial Economics* 14(3): 226-242.

Cox, R.F., Issa, R.R.A. and Ahrens, D. (2003). "Management's Perception of Key Performance Indicators for Construction". *Journal of Construction Engineering and Management* 129(2): 142-151.

Coyle, J.J. (2001). "A Reconsideration of Value of Service Pricing". *Land Economics* 41(2): 193 -199.

Crosthwaite, D. (2000). "The Global Construction Market: A Cross-Sectional Analysis". *Construction Management and Economics* 18(5): 619-627.

Das, B.J., Chappell, W.F. and Shughart, I.W.F. (1993). "Advertising, Competition and Market Share Instability". *Applied Economics* 25(11): 1409-1012.

Dash, S. and Loggie, K. (2008). "Equal Weight Indexing: Five Years Later ". Standard & Poor's. http://www.indexuniverse.com/component/content/article/11/4022.html?Itemid=17.

Davies, S.W. (1979). "Choosing between Concentration Indices: The Iso-concentration Curve". *Economica* 46(181): 67-75.

Davies, S.W. and Geroski, P.A. (1997). "Changes in Concentration, Turbulence, and the Dynamics of Market Shares". *Review of Economics and Statistics* 79(3): 383-391.

Davis, S., Haltiwanger, J. and Schuh, S. (1996). "Job Creation and Destruction"

MIT Press. Cambridge, MA.
Dawood, N.N. (1995). "An Integrated Bidding Management Expert System for the Make-to-order Precast Industry". *Construction Management and Economics* 13(2): 115-125.
de Neufville, R. and King, D. (1991). "Risk and Need-for-work Premiums in contractor Bidding". *Journal of Construction Engineering and Management* 117(4): 659-673.
Deep, R. (2006). "Probability and Statistics" Burlington, Mass.: Academic Press.
Devine, P.J., Lee, N., Jones, R.M. and Tyson, W.J. (1985). "An Introduction to Industrial Economics" (4th edn). Allen and Unwin. London.
Domowitz, I., Hubbard, G.R. and Petersen, B.C. (1986). "The Intertemporal Stability of the Concentration-Margins Relationship". *Journal of Industrial Economics* 35(1): 12-34.
Donsimoni, M.P., Geroski, P. and Jacquemin, A. (1984). "Concentration Indices and Market Power". *Journal of Industrial Economics* 32(4): 419-434.
Drew, D. and Skitmore, M. (1997). "The Effect of Contract Type and Size on Competitiveness in Bidding". *Construction Management and Economics* 15(5): 469-489.
Drew, D.S., Shen, L.Y. and Zou, P.X.W. (2002). "Developing an Optimal Bidding Strategy in Two-envelope Fee Bidding". *Construction Management and Economics* 20(7): 611-620.
Drew, D.S. and Skitmore, R.M. (1992). "Competitiveness in Bidding: A Consultant's Perspective". *Construction Management and Economics* 10(3): 227-247.
Duffy, B. (1999). "The Analysis of Documentary Evidence". *Doing Your Research Project* (3rd edn). edited by J. Bell, Open University Press, Maidenhead, Philadelphia.
Dulaimi, M.F. (2005). "The Challenge of Customer Orientation in the Construction Industry". *Construction Innovation: Information, Process, Management* 5(1): 3-12.
Eckard, E.W. (1987). "Advertising, Competition, and Market Share Instability". *The Journal of Business* 60(4): 539-552.
Egemen, M. and Mohamed, A.N. (2006). "Clients' Needs, Wants and Expectations from Contractors and Approach to the Concept of Repetitive Works in the Northern Cyprus Construction Market". *Building and Environment* 41(5): 602-614.
Egghe, L. (2005). "Zipfian and Lotkaian Continuous Concentration Theory". *Journal of the American Society for Information Science & Technology* 56(9): 9325-9345.
EI-Namaki, M.S.S. (2002). "An Analysis of China's Competitiveness between 1995 and 1999". *Competitiveness Review* 12(1): 66-75.
EI-Rayes, K. (2001). "Optimum Planning of Highway Construction under A+B Bidding Method". *Journal of Construction Engineering and Management*

