The copyright © of this thesis belongs to its rightful author and/or other copyright owner. Copies can be accessed and downloaded for non-commercial or learning purposes without any charge and permission. The thesis cannot be reproduced or quoted as a whole without the permission from its rightful owner. No alteration or changes in format is allowed without permission from its rightful owner.

# AN EMPIRICAL ANALYSIS OF PRODUCTION AND COST EFFICIENCY AMONG FIRMS IN MALAYSIA'S PROPERTY INDUSTRY

**MUHAMMAD RIDHUAN BOS ABDULLAH**

Universiti Utara Malaysia

**DOCTOR OF PHILOSOPHY**

**UNIVERSITI UTARA MALAYSIA**

**MARCH 2026**

# AN EMPIRICAL ANALYSIS OF PRODUCTION AND COST EFFICIENCY AMONG FIRMS IN MALAYSIA'S PROPERTY INDUSTRY

**By**

**MUHAMMAD RIDHUAN BOS ABDULLAH**

Universiti Utara Malaysia

**Thesis Submitted to**
**Othman Yeop Abdullah Graduate School of Business,**
**Universiti Utara Malaysia,**
**in Fulfillment of the Requirement for the Degree of Doctor of Philosophy**

**OTHMAN YEOP ABDULLAH GRADUATE SCHOOL OF BUSINESS**
**UNIVERSITI UTARA MALAYSIA**

**PERAKUAN KERJA TESIS / DISERTASI**
*(Certification of thesis / dissertation)*

Kami, yang bertandatangan, memperakukan bahawa **Muhammad Ridhuan Bos Abdullah**
*(We, the undersigned, certify that)*

calon untuk Ijazah **Doctor of Philosophy (Industrial & Development Economics)**
*(candidate for the degree of)*

telah mengemukakan tesis / disertasi yang bertajuk:
*(has presented his/her thesis / dissertation of the following title):*

**An Empirical Analysis of Production and Cost Efficiency Among Firms in Malaysia's Property Industry**

seperti yang tercatat di muka surat tajuk dan kulit tesis / disertasi.
*(as it appears on the title page and front cover of the thesis / dissertation).*

Bahawa tesis/disertasi tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan, sebagaimana yang ditunjukkan oleh calon dalam ujian lisan yang diadakan pada:
**11 November 2025**
*(That the said thesis/dissertation is acceptable in form and content and displays a satisfactory knowledge of the field of study as demonstrated by the candidate through an oral examination held on:*
***11 November 2025**.*

| | | | |
|---|---|---|---|
| Pengerusi Viva *(Chairman for Viva)* | **Prof. Dr. Wong Woei Chyuan** | Tandatangan *(Signature)* | |
| Pemeriksa Luar *(External Examiner)* | **Prof. Dr. Dato' Dr. Azali Mohamed (UKKM)** | Tandatangan *(Signature)* | |
| Pemeriksa *Luar* *(External Examiner)* | **Prof. Dr. Mohd Azlan Shah Zaidi (UKM)** | Tandatangan *(Signature)* | |

Tarikh: **15 Mac 2026**
*(Date)*

Universiti Utara Malaysia

| | | |
|---|---|---|
| Nama Pelajar<br>(Name of Student) | : | **Muhammad Ridhuan Bos Abdullah** |
| Tajuk Tesis / Disertasi<br>*(Title of the Thesis / Dissertation)* | : | **An Empirical Analysis of Production and Cost Efficiency Among Firms in Malaysia's Property Industry** |
| Program Pengajian<br>*(Programme of Study)* | : | **Doctor of Philosophy (Industrial & Development Economics)** |
| Nama Penyelia/Penyelia-penyelia<br>*(Name of Supervisor/Supervisors)* | : | **Prof. Dr. Mohd Zaini Abd Karim** |

Tandatangan
(Signature)

Universiti Utara Malaysia

## PERMISSION TO USE

In submitting this thesis to satisfy the requirements for a postgraduate degree at Universiti Utara Malaysia (UUM), I hereby authorize the university's library to make it accessible for examination. I also grant permission for the reproduction of this thesis, either in its entirely or in part, for scholarly purposes, subject to approval by my supervisor(s) or, in their absence, by Dean of the Othman Yeop Abdullah Graduate School of Business, where my thesis or its components for financial gain is strictly prohibited without obtaining my written consent. Additionally, it is understood that proper acknowledgment of both myself and UUM must be provided in any scholarly application of the materials derived from my thesis.

Request for permission to copy or to make other use of materials in this thesis in whole or in part should be addressed to:

Dean of Othman Yeop Abdullah Graduate School of Business
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman

Universiti Utara Malaysia

## ABSTRAK

Sektor hartanah kediaman di Malaysia terus berdepan dengan peningkatan kos, ketidakseimbangan kuasa pasaran input, serta perbezaan struktur di kalangan firma. Meskipun pelbagai pembaharuan dasar dan harga telah dilaksanakan, tahap kecekapan masih tidak seimbang, sekali gus menekankan keperluan untuk meneliti pengaruh saiz, struktur, dan lokasi firma terhadap kecekapan pengeluaran dan kos dalam persekitaran pasaran yang semakin berubah. Kajian ini menilai kecekapan pengeluaran dan kos firma hartanah kediaman di Malaysia, meneliti skala ekonomi, mengkaji kesan liberalisasi tarif keluli dan simen terhadap kecekapan firma, serta menganalisis pengaruh ciri-ciri firma termasuk saiz, tumpuan pemilikan, umur, jenis penubuhan, status subsidiari, dan lokasi geografi terhadap pencapaian kecekapan. Menggunakan Analisis Sempadan Stokastik (Stochastic Frontier Analysis, SFA) dalam kerangka ketidakefisienan berubah mengikut masa oleh Battese dan Coelli (1995), kajian ini menganalisis data panel daripada 76 firma yang tersenarai di Bursa Malaysia bagi tempoh 2000 hingga 2020. Dapatan kajian menunjukkan bahawa kecekapan pengeluaran purata adalah sederhana, dengan firma-firma bersaiz besar yang beroperasi di kawasan bandar menunjukkan penyelarasan input dan keupayaan teknologi yang lebih baik. Sebaliknya, kecekapan kos adalah lebih rendah, disekat oleh ketidakefisienan peruntukan yang berterusan dalam penetapan harga input bagi buruh dan bahan binaan. Ketidakefisienan ini dikaitkan dengan amalan perolehan yang tegar serta tindak balas yang lemah terhadap isyarat pasaran input. Kebanyakan firma memperoleh manfaat daripada pulangan skala yang meningkat, manakala firma yang lebih ketara menghadapi kelebihan skala yang semakin berkurang akibat kecelaruan penyelarasan dan kerumitan organisasi. Firma perlu memperkukuh kapasiti penyerapannya, menambah baik sistem perolehan untuk mengurangkan ketidakefisienan, serta menyelaraskan operasi dengan pembaharuan peraturan yang menyokong peningkatan industri berasaskan kecekapan. Kajian ini berasaskan pendekatan teori Organisasi Industri dan Ekonomi Institusi Baharu untuk menjelaskan bagaimana struktur pasaran, kos transaksi, dan tadbir urus mempengaruhi kecekapan firma dalam sektor hartanah. Kajian ini juga mengukuhkan kesesuaian penggunaan analisis sempadan stokastik untuk mengukur perbezaan kecekapan yang berpunca daripada had skala dan kecelaruan dasar.



**Kata kunci**: Kecekapan pengeluaran, Kecekapan kos, Sempadan stokastik, Penganggaran Kemungkinan Maksimum, Skala ekonomi



Universiti Utara Malaysia

## ABSTRACT

Malaysia's residential property sector continues to face rising costs, unequal input-market power, and structural differences among firms. Despite various policy and price reforms, efficiency remains uneven, underscoring the need to examine how firm size, structure, and location influence production and cost efficiency amid evolving market conditions. This study investigates the production and cost efficiency of residential property firms in Malaysia, assesses economies of scale, evaluates the impact of steel and cement tariff liberalization on firm-level efficiency, and analyzes the effects of firm characteristics, including size, ownership concentration, age, establishment type, subsidiary status, and geographic location, on efficiency outcomes. Using Stochastic Frontier Analysis (SFA) within the time-varying inefficiency framework of Battese and Coelli (1995), the study analyzes panel data from 76 firms listed on Bursa Malaysia between 2000 and 2020. The results reveal that average production efficiency is moderate, with larger, urban-based firms demonstrating stronger input coordination and technological capabilities. In contrast, cost efficiency is notably lower, constrained by persistent allocative inefficiencies in labor and material input pricing. These inefficiencies are linked to rigid procurement practices and weak responsiveness to input-market signals. Most firms benefit from increasing returns to scale, while the most prominent firms face diminishing scale advantages due to coordination frictions and organizational complexity. Firms should strengthen absorptive capacity, improve procurement systems to reduce inefficiencies, and align operations with regulatory reforms that support efficiency and industrial upgrading. This study draws on Industrial Organization and New Institutional Economics to explain how market structure, transaction costs, and governance affect firm efficiency in the property sector. It also reinforces the use of stochastic frontier analysis to capture efficiency differences arising from scale limitations and policy-induced frictions.



**Keywords**: Production efficiency, Cost efficiency, Stochastic frontier, Maximum Likelihood Estimation, Economies of scale



Universiti Utara Malaysia

## ACKNOWLEDGMENT

In the name of Allah, the Most Gracious and Most Merciful.

"Alhamdulillah," all praise and gratitude be to Allah SWT for granting me the strength and ease to complete this dissertation. First and foremost, I would like to express my deepest gratitude to my supervisor, Professor Dr. Mohd. Zaini Abd. Karim, for his earnest guidance, invaluable advice, and patience throughout this journey. Without his enduring support, this dissertation would not have become a reality.

My sincere thanks also go to those who provided guidance in my modelling, both directly and indirectly, as well as for the meticulous work provided on technical editing. I also extend my appreciation to the OYA Graduate School of Business and the School of Economics, Finance, and Banking (SEFB) at UUM for their institutional support.

I am further indebted to the Ministry of Investment, Trade, and Industry (MITI), the Royal Malaysian Customs Department (JKDM), the Ministry of Housing and Local Government (KPKT), and all other stakeholders for their valuable data and expertise.

Finally, my deepest gratitude goes to my beloved family including my wife, my son, and my daughter. Their constant prayers (*doa*) were essential to the completion of my studies, and I will forever be indebted to them for their love and sacrifice.

Universiti Utara Malaysia

## TABLE OF CONTENT

PERMISSION TO USE ..... iv
ABSTRAK ..... v
ABSTRACT ..... vi
ACKNOWLEDGMENT ..... vii
TABLE OF CONTENT ..... viii
LIST OF TABLES ..... xiii
LIST OF FIGURES ..... xv
LIST OF ABBREVIATIONS ..... xvi
CHAPTER ONE ..... 1
1.0 Introduction ..... 1
1.1 Background of the Study ..... 1
1.1.1 The Property Industry in Malaysia ..... 4
1.1.2 Regulatory reform in Malaysia Property industry ..... 8
1.1.3 Construction and Input Prices ..... 10
1.1.4 Productivity and the Importance of Efficiency in Property Industry ..... 15
1.1.5 Liberalization in Steel and Cement Tariff ..... 21
1.2 Problem Statement ..... 24
1.3 Research Questions ..... 27
1.4 Research Objectives ..... 28
1.5 Significance of the Study ..... 29
1.6 Conclusion ..... 30
CHAPTER TWO ..... 31
2.0 Introduction ..... 31
2.1 Review of Theories Relating to Production and Cost Efficiency ..... 32
2.1.1 Theoretical Perspectives on Firm Inefficiency in Property Development ..... 32
2.1.2 Cost Efficiency and Duality Theory ..... 33
2.1.3 Industrial Organization Theory ..... 34
2.1.4 Transaction Cost Economics ..... 37
2.2 Theory of the Firm and Efficiency in the Property Sector ..... 39

Universiti Utara Malaysia

2.2.1 Cost Minimization and Efficiency ....39
2.2.2 Market Structure, Competition, and Efficiency ....41
2.2.3 Economies of Scale and Firm Growth ....42
2.3 Literature Review on Methodologies .... 43
2.3.1 Economic Efficiency ....44
2.3.2 Conceptual of Production and Cost Efficiency ....46
2.3.3 Parametric and Non-Parametric Estimation of Efficiency ....60
2.4 Empirical Justification for Modeling Firm Inefficiency .... 66
2.5 Review on Empirical Studies on Production and Cost Efficiency .... 68
2.5.1 International Evidence on Efficiency in Property and Construction Sectors ...69
2.5.2 Malaysian Studies on Property Firm Performance ....76
2.6 Empirical Evidence on Firm-Specific Determinants of Inefficiency .... 80
2.6.1 Firm Size ....81
2.6.2 Firm Age ....84
2.6.3 Ownership Concentration ....85
2.6.4 Subsidiary and Group Structure ....86
2.6.5 Establishment Types ....88
2.6.6 Location and Agglomeration Effects ....90
2.6.7 Inputs Tariff Liberalization ....93
2.8 Summary .... 98
CHAPTER THREE .... 99
3.0 Introduction .... 99
3.1 Production Efficiency Analysis .... 100
3.1.1 Conceptual Framework: Efficiency in the Property Sector ....101
3.1.2 Definitions of Technical and Cost efficiency ....105
3.1.3 Application of Dual Efficiency Framework ....106
3.2 Stochastic Frontier Production Model .... 108
3.2.1 Functional Form: Translog Production Function ....109
3.2.2 Empirical Specification ....111
3.2.3 Comparative Framework for Inefficiency Modeling ....115
3.2.4 Empirical Model Selection ....118
3.3 Property Industry Data Set .... 122

Universiti Utara Malaysia

3.3.1 Choice of Properties Input and Output....125
3.3.2 Inputs....126
3.3.3 Output....129
3.4 Correlates of Property Firms' Production Inefficiency....131
3.4.1 Research Hypotheses on Production Inefficiency....133
3.4.2 Firm Size....135
3.4.3 Location....139
3.4.4 Liberalization in Steel and Cement....148
3.4.5 Ownership Concentration....153
3.4.6 Firm Age....154
3.4.7 Subsidiary....155
3.4.8 Firm Establishment....157
3.5 Stochastic Costs Frontier....159
3.5.1 Functional Form for Translog Costs....160
3.5.2 Empirical Specification....161
3.5.3 Estimation of Cost Efficiency....164
3.6 Input and Output Specification for the Cost Model....171
3.6.1 Input Quantities....174
3.6.2 Input Prices....175
3.6.3 Output and Total Costs....176
3.7 Correlates of Property Firms' Cost Inefficiency....177
3.7.1 Research Hypotheses on Cost Inefficiency....178
3.7.2 Firm Size....180
3.7.3 Location....182
3.7.4 Steel and Cement Tariff Liberalization....184
3.7.5 Ownership Concentration....186
3.7.6 Firm Age and Nonlinear Effects on Cost Inefficiency....189
3.7.7 Subsidiary....192
3.7.8 Firm Establishment....194
3.8 Estimation of Scale Economies....196
3.9 Summary....200
CHAPTER FOUR....202

Universiti Utara Malaysia

4.0 Introduction ..... 202
4.1 Estimation of the Production Frontier and Technical Efficiency ..... 203
4.1.1 Descriptive Statistics for the Production Frontier Model ..... 204
4.1.2 Maximum Likelihood Estimates of the Translog Stochastic Production Frontier ..... 208
4.1.3 Model Performance and Diagnostic Validity ..... 220
4.1.4 Distribution of Technical Efficiency Scores ..... 226
4.2 Technical Efficiency Scores of Property Firms ..... 229
4.2.1 Firm Size and Technical Efficiency Scores ..... 231
4.2.2 Firm Age and Technical Efficiency Scores ..... 234
4.2.3 Ownership Concentration and Technical Efficiency Scores ..... 237
4.2.4 Subsidiary Structure and Technical Efficiency Scores ..... 239
4.2.5 Firm Establishment and Technical Efficiency Scores ..... 241
4.2.6 Technical Efficiency Score by Firms Size to Steel Tariff Liberalization ..... 244
4.2.7 Cement Tariff and Technical Efficiency Scores ..... 248
4.2.8 Location and Technical Efficiency Scores ..... 251
4.3 Correlates of Property Firms' Production Inefficiency ..... 254
4.3.1 Firm Size and Production Inefficiency ..... 256
4.3.2 Location and Production Inefficiency ..... 257
4.3.3 Steel Tariff and Production Inefficiency ..... 258
4.3.4 Cement Tariff and Production Inefficiency ..... 259
4.3.5 Ownership Concentration and Production Inefficiency ..... 261
4.3.6 Firm Subsidiaries and Production Inefficiency ..... 263
4.3.7 Establishment Types and Production Inefficiency ..... 264
4.3.8 Firm Age and Production Inefficiency ..... 266
4.4 Cost Frontier Model and Efficiency Estimation ..... 268
4.4.1 Descriptive Statistics for the Cost Frontier Model ..... 268
4.4.2 Maximum Likelihood Estimates of the Stochastic Cost Frontier Model ..... 271
4.4.3 Model Performance and Diagnostic Validity ..... 277
4.4.4 Distribution of Cost Efficiency Scores ..... 280
4.5 Cost Efficiency Scores of Property Firms ..... 283
4.5.1 Firm Size and Cost Efficiency Score, 2000-2020 ..... 284
4.5.2 Ownership Concentration and Cost Efficiency Score, 2000-2020 ..... 287

Universiti Utara Malaysia

4.5.3 Firm Age and Cost Efficiency Score, 2000-2020 .....289
4.5.4 Firm Subsidiaries and Cost Efficiency Score, 2000-2020 .....291
4.4.5 Establishments and Cost Efficiency Score, 2000-2020 .....293
4.5.6 Steel Tariff and Cost Efficiency Score, 2000-2020.....295
4.5.7 Cement Tariff and Cost Efficiency Score, 2000-2020 .....298
4.5.8 Location and Cost Efficiency Score, 2000-2020 .....300
4.6 Correlates of Property Firm's Cost Efficiency..... 303
4.6.1 Firm Size and Cost Inefficiency.....305
4.6.2 Location and Cost Inefficiency .....306
4.6.3 Steel Tariff and Cost Inefficiency .....307
4.6.4 Cement Tariff and Cost Inefficiency .....308
4.6.5 Ownership Concentration and Cost Inefficiency .....309
4.6.6 Firm Age and Cost Inefficiency .....310
4.6.7 Subsidiary and Cost Inefficiency .....311
4.7.8 Establishment Types and Cost Inefficiency .....312
4.7 Economies of Scale..... 313
4.8 Comparing Production and Cost Efficiency Model..... 318
4.9 Summary..... 322
CHAPTER FIVE..... 325
5.0 Introduction..... 325
5.1 Summary of Study .....326
5.2 Policy Implications .....332
5.3 Contributions.....337
5.4 Limitation.....338
5.5 Recommendation for Further Study.....339
5.6 Summary..... 339
REFERENCES..... 341
Appendices..... 355

Universiti Utara Malaysia

## LIST OF TABLES


| | | |
|---|---|---|
| Table 1.1 | Residential Trend and Pattern, Malaysia (2008-2015) | 14 |
| Table 1.2 | Revenue of Selected Developers in Malaysia, (2016-2020). | 20 |
| Table 1.3 | Economic Regulatory and Deregulatory in the Construction Sector (2008). | 23 |
| Table 2.1 | Comparison of Stochastic Frontier Approach (SFA) and Data Envelopment Analysis (DEA). | 64 |
| Table 2.2 | Summary of Selected Studies on Efficiency Analysis in the Construction and Real Estate Sector | 76 |
| Table 3.1 | Comparative Features of the BC92 and BC95 Stochastic Frontier Models | 118 |
| Table 3.2 | Definitions of Inefficiency Variables | 121 |
| Table 3.3 | Definitions of Inputs, Output and Costs | 124 |
| Table 3.4 | Variables and Expected Relationships with Production Efficiency | 134 |
| Table 3.5 | Distribution of Property Firms by Total Asset Tier (2000-2020) | 136 |
| Table 3.6 | Classification of Firm-Level Location Dominance Based on Annual Residential Project Distribution | 140 |
| Table 3.7 | Construction of Urban Dominance Factor Based on Institutional and Spatial Dimensions | 143 |
| Table 3.8 | Average Import Tariff Rates for Steel and Cement Products (2010-2020) | 150 |
| Table 3.9 | Input and Output Specification for the Stochastic Cost Frontier Model | 172 |
| Table 3.10 | Variables and Expected Relationships with Cost Inefficiency | 180 |
| Table 4.1 | Summary of Statistics for Production Efficiency Model | 205 |
| Table 4.2 | Maximum-Likelihood Estimates for Parameters of the Translog Stochastic Frontier Production Function Model | 211 |
| Table 4.3 | Likelihood Ratio Tests for Production Frontier Model Comparison and Inefficiency Specification | 221 |
| Table 4.4 | The Spearman correlation for cross section, EBC92 and EBC95 | 224 |
| Table 4.5 | Summary Statistics of Technical Efficiency Scores under BC92 and BC95 Models | 226 |
| Table 4.6 | Technical Efficiency Scores by Firm Size Tier, 2000-2020 | 232 |
| Table 4.7 | Technical Efficiency Score by Firm Age, 2000-2020 | 236 |
| Table 4.8 | Technical Efficiency Score by Ownership Concentration, 2000-2020 | 238 |
| Table 4.9 | Technical Efficiency Score by Subsidiary, 2000-2020 | 240 |
| Table 4.10 | Technical Efficiency Score by Firm Establishment, 2000-2020 | 242 |
| Table 4.11 | Technical Efficiency by Firm Size in the Pre- and Post-Steel Tariff Liberalization Periods, 2000-2020 | 244 |
| Table 4.12 | Technical Efficiency by Firm Size in the Pre- and Post-Cement Tariff Liberalization Period, 2000-2020 | 249 |
| Table 4.13 | Technical Efficiency Score by Location, 2000-2020 | 252 |

| | | |
|---|---|---|
| Table 4.14 | Summary Statistics of Variables Used in the Stochastic Frontier Cost Efficiency Model | 269 |
| Table 4.15 | Maximum Likelihood Estimates for the Translog Stochastic Cost Frontier Model | 272 |
| Table 4.16 | Cost Efficiency Scores by Firm Size Tier, 2000-2020 | 285 |
| Table 4.17 | Cost Efficiency Scores by Ownership Concentration Level, 2000-2020 | 288 |
| Table 4.18 | Cost Efficiency Scores by Firm Age Group, 2000-2020 | 290 |
| Table 4.19 | Cost Efficiency Scores by Subsidiary, 2000-2020 | 292 |
| Table 4.20 | Cost Efficiency Scores by Establishment Type, 2000-2020 | 293 |
| Table 4.21 | Cost Efficiency by Firm Size in the Pre- and Post-Steel Tariff Liberalization Periods, 2000-2020 | 296 |
| Table 4.22 | Cost Efficiency by Firm Size in the Pre-and Post-Cement Tariff Liberalization Periods, 2000-2020 | 299 |
| Table 4.23 | Cost Efficiency Scores by Location, 2000-2020 | 301 |
| Table 4.24 | Economies of Scale for Property Firms by Asset Size | 315 |
| Table 4.25 | Maximum Likelihood Estimates of Inefficiency Models from Cost and Production Frontiers | 319 |


Universiti Utara Malaysia

## LIST OF FIGURES


| | | |
|---|---|---|
| Figure 1.1 | Residential Transactions Value Trend, 2020-2024 (RM billion) | 4 |
| Figure 1.2 | Residential Property Sub-Sector Transactions, Malaysia (2004-2015) | 12 |
| Figure 2.1 | Structure, Conduct and Performance Paradigm (SCP) | 36 |
| Figure 2.2 | Technical, allocative, and overall cost efficiency | 52 |
| Figure 3.1 | Methodological Framework for Efficiency Analysis | 103 |
| Figure 3.2 | Average Total Asset of Listed Property Firms, Malaysia (2000-2020) | 138 |
| Figure 4.1 | Distribution of Mean Technical Efficiency Scores of Residential Property Firms (2000-2020) | 229 |
| Figure 4.2 | Trends in Technical Efficiency Scores by Firm Size Tier, 2000-2020 | 234 |
| Figure 4.3 | Distribution of Firm-Level Mean Cost Efficiency (2000-2020) | 281 |
| Figure 4.4 | Cost Efficiency Trends by Firm Size Tier, 2000-2020 | 286 |


Universiti Utara Malaysia

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| BIM | - | Building Information Modelling |
| BNM | - | Bank Negara Malaysia |
| CIDB | - | Construction Industry Development Board |
| CAGR | - | Compound Annual Growth Rate |
| COA | - | Certificate of Approval |
| CE | - | Cost Efficiency |
| DEA | - | Data Envelopment Analysis |
| GLC | - | Government Link Company |
| EOS | - | Economies of Scale |
| HDA | - | Housing Development Acts (Control & Licensing), 1966 |
| IBS | - | Industrialized Buildings System |
| IO | - | Industrial Organization |
| JKDM | - | Jabatan Kastam Diraja Malaysia |
| JPPH | - | Jabatan Penilaian dan Perkhidmatan Harta |
| KPKT | - | Kementerian Perumahan dan Kerajaan Tempatan |
| KRI | - | Khazanah Research Institute |
| MITI | - | Ministry of Investment, Trade and Industry |
| MLE | - | Maximum Likelihood Estimation |
| MPC | - | Malaysian Productivity Corporation |
| MSIC | - | Malaysian Standard Industrial Classiffication 2008 |
| MOF | - | Ministry of Finance |
| NAPIC | - | National Property Information Centre |
| NLC | - | National Land Code |
| PBT | - | Pihak Berkuasa Tempatan |
| PE | - | Production Efficiency |
| REHDA | - | Real Estate and Housing Developers' Association |
| SEDC | - | State Economic Development Corporations |
| SCP | - | Structure, Conduct and Performance Paradigm |
| SFA | - | Stochastic Frontier Analysis |
| TE | - | Technical Efficiency |
| TNB | - | Tenaga Nasional Bhd |
| WB | - | World Bank |
| WTO | - | World Trade Organization |

Universiti Utara Malaysia

# CHAPTER ONE

# INTRODUCTION

## 1.0 Introduction

This chapter deals with the pillars of the study. Specific topics that are covered include background of the study, problem statement, research questions, objectives of the studies, and significance of the study. The aim of this introductory chapter is to provide an overview of some of this subject material which will be tailored to the entire research.

The chapter begins in Section 1.1 by examining the background of the real estate industry in Malaysia. The structure of the industry and the significant of the industry toward Malaysian economy will be included in this part. Section 1.2 describes the problem statement and research intention. The research objectives and research questions of this study will be discussed in Section 1.3 till Section 1.4. Finally, why this study is researchable and significant to promote knowledge will be discussed in Section 1.5.

## 1.1 Background of the Study

The residential property sector operates in a highly competitive environment shaped by market forces, regulatory policies, and input cost dynamics. As both an upstream and downstream industry, it plays a vital role in the economy, linking over 120 related sectors

such as construction, manufacturing, finance, and logistics. However, its dependence on labor, equipment, and key materials like steel, cement, and timber makes it vulnerable to cost fluctuations, supply chain disruptions, and regulatory changes. According to the Real Estate and Housing Developers' Association (REHDA, 2013), the industry faces significant challenges from both supply and demand sides. Supply-side issues include rising construction costs, material price volatility, labor shortages, and compliance burdens. On the demand side, affordability concerns, interest rate hikes, and shifting consumer preferences continue to shape housing demand. Sustaining the industry requires strategic cost management, policy responsiveness, and technological innovation to improve efficiency and ensure long-term competitiveness.

Real estate accounts for nearly half of global economic wealth, highlighting its central role in financial systems and economic development. In Malaysia, the sector includes activities such as buying, selling, renting, and managing properties, as classified under the Malaysia Standard Industrial Classification (MSIC, 2008). As the economy grew, the property industry developed into a structured ecosystem supported by key institutions. These include banks and mortgage lenders, developers and builders, real estate agents, insurers, and specialized service providers such as surveyors, legal advisors, and property managers. These interdependent actors form a coordinated institutional framework that shapes market structure, facilitates resource allocation, and reinforces sectoral efficiency, stability, and long-term sustainability.

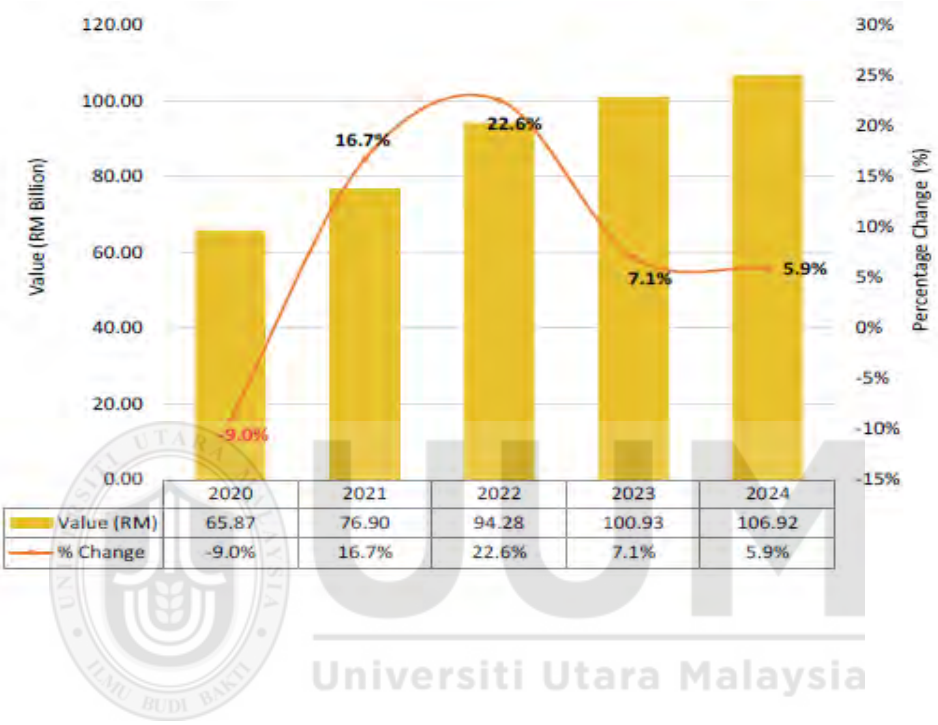
Universiti Utara Malaysia

Convincingly, the study conducted by the Economic Planning Unit of the Prime Minister's Department (EPU) demonstrated that a RM1.0 million investment in the housing sector resulted in a total multiplier effect of RM1.469 million for the whole economy in 2009 (Isa, Tan, and Nasir; 2010). Since 2010, there has been an increase in housing investments in the private sector. For instance, 2012 saw a 10.1% increase amounting to RM30.3 billion from RM15.1 billion in 2011, while investments in 2011 registered an even bigger increase of 218.9% compared to 2010 (RM4.7 billion). This surge was largely driven by the growing number of houses being built and the conducive investment climate in Malaysia (Jabatan Perumahan Negara, 2012). Malaysia's residential property market continued this upward trajectory over the years, with the total market value more than tripling from RM22 billion in 2001 to RM72 billion in 2019.

However, the COVID-19 pandemic in 2020 temporarily disrupted this momentum, leading to an 9.9% decline in total property transactions (295,968 units) and a 15.8% drop in total transaction value (RM119.08 billion) compared with 2019 (328, 647 transactions worth RM141.40 billion). The residential sub-sector recorded 191,350 transactions worth RM65.87 billion, reflecting an 8.6% decline in volume and a 9.0% drop in value compared to 2019 (209,295 transactions worth RM72.41 billion). Despite this setback, the market showed resilience in the post-pandemic period, with residential property transactions increasing by 4% to 260,516 units (2024) compared to the same period in 2023, while transaction value rose by 5.9% year-on-year to RM 106.92 billion (2023:250,586 transactions worth RM100.93 billion). This recovery underscores the housing sector's

pivotal role in Malaysia's economic growth and its continued attractiveness to private investors (Figure 1.1).