127(4): 261-269.
Ellinger, R. (1977). "Industrial Location Behaviour and Spatial Evolution". *Journal of Industrial Economics* 25(4): 295-312.
Ely, R.T. (1901). "Competition: its Nature, its Permancy, and its Beneficence". *Publications of the American Economic Association* 3(2): 55-70.
ENR (2007). "The Top Global Contractors". *Engineering News-Record* 259(23).
Fagerberg, J. (1996). "Technology and Competitiveness". *Oxford Review of Economic Policy* 12(3): 39-51.
Faniran, O.O., Love, P.E.D. and Li, H. (1999). "Optimal Allocation of Construction Planning Resources". *Journal of Construction Engineering and Management* 125(5): 311-319.
Farber, S. (1981). "Buyer Market Structure and R&D Effort: A Simultaneous Equations Model". *The Review of Economics and Statistics* 63(3): 336-345.
Fayek, A. (1998). "Competitive Bidding Strategy Model and Software System for Bid Preparation". *Construction Engineering and Management* 124(1): 1-9.
Finkel, G. (1997). "The Economics of the Construction Industry" M.E. Sharpe. London, England.
Fiori, C.M. (2003). "What's Wrong with Working in Construction? How Image and Diversity Issues are Affecting the Shortage of Skilled Labour". *Proceedings of Construction Research Congress - Wind of Change: Integration and Innovation*, Honolulu, Hawaii.
Fitzgerald, E. and Akintoye, A. (1995). "The Accuracy and Optimal Linear Correction of UK Construction Tender Price Index Forecasts". *Construction Management and Economics* 13(6): 493-500.
Flanagan, R. and Norman, G. (1982). "Making Good Use of Low Bids". *Chartered Quantity Surveyor* 4: 226-227.
Flanagan, R. and Norman, G. (1983). "The Accuracy and Monitoring of Quantity Surveyors' Price Forecasting for Building Work". *Construction Management and Economics* 1(2): 157-180.
Flanagan, R. and Norman, G. (1985). "Sealed Bid Auctions: An Application to the Building Industry". *Construction Management and Economics* 3(2): 145-161.
Fleming, L. (2008). "Diversity in Engineering Education: An African American Female Professor's Perspective". *Leadership and Management in Engineering* 8(1): 32-34.
Fonteyn, P.J. and Mahall, B.E. (1981). "An Experimental Analysis of Structure in a Desert Plant Community". *Journal of Ecology* 69(3): 883-896.
Freire, J. and Alarcón, L.F. (2002). "Achieving Lean Design Process: Improvement Methodology". *Journal of Construction Engineering and Management* 128(3): 248-256.
Friedland, T.S. (1977). "Advertising and Concentration". *Journal of Industrial Economics* 26(2): 151-160.
Friedman, L. (1956). "A Competitive-bidding Strategy". *Operations Research* 4(1):

104-112.
Fu, W.K., Drew, D.S. and Lo, H.P. (2003). "Competitiveness of Inexperienced and Experienced Contractors in Bidding". *Journal of Construction Engineering and Management* 129(4): 388-395.
Fuchs, V.R. (1961). "Integration, Concentration, and Profits in Manufacturing Industries". *Quarterly Journal of Economics* 75(2): 278-291.
Gause, G.F. (1934). "The Struggle for Existence" Hafner. New York.
George, K.D. (1967). "Changes in British Industrial Concentration 1951-1958". *Journal of Industrial Economics* 15(3): 200-211.
George, K.D. (1972). "Concentration and Specialization in Industry". *Journal of Industrial Economics* 20(2): 107-123.
Geroski, P.A. and Pomroy, R. (1990). "Innovation and the Evolution of Market Structure". *Journal of Industrial Economics* 38(3): 299-314.
Ghosh, A. (1975). "Concentration and Growth of Indian Industries, 1948- 68". *Journal of Industrial Economics* 23(3): 203-222.
Goh, B.H. and Teo, H.P. (2000). "Forecasting Construction Industry Demand, Price and Productivity in Singapore: the Box-Jenkins Approach". *Construction Management and Economics* 18(5): 607-618.
Goldberg, P.K. and Knetter, M.M. (1999). "Measuring the Intensity of Competition in Export Markets". *Journal of International Economics* 47(1): 27-60.
Gort, M. (1963). "Analysis of Stability and Change in Market Shares". *Journal of Political Economy* 71(1): 51-63.
Grace, J.B. (1995). "On the Measurement of Plant Competition Intensity". *Ecology* 76(1): 305-308.
Greer, D.F. (1971). "Product Differentiation and Concentration in the Brewing Industry". *Journal of Industrial Economics* 19(3): 201-219.
Greer, D.F. (1992). "Industrial Organization and Public Policy" (3rd edn). Macmillan Publishing Company. New York.
Grogan, T. (1992). "Low Bids Raise Hidden Costs". *Engineering News-Record* 228(13): 30-31.
Grossack, I.M. (1972). "The Concept and Measurement of Permanent Industrial Concentration". *Journal of Political Economy* 80(4): 745-760.
Gruneberg, S.L. and Ive, G.J. (2000). "The Economics of the Modern Construction Firm" Antony Rowe Ltd. Chippenham, Great Britain.
Gunhan, S. and Arditi, D. (2005). "Factors Affecting International Construction". *Journal of Construction Engineering and Management* 131(3): 273-282.
Gupta, V.K. (1968). "Cost Functions, Concentration, and Barriers to Entry in Twenty-nine Manufacturing Industries of India". *Journal of Industrial Economics* 17(1): 57-82.
Guth, L.A. (1971). "Advertising and Market Structure Revisited". *Journal of Industrial Economics* 19(2): 179-198.
Hall, M. and Tideman, N. (1967). "Measures of Concentration". *Journal of*