**Figure 1.1: Residential Transactions Value Trend, 2020-2024 (RM billion)**




Universiti Utara Malaysia

### 1.1.1 The Property Industry in Malaysia

The Malaysian property industry operates within a complex institutional framework involving federal ministries, state governments, and private sector developers. At the federal level, key ministries and agencies play distinct roles in housing policy, planning, financing, and development. The Kementerian Perumahan dan Kerajaan Tempatan (KPKT) oversees urban housing policies and regulations, while the Kementerian Kemajuan Desa dan Wilayah (KKDW) and Regional Development Authorities (RDA) focus on rural housing and regional growth initiatives. The Ministry of Federal Territories is responsible for property development in designated urban regions, whereas the Prime

Minister's Office (PMO), through PR1MA (Perumahan Rakyat 1Malaysia), facilitates affordable housing programs.

Financial support mechanisms are primarily managed by the Ministry of Finance (MOF), which provides housing loans through Syarikat Perumahan Negara Berhad (SPNB) and Cagamas Berhad under the My First Home Scheme (Skim Rumah Pertamaku – SRP). Additionally, the Housing Loan Division for civil servants ensures home financing accessibility for government employees. The Ministry of Agriculture (MoA) is also involved in property-related initiatives, particularly in rural housing and land development. Collectively, these entities shape the industrial organization of Malaysia's property sector, ensuring policy coordination, financial accessibility, and development planning at both national and state levels.

Leading State Economic Development Corporations (SEDCs) also play a significant role in housing programs, with key entities such as the Penang Development Corporation, Selangor State Development Corporation, and Perak State Development Corporation actively involved in property development. In line with the nation's aspirations to promote homeownership, both government policies and industry approaches to housing provision have evolved significantly in recent years, reflecting a shift towards more inclusive and sustainable housing initiatives.

Since 2011, the Malaysian government has introduced two key programmes to improve housing affordability and homeownership among middle-income (M40) groups. The *Skim*

*Rumah Pertamaku* (SRP), launched in 2011, offers 100% financing for first-time buyers under 35, with Cagamas SRP guaranteeing the first 10% of the loan (Cagamas, 2013). In 2012, the *1Malaysia People's Housing Programme* (PR1MA) was established under the PR1MA Act to develop affordable homes priced between RM100,000 and RM400,000 in urban areas. These units are allocated by ballot to households with joint monthly incomes of RM2,500 to RM7,500. Both initiatives reflect the government's effort to support urbanization and improve living standards for lower-middle and middle-income households.

The National Housing Policy 2.0 (NHP 2.0), launched on 28 January 2019, provides a strategic framework for housing development across federal, state, and local levels (KPKT, 2019). A key component is the National Affordable Housing Policy, which targets the bottom 40% (B40) households with median monthly incomes around RM3,000 by promoting access to quality, affordable homes. NHP 2.0 outlines five key focus areas, 16 strategies, and 57 action plans, 15 of which were prioritized in the first two years.

In addition, one of the policy aims is to strengthen the involvement of state governments and agencies, alongside federal bodies and private developers, in delivering affordable housing for both sale and rental. The Ministry of Housing and Local Government (KPKT) is also tasked with setting price limits for subsidized homes and regulating ownership to curb speculation. In addition, private developers are encouraged to build medium-cost housing for the middle-income group earning between RM2,500 and RM7,500 per month.

Moreover, the National Housing Policy 2.0 (NHP 2.0) highlights several structural challenges in Malaysia's real estate sector. First, rising construction costs and income disparities have intensified affordability issues. Second, a supply-demand mismatch persists, as developers often focus on high-end projects in urban centers, overlooking demand in suburban and rural areas. Third, limited adoption of technology hampers cost efficiency, labor productivity, and material optimization. Fourth, the absence of an integrated market mechanism weakens the alignment between housing supply and actual demand, resulting in resource misallocation and inefficient capital use. These issues undermine the sector's efficiency and competitiveness. Affordability gaps and supply imbalances distort the market, raise production costs, and reduce firm performance. At the same time, weak innovation and coordination hinder firms' ability to manage inputs and adapt to market changes.

Universiti Utara Malaysia

These challenges make the efficiency of Malaysia's real estate sector a valuable subject of inquiry. The persistence of affordability gaps, supply-demand imbalances, and limited innovation raises fundamental questions about how firms operate within a structurally constrained environment. Given the sector's deep linkages to over 120 industries and its influence on employment, capital markets, and national development, understanding the sources of inefficiency is not only timely but also economically significant. A closer examination of these structural issues offers the potential to uncover inefficiencies that may not be immediately visible at the macro level, providing a richer understanding of how policy, market structure, and firm behavior interact in shaping sectoral performance.

### 1.1.2 Regulatory reform in Malaysia Property industry

In the context of industrial organization, regulatory reform involves modifying government controls over pricing, output, and market entry to improve economic performance. In Malaysia's property sector, regulation has historically played a central role in shaping firm behavior and market dynamics. Both market forces and administrative policies influence how firms allocate resources, compete, and adjust to changing economic conditions. These regulatory frameworks are critical in determining the sector's allocative and productive efficiency.

Efforts to strengthen Malaysia's regulatory framework were initiated under the 10th Malaysia Plan (RMK-10, 2011-2015), which emphasized streamlining regulations, reducing compliance costs, and improving economic efficiency. The Malaysia Productivity Corporation (MPC) was tasked with a Comprehensive Review of Regulations to identify redundant rules, lower business costs, and enhance competitiveness. This included evaluating both existing and proposed regulations through economic impact assessments.

The Ministry of Investment, Trade and Industry (MITI) supported these reforms by advancing trade liberalization, investment facilitation, and deregulation to attract private investment and foreign direct investment (FDI). A key institutional milestone was the introduction of the National Policy on the Development and Implementation of Regulations (NPDIR), which mandated Regulatory Impact Assessments (RIA) to ensure evidence-based, cost-effective policymaking.

Universiti Utara Malaysia

These regulatory reforms aimed to create a more predictable and transparent business environment, directly contributing to cost efficiency across sectors including property development by reducing bureaucratic hurdles, compliance burdens, and transaction costs. Recognizing the need for broader impact, the 11th Malaysia Plan (RMK-11, 2016-2020) extended these efforts to the state and local levels, positioning regulatory reform as a driver of productivity, inclusive growth, and long-term economic sustainability.

In Malaysia's property sector, regulatory frameworks and policy interventions significantly influence cost efficiency, production efficiency, and overall market performance. Policies such as tariff liberalization on steel and cement, financial regulations, and housing incentives directly shape input costs, firm competitiveness, and project viability. While these measures are designed to improve efficiency, their actual impact on sustainable productivity gains remains uncertain.

Universiti Utara Malaysia

The sector continues to face structural challenges, including limited technological adoption, labor-intensive practices, and vulnerability to external shocks all of which constrain efficiency optimization. A more integrated approach that aligns regulatory oversight with market incentives and technological progress is crucial to enhancing sectoral resilience, cost control, and affordability. Empirical research remains essential to assess how these policy shifts affect firm-level efficiency across cost structures, production processes, and housing market stability.

### 1.1.3 Construction and Input Prices

More than a decade after the 2008/09 global recession, Malaysia's construction and property development sector continues to grapple with rising input costs, posing persistent challenges to both cost and production efficiency in residential housing delivery. Escalating prices of key materials such as steel, cement, and timber undermine developers' ability to control costs, sustain profit margins, and ensure housing affordability.

According to the Real Estate and Housing Developers' Association (REHDA), five key components determine housing costs: land acquisition, construction costs, compliance costs, capital contributions, and financing and profit margins. Representing over 80% of active developers nationwide, REHDA members have contributed to the delivery of more than four million housing units. Meanwhile, property market activity peaked in 2011 and 2012, with total transactions reaching 430,403 and 427,520 units respectively (NAPIC).

Universiti Utara Malaysia

Government-led supply-side policies have influenced developers to adopt new strategies in product design and pricing. However, rising input prices continue to strain efficiency, underscoring the need for innovation in procurement, construction methods, and project planning to maintain affordability and competitiveness.

Therefore, the performance of Malaysia's real estate sector is highly sensitive to economic cycles and input cost fluctuations, particularly in building materials such as iron and steel. Past crises such as the 1997/98 Asian Financial Crisis and the 2008/09 Global Recession highlight how macroeconomic shocks and volatile input prices affect transaction volumes,

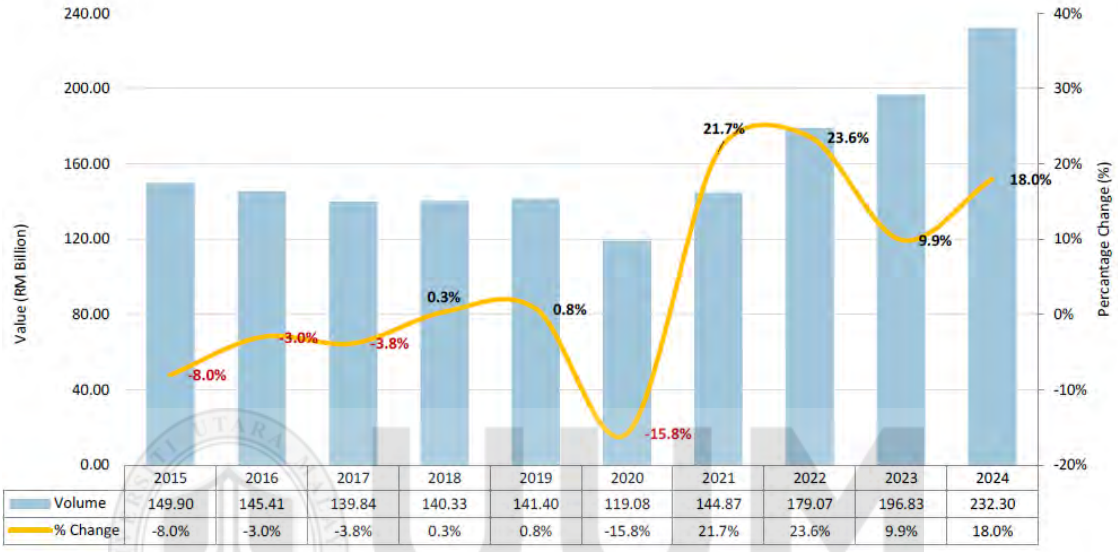
property values, and development activity. These disruptions not only influence market dynamics but also impact cost and production efficiency, as developers are forced to adjust supply, manage financial constraints, and optimize resource use.

The link between input prices and housing affordability is central to understanding cost efficiency in the sector. While the 2008 tariff liberalization on steel and cement aimed to reduce material costs, its effectiveness remains limited due to persistent global price volatility. At the same time, the industry's reliance on labor-intensive methods and slow adoption of technology continues to constrain productivity and inflate production costs. Although some developers have explored cost-saving strategies such as modular construction and alternative materials, broader adoption has been hindered by high initial costs and regulatory challenges. These structural frictions between policy, market inefficiencies, and input volatility highlight the need for further empirical investigation into how cost dynamics shape firm-level efficiency and sectoral sustainability.

Over the past decade, residential property prices have exhibited a sustained upward trajectory, contributing to increased transaction values. For instance, between 2015-2024 (Figure 1.2), property prices experienced a consistent appreciation, leading to a substantial rise in transaction values. According to data from the National Property Information Centre (NAPIC), the proportion of transacted properties priced at RM500,000 and above more than doubled, increasing from 31.74% in 2008 to 57.16% in 2014. This shift reflects a structural transformation in market dynamics, with a growing concentration of

transactions in higher price segments, potentially exacerbating affordability challenges for middle-income households.

**Figure 1.2: Residential Property Sub-Sector Transactions, Malaysia (2015-2024)**




| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume | 149.90 | 145.41 | 139.84 | 140.33 | 141.40 | 119.08 | 144.87 | 179.07 | 196.83 | 232.30 |
| % Change | -8.0% | -3.0% | -3.8% | 0.3% | 0.8% | -15.8% | 21.7% | 23.6% | 9.9% | 18.0% |

Universiti Utara Malaysia

As a results, from 20015 to 2018, Malaysia's property market experienced significant shifts, influenced by policy interventions, economic conditions, and evolving buyer preferences. The Global Recession (2008-2009) initially led to a slight contraction in property transactions, but market activity rebounded with the introduction of the interest-bearing scheme (2009-2013), which encouraged purchases through easy financing. This led to a notable increase in transactions, particularly in the RM200,000-RM500,000 segment, which peaked in 2014 at 41.29% of total transactions. The data shows (Table 1.1), the high-end property market (RM500,000 and above) expanded, capturing a growing share of total market value, from 31.74% in 2008 to 57.16% in 2014. This

suggests that financing accessibility and rising incomes may have fuelled higher-end property demand, contributing to price appreciation and market expansion.

In addition, the ban on the interest-bearing scheme (2014) marked a turning point, leading to a decline in both transaction volume and total value by 2015, indicating that the market had become heavily reliant on easy financing. The affordability of mid-range properties also became a concern, as transactions in the RM200,000-RM500,000 category declined from 41.29% in 2014 to 32.96% in 2015.

UUM
Universiti Utara Malaysia

**Table 1.1: Residential Trend and Pattern, Malaysia (2008-2015).**

| **VOLUME** | **Global Financial Crisis** | | **Start of interest-bearing scheme** | | | | | | | | | | **Interest bearing scheme banned** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | | 2009 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | |
| **Price range** | **Units** | **%** | **Units** | **%** | **Units** | **%** | **Units** | **%** | **Units** | **%** | **Units** | **%** | **Units** | **%** | **Units** | **%** |
| **RM200,000 to RM500,000** | 42,747 | 19.73 | 45,187 | 21.35 | 51,589 | 22.74 | 67,035 | 24.84 | 71,771 | 26.32 | 91,123 | 37.0 | 102,081 | 41.29 | 77,786 | 32.96 |
| **RM500,000 and above** | 11,267 | 5.2 | 12,122 | 5.73 | 16,782 | 7.4 | 21,905 | 8.12 | 26,486 | 9.71 | 31,857 | 12.94 | 38,595 | 15.61 | 34,504 | 14.62 |
| **Total transactions** | 216,703 | | 211,600 | | 226,874 | | 269,789 | | 272,669 | | 246,225 | | 247,251 | | 235,967 | |
| **VALUE** | | | | | | | | | | | | | | | | |
| | 2008 | | 2009 | | 2010 | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | |
| **Price range** | **RM bil** | **%** | **RM bil** | **%** | **RM bil** | **%** | **RM bil** | **%** | **RM bil** | **%** | **RM bil** | **%** | **RM bil** | **%** | **RM bil** | **%** |
| **RM200,000 to RM500,000** | 12.74 | 30.81 | 13.63 | 32.58 | 15.83 | 31.26 | 20.46 | 33.09 | 22.20 | 32.75 | 26.13 | 36.27 | 29.88 | 36.42 | 25.26 | 34.38 |
| **RM500,000 and above** | 13.11 | 31.74 | 13.45 | 32.13 | 19.67 | 38.83 | 23.82 | 38.52 | 28.63 | 42.24 | 34.40 | 47.74 | 42.00 | 57.16 | 35.91 | 48.88 |
| **Total value** | 41.30 | | 41.85 | | 50.65 | | 61.83 | | 67.76 | | 72.06 | | 82.06 | | 73.47 | |

Source: NAPIC, Ridhuan (adopted), 2016

Universiti Utara Malaysia

### 1.1.4 Productivity and the Importance of Efficiency in Property Industry

Malaysia's property sector remains reliant on labor-intensive construction methods, with limited adoption of advanced technologies (Productivity Report, 2024). Since the 2008/09 Global Recession, developers have faced persistent challenges, including rising steel prices, labor shortages, and dependence on low-skilled workers factors that continue to constrain productivity and efficiency, while exposing firms to cost volatility and external shocks.

From an economic perspective, productivity gains and cost efficiency are closely linked to economies of scale, where average production costs decline as output increases. However, empirical studies (Somerville, 1999) show that residential construction trends influence macroeconomic outcomes and housing prices in ways that often diverge from theory. While rising construction costs should, in principle, dampen new housing supply, real-world data suggest that house and land prices tend to rise alongside these costs. These deviations point to the role of non-cost factors such as regulatory barriers, speculative behavior, and supply chain inefficiencies in shaping market outcomes. Understanding these dynamics is essential for improving efficiency, guiding policy reform, and addressing housing affordability in a more targeted and sustainable manner.