American Statistical Association 62(317): 162-168.
Hannan, M.T. (1986). "Competitive and Institutional Processes in Organisational Ecology". *Technical Report 86-1, Cornell University*.
Harper, J.L. (1977). "Population Biology of Plants" Academic Press. New York.
Hastakm, M., Vanegas, J.A. and Manuel, P.C. (1993). "Time-Based Competition: Competitive Advantage Tool for A/E/C Firms". *Journal of Construction Engineering and Management* 119(4): 785-790.
Hatirli, S.A. (2000). "A Measurement of Market Power and/ or Cost Efficiency in the U.S. Frozen and Potato Chips Sub-sectors". PhD dissertation. The Ohio State University.
Haworth, T.C. and Reuther, J.C. (1978). "Industrial Concentration and Interindustry Wage Determination". *Review of Economics and Statistics* 60(1): 85-95.
Hayek, F.A. (1948). "The Meaning of Competition, Individualism and Economic Order" University of Chicago Press. Chicago.
Heggestad, A.A. and Rhoades, A.S. (1976). "Concentration and Firm Stability in Commercial Banking". *Review of Economics and Statistics* 58(4): 443-452.
Henley, A. (1987). "Trades Unions, Market Concentration and Income Distribution in United States Manufacturing Industry". *International Journal of Industrial Organization* 5(2): 193-210.
Herbsman, Z.J. (1995). "A+B Bidding Method - Hidden Success Story for Highway Construction". *Journal of Construction Engineering and Management* 121(4): 430-437.
High, J. (2001). "Competition" Edward Elgar Publishing Limited. UK.
Hofer, C.W. and Schendel, D. (1978). "Strategy Formulation: Analytical Concepts" West Publishing Company. St Paul, MN.
Holtermann, S.E. (1977). "Market Structure and Economic Performance in U.K. Manufacturing Industry". *Journal of Industrial Economics* 25(3): 177-193.
Hong Kong Housing Authority (2008). "Tender Price Index for New Works in Hong Kong". *http://www.housingauthority.gov.hk/hdw/content/document/en/business_partners/TPIQ2006%20(For%20HD).pdf*.
Horowitz, A. and Horowitz, I. (1968). "Entropy, Markov Process and Competition in the Brewing Industry". *Journal of Industrial Economics* 16(3): 196-211.
Horowitz, I. (1971). "An International Comparison of the International Effects of Concentration on Industry Wages Investment, and Sales". *Journal of Industrial Economics* 19(2): 166-178.
Hymer, S. and Pashigian, P. (1962). "Turnover of Firms as a Measure of Market Behaviour". *Review of Economics and Statistics* 44(1): 82-87.
Invancevich, J.M., Lorenzi, P. and Skinner, S.J. (1997). "Management Quality and Competitiveness" (2nd edn). McGraw-Hill. New York.
Ioannou, P.G. and Leu, S. (1993). "Average-Bid Method - Competitive Bidding

Strategy". *Journal of Construction Engineering and Management* 119(1): 131-147.

Jacquemin, A. (1987). "The New Industrial Organisation - Market Forces and Strategic Behaviour" The MIT Press. Cambridge, Massachusetts, London.

James, D.T. (2008). "Importance of Diversity in a Successful Firm". *Leadership and Management in Engineering* 8(1): 16-18.

Jayachandran, S., Gimeno, J. and Varadarajan, P.R. (1999). "The Theory of Multimarket Competition: A Synthesis and Implications for Marketing Strategy". *Journal of Marketing* 63(3): 49-66.

Jenny, F. (1978). "Wage Rates, Concentration and Unionization in French Manufacturing Industries". *Journal of Industrial Economics* 26(4): 315-327.