In principle, housing starts (output) should decline with increases in construction costs (input costs). However, empirical findings indicate that house prices rise alongside construction costs, and contrary to theoretical predictions, land prices also tend to increase. This suggests that additional factors, such as regulatory constraints, speculative

Universiti Utara Malaysia

investment, and supply chain inefficiencies, may be influencing housing market dynamics beyond basic supply and demand mechanisms. Understanding these deviations from theory is crucial for designing effective policies that enhance housing affordability and market efficiency.

Land governance in Malaysia is shaped by a complex framework of state planning systems, laws, policies, regulations, and both formal and informal conventions. The primary legislative framework in Peninsular Malaysia is the National Land Code 1965 (NLC), which establishes a unified system of land ownership, registration, and dealings based on the Torrens system[1]. However, land matters fall under state jurisdiction as stipulated in the Federal Constitution, granting state governments exclusive authority over land alienation, subdivision, and conversion. The federal government has no legal standing to override state-level land decisions, resulting in significant variation in land-use policies and regulatory practices across states.

Universiti Utara Malaysia

Importantly, Sabah and Sarawak are not governed by the National Land Code. Instead, they operate under their own respective legal frameworks the Sabah Land Ordinance (Chapter 68, 1930) and the Sarawak Land Code (1958), which reflect their special constitutional status and autonomy over land matters. These state-specific codes recognize customary land rights and native titles to a greater extent and include administrative procedures distinct from those in Peninsular Malaysia. This legal

[1] The Torrens system, adopted under Malaysia's National Land Code 1965, is a land registration system where the government-issued title is conclusive proof of ownership. It streamlines land transactions, reduces legal disputes, and enhances transparency in property dealings.

differentiation further underscores the fragmented nature of land governance in the country.

However, planning and housing matters are allocated within the Concurrent List of the Federal Constitution, meaning they are shared responsibilities between the federal and state governments. While states retain control over land administration, the federal government plays a crucial role in shaping national housing policies and urban development frameworks. The coordination between these two levels of government presents both opportunities and challenges in achieving coherent and effective land and housing policies, particularly in addressing affordability and ensuring efficient land use.

Compliance costs are also closely tied to local authorities' planning requirements, which encompass regulations on density versus plot ratio, development charges, and other planning specifications. Developers with agricultural land backgrounds may have lower initial land costs, around 10% of total project costs, whereas others may face costs of up to 20%. Since land is under state jurisdiction, the compliance costs imposed by state authorities contribute to high land prices. Furthermore, corporatized utility companies such as Tenaga Nasional Bhd (TNB), water concessionaires, Indah Water, Telekom, and the Construction Industry Development Board (CIDB) shift capital expenditure costs onto developers, who in turn pass these costs to homebuyers, exacerbating affordability concerns.

Universiti Utara Malaysia

Recent research undertaken by CIDB in 2012 found that construction costs are primarily driven by three major resources: construction materials (65%), construction labor (33%), and machinery and equipment (3%), with overheads and profit margins accounting for 13%. These findings underscore the significance of material costs in determining overall construction expenses. Additionally, CIDB's reports provide a complementary review of the challenges faced by Malaysia's construction industry and the approaches taken to address them. Under the authority of the relevant eight functions outlined in Act 520 Section 4(1), CIDB has implemented measures to meet the construction sector's resource requirements. These measures prioritize the allocation of construction materials, labor, and machinery according to their contribution to total construction costs, thereby ensuring resource efficiency and cost control within the industry.

As a result, large-scale private firms have dominated the sector, with certification and regulation overseen by the Construction Industry Development Board (CIDB). These firms are subject to various regulatory frameworks, including compliance with CIDB's certification requirements, which influence market entry and operational efficiency. Understanding the production and cost efficiencies of these developers is crucial for assessing their ability to supply affordable housing in a market characterized by rising land and construction costs.

The expansion of private-sector housing delivery has been largely facilitated by the rising number of housing developers, which currently stands at approximately 19,471 (DOSM, Economic Survey, 2023). This increasing number of players has intensified competition

within the industry, compelling firms to innovate and enhance efficiency to maintain their market position. Developers unable to sustain profitability and operational viability are forced to exit the industry, often replaced by new entrants attracted by the potential for high returns (A. Abdul-Aziz et al., 2007).

Table 1.2 reports the Compound Annual Growth Rate (CAGR) in revenue for listed residential property firms in Malaysia between 2016 and 2020. The observed variation in growth rates across firms underscores the structural heterogeneity of the industry. From an economic perspective, these differences reflect not only the cyclical nature of housing demand but also firm-level asymmetries in capital access, scale, and integration strategies. For example, developers such as SP Setia and Malton recorded double-digit CAGR, indicative of stronger market positioning and the ability to leverage scale economies and diversified project portfolios. Therefore, firms like Paramount, CHHB, and DUTA experienced sharp revenue contractions, suggesting higher cost burdens, exposure to weaker submarkets, or reduced financial flexibility.

Universiti Utara Malaysia

Table 1.2: Revenue of Selected Developers in Malaysia, (2016-2020).

| **Developers** | **Revenue (RM million)** | | | | | **CAGR (2016-2020)** |
|---|---|---|---|---|---|---|
| | 2016 | 2017 | 2018 | 2019 | 2020 | |
| E&O | 422183 | 704764 | 982706 | 886320 | 486802 | 3.62 |
| Talam | 360836 | 282099 | 179302 | 148563 | 131870 | -22.25 |
| OSK | 1,305 | 1,169 | 1,204 | 1,208 | 1,086 | -4.49 |
| EcoWorld | 212621 | 227942 | 250112 | 229622 | 184953 | -3.41 |
| Mahsin | 137619 | 155872 | 227352 | 244235 | 288089 | 20.3 |
| Tropicana | 741864 | 820193 | 887009 | 903906 | 106257 1 | 9.4 |
| IGB | 195802 8 | 192011 7 | 206944 9 | 194867 5 | 197439 3 | 0.21 |
| UEM Sunrise | 431961 | 363325 | 445552 | 484585 | 496025 | 3.52 |
| Sunway | 188075 4 | 205111 0 | 185709 4 | 274916 5 | 306215 0 | 13 |
| SPSetia | 271508 | 425120 | 524328 | 719096 | 775206 | 30 |
| DUTA | 933720 | 338900 | 340212 | 350332 | 369436 | -20.7 |
| Glomac | 53378 | 51002 | 50830 | 47426 | 53516 | 0.1 |
| YNH | 182983 | 169744 | 162070 | 199809 | 263126 | 9.51 |
| Paramount | 436186 | 624924 | 682552 | 63159 | 61158 | -38.81 |
| KSL | 14837 | 14689 | 15395 | 14778 | 17242 | 3.83 |
| MKH | 541282 | 495022 | 436254 | 447612 | 427135 | -5.75 |
| Malton | 9560 | 12339 | 15230 | 40189 | 47622 | 49.4 |
| CHeight | 669604 | 684909 | 786022 | 880390 | 36579 | -51.65 |
| MKLD | 195619 | 188298 | 177560 | 177574 | 172668 | -3.07 |
| ENCOR | 6878 | 6258 | 5623 | 26354 | 13411 | 18.17 |
| LBS | 266433 | 273614 | 399100 | 437784 | 473911 | 15.5 |
| Gouco | 336524 | 523832 | 375520 | 349175 | 338038 | 0.11 |

Source: Companies' Annual Reports & Bloomberg, 2016-2021

The variation in firm growth aligns with Industrial Organization theory, which emphasizes how performance is shaped by cost structures and strategic conduct. Despite all firms being publicly listed and operating under similar regulatory conditions, the sector remains segmented by differences in average costs, input procurement efficiency, and vertical integration. As such, Table 1.2 captures more than revenue trends it reflects

underlying structural dynamics that influence competition and the sustainability of firm growth within Malaysia's residential property market.

### 1.1.5 Liberalization in Steel and Cement Tariff

Sudden and unexpected increases in construction material prices can significantly impact the implementation of construction projects, particularly during the construction phase. To stabilize material prices, Malaysia has implemented various measures, including price controls on steel bars and cement under the Price Control Act 1946. However, the government's approach in stabilizing the prices of steel and cement price through this approach was ineffective as both materials continued to be sold above the ceiling price resulting in the industry requesting for the steel and cement market to be fully liberalized to allow prices to be determined by market forces.

Universiti Utara Malaysia

In response, the government removed price controls on steel in May 2008 and cement in June 2008, followed by liberalization measures (CIDB, Table 1.3). The first stage involved exempting steel imports from duties and approved permits, provided they met recognized quality standards. For cement, import duties were reduced from 50% to 10% for non-ASEAN countries, while the 5% duty for ASEAN imports remained unchanged. The second stage of liberalization began in November 2008, when full import duty exemptions were extended to all importers of steel and cement. The scope of liberalized steel products expanded significantly from 3 to 57 Customs Tariff Code items, of which

15 were directly related to construction. To ensure quality control, importation remained subject to CIDB's Certificate of Approval.

These reforms were introduced to stabilize material prices, enhance competition, and reduce construction costs. Prior to liberalization, price ceilings and high import duties restricted market flexibility, contributing to supply shortages and price volatility. The government removed ceiling prices on key materials such as steel bars, billets, and cement while cutting cement import duties from 50% to 10% for non-ASEAN countries and maintaining a 5% rate for ASEAN imports. In parallel, Approval Permit (AP) requirements were lifted, allowing freer imports of long steel products and cement particularly benefiting Sabah and Sarawak, which had faced higher transport and material costs. The reforms also extended to public sector procurement through updates to the Variation of Price (VOP) scheme, which expanded the list of eligible materials and applied a 50:50 cost-sharing model to design-and-build contracts.

Universiti Utara Malaysia

Table 1.3: Economic Regulatory and Deregulatory in the Construction Sector (2008).

| | |
|---|---|
| **Liberalisation in steel industry**<br><br>**12 May 2008** | • Abolishment of ceiling prices on steel bars and billets<br>• Allow import of long steel products without the requirement of an AP (Approval Permit) and abolishment of import duty for steel bars under the HS Code 7214.10910 and 7214.20910 |
| **Liberalisation in cement industry**<br><br>**5 June 2008** | • Abolishment on ceiling price of cement<br>• Import duty reduced to 10% from 50% in non-Asean countries<br>• The liberalization is effective on the following cement only;<br>- HS 2523 29 900 (ordinary Portland cement); and<br>- HS 2523 90 000 (hydraulic cement).<br>Cement importers in Sabah and Sarawak are excluded from obtaining license (Approval Permit) to import |
| **Adjustment to the Variation of Price (VOP) Clause Specifications**<br><br>**August 2008** | • Expanded to include design and build projects on 50:50 cost sharing basis<br>• The materials that come under VOP scheme can be categorized under:<br>1) Civil works- 11 items from the previous 5 items<br>2) Buildings Works – 15 items<br>3) Mechanical and Electrical works – 7 items<br>The ruling is applicable for Government projects implemented after 1 January 2008, including design and build projects on 50:50 cost sharing basis |
| **First Stimulus Package**<br><br>**4 November 2008** | • 10 % import duty on cement abolished<br>• Import duty of another 54 HS Codes for long steel products abolished<br>• All imports must comply with Malaysian Standards (MS) or recognized International Standards if MS is not available |

Universiti Utara Malaysia

## 1.2 Problem Statement

Despite the growing importance of the residential property sector in Malaysia's development agenda, the internal efficiency of property firms has received limited analytical attention. Most assessments have concentrated on macroeconomic conditions, affordability gaps, or institutional constraints, with relatively little focus on how firms manage inputs, coordinate production processes, and contain cost structures. Yet in an environment marked by escalating land prices, volatile input costs, and heightened affordability pressures, firm-level efficiency is increasingly central to sustainable housing delivery. In particular, understanding how effectively developers convert labor, capital, and materials into built output and whether this occurs at minimum cost is critical for evaluating the sector's capacity to respond to market and policy expectations. As developers operate under greater liberalization and competitive pressure, internal inefficiencies in production and cost allocation may represent a more binding constraint than external market conditions alone.

Universiti Utara Malaysia

From the perspective of industrial organization theory, firm efficiency in the property sector is shaped by underlying market structure, firm behavior, and regulatory influences. The industry's high fixed costs, capital-intensive operations, and project-based production cycles imply that achieving scale is essential for cost minimization and long-term viability. However, regulatory constraints including density limits, open space requirements, and impact fees particularly in high-demand urban regions such as the Klang Valley, Johor Bahru, and Penang, often restrict project scale and increase

compliance costs. These structural limitations reduce housing supply elasticity, reinforce price pressures, and deter the development of lower-margin affordable units. More importantly, such constraints may prevent firms from exploiting available economies of scale, leading to suboptimal cost structures and inefficient resource allocation across the sector.

Compounding these structural challenges, the 2008-09 Global Recession led to a sharp escalation in input prices, particularly for steel and cement, as global supply shocks disrupted material flows. In Malaysia, steel prices surged by 103% and cement prices by 35%, significantly increasing cost pressures across the development pipeline. In response, the government liberalized tariffs on key construction materials to enhance input market flexibility and stabilize prices. However, the actual impact of these liberalization measures on firm-level efficiency remains empirically inconclusive, particularly in a sector marked by heterogeneous firm capabilities and regulatory fragmentation. While steel and cement are critical components of residential construction, broader input categories including land, labor, and capital as well as localized planning constraints, continue to shape firms' production choices and cost structures, potentially moderating the intended gains from input market reforms.

At the firm level, Khazanah Research Institute notes that inefficiencies in Malaysia's housing sector are structural rather than merely welfare-driven, rooted in a fragmented and unresponsive supply system. Despite rising input costs, many large developers

continue to retain healthy profit margins through cross-subsidization, indicating deeper weaknesses in how firms organize resources and manage cost pressures. Understanding these disparities requires attention to firm structure: size, ownership concentration, age, establishment type, subsidiary involvement, and location each shape a developer's capacity to coordinate inputs, manage capital intensity, and navigate regulatory settings. Positioning efficiency outcomes within these structural features clarifies why inefficiency persists even after liberalization and amid sustained profitability among leading firms.

Building on these organizational asymmetries, an Industrial Organization perspective highlights a central mechanism underpinning inefficiency: how firm size conditions the realisation of economies of scale. Although developers vary widely in scale, many are unable to translate size into proportionate cost advantages due to rigidities in upstream supply networks, inconsistencies in input coordination systems, and uneven managerial or operational capacities. Larger developers may experience coordination burdens and multi-layered decision structures that dilute potential scale efficiencies, while medium-sized listed firms often operate below the minimum efficient scale required to internalise procurement and project-management advantages. These size-related frictions undermine the sector's ability to secure cost reductions through scale, generating systematic variation in efficiency. As such, inefficiency reflects structural and organisational asymmetries that influence how firms appropriate scale, coordinate inputs, and adjust their cost structures in response to shocks.

Universiti Utara Malaysia

In economic theory, these concerns correspond to both technical inefficiencies, where firms consume more inputs than necessary for a given output, and allocative inefficiency, where inputs are misused relative to their prices. In environments marked by regulatory distortions, supply-chain frictions, and imperfectly competitive input markets, firms may operate inside the cost-minimizing frontier, leading to avoidable cost escalation. Given these interrelated challenges, a comprehensive empirical assessment is needed to evaluate the magnitude and sources of inefficiency in Malaysia's property development sector. This study responds to that need by estimating firm-level production and cost efficiency over a twenty-year period, accounting for policy shifts (tariff liberalization), firm characteristics (size, ownership, subsidiary structure), and broader structural constraints that shape firm performance.

Universiti Utara Malaysia

## 1.3 Research Questions

This study is guided by the following key research questions:

1. To what extent are Malaysian property companies achieving cost and production efficiency?

2. Do economies of scale prevail in Malaysia's residential property industry, and how do they vary across firm size?

3. What is the impact of steel and cement tariff liberalization on the efficiency of property developers in Malaysia?

4. How do firm-specific structural characteristics such as size, ownership concentration, establishment type, and subsidiary status influence efficiency outcomes among property developers?

## 1.4 Research Objectives

The general objective of this study is to empirically examine the efficiency and economies of scale of residential property firms in Malaysia. In particular, the study applies a stochastic frontier framework to evaluate how internal firm characteristics and external policy changes influence cost and production efficiency across the industry. The specific objectives are:

1. To estimate the production efficiency and cost efficiency of residential property firms in Malaysia using firm-level panel data.
2. To assess the presence and extent of economies of scale in the Malaysian property sector.
3. To examine whether the liberalization of steel and cement tariffs has significantly affected firm-level efficiency.
4. To analyze how firm structure including size, ownership concentration, age, establishment type, subsidiary status, and geographic location affects production and cost efficiency.