Jin, X. and Ling, F.Y.Y. (2006). "Key Relationship-based Determinants of Project Performance in China". *Building and Environment* 41(7): 915-925.

Johns, B.L. (1962). "Barriers to Entry in a Dynamic Setting". *Journal of Industrial Economics* 11(1): 48-61.

Johnson, G. and Scholes, L. (1988). "Exploring Corporate Strategic" (2nd edn). Prentice Hall, Hemel Hempstead.

Kaplan, A.D.H. (1980). "Big Enterprise in a Competitive System" (Revised edition). Greenwood Press.

Keddy, P.A. (2001). "Competition" Kluwer Academic Publisher. Netherland.

Kessides, N.I. (1990). "Market Concentration, Contestability, and Sunk Costs". *Review of Economics and Statistics* 72(4): 614-622.

Khandwalla, P.N. (1972). "The Effect of Different Types of Competition on the Use of Management Controls". *Journal of Accounting Research* 10(2): 275-285.

Kim, H.J. and Reinschmidt, K.F. (2006). "A Dynamic Competition Model for Construction Contractors". *Construction Management and Economics* 24(9): 955-965.

Kim, J. (2007). "The Intensity of Competition in the Hoteling Model: A New Generalization and Applications". Michigan State University. http://mpra.ub.uni-muenchen.de/3043.

Kleindorfer, G.B., O'Neill, L. and Ganeshan, R. (1998). "Validation in Simulation: Various Positions in the Philosophy of Science". *Management Science* 44(8): 1087-1099.

Koskela, E. and Stenbacka, R. (2005). "Product Market Competition, Profit Sharing and Equilibrium Unemployment". Helsinki Centre of Economic Research, University of Helsinki, FINLAND. http://ethesis.helsinki.fi/julkaisut/eri/hecer/disc/86/productm.pdf.

Kotler, P. and Keller, K.L. (2009). "A Framework for Marketing Management" (4th edn.). Upper Saddle River, N.J.: Pearson Prentice Hall.

Kwan, A.Y. and Ofori, G. (2001). "Chinese Culture and Successful Implementation of Patterning in Singapore's Construction Industry". *Construction Management and Economics* 19(6): 619-632.

Kwoka, J.E. (1981). "Does the Choice of Concentration Measure Really Matter". *Journal of Industrial Economics* 29(4): 445-453.

Lall, S. (1999). "Promoting Industrial Competitiveness in Developing Countries: Lessons from Asia" Commonwealth Secretariat.

Langford, D. and Male, S. (2001). "Strategic Management in Construction" (2nd edn). Blackwell Science Ltd, Berlin, Germany.

Layne, P. (2001). "Diversity by the Numbers". *Leadership and Management in Engineering* 1(4): 65-71.

Layne, P. (2002). "Best Practices in Managing Diversity". *Leadership and Management in Engineering* 2(4): 28-30.

Lemer, A.C. (2001). "Book Review: Construction - the Third Way: Managing Cooperation and Competition in Construction, by John Bennett, Butterworth Heinemann". *Construction Management and Economics* 19(5): 551-552.

Ling, F.Y.Y., Ibbs, C.W. and Cuervo, J.C. (2005). "Entry and Business Strategies Used by International architectural, Engineering and Construction Firms in China". *Construction Management and Economics* 23(5): 509-520.

Lipczynski, J. and Wilson, J. (2001). "Industrial Organisation: An Analysis of Competitive Markets" Pearson Education Limited. Harlow, England.

Lisa, T.S. and Keddy, P.A. (1996). "Above- and Below- ground Competition Intensity in Two Contrasting Wetland Plant Communities". *Ecology* 77(1): 259-270.

Lo, W., Lin, C.L. and Yan, M.R. (2007). "Contractor's Opportunistic Bidding Behaviour and Equilibrium Price Level in the Construction Market". *Journal of Construction Engineering and Management* 133(6): 409-416.

Loosemore, M. (1999). "International Construction Management Research: Cultural Sensitivity in Methodological Design". *Construction Management and Economics* 17(5): 553-561.

Lu, W.D. (2000). "SPSS for Windows, Statistical Analysis" Publishing House of Electronics Industry. Beijing.

Lustgarten, S.H. (1975). "The Impact of Buyer Concentration in Manufacturing Industries". *The Review of Economics and Statistics* 57(2): 125-132.

MacArthur, R.H. (1972). "Geographical Ecology: Patterns in the Distribution of Species" Harper & Row. New York.

Male, S.P. (1991). "Strategic Management in Construction: Conceptual Foundations" edited by S. P. Male and R. K. Stocks, Butterworth-Heinemann, Oxford.

Mann, H.M., Henning, J.A. and Jeehan, J.W. (1967). "Advertising and Concentration: An Empirical Investigation". *Journal of Industrial Economics* 16(1): 34-45.

Martin, S. (1988). "The Measurement of Profitability and the Diagnosis of Market Power". *International Journal of Industrial Organisation* 6(3): 301-321.

Martin, S. (2004). "Globalisation and the Natural Limits of Competition". *The*

International Handbook of Competition edited by N. Manfred and W. Jürgen, Edward Elgar.

Marzouk, M. and Moselhi, O. (2003). "A Decision Support Tool for Construction Bidding". *Construction Innovation: Information, Process, Management* 3(2): 111-124.

Mathis, S. and Koscianski, J. (1996). "Excess Capacity as a Barrier to Entry in the US Titanium Industry". *International Journal of Industrial Organisation* 15(2): 263-281.

McCaffer, R., McCaffrey, M.J. and Thorpe, A. (1983). "The Disparity between Construction Cost and Tender Price Movements". *Construction Papers* 2(2): 17-27.

Mccloughan, P. (2004). "Construction Sector Concentration: Evidence from Britain". *Construction Management and Economics* 22(9): 979-999.

Mccloughan, P. and Abounoori, E. (2003). "How to Estimate Market Concentration Given Grouped Data". *Applied Economics* 35(8): 973-983.

McCulloch, G. and Richardson, W. (2000). "Historical Research in Education Settings" Open University. Philadelphia.

Merna, A. and Smith, N.J. (1990). "Bid Evaluation for UK Public Sector Construction Contracts". *Proceedings of the Institution of Civil Engineers Part 1* 1(88): 91-105.

Mill, J.S. (1984). "Principles of Political Economy" Longmans. London.

Miller, R.A. (1969). "Market Structure and Industrial Performance: Relation of Profit Rates to Concentration, Advertising Intensity, and Diversity". *Journal of Industrial Economics* 17(2): 104-118.

Miller, R.A. (1971). "Marginal Concentration Ratios as Market Structure Variables". *Review of Economics and Statistics* 53(3): 289-293.

Miller, T.E. (1996). "On Quantifying the Intensity of Competition across Gradients". *Ecology* 77(3): 978-981.

Milne, G.R. and Mason, C.H. (1989). "An Ecological Niche Theory Approach to the Measurement of Brand Competition". *Marketing Letters* 1(3): 267-281.

MOC (2007). Regulation on Qualification Management of Construction Firms, Ministry of Construction, The People's Republic of China.

Montgomery, C.A. (1985). "Product Diversification and Market Power". *Academy of Management Journal* 28(4): 789-798.

Moselhi, O., Hegazy, T. and Fazio, P. (1993). "DBID: Analogy-Based DSS for Bidding in Construction". *Journal of Construction Engineering and Management* 119(3): 466-479.

Mueller, W.F. and Hamm, L.G. (1974). "Trends in Industrial Market Concentration, 1947-1970". *Review of Economics and Statistics* 56(4): 511-520.

Myers, D. (2004). "Construction Economics: A New Approach" Spon Press: Taylor & Francis Group. New York.