Universiti Utara Malaysia

## 1.5 Significance of the Study

This study contributes to the literature by providing empirical insights into production and cost efficiency in the property sector, particularly in the context of market liberalization, economies of scale, and firm structure. It expands the use of stochastic frontier analysis (SFA) to assess firm-level efficiency in a liberalized market environment, filling a gap in existing research on efficiency measurement in property development.

From a policy perspective, the findings of this study offer practical insights for government agencies in designing strategies to improve production efficiency, reduce development costs, and strengthen housing affordability. The analysis provides empirical evidence on how policy reforms, input market liberalization, and firm-level economies of scale influence efficiency outcomes across the sector. The results also support the formulation of targeted interventions that enhance firm-level absorptive capacity, promote scale-appropriate strategies, and address structural inefficiencies particularly in relation to input market reforms and institutional support thereby fostering sustainable growth across different tiers of housing developers and ensuring a more balanced distribution of housing supply.

Therefore, for real estate firms and property developers, the study identifies key efficiency benchmarks and cost-saving strategies, allowing firms to recognize performance gaps and enhance resource allocation. Additionally, it provides insights into how firm structure and

Universiti Utara Malaysia

competitive positioning impact operational efficiency, offering practical strategies for long-term sustainability and industry competitiveness.

## 1.6 Conclusion

This study investigates the efficiency and economies of scale of Malaysian property firms, focusing on how firm characteristics and input market reforms influence performance. The efficiency of these firms is critical to sustaining cost competitiveness, particularly in a policy environment shaped by tariff liberalization on steel and cement. While theory suggests that lower input costs should enhance production and cost efficiency, empirical validation is necessary to understand how firms respond to these changes in practice.

The subsequent chapters are structured to address these objectives systematically. Chapter Two reviews the theoretical and empirical literature on firm efficiency, economies of scale, and policy interventions in the property and construction sector. Chapter Three outlines the methodological approach, including the application of the stochastic frontier framework. Chapter Four presents the empirical findings on production and cost efficiency, economies of scale, and the role of firm-specific factors such as size, ownership, location, and age. Finally, Chapter Five interprets these results considering industrial organization theory and provides policy recommendations for enhancing firm-level performance in the Malaysian property sector.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Introduction

The previous chapter discussed the significance of the real estate industry in the Malaysian economy and its contribution to economic development. This chapter provides a comprehensive literature review, structured into two key sections.

The first section reviews the theory relates to this study. It introduces the theory of the firm, which explains firms' behaviour in response to market conditions, and the theory of efficiency frontier, which serves as the foundation for evaluating property companies' efficiency using Stochastic Frontier Analysis (SFA). This section establishes the conceptual basis for analysing efficiency in the property sector.

The second section reviews empirical studies on efficiency in the property industry, with a structured comparison between Malaysian and international contexts. It examines key determinants of efficiency, variations in market structure, and firm performance across different settings.

Universiti Utara Malaysia

## 2.1 Review of Theories Relating to Production and Cost Efficiency

This section review theories relating to foundation for this study, providing the necessary conceptual and analytical structure to assess efficiency dynamics in the property sector. Incorporating insights from multiple economic theories, this framework provides a well-rounded perspective on how firms respond to market changes, regulatory constraints, and efficiency-related factors.

### 2.1.1 Theoretical Perspectives on Firm Inefficiency in Property Development

The X-efficiency theory, introduced by Leibenstein (1966), posits that firms may not always operate at their optimal efficiency due to factors such as agency problems, diseconomies of scope, and regulatory constraints. In the property industry, inefficiencies may arise from ownership concentration, subsidiary structures, firm establishment, and firm age, all of which influence a firm's ability to adapt to market liberalization, optimize cost structures, and enhance operational efficiency. Regulatory burdens, including compliance requirements and administrative constraints, can further affect firms' decision-making processes and resource allocation, thereby shaping their efficiency levels.

Additionally, firm-specific characteristics such as asset size, geographic location (urban vs. suburban), and exposure to tariff liberalization in steel and cement play a crucial role in determining efficiency. Larger firms may benefit from economies of scale, yet they

may also face regulatory inefficiencies or coordination challenges across subsidiaries. Location dynamics significantly impact efficiency due to variations in construction costs, labor availability, and demand conditions between urban and suburban areas. Meanwhile, tariff reductions on steel and cement introduce cost variability, necessitating firms to develop adaptive strategies to mitigate input price fluctuations and maintain a competitive market position.

### 2.1.2 Cost Efficiency and Duality Theory

The theory of cost efficiency, grounded in duality theory, was originally introduced by Shephard (1953, 1970) and later expanded by Diewert (1974). This framework posits that firms seek to minimize costs given their input prices and output levels, aligning their production decisions with cost-minimization behavior. However, in real-world settings, various constraints market imperfections, policy interventions, and firm-specific inefficiencies can prevent firms from achieving full cost efficiency.

Therefore, a significant advancement in cost efficiency analysis is Diewert's (1974) development of flexible functional forms, particularly the Translog cost function, which provides a more adaptable and realistic representation of firm behavior. Unlike restrictive functional forms (Cobb-Douglas), the Translog model enables input substitution and nonlinear interactions, making it particularly suitable for industries like the property sector, where firms operate under dynamic cost structures influenced by regulatory changes and material price fluctuations.

The theoretical contributions of Shephard (1953, 1970) and Diewert (1974) have had a lasting impact on the development of cost efficiency analysis in empirical research. Their duality-based framework laid the groundwork for connecting production and cost functions, enabling researchers to estimate inefficiency not just through output maximization, but also through cost minimization given observable prices and outputs. Diewert's introduction of the Translog cost function marked a significant evolution in empirical modeling by offering a flexible functional form that accommodates nonlinear input relationships and substitution effects. This advancement has been widely adopted in applied studies, particularly those using Stochastic Frontier Analysis (SFA) to evaluate firm behavior under price volatility, policy reform, and market uncertainty.

### 2.1.3 Industrial Organization Theory

The Structure-Conduct-Performance (SCP) paradigm, a fundamental aspect of Industrial Organization Theory, suggests that market structure plays a crucial role in shaping firm behavior, which in turn influences performance and efficiency (Bain, 1956). This framework emphasizes that market concentration, competition levels, and firm size significantly impact firms' strategic decisions, affecting their ability to operate efficiently. In a liberalized market, the degree of competition and firm dominance determines how effectively firms respond to cost reductions, technological changes, and resource allocation.

Universiti Utara Malaysia

In the context of the Malaysian property sector, market competition, regulatory constraints, and industry consolidation significantly affect efficiency dynamics. Highly concentrated markets with dominant firms may lead to inefficiencies due to reduced competitive pressure, while a competitive market structure fosters cost minimization, productivity enhancement, and operational efficiency. Moreover, regulatory and institutional factors, such as land acquisition policies, government incentives, and financial regulations, further shape firms' strategic conduct and efficiency potential.

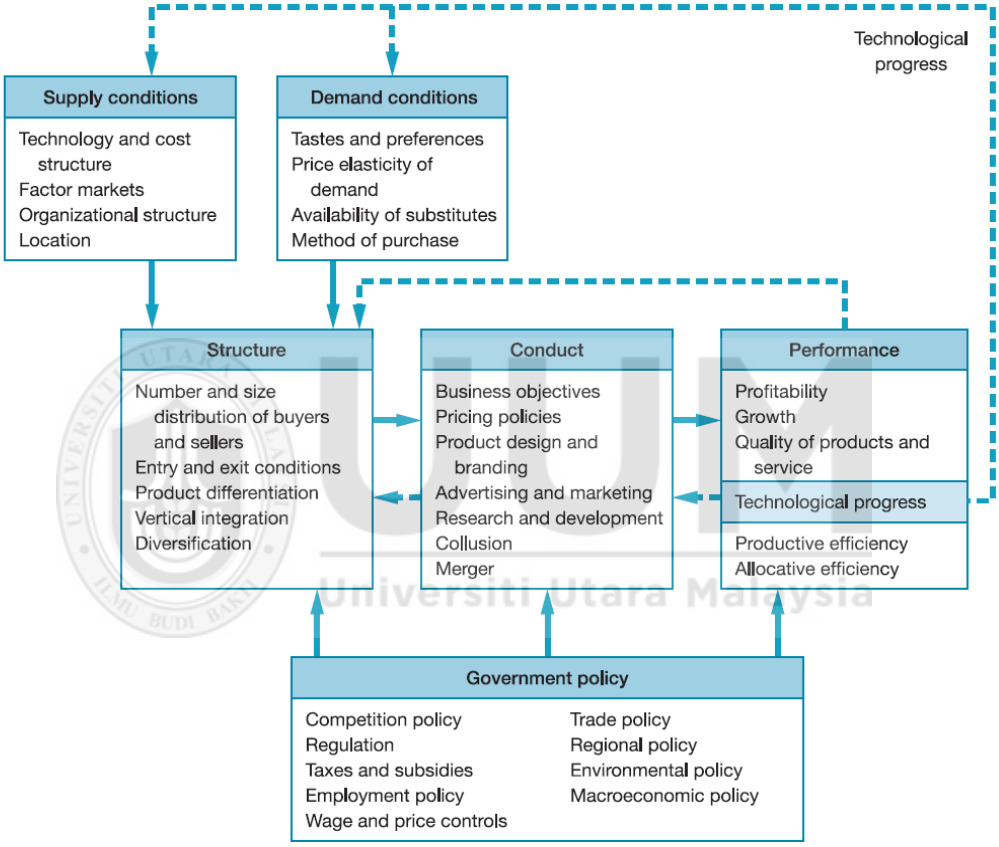
Figure 2.1 illustrates the framework of the Structure-Conduct-Performance (SCP) paradigm, which explains the relationship between market structure, firm behavior, and economic performance[2]. This framework illustrates how market structure including the number of buyers and sellers, entry barriers, and product differentiation determines firms' conduct, such as pricing strategies, R&D, advertising, and collusion. These behaviors, in turn, influence performance metrics, including profitability, growth, and efficiency. Additionally, external factors such as government policies (competition policy, trade regulation) and technological progress play a crucial role in shaping industry dynamics.

Furthermore, for the Malaysian property sector, this model helps explain how tariff liberalization on steel and cement alters market structure by lowering input costs and increasing competitive pressures. Firms must then adjust their conduct whether through

[2] Lipczynski, J., Wilson, J. O. S., & Goddard, J. (2017). *Industrial organization: Competition, strategy and policy* (5th ed.). Pearson

cost-cutting measures, innovation, or strategic mergers which ultimately affects efficiency and profitability.

Figure 2.1: Structure, Conduct and Performance Paradigm (SCP) Framework




Additionally, Contestable Market Theory (Baumol, Panzar, & Willig, 1982) extends the SCP paradigm by arguing that even in markets dominated by a few firms, low entry and exit barriers can maintain competitive pressures and drive firms toward efficiency. However, in the Malaysian property sector, significant entry barriers, including high

capital requirements, zoning laws, and bureaucratic hurdles, may limit contestability, potentially reducing efficiency incentives for incumbent firms.

Incorporating industrial organization theory perspectives, this research establishes a comprehensive framework for analysing efficiency dynamics in the property sector, particularly in the context of tariff reductions on steel and cement. The combination of X-efficiency theory, cost efficiency, stochastic frontier theory, institutional economics, and industrial organization provides a multifaceted foundation for evaluating firm performance in a liberalized market environment. This theoretical integration enables a nuanced assessment of how market structure, competition, and regulatory dynamics influence firm-level efficiency outcomes.

Universiti Utara Malaysia

### 2.1.4 Transaction Cost Economics

The Transaction Cost Economics (TCE) framework, pioneered by Coase (1937) and further developed by Williamson (1975, 1985), provides another critical perspective on firm efficiency by focusing on the costs of market transactions, contract enforcement, and governance structures. Coase (1937) argues that firms exist to minimize transaction costs associated with negotiating, monitoring, and enforcing contracts in the marketplace. Williamson's contributions emphasize the role of hierarchical governance, uncertainty, and asset specificity in determining whether firms internalize production or rely on market transactions to reduce costs.

In the property sector, tariff reductions on key inputs such as steel and cement have the potential to lower transaction costs by reducing procurement expenses, improving supply chain coordination, and decreasing reliance on formal contractual safeguards. These changes not only affect direct input costs but also reshape how firms manage relationships with suppliers and contractors' elements that are central to Transaction Cost Economics (TCE). As proposed by Williamson (1985), firms weigh the costs of using markets versus organizing internally, particularly under conditions of uncertainty, asset specificity, and frequency of exchange. In the context of property development, input liberalization may shift these boundaries by enabling firms to reduce dependence on vertically integrated structures or long-term contracts.

Integrating the TCE perspective into the literature on firm efficiency suggests that efficiency gains are not limited to production technologies or input optimization alone but also arise from improved organizational and contractual arrangements. As firms adjust to lower input tariffs, their ability to restructure transactions through more flexible sourcing, streamlined logistics, or reduced administrative overhead becomes a relevant factor in overall cost efficiency. This perspective expands the traditional scope of efficiency studies by recognizing the role of institutional and contractual responses to policy change. It also aligns with recent research exploring how regulatory shifts reshape firm boundaries, governance structures, and operational efficiency making TCE a useful complementary framework in analysing efficiency outcomes in liberalizing industries such as Malaysia's property sector.

Universiti Utara Malaysia

## 2.2 Theory of the Firm and Efficiency in the Property Sector

The Theory of the Firm serves as a foundational framework for analysing how firms organize production, allocate resources, and respond to market forces to maximize efficiency. In the Malaysian residential property sector, firms operate within a capital-intensive and highly regulated environment, where efficiency is a key determinant of competitiveness.

This study draws on key economic theories to explore how firm efficiency, economies of scale, market liberalization, and organizational structure influence performance in the residential property sector. Efficient resource allocation is critical in this industry, where firms operate under conditions of input price volatility, regulatory complexity, and competitive market pressures. The literature highlights that firms' ability to adapt to these challenges through cost optimization, flexible production strategies, and strategic restructuring plays a central role in shaping their efficiency outcomes.

Universiti Utara Malaysia

### 2.2.1 Cost Minimization and Efficiency

A fundamental principle of the Theory of the Firm is that firms seek to minimize costs while maximizing output to enhance efficiency. However, X-Efficiency Theory (Leibenstein, 1966) posits that firms may not always operate at optimal efficiency due to managerial slack, weak competitive pressures, or organizational inertia. In this context,

tariff liberalization such as reductions in steel and cement tariffs introduces competitive pressures that can incentivize firms to eliminate inefficiencies and enhance productivity.

Additionally, Cost Efficiency and Duality Theory (Diewert, 1974; Fried et al.,2008) emphasize that firms seek to minimize costs within the constraints of input prices and production limitations. This theoretical perspective is particularly relevant to the property sector, where fluctuations in material costs significantly influence overall efficiency. Tariff reductions on key construction materials provide an empirical setting to examine how firms strategically adjust input allocation and cost structures in response to changing market conditions.

Universiti Utara Malaysia

Firms that capitalize on cost-saving opportunities within a competitive environment can achieve greater operational efficiency while sustaining profitability and market competitiveness. Understanding these efficient mechanisms contributes to a broader analysis of how market liberalization, firm behavior, and production dynamics interact to shape long-term industry performance. This perspective reinforces the relevance of efficiency studies in the property sector, particularly in the context of evolving input costs, regulatory reforms, and strategic firm-level adaptations.

### 2.2.2 Market Structure, Competition, and Efficiency

Market dynamics play a critical role in determining firm efficiency, influencing their ability to compete, innovate, and optimize resource allocation. Industrial Organization Theory, particularly the Structure-Conduct-Performance (SCP) paradigm (Bain, 1956), posits that competitive markets drive firms to enhance efficiency by minimizing costs, improving productivity, and adopting innovation. In contrast, firms operating in monopolistic or highly concentrated markets may lack competitive discipline, leading to inefficiencies and suboptimal resource utilization.