Naylor, T.H. and Finger, J.M. (1967). "Verification of Computer Simulation

Models". *Management Science* 14(2): B92-B101.
NBSC (2007). "China Statistical Yearbook (2006)". National Bureau of Statistics of China. www.stats.gov.cn/tjsj/ndsj/.
Needham, D. (1978). "The Economics of Industrial Structure, Conduct and Performance" Holt, Rinehart and Winston. London.
Nelson, R.L. (1960). "Market Growth, Company Diversification and Product Concentration, 1947-58". *Journal of American Statistics Association* 55(292): 640-649.
Neumann, M., Bobel, I. and Haid, A. (1985). " Domestic Concentration, Foreign Trade and Economic Performance". *International Journal of Industrial Organization* 3(1): 1-19.
Neumann, M. and Weigand, J. (2004). "The International Handbook of Competition" Edard Elgar Publishing, Inc. USA.
Neumann, M., Weigand, J., Gross, A. and Munter, M.T. (2001). "Market Size, Fixed Costs and Horizontal Concentration". *International Journal of Industrial Organisation* 19(5): 823-840.
Newmark, C.M. (1989). "Administrative Control, Buyer Concentration, and Price-Cost Margins". *Review of Economics and Statistics* 71(1): 74-79.
Ng, S.T., Cheung, S.O., Skitmore, M., Lam, K.C. and Wong, L.Y. (2000). "Prediction of Tender Price Index Directional Changes". *Construction Management and Economics* 18(7): 843-852.
Ngai, S.C., Drew, D.S., Lo, H.P. and Skitmore, M. (2002). "A Theoretical Framework for Determining the Minimum Number of Bidders in Construction Bidding Competitions". *Construction Management and Economics* 20(6): 473-482.
Nickell, S.J. (1996). "Competition and Corporate Performance". *Journal of Political Economy* 104(4): 724-746.
Noh, G. (2000). "The Effects of Competition and Resource on Firm Performance in Local Information Service on the Web". PhD Dissertation. Michigan State University.
OECD (2005). "OECD Broadband Statistics". www.oecd.org.
Ofori, G. (1990). "The Construction Industry, Aspects of its Economics and Management" Singapore University Press. Kent Ridge, Singapore.
Orr, D. (1974). "An Index of Entry Barriers and its Application to the Market Structure Performance Relationship". *Journal of Industrial Economics* 23(1): 39-49.
Oster, S.M. (1999). "Modern Competitive Analysis" (3rd edn). Oxford University Press. New York.
Owen, N. (1971). "Competition and Structural Change in Unconcentrated Industries". *Journal of Industrial Economics* 19(2): 133-147.
Parker, S.C. (1991). "Significantly Concentrated Markets Theory and Evidence for the U.K." *International Journal of Industrial Organization* 9(4): 585-590.
Peltzer, D.A., Wilson, S.D. and Gerry, A.K. (1998). "Competition Intensity along

a Productivity Gradient in a Low-Diversity Grassland". *The American Naturalist* 151(5): 465-476.

Pepall, L., Richards, D.J. and Norman, G. (2002). "Industrial Organization Contemporary Theory and Practice" (2nd edn). South-Western Thomson Learning.

Phillips, A. (1976). "A Critique of Empirical Studies of Relations Between Market Structure and Profitability". *Journal of Industrial Economics* 24(4): 241-249.

Porter, M. (1980). "Competitive Strategy: Techniques for Analysing Industries and Competitors" Free Press. New York.

Porter, M. (1985). "Competitive Advantage" Free Press. New York.

Porter, M.E. (1990). "The Competitive Advantage of Nations" Macmillan Press. London.

Powell, I. (1987). "The Effect of Reductions in Concentration on Income Distribution". *Review of Economics and Statistics* 69(1): 75-82.

Powl, A. and Skitmore, M. (2005). "Factors Hindering the Performance of Construction Project Managers". *Construction Innovation: Information, Process, Management* 5(1): 41-51.

PWCEI (2007). "Public Website of China's Construction and Engineering Information". http://www.cein.gov.cn/home/qyxx/index.asp.

Qualls, D. (1972). "Concentration, Barriers to Entry, and Long Run Economic Profit Margins". *Journal of Industrial Economics* 20(2): 193-195.

Raftery, J., Pasadilla, B., Chiang, Y.H., Hui, E.C.M. and Tang, B.S. (1998). "Globalisation and Construction Industry Development: Implications of Recent Developments in the Construction Sectors in Asia". *Construction Management and Economics* 16(6): 729-737.

Raftery, J., Pasadilla, B., Y.H. Chang, Hui, E.C.M. and Tang, B.S. (1998). "Globalization and Construction Industry Development: Implications of Recent Developments in the Construction Sector in Asia". *Construction Management and Economics* 16(6): 729-737.

Ramaswamy, K. and Renforth, W. (1996). "Competitive Intensity and Technical Efficiency in Public Sector Firms: Evidence from India". *International Journal of Public Sector Management* 9(3): 4-17.

Ramírez, R.R., Alarcón, L.F.C. and Knights, P. (2004). "Benchmarking System for Evaluating Management Practices in the Construction Industry". *Journal of Management in Engineering* 20(3): 110-117.

Rawlinson, S. and Raftery, J. (1997). "Price Stability and the Business Cycle: UK Construction Tendering Patterns 1970-91". *Construction Management and Economics* 15(1): 5-18.

Reid, G. (1987). "Theories of Industrial Organization". Oxford, Basil Blackwell.

Runeson, G. and Bennett, J. (1983). "Tendering and the Price Level in the New Zealand Building Industry". *Construction Papers* 2(2): 29-35.

Sawyer, C.M. (1985). "The Economics of Industries and Firms" (2nd edn). Croom

Helm. London.
Scherer, F.M. (1973). "Investment Variability, Seller Concentration, and Plant Scale Economies". *Journal of Industrial Economics* 22(2): 157-160.
Scherer, F.M. (1980). "Industrial Market, Structure and Economic Performance" (2nd edn). Rand-McNally. Chicago.
Schumpeter, J. (1942). "Capitalism, Socialism, and Democracy" Harper & Bros. New York.
Schumpeter, J.A. (1949). "The Historical Approach to the Analysis of Business Cycles" in *Essays on Entrepreneurs, Innovations, Business Cycles, and the Evolution of Capitalism*. edited by J. A. Schumpeter. New Brunswick, N.J. and London, Transaction, 1989**:** 322-329.
Shash, A.A. (1993). "Factors Considered in Tendering Decisions by Top UK Contractors". *Construction Management and Economics* 11(2): 111-118.
Shen, L.Y. and Song, W.G. (1998). "Competitive Tendering Practice in Chinese Construction". *Journal of Construction Engineering and Management* 124(2): 155-161.
Shen, L.Y., Ye, K.H. and Deng, X.P. (2006). "Competitiveness for Contractors - Evaluation and Improvement" The Chinese Architect and Building Press. Beijing, ISBN: 7112083370.
Shepherd, W.G. (1964). "Trends of Concentration in American Manufacturing Industries". *Review of Economics and Statistics* 46(2): 200-212.
Shepherd, W.G. and Shepherd, J.M. (2004). "The Economics of Industrial Organisation" (5th edn). Waveland Press Inc. Long Grove, Illinois.
Shrieves, R.E. (1978). "Market Structure and Innovation: A New Perspective". *Journal of Industrial Economics* 26(4): 329-347.
Sillars, D.N. and Kangari, R. (1997). "Japanese Construction Alliances". *Journal of Construction Engineering and Management* 123(2): 146-152.
Singh, A. (2002). "Competition and Competition Policy in Emerging Markets: International and Developmental Dimensions". United Nations Conference on Trade and Development. *http://www.unctad.org/en/docs/gdsmdpbg2418_en.pdf*.
Singh, A. and Shoura, M.M. (1996). "Optimising Bidding Success and Profitability in Airport Runway Construction in French Polynesia". *Construction Management and Economics* 14(6): 507-530.
Skitmore, M. and Runeson, G. (2006). "Bidding Models: Testing the Stationarity Assumption". *Construction Management and Economics* 24(8): 791-803.
Sleuwaegen, L. and Dehandschutter, W. (1986). "The Critical Choice between the Concentration Ratio and the H-Index in Assessing Industry Performance". *Journal of Industrial Economics* 35(2): 193-208.
Smith, A. (1776). "The Wealth of Nations" Stratton and Cadell. London.
Song, Y., Liu, C. and Langston, C. (2006). "Linkage Measures of the Construction Sector Using the Hypothetical Extraction Method". *Construction Management and Economics* 24(6): 579 - 589.

Stekler, H.O. (1961). "A Note on the Size of a Market". *Journal of Industrial Economics* 9(3): 251-254.

Stigler, G.J. (1968). "The Organization of Industry" Homewood. Ill: Irwin.

Stigler, G.J. (1987). "Competition" in *The New Palgrave*. edited by J. Eatwell, M. Milgate and P. Newman. London, Macmillan.

Straiger, R.W. and Wolak, F.A. (1992). "Collusive Pricing with Capacity Constraints in the Presence of Demand Constraints in the Presence of Demand Uncertainty". *Journal of Economics* 23(2): 203-220.

Sturts, C.S. and Griffis, F.H. (2005). "Addressing Pricing: Value Bidding for Engineers and Consultants". *Journal of Construction Engineering and Management* 131(6): 621-630.

Tang, J.C.S., Karasudhi, P. and Tachopiyagoon, P. (1990). "Thai Construction Industry: Demand and Projection". *Construction Management and Economics* 8(3): 249-257.

Tansley, A.G. (1917). "On Competition between Gallium Saxatile L. (G. hercynicum Weig.) and Galium Sylvestre Poll (G. asperum Schreb) on Different Types of Soil". *Journal of Ecology* 5: 173-179.

Tay, L. and Morgan, N.A. (2002). "Antecedents and Consequences of Market Orientation in Chartered Surveying Firms". *Construction Management and Economics* 20(4): 331-341.

Telser, L.G. (1964). "Advertising and Competition". *Journal of Political Economy* 72(6): 537-562.