Additionally, New Trade Theory (Krugman,1991) highlights the role of economies of scale and market expansion in driving efficiency improvements. Market liberalization, particularly through tariff reductions on critical inputs such as steel and cement, lowers production costs and facilitates firm expansion, fostering greater efficiency within the property sector. However, the extent to which firms benefit from liberalization depends on their ability to scale operations, adjust procurement strategies, and adapt to competitive pressures.

Further empirical evidence from Tybout (2000) suggests that trade liberalization leads to efficiency gains, though these benefits are contingent upon institutional quality, firm size, and prevailing market conditions. In the context of the Malaysian residential property sector, firms that effectively navigate regulatory changes, optimize supply chain

strategies, and leverage economies of scale are more likely to achieve sustained efficiency improvements and maintain competitiveness in an evolving market landscape.

### 2.2.3 Economies of Scale and Firm Growth

The Theory of the Firm emphasizes the role of economies of scale in enhancing firm efficiency. Economies of scale arise when firms expand production, leading to lower average costs per unit through mechanisms such as bulk material procurement, labor specialization, technological advancements, and financial leverage (Coase, 1937; Williamson, 1985). Larger firms often benefit from cost efficiencies and risk absorption due to their ability to spread fixed costs over a greater output volume, negotiate favorable input prices, and invest in process innovations. These advantages allow firms to maintain operational stability and respond more effectively to market fluctuations compared to smaller competitors.

Universiti Utara Malaysia

Krugman's New Trade Theory (1991) further supports the premise that market liberalization enhances firm efficiency when firms scale production and optimize resource allocation. In the Malaysian property sector, tariff reductions on steel and cement create opportunities for firms to reduce input costs, but the extent of efficiency gains depends on firm-specific characteristics. Larger firms with strong capital structures, integrated supply chains, and broader market reach are better positioned to capitalize on cost advantages and productivity improvements (Helpman & Krugman, 1985). In contrast, smaller firms

may encounter capital constraints, higher borrowing costs, or market disadvantages, limiting their ability to realize economies of scale and efficiency gains (Tybout, 2000).

Furthermore, the literature suggests that firm growth and efficiency differentials can be attributed to factors such as financial constraints (Beck et al., 2005), market positioning (Porter, 1980), and industry competitiveness (Caves & Barton, 1990). Larger firms often gain competitive advantages through horizontal and vertical expansion, while smaller firms may struggle with cost inefficiencies due to limited economies of scale and resource constraints (Jovanovic, 1982).

## 2.3 Literature Review on Methodologies

The purpose of this literature review is to conceptualize economic efficiency, examine how it has been modeled and operationalized in firm-level studies, evaluate the techniques proposed in the literature, engage with key methodological debates, and compare alternative frontier estimation approaches used to measure production and cost efficiency.

Efficiency analysis offers a structured econometric approach to evaluating firm performance, particularly in input-intensive sectors such as property development. The first part of this section introduces the concept of economic efficiency, focusing on its theoretical underpinnings and relevance in understanding how firms optimize resource allocation to improve performance. The second part discusses the distinction between production efficiency and cost efficiency, highlighting their analytical differences and

complementary roles in capturing both technical performance and cost-minimizing behavior. This provides the conceptual basis for identifying sources of inefficiency across firms.

The final part introduces Stochastic Frontier Analysis (SFA) as a widely used econometric technique for estimating production and cost frontiers. It outlines how SFA accommodates statistical noise and firm-level heterogeneity, and explains the use of flexible functional forms, such as the Translog, in modeling firm behavior and performance within the Industrial Organization framework adopted in this study.

### 2.3.1 Economic Efficiency

Economic efficiency is a foundational concept in microeconomic theory, referring to the optimal allocation of resources to achieve maximum output at the lowest possible cost. It reflects how well firms utilize inputs given existing technology and market conditions, and it is central to productivity and performance analysis. Firms that efficiently allocate resources tend to achieve higher competitiveness and more sustainable cost structures.

Efficiency and productivity, though related, are distinct concepts. Productivity measures the ratio of output to input, reflecting the overall performance of a firm or industry. It is commonly expressed as:

$$Productivity = \frac{Output}{Input} \tag{2.1}$$

An increase in this ratio indicates higher productivity, but it does not necessarily imply efficiency, as firms may still waste or misallocate resources despite producing high output.

Economic efficiency is commonly decomposed into technical efficiency, allocative efficiency, and cost efficiency. Technical efficiency reflects a firm's ability to maximize output from a given set of inputs, ensuring that no resources are wasted. Allocative efficiency concerns whether inputs are used in proportions consistent with their relative prices. Cost efficiency combines both dimensions:

$$CE = TE \times AE \tag{2.2}$$

A firm is fully cost-efficient when $CE = 1$. Any value below unity indicates excess cost arising from either technical inefficiency where inputs are underutilized or allocative inefficiency, where inputs are chosen in suboptimal proportions.

The analytical foundations of economic efficiency stem from several seminal contributions. Farrell (1957) pioneered modern efficiency measurement by proposing input- and output-oriented efficiency scores, laying the groundwork for frontier-based methods such as Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA). Koopmans (1951) earlier defined technical efficiency as a condition where increasing any output requires sacrificing another output or increasing at least one input. Debreu (1951) and Shephard (1953) further advanced the theory through the development

of distance functions, providing a formal representation of production technology and inefficiency.

Efficiency measurement is especially relevant in the property and real estate industry, which is characterized by high capital intensity and exposure to input-cost volatility. Developers face pressures related to construction materials, land acquisition, labour, regulatory compliance, and project financing. Policy interventions such as tariff liberalisation on steel and cement directly influence firms' cost structures and ability to operate efficiently. Assessing economic efficiency in this sector therefore offers valuable insights into how developers respond to market conditions, regulatory frameworks, and internal cost management challenges.

### 2.3.2 Conceptual of Production and Cost Efficiency

The conceptual of production and cost efficiency provides a structured representation of how firms optimize their production processes and cost structures. Efficiency in firm performance is primarily assessed through two dimensions: technical efficiency and allocative efficiency. Technical efficiency measures a firm's ability to maximize output given a specific set of inputs, ensuring that no resources are wasted in the production process. Allocative efficiency, on the other hand, ensures that firms choose the cost-minimizing combination of inputs based on their relative prices. When a firm achieves both technical and allocative efficiency, it attains cost efficiency, which is critical in industries where input costs and resource allocation significantly impact profitability and sustainability.

Universiti Utara Malaysia

Efficiency in economic and industrial contexts is typically examined through various theoretical and empirical lenses. The concept of efficiency is fundamental in assessing firm performance, particularly in the residential property sector, where resource utilization, cost minimization, and optimal output levels are crucial.

### i. Production Efficiency

Production efficiency refers to a firm's ability to maximize output given a set of inputs or, alternatively, to minimize input usage for a given level of output. This is commonly expressed as the ratio of actual output to the potential output on the production frontier. The closer a firm operates to the frontier, the more efficient it is.

Universiti Utara Malaysia

Studies on production efficiency in the property and construction sectors commonly emphasize the role of three fundamental input factors: labor, capital, and materials. Labor costs are frequently examined as a reflection of workforce deployment and productivity, particularly in sectors where skilled labor shortages, wage structures, and labor regulations influence operational efficiency. Capital investment is another core input, representing the long-term financial commitment to infrastructure, machinery, and construction technology elements critical to sustaining large-scale development projects. Material costs, especially those associated with steel and cement, are consistently identified as major cost components in property development, with price volatility and supply constraints significantly affecting project timelines and efficiency outcomes.

The literature suggests that optimal allocation and management of these inputs is central to improving firm-level productivity and minimizing technical inefficiency. This line of research is particularly relevant in capital-intensive and demand-sensitive industries like real estate, where input prices and supply conditions are frequently influenced by market liberalization, regulatory intervention, and macroeconomic shifts. As such, examining how firms navigate input cost structures offers a promising direction for understanding the drivers of efficiency and the constraints that limit productivity. These insights lay the groundwork for more nuanced empirical investigations into how firms can respond strategically to shifting resource environments within liberalizing and competitive markets.

Universiti Utara Malaysia

Efficiency in production can be visualized through the Production Frontier, which defines the maximum attainable output for a given set of inputs. Firms that operate on the production frontier are fully efficient, while firms operating below the frontier experience inefficiency. The concept of the stochastic production frontier further refines this model by allowing for random shocks that may influence production outcomes.

The general form of the stochastic production frontier model is given by:

$$Y_{it} = f\left(X_{it\,;}\,\beta\right)e^{V_{it}-U_{it}} \tag{2.3}$$

where:
$Y_{it}$ is the output of firm *i* at time *t*,
$f\left(X_{it\,;}\,\beta\right)$ is the production function with inputs $X_{it}$ and parameter $\beta$,

$V_{it}$ is the statistical noise term, assumed to follow a normal distribution, $V_{it} \sim N(0, \sigma_v^2)$ accounting for measurements errors and external shocks,
$U_{it}$ is the inefficiency term, assumed to follow a non-negative distribution (e.g., half-normal, exponential, or truncated normal), which captures deviations from the efficiency frontier.

To allow for greater flexibility in capturing non-linear relationships between inputs and output, this study adopts a Translog functional form. Unlike the restrictive Cobb-Douglas specification, the Translog model accommodates input interactions and varying returns to scale, making it well-suited for analyzing production efficiency in the residential property sector.

Therefore, technical efficiency represents a firm's ability to maximize output given a specific set of inputs. Firms that operate on the production frontier are considered fully efficient, while those below the frontier experience inefficiencies due to factors such as suboptimal resource allocation, managerial constraints, or technological limitations. Thus, by evaluating the gap between actual and potential output, technical efficiency provides a measure of how effectively a firm utilizes its resources. To measure technical efficiency (TE), a firm's actual output is compared to its potential output on the production frontier:

$$TE_{it} = \frac{Y_{it}}{Y_{it}^*} \tag{2.4}$$

where:
$Y_{it}^*$ represents the firm's potential output if it were fully efficient, operating on the production frontier.
If $TE_{it} = 1$, the firm is fully efficient and operating at the frontier.
If $TE_{it} < 1$, the firm is inefficient, meaning there is room for improvement in its production processes.

To evaluate industry-wide efficiency, the average technical efficiency is computed as:

$$\overline{TE} = \frac{1}{N}\sum_{i=1}^{N} e^{-U_{it}} \quad (2.5)$$

The production frontier concept aligns with the neoclassical theory of firm behavior, which assumes that firms aim to optimize output with given resources. However, inefficiencies arise due to managerial decisions, operational constraints, and market dynamics. Studies by Farrell (1957) and Kumbhakar & Lovell (2000) suggest that inefficiencies in production can stem from both internal (firm-specific) and external (market-related) factors. Kumbhakar & Lovell (2000) further emphasize that inefficiency can be decomposed into persistent inefficiency, which is structural and long-term, and transient inefficiency, which fluctuates due to short-term management or external conditions. This distinction is crucial in analysing efficiency in the property sector, as regulatory changes, firm management, and market conditions contribute differently to firms' long-term and short-term efficiency levels. Thus, incorporating stochastic elements into the frontier model allows for distinguishing between inefficiencies and random shocks.

Firm-specific determinants of production inefficiency capture structural and operational characteristics that influence how effectively a firm utilizes its inputs. Larger firms may benefit from economies of scale, while ownership structures such as government-linked or foreign-owned firms can shape managerial efficiency. Similarly, having multiple subsidiaries may enhance diversification but also introduce bureaucratic inefficiencies,

and geographical location affects access to infrastructure, labor markets, and material costs, all of which contribute to variations in production efficiency.

To explain variations in production inefficiency, the inefficiency term is modelled as:

$$U_{it} = \delta_0 + \sum_m \delta_m Z_{mit} + \eta_{it} \quad (2.6)$$

where:

$Z_{mit}$ represents firm-specific variables, such as firm size, ownership structure and geographical location.
$\delta_m$ measures the impacts of these factors on inefficiency.
$\eta_{it}$ is the unobservable inefficiency component.

Battese and Coelli (1995) provide a widely used framework for modeling inefficiency as a function of firm-specific characteristics, offering a more structured approach to understanding production inefficiency. Their model allows for alternative inefficiency distributions, such as half-normal, truncated normal, and exponential, which can be used to assess the robustness of estimated inefficiency effects. Additionally, studies employing this approach often incorporate sensitivity analyses, including outlier exclusion and firm-fixed effects, to ensure that firm-specific determinants consistently explain variations in production efficiency.

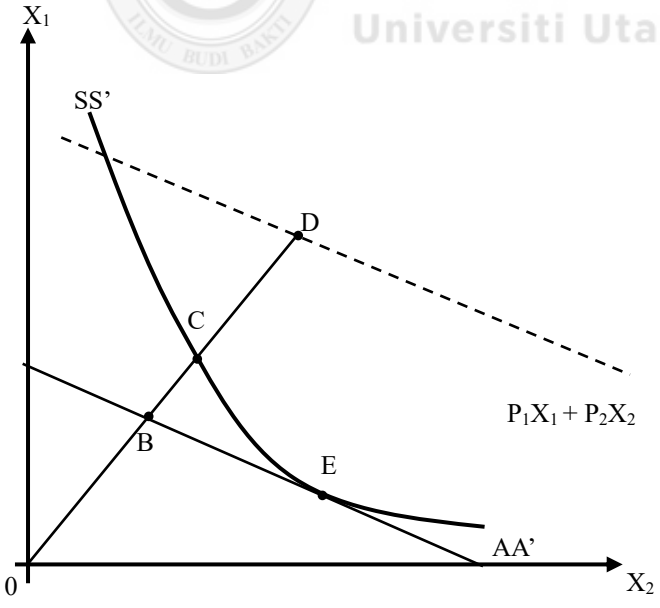
**ii. Cost Efficiency**

Cost efficiency represents the extent to which a firm attains the minimum feasible cost of producing a given output level, conditional on observed input prices and the technological environment. In Farrell's (1957) formulation, it is a composite measure integrating technical efficiency the firm's ability to convert inputs into output without waste and

allocative efficiency, which captures the firm's ability to select the cost-minimizing input mix in response to relative input prices. A firm is fully cost-efficient when its actual cost coincides with the cost frontier; any divergence reflects suboptimal input use or misallocation that inflates total cost above the theoretically attainable minimum.

To illustrate the concept of technical efficiency, allocative, and overall cost efficiency consider a firm that only uses two factors of production to produce a single product. Figure 2.2 shows the isoquant (SS') of the various combinations of the two inputs together with the slope of the prices of the factors of production (AA').

**Figure 2.2: Technical, allocative, and overall cost efficiency.**




Universiti Utara Malaysia

In Figure 2.2, point D represents the inputs of the two factors used to produce a unit of output for a particular firm. In this case, the firm is technically inefficient. This is because the firm can produce the same level of output with fewer inputs at point C using only a part of OC/OD. The ratio of a perfectly efficient firm takes the value of unity because it will become indefinitely small if the amounts of input per unit output become indefinitely large. Consequently, looking beyond the technical efficiency proposed by Farrell, he also proposed the measure for cost efficiency with the assumption of prices are fixed and known with the probabilities of being different between the DMUs.

Therefore, to illustrate the concept of cost efficiency, let consider the DMU D in Figure 2.2 with an input price of $P_1$ and $P_2$. The isocost line of $P_1X_1 + P_2X_2 = k$ and it is represented by the broken line in Figure 1 is with the slope which equal to the relative prices at D. Firm D is also said to exhibit allocative inefficiency. The least-cost combination of input that used in production is given by point E in which the marginal rate of technical substitution is equal to the input price ratio. In order to achieve the same level of cost, the firm would have to reduce their inputs towards point B and it is represented by the fraction of OB/OC.

Here the total cost (k) represented by the isocost line can be further reduced with a parallel downward movement until it is tangent to the efficient frontier. Hence, point E gives the combination which corresponds to the minimal cost of output production for the combination of input prices. It is noted that when the firm is perfectly efficient, it costs

would be a fraction of OB/OD, and this ratio is known as overall efficiency or cost efficiency. The cost efficiency associated by DMU D is obtained with the ratio of the minimal cost to the observed cost given the current input prices.

In this analysis, it is assumed that producers operate under given input prices and aim to minimize their production costs while determining their output levels. Rather than being assessed against the production frontier, their performance is evaluated relative to the cost frontier. Notably, achieving input-oriented technical efficiency is a necessary but not sufficient condition for attaining cost efficiency. This distinction arises because a technically efficient firm may still employ a suboptimal input combination, failing to minimize costs given the input prices it faces.