Teo, H.P. and Scott, W.F. (1994). "Bidding Model for Refurbishment Work". *Journal of Construction Engineering and Management* 120(2): 257-273.

Trefler, D. (2004). "The Long and Short of the Canada - U.S. Free Trade Agreement". *American Economic Review* 94(4): 870-895.

Utton, M.A. (1970). "Industrial Concentration" Penguin Books Ltd. Harmondsworth, Middlesex, England.

van Horn, R.L. (1971). "Validation of Simulation Results". *Management Science* 17(5): 247-258.

van Kranenburg, H. (2002). "Mobility and Market Structure in the Dutch Daily Newspaper Market Segments". *Journal of Media Economics* 15(2): 107-123.

Vermeulen, I. (2002). "A Logical Approach to Competition in Industries". PhD Dissertation. Universiteit van Amsterdam.

Vernon, J.M. (1971). "Concentration, Promotion, and Market Share Stability in the Pharmaceutical Industry". *Journal of Industrial Economics* 19(3): 246-266.

Vickers, J. (1986). "The Evolution of Market Structure When There is a Sequence of Innovations". *Journal of Industrial Economics* 35(1): 1-12.

Walras, L. (1874). "Elements of Pure Economics" George Allen and Unwin Ltd. London.

Wang, D. (2004). "The Chinese Construction Industry from the Perspective of Industrial Organization". PhD Dissertation. North-western University.

Wang, D., Hadavi, A. and Krizek, R.J. (2006). "Chinese Construction Firms in Reform". *Construction Management and Economics* 24(5): 509-519.

Weiss, L.W. (1963). "Average Concentration Ratios and Industrial Performance". *Journal of Industrial Economics* 11(3): 237-254.

Wells, J. (2007). "Informality in the Construction Sector in Developing Countries". *Construction Management and Economics* 25(1): 87-93.

Wenders, J.T. (1971). "Excess Capacity as a Barrier to Entry". *Journal of Industrial Economics* 20(1): 14-19.

White, K.R. (1973). "On the Choice of a Concentration Measure". *American Business Law Journal* 14: 236-241.

Whittaker, R.H. and Levin, S.A. (1975). "Niche: Theory and Application." Dowden, Hutchinson & Ross, Inc. Stroudsburg, PA.

Williamson, O.E. (1985). "The Economic Institutions of Capitalism" Free Press. New York.

Wilson, S.D. and Tilman, D. (1993). "Plant Competition and Resource Availability in Response to Disturbance and Fertilization". *Ecology* 74(2): 599- 611.

Wong, C.H., HolT, G.D. and Cooper, P.A. (2000). "Lowest Price or Value? Investigation of UK Construction Clients' Tender Selection Process". *Construction Management and Economics* 18(7): 767-774.

Wu, X. and Zhang, Z. (2005). "Input-Output Analysis of the Chinese Construction Sector". *Construction Management and Economics* 23(9): 905-912.

Xinhua Website-a (2004). "How to Interpret Over Supply and Heavy Demand of Rural Labours in Urban Areas". *http://www.fj.xinhuanet.com/news/2004-09/02/content_2796831.htm*.

Yamawaki, H. (1984). "Market Structure, Capacity Expansion, and Pricing - A Model Applied to the Japanese Iron and Steel Industry". *International Journal of Industrial Organisation* 2(1): 29-62.

Yates, J.K. (1991). "Construction Competitiveness in the 21st Century". *American Association of Cost Engineers* ABI/INFORM Global: H.1.1-H.1.5.

Yates, J.K. (1994). "Construction Competition and Competitive Strategies". *Journal of Management in Engineering* 10(1): 58-69.

Yates, J.K. and Aniftos, S. (1997). "International Standards and Construction". *Journal of Construction Engineering and Management* 123(2): 127-137.

Ye, K.H., Jiang, W.Y. and Shen, L.Y. (2008). "Project Competition Intensity (PCI) in the Construction Market: A Case Study in China". *Construction Management and Economics* 26(5): 463 - 470.

Ye, K.H., Shen, L.Y. and Khalid, A.G. (2008). "Measurement for Competition Intensity (CI) in Construction Market". *Management Decision*: (under review).

Yee, C.Y. and Cheah, C.Y.J. (2006). "Fundamental Analysis of Profitability of Large Engineering and Construction Firms". *Journal of Management in*

Engineering 22(4): 203-210.
Zou, P.X.W., Fang, D., Wang, S. and Loosemore, M. (2007). "An Overview of the Chinese Construction Market and Construction Management Practice". *Journal of Technology Management in China* 2(2): 163-176.