Universiti Utara Malaysia

Building on this framework, cost efficiency estimation within Stochastic Frontier Analysis (SFA) follows a structured process that includes specifying the cost frontier, selecting a functional form, estimating inefficiency terms, and conducting robustness checks. The stochastic cost frontier approach distinguishes between random noise and inefficiency, offering a more accurate assessment of firm performance under conditions of uncertainty and data variability. Foundational studies by Aigner, Lovell, and Schmidt (1977) and later by Kumbhakar and Lovell (2000) have established the methodological basis for cost frontier analysis, enabling researchers to evaluate not only the level of inefficiency but also the underlying factors contributing to it. These methodological developments provide a strong foundation for analyzing cost behavior in sectors like

property development, where firms operate under both market-driven and policy-induced cost pressures.

The cost efficiency model identifies deviations from the cost frontier, capturing the impact of input price variations and firm-specific factors on inefficiency. Cost efficiency is examined through the cost frontier, which represents the minimum cost required to produce a given level of output. Firms that operate on the cost frontier are fully cost-efficient, while those above the cost frontier incur excess costs due to inefficiencies. The stochastic cost frontier model is specified as:

$$C_{it} = f(W_{it}, Y_{it}; \beta) e^{V_{it}+U_{it}} \quad (2.7)$$

Where:
$C_{it}$ is total cost of firm *i* at time *t*,
$f(W_{it}, Y_{it}; \beta)$ is the cost function with input prices $W_{it}$ and output $Y_{it}$,
$V_{it}$ is the statistical noise term,
$U_{it}$ represents cost inefficiency, where higher values indicate greater inefficiency.

The distinction between inefficiency and statistical error allows for a more accurate representation of firm performance in cost management. Empirical studies on cost efficiency often adopt the Translog cost function due to its flexibility in capturing non-linear relationships and input substitution effects (Christensen, Jorgenson & Lau, 1973).

Cost efficiency measures the extent to which a firm minimizes its total expenditure for a given level of output, relative to the optimal cost frontier. A firm is considered fully cost-

efficient if it operates on the cost frontier, where inefficiencies are absent, and total costs reflect the minimum possible expenditure required for production. In a stochastic cost frontier framework, cost efficiency is typically expressed as the ratio of the minimum attainable cost to the observed cost. A firm achieves full cost efficiency when the inefficiency term ($U_{it}$) is equal to zero, resulting in a cost efficiency score of $CE_{it}$=1. Conversely, as the inefficiency component increases ($U_{it} > 0$, cost efficiency declines, indicating that the firm incurs excess costs due to resource misallocation, operational inefficiencies, or structural constraints. Thus, by distinguishing between inefficiency effects and random noise, cost frontier models provide a robust approach to estimating firm-level cost efficiency, offering valuable insights into industry competitiveness and policy implications.

Universiti Utara Malaysia

Cost efficiency can be interpreted as a firm's ability to minimize its total expenditure for a given level of output. Firms operating on the cost frontier are considered fully efficient, while those incurring excess costs due to misallocation of resources or operational inefficiencies fall below this benchmark. The cost efficiency (*CE)* score is then computed as:

$$CE_{it} = e^{-U_{it}} \quad (2.8)$$

Where:

If CE = 1 indicates full cost efficiency, signifying that the firm operates at the minimum possible cost for its given output level, with no observable inefficiencies.

If CE < 1, the firm is experiencing cost inefficiency, implying excess expenditures due to suboptimal resource allocation, mismanagement, or structural constraints that prevent cost minimization.

Larger firms often benefit from economies of scale, leading to lower inefficiency levels, whereas smaller firms may struggle with higher operational costs per unit due to limited resource access. Government-linked and foreign-owned firms may exhibit different efficiency patterns due to regulatory influences and financial constraints (Coelli et al., 2005).

### iii. Economies of Scale

Economies of scale (EOS) refer to the cost advantages that firms experience as production scales up, typically resulting in lower average costs per unit as output increases. In the property sector, economies of scale arise when larger firms benefit from cost efficiencies in construction, land acquisition, labor specialization, and material procurement. Understanding EOS is particularly important for evaluating the competitiveness and efficiency of residential property firms, as firms operating under increasing returns to scale may achieve cost reductions that allow for more competitive pricing strategies.

Universiti Utara Malaysia

EOS is traditionally measured by the cost elasticity of output, which indicates how total costs respond to changes in output. If costs increase proportionally less than output, the firm experiences economies of scale (SC > 1), whereas if costs increase more than output, the firm faces diseconomies of scale (SC < 1). Following the framework proposed by Hanoch (1975), EOS is best analyzed through the cost-output relationship along an expansion path, where input prices remain constant, and cost minimization is assumed at all output levels.

For firms operating under a Translog cost function, the elasticity of total cost with respect to output is defined as:

$$\frac{\partial \ln C(y,w)}{\partial\, lny_i} = \alpha_1 + S_{ik}\, lny_k + \sum_{k=1}^{n} d_{ij}\; lnw_j \qquad (2.9)$$

where,

$C(y, w)$ = Total cost as a function of output y and input prices w.

$\frac{\partial \ln C}{\partial \ln y_i}$ = Cost elasticity with respect to output.

$\alpha_1$= Base elasticity parameter.

$S_{ik}$ and $d_{ij}$ = Estimated parameters capturing interaction effects between output and input prices.

Universiti Utara Malaysia

Understanding economies of scale is essential in evaluating how cost structures respond to changes in output levels. Thus, by analyzing the relationship between total cost and production scale, we can determine whether firms benefit from cost reductions as output expands or face rising costs due to diseconomies of scale.

Economies of scale are then computed as:

$$SC\ (y, w) = \left[\sum_{i=1}^{n} \frac{\partial \ln C\ (y,W)}{\partial lny_i}\right]^{-1} \qquad (2.10)$$

The estimation of economies of scale provides insight into how firms' cost structures respond to changes in output levels. When the scale economy measure (SC) is greater than 1 (SC > 1), the firm experiences increasing returns to scale, meaning that as production

expands, total costs rise at a slower rate than output, leading to improved cost efficiency. This indicates that firms can spread fixed costs over a larger production volume, benefiting from cost savings associated with bulk procurement, operational efficiencies, or technological advancements. In contrast, when SC=1, the firm operates under constant returns to scale, where an increase in output results in a proportional increase in total cost, implying that the firm has reached an optimal production scale with no additional cost advantages. However, when SC < 1, decreasing returns to scale emerge, indicating that as firms expand their production, costs increase at a higher rate than output. This inefficiency may arise due to factors such as resource constraints, managerial challenges, rising input costs, or diminishing marginal productivity. Understanding these cost-output relationships is crucial for firms to determine their optimal production scale and make informed operational and investment decisions.

Universiti Utara Malaysia

The relationship between EOS and firm size has been widely examined in the literature, particularly in industries where fixed costs and operational scale significantly influence cost efficiency (Coelli et al., 2005). Studies suggest that property firms with larger asset bases may benefit from cost efficiencies due to better capital allocation and access to bulk purchasing discounts on materials (Battese & Coelli, 1995). However, beyond a certain firm size, managerial complexity, regulatory compliance costs, and inefficient decision-making structures may lead to diseconomies of scale (Kumbhakar et al., 2012).

Recent research has incorporated EOS analysis within stochastic cost frontier models to examine how firm size contributes to differences in cost efficiency and competitiveness, especially in sectors undergoing structural or policy changes. This approach enables a more nuanced understanding of how scale-related advantages translate into cost performance under varying market conditions. In the context of liberalizing economies, such frameworks offer valuable insights into how firm structure interacts with policy shifts to shape industry dynamics an area of growing relevance in emerging markets such as Malaysia.

### 2.3.3 Parametric and Non-Parametric Estimation of Efficiency

The estimation of firm-level efficiency commonly relies on two methodological frameworks: parametric and non-parametric approaches. Both are designed to evaluate the distance of a firm from a theoretical best-practice frontier, but they differ fundamentally in their structural assumptions, estimation techniques, and treatment of inefficiency. Parametric models, such as Stochastic Frontier Analysis (SFA), require the specification of a functional form (Cobb-Douglas or Translog) and employ a composed error term to distinguish inefficiency from statistical noise. On the other hand, non-parametric techniques like Data Envelopment Analysis (DEA) construct the frontier using linear programming methods without imposing a specific functional form. While DEA is methodologically flexible and frequently applied in benchmarking exercises involving multiple inputs and outputs, it does not accommodate stochastic disturbances and attributes all deviations from the frontier to inefficiency, making it highly sensitive to outliers and data irregularities.

As Greene (2020) emphasizes, parametric frontier models estimated via Maximum Likelihood Estimation (MLE) provide a coherent statistical framework for jointly identifying the frontier parameters and the distributional properties of inefficiency. This approach supports formal hypothesis testing, accommodates time-varying inefficiency in panel settings, and integrates firm-level determinants directly into the inefficiency function. Therefore, in contrast, non-parametric methods such as DEA, while useful for benchmarking, are deterministic and therefore unable to disentangle inefficiency from random noise or incorporate explanatory covariates. Insights from the broader econometric literature, particularly Greene (2020) and Coelli et al. (2005), consistently highlight the analytical advantages of SFA its flexibility, robustness, and ability to model firm heterogeneity over deterministic alternatives. These methodological insights collectively justify the adoption of SFA in this study and form the analytical foundation for the modelling strategy elaborated in the Methodology chapter.

Universiti Utara Malaysia

### 2.3.4 Stochastic Frontier Analysis (SFA)

The stochastic frontier approach is a widely applied parametric method in efficiency estimation, introduced independently by Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977). Efficiency estimation techniques are broadly categorized into parametric and non-parametric approaches. Parametric methods, such as the Stochastic Frontier Analysis (SFA), require the specification of a functional form for the production or cost frontier and allow for statistical noise in the data.

SFA allows for the decomposition of deviations from the efficiency frontier into two components: random noise and inefficiency effects. Unlike non-parametric methods, SFA explicitly accounts for external shocks, measurement errors, and statistical noise, making it particularly suitable for industries influenced by market uncertainties and policy changes, such as the residential property sector. As argued by Schmidt and Lovell (1979), one of the main advantages of the parametric approach is its ability to separate inefficiency from random variation, offering a more statistically robust estimation of firm performance.

While non-parametric approaches like Data Envelopment Analysis (DEA) are flexible and do not require functional form assumptions, they treat all deviations from the frontier as inefficiency potentially misclassifying noise or policy shocks as poor performance. In contrast, SFA's stochastic specification is particularly advantageous in real-world applications where data are often affected by institutional changes, liberalization policies, and demand-side volatility.

In recent years, researchers have increasingly used both DEA and SFA in the analysis of construction, real estate, and infrastructure sectors, particularly to understand the interplay between firm structure, policy, and efficiency. While DEA offers valuable benchmarking tools, SFA's stochastic nature and econometric flexibility have made it especially useful for studies assessing the impact of regulatory reforms and market shocks on firm performance. This growing body of literature highlights the importance of selecting a

method that is not only technically appropriate but also aligned with sectoral characteristics and research objectives.

Thus, an important feature of the Stochastic Frontier Approach (SFA) is its composite error structure, which distinguishes between random statistical noise and firm-specific inefficiency. This decomposition allows for a more accurate and policy-relevant evaluation of efficiency by separating exogenous shocks such as price volatility or regulatory delays from managerial or operational inefficiency.

According to Fried, Lovell, and Schmidt (2008), this characteristic makes SFA particularly suitable for settings where performance is influenced by uncontrollable external factors, as it enhances the credibility and robustness of efficiency estimates. Table 2.1 outlines the key methodological, statistical, and practical distinctions between Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA), providing a comparative foundation for understanding their respective strengths and applications in efficiency studies.

Universiti Utara Malaysia

Table 2.1: Comparison of Stochastic Frontier Approach (SFA) and Data Envelopment Analysis (DEA).

| **Feature** | **Stochastic Frontier Approach (SFA)** | **Data Envelopment Analysis (DEA)** |
|---|---|---|
| Approach | Parametric, econometric based | Non-parametric, linear programming-based |
| Functional Form | Requires a pre-specified functional form (Cobb-Douglas, Translog) | No functional form required; frontier is constructed from the data |
| Error Structure | Composite error term separates random noise (shocks, measurement error) from inefficiency | Assumes all deviations from the frontier are inefficiency |
| Deterministic vs. Stochastic | Stochastic: accounts for external shocks and statistical error | Deterministic: assumes perfect data, no random error |
| Interpretation | Allows statistical inference: hypothesis testing, confidence intervals, and inefficiency regressions | Results based on relative efficiency scores; lacks standard statistical inference tools |
| Input/Output Flexibility | Can incorporate input/output prices and inefficiency effects in cost/production models | Handles multiple inputs and outputs without requiring price data |
| Suitability | Well-suited to noisy environments with external variability (policy, regulation, market shocks) | Effective for benchmarking in stable environments with low noise and many comparable units |
| Application Focus | Widely used in regulatory analysis, policy evaluation, and studies requiring causal interpretation | Commonly applied in performance benchmarking, public sector, and exploratory comparisons |

*Adapted and enhanced based on Fried, Lovell, & Schmidt, 2008

Universiti Utara Malaysia

On the other hand, Data Envelopment Analysis (DEA) attributes all deviations from the efficiency frontier to inefficiency, which may lead to overstated inefficiency scores in environments with substantial measurement error or market fluctuations. The general SFA framework can be applied through two main specifications: the Stochastic Production Frontier, which estimates the maximum attainable output given input levels, and the Stochastic Cost Frontier, which estimates the minimum cost required to produce a given output. These models enable researchers to assess technical and cost efficiency while simultaneously analyzing the influence of firm-specific and environmental variables on inefficiency, further reinforcing the versatility of the stochastic frontier approach in empirical research.

In the Malaysian context, the use of SFA in property sector research is even more minimal. Existing studies tend to focus on macroeconomic trends (Thake & Ariff, 2020; Chia et al. 2014), profitability (Abdul Aziz et al., 2006; Shehu et al. 2014), or housing affordability (KRI, 2019 & 2015) with limited empirical work that applies firm-level panel data models to estimate production and cost inefficiency. Despite the sector's strategic role in the economy and its linkages to upstream industries such as cement and steel, rigorous frontier-based efficiency analysis remains scarce. This gap provides a strong empirical justification for the present study, which applies translog stochastic frontier models to assess the efficiency performance of residential property firms in Malaysia. The next section reviews empirical findings related to firm inefficiency, structured around key international studies, domestic evidence, and firm-specific determinants included in the econometric framework.

## 2.4 Empirical Justification for Modeling Firm Inefficiency

Frontier-based efficiency analysis has been widely applied in sectors such as agriculture, banking, manufacturing, and utilities, yet its adoption within the property and construction industries remains comparatively limited. International studies that do employ frontier methods such as You and Zi (2007) on Korean contractors, Dzeng and Wu (2013) on Taiwanese construction firms, Park et al. (2018) on productivity patterns in East Asian construction, and Li et al. (2013) on Hong Kong and Chinese contractors demonstrate the usefulness of SFA in capturing cost and technical inefficiencies in project-based industries. However, these studies also highlight broader methodological constraints: many continue to rely on Cobb-Douglas functional forms, omit firm-level determinants grounded in industrial organization theory, or focus on short time horizons that limit insight into long-run efficiency dynamics.

Universiti Utara Malaysia

At the same time, a substantial portion of the literature continues to rely on conventional financial ratios, total factor productivity indices, or non-parametric techniques such as DEA. While studies using DEA particularly in construction benchmarking offer valuable descriptive comparisons, they are unable to separate inefficiency from statistical noise and do not account for firm heterogeneity arising from differences in scale, organisational structure, or input coordination. This limitation is particularly salient in the property development industry, where fragmented production networks, volatile material prices, and heterogeneous project portfolios introduce considerable stochastic variation.

In Malaysia, the methodological gap is even more pronounced. Frontier-based studies in the Malaysian context have largely centred on banking and manufacturing (Karim, 2001; and subsequent sectoral applications) with minimal application to the property or construction sectors. Existing Malaysian property research tends to emphasise macroeconomic trends, profitability, or affordability, leaving a scarcity of empirical work that utilises firm-level panel data to estimate production or cost inefficiency. Moreover, despite the sector's extensive linkages to upstream industries such as cement and steel industries that have been the focus of policy reforms and tariff liberalisation very few Malaysian studies integrate these structural factors into a frontier framework capable of separating inefficiency from random shocks.

These gaps collectively indicate a clear need for a more rigorous empirical approach that model's inefficiency explicitly, accommodates firm heterogeneity, and aligns with theoretical perspectives from industrial organization. The present study responds to this gap by applying translog stochastic frontier models to evaluate the efficiency performance of Malaysian residential property developers, incorporating firm-level structural variables and input-related policy measures into the inefficiency specification.

The next section reviews empirical findings related to firm inefficiency in greater depth, drawing together international evidence, domestic studies, and the structural determinants included in the econometric framework.

## 2.5 Review on Empirical Studies on Production and Cost Efficiency

The purpose of this empirical review is to examine how efficiency has been measured and observed across firm-level studies, highlight key findings on production and cost performance, evaluate the influence of structural and institutional factors, and identify empirical gaps particularly in the context of property and construction sectors where frontier techniques have been underutilized or inconsistently applied. The first part of this section reviews international studies that apply frontier efficiency models, particularly in countries such as Korea, Taiwan, China, and Spain. These studies provide insights into how firm size, market structure, input costs, and regulatory settings shape efficiency outcomes across diverse construction and real estate environments.

Universiti Utara Malaysia

The second part focuses on empirical studies conducted in Malaysia. While local research has examined firm performance in the broader property and construction sectors, applications of frontier efficiency models remain limited. Most Malaysian studies emphasize financial ratios, profitability, or productivity indices, with relatively few incorporating Stochastic Frontier Analysis (SFA) or exploring cost-side inefficiencies linked to material input shocks or tariff reforms.

The final part highlights key empirical gaps that motivate the present study. These include the lack of firm-level efficiency analysis using translog frontier models, limited investigation into the effects of input cost liberalization (steel and cement tariffs), and

insufficient attention to structural firm characteristics such as ownership concentration, subsidiary formation, and geographic scope.

### 2.5.1 International Evidence on Efficiency in Property and Construction Sectors

Several empirical studies in other countries have applied frontier-based techniques to evaluate the efficiency of real estate firms, offering useful methodological and conceptual guidance. These studies vary in their choice of approach either parametric (SFA) or non-parametric (DEA) and differ in focus, ranging from financial performance to production and cost efficiency. Research from countries such as South Korea (You & Zi, 2007), Taiwan (Dzeng & Wu, 2013), and the United States (Gyourko, 2009) has demonstrated how firm-level characteristics and macroeconomic conditions jointly influence efficiency outcomes. The following section reviews key international contributions, with emphasis on those that inform the modelling choices and variable selection in the present study.

Empirical research on the efficiency of real estate and construction-related firms has been more prominent in certain international contexts, particularly in East Asia (Chau et al., 2005; Li et al., 2013; Park et al., 2015). Although studies directly examining housing developers remain limited, the use of frontier-based techniques such as Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) has been applied to broader construction and real estate sectors. These studies offer important methodological and contextual insights that inform the present research, especially in terms of model specification, variable selection, and the role of macroeconomic conditions.

One notable study is by You and Zi (2007), who assessed both technical and cost efficiency among Korean construction firms over the period 1996-2000, which spans the Asian Financial Crisis. Using a non-parametric DEA approach, the study found that efficiency levels declined significantly during the crisis, with sharp differences observed between the pre- and post-crisis periods. Crucially, the authors reported that the low-cost efficiency observed was primarily due to allocative inefficiency stemming from an inappropriate input mix rather than technical inefficiency. The analysis also identified several key firm-specific factors contributing to efficiency losses, including high leverage, the accumulation of unproductive assets, and poor receivables management. Additionally, the study emphasized the role of institutional ownership and agency costs in shaping performance outcomes. Although the study does not apply a parametric frontier model or estimate inefficiency effects explicitly, its findings underscore the relevance of firm heterogeneity, capital structure, and ownership dynamics elements central to the current study's modeling framework. Moreover, the absence of a stochastic frontier approach presents a methodological gap that this thesis addresses.

Therefore, a more directly comparable study in terms of methodology is that by Dzeng and Wu (2013), who applied a time-varying stochastic frontier model with a translog production function to assess the efficiency of the Taiwanese construction industry from 1991 to 2007. Using inputs such as labour cost, capital, and materials, and gross construction output as the output variable, their analysis revealed that the industry operated below the efficient frontier, with an average efficiency level of approximately 72 percent. They also found that larger firms tended to be more efficient, and that

efficiency improved over time due to policy reforms and increased competition. This study provides important methodological validation for the current research, particularly in its application of the Battese and Coelli (1995) framework and its recognition of both structural and temporal dimensions of efficiency.

Li et al. (2013) adopted a two-stage methodological framework to analyze contractor efficiency across Hong Kong and China. In the first stage, technical efficiency scores were calculated using Data Envelopment Analysis (DEA), which constructs a non-parametric frontier based on observed input-output combinations. DEA enables the estimation of firm-level efficiency without imposing a specific functional form, making it suitable for identifying performance variation across heterogeneous firms. In the second stage, the authors applied a panel data regression model to analyze the determinants of efficiency scores over time. This parametric component allows for the control of unobserved individual effects, providing a means to isolate the influence of structural factors such as ownership type, firm scale, and capital intensity. Additionally, the model controls for variations in returns to scale, allowing for a more nuanced interpretation of scale efficiency. While Li et al. adopt a fully parametric stochastic frontier model, their integration of non-parametric and parametric techniques highlights the importance of incorporating firm-specific and institutional characteristics when analyzing efficiency outcomes. This combined approach reinforces the relevance of contextual and structural variables in shaping efficiency, particularly in sectors characterized by heterogeneity and regulatory complexity.

Universiti Utara Malaysia

Interestingly, Park, Yoo, Lee, Kim, and Kim (2015) conducted a comparative analysis of construction firm efficiency and productivity in China, Japan, and South Korea between 2005 and 2011. Using Data Envelopment Analysis (DEA) and a DEA-based Malmquist Productivity Index (MPI), the study evaluated both technical efficiency and productivity change by decomposing the MPI into technical change and technical efficiency change components. The results revealed that Korean firms achieved the highest average efficiency score (0.861), followed by Japanese (0.775) and Chinese firms (0.639).

However, Chinese firms recorded the highest average productivity growth (5.5%), outperforming Korean (0.9%) and Japanese (0.1%) firms, primarily due to rapid technical change despite lower baseline efficiency. These findings underscore the differing institutional and market conditions across countries and highlight how structural and innovation-related factors influence firm performance.

Universiti Utara Malaysia

Although the study employs a non-parametric methodology, it offers valuable cross-national insights into how institutional and structural factors shape firm-level efficiency in the construction sector. The use of the Malmquist index also emphasizes the importance of capturing temporal changes in performance. These contributions support the present study's inclusion of both firm-specific characteristics and macroeconomic policy variables in a time-varying parametric efficiency model, particularly in the context of Malaysia's evolving housing development industry.

Interestingly, You and Zi (2007) and Park et al. (2015) examine efficiency patterns in East Asia's construction sector, with a focus on Korea and Japan. You and Zi employ Data Envelopment Analysis (DEA) to evaluate Korean construction firms during the 1997 Asian Financial Crisis, documenting a significant decline in technical efficiency and identifying firm-specific attributes such as financial leverage and adaptive capacity as key to post-crisis recovery. In contrast, Park et al. utilize DEA and the Malmquist Productivity Index to analyze firms in Korea, Japan, and China from 2005 to 2011. Their findings indicate that Korean firms attained the highest levels of technical efficiency, Japanese firms exhibited stable operational performance, while Chinese firms experienced the most rapid productivity gains driven by technological progress. Whereas You and Zi highlight firm-level resilience mechanisms, Park et al. attribute performance differentials to institutional configurations and variations in ownership structure. Collectively, these studies provide empirical support for incorporating both internal firm characteristics and external institutional determinants in the modeling of inefficiency among Malaysian property developers.

Therefore, De Jorge-Moreno, de Jorge-Huertas, and Rojas-Carrasco (2016) assess the technical efficiency of the Spanish construction industry using Stochastic Frontier Analysis (SFA) with a translog functional form. Their study evaluates both time-invariant and time-varying inefficiency models, applied to a sample of construction firms across Spain. Inputs include labour, materials, and capital, while output is measured as the gross production value. The findings indicate that firm efficiency differs across regions and firm

sizes, with larger firms generally achieving higher efficiency. The authors also highlight how industry structure and economic cycles affect resource allocation and performance.

In addition to quantitative efficiency assessments, insights from the Industrial Organization (IO) literature offer important theoretical context for interpreting firm behavior in the property and construction sectors. Ball (2003), in his comparative analysis of housebuilding industries across advanced economies, emphasizes that efficiency is shaped not only by firm-level operational choices but also by broader systemic forces such as planning regimes, land supply mechanisms, and market structure. He contends that many housing markets function under oligopolistic conditions, with supply-side constraints and coordination failures that limit responsiveness and undermine allocative efficiency.

Universiti Utara Malaysia

Similarly, Somerville (1999) investigates the structure of housing supply through an IO lens, finding that regulatory barriers, construction delays, and institutional rigidities distort the timing and scale of housing production. His work highlights that firm responses are embedded within institutional frameworks that impose friction and inefficiency beyond what standard neoclassical models predict.

In summary, international studies on construction and real estate efficiency provide both methodological and conceptual grounding for this research (see Table 2.2). Studies like

You and Zi (2007) and Dzeng and Wu (2013) apply frontier-based models to capture firm-level inefficiencies driven by macroeconomic shocks and firm characteristics. Li et al. (2013), Park et al. (2015), and De Jorge-Moreno et al. (2016) further highlight the role of ownership, market maturity, and capital intensity, while supporting the use of translog specifications and time-varying inefficiency models. Complementing these empirical works, Ball (2003) and Somerville (1999) offer an industrial organization perspective, emphasizing how planning systems, market structure, and institutional settings shape firm performance. Collectively, these studies inform both the modeling choices and variable selection adopted in the present analysis of Malaysian property firms.

Universiti Utara Malaysia

Table 2.2: Summary of Selected Studies on Efficiency Analysis in the Construction and Real Estate Sector

| Author | Industry | Methodology | Input Variables | Output Variables | Key Findings |
|---|---|---|---|---|---|
| You and Zi (2007) | Construction | DEA | Labor, Capital, Materials | Output value of construction | Efficiency variation across firm sizes |
| Dzeng and Wu (2013) | Construction | DEA (Malmquist Index) | Labor, Subcontracting costs, Equipment usage | Construction output, Project value | Dynamic efficiency changes over time |
| Li et al. (2013) | Construction | SFA (Translog) | Capital, Labor, Materials | Total construction output | Inefficiency linked to firm size and regulations |
| Park, Yoo, Lee, Kim, and Kim (2015) | Real Estate Dev. | DEA + Tobit Regression | Land cost, Labor, Equipment, Financial resources | Housing units completed | Determinants of firm inefficiency |
| De Jorge-Moreno, de Jorge-Huertas, and Rojas-Carrasco (2016) | Real Estate | DEA | Financial resources, Labor | Business performance index | Small firm performance in real estate |

### 2.5.2 Malaysian Studies on Property Firm Performance

While efficiency measurement in the real estate sector has received significant attention in countries such as the United States, United Kingdom, South Korea, and Singapore, empirical research within the Malaysian context remains limited. International studies

frequently employ Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) to evaluate firm-level productivity, cost efficiency, and the role of institutional frameworks. In contrast, Malaysian studies tend to emphasize housing affordability, market cycles, and policy reforms, with relatively little focus on operational efficiency among property developers. This gap highlights the need for more rigorous empirical investigation into how Malaysian firms manage production inputs and cost structures under evolving regulatory and market conditions.

The Malaysian housing industry consists of two main types of developers: public and private. Public developers are typically aligned with government policies and social housing objectives, while private developers operate with greater autonomy and are driven by profit incentives. As Goh (1997a) notes, private developers are the primary suppliers of medium- and high-cost housing, making them central actors in Malaysia's formal housing supply. Despite their significance, studies examining their operational or technical efficiency remain limited. Much of the existing literature has focused on housing policy (Agus, 2002), supply dynamics (Malpezzi & Mayo, 1997), planning regulations (Bertaud & Malpezzi, 2001), design issues (Abdul-Rahman et al., 1999; Al-Obaidi & Woods, 2006), and consumer preferences (Lee & Ng, 1996), rather than on firm-level performance metrics.

Moreover, the strong market performance of private housing developers has often been attributed to favorable macroeconomic conditions and rising property demand. These

firms licensed to undertake and profit from housing development have leveraged economic growth to achieve high returns. However, profitability alone does not reflect how efficiently firms manage resources. This reinforces the need to evaluate production and cost efficiency using firm-level data, especially considering input constraints, regulatory complexity, and varying firm characteristics across the sector.

Firm-level resource endowments play a critical role in shaping performance outcomes in Malaysia's housing development sector. Abdul Aziz, Ho, and Jaafar (2006), adopting a resource-based view, identify key strategic assets such as land banks, financing access, skilled personnel, and institutional networks. Among these, location stands out as a major determinant of success, influencing both the market appeal and profitability of housing projects. Developers operating in high-demand or well-connected areas are often better positioned to respond to market dynamics and secure faster returns. Although the study does not employ formal efficiency models, it offers important insights into how resource advantages particularly locational factors can drive firm-level disparities. These disparities provide a strong basis for including location as a firm-specific variable in the production and cost efficiency models used in the present study.

Although not directly focused on efficiency measurement, the study by Jaafar, Nuruddin, and Syed Abu Bakar (2015) offers valuable insights into the internal dynamics of Malaysian housing developers by examining their managerial capabilities. The study highlights how competencies such as strategic planning, innovation, and networking

contribute to overall firm performance in the property development sector. These capabilities enable firms to better navigate regulatory complexity, respond to market fluctuations, and manage project-related risks. While the study does not employ formal parametric or non-parametric efficiency measurement techniques, it underscores the importance of firm-level characteristics and managerial quality as underlying factors influencing performance. As such, these findings support the inclusion of variables such as firm size, ownership structure, and managerial experience as potential determinants of inefficiency in empirical analyses of production and cost efficiency.

A notable empirical contribution within the Malaysian context is the study by Abdullah, Maamor, and Abd Karim (2019), which evaluates the technical efficiency of 67 listed real estate firms using Data Envelopment Analysis (DEA) based on data from the year 2012. The analysis uses key inputs such as total assets, operating expenses, and number of employees, with revenue and net profit as output variables. The results reveal an average technical efficiency score of approximately 76 percent, suggesting considerable variation in firms' ability to convert resources into financial outcomes. The study further examines correlates of efficiency, showing that firms with larger asset bases and lower financial leverage tend to perform more efficiently. While the study offers valuable insights into firm-level efficiency in Malaysia's property sector, its cross-sectional design presents a limitation in capturing dynamic performance over time. Nonetheless, it provides an important empirical foundation and highlights the need for longitudinal approaches, such as Stochastic Frontier Analysis (SFA), to assess time-varying inefficiency in the industry.

Universiti Utara Malaysia

In summary, while there have been efforts to explore firm performance among Malaysian property developers by examining managerial capabilities and resource-based perspectives, formal efficiency analysis using frontier-based methods remains underdeveloped. Studies employing non-parametric approaches, such as DEA, have provided useful insights, yet they are often constrained by limited data scope, cross-sectional design, or methodological depth. Moreover, there is a lack of studies that distinguish between production and cost efficiency or incorporate time-varying inefficiency effects critical aspects for understanding dynamic firm performance.

## 2.6 Empirical Evidence on Firm-Specific Determinants of Inefficiency

A growing body of empirical research especially from the industrial organization (IO) perspective recognizes that firm-level characteristics are key drivers of efficiency variation across industries. This study focuses on five prominent attributes: firm size, location, steel and cement input tariffs, subsidiary status, and establishment type. These characteristics are not only observable and measurable but also align with structural and strategic factors emphasized in the SCP paradigm. For instance, firm size relates directly to economies of scale (EOS), affecting both production capacity and cost absorption. Geographic location captures access to urban markets, labor, and infrastructure, which are especially relevant in the property sector. Tariffs on steel and cement two core construction inputs reflect firms' exposure to input cost shocks and regulatory distortions.

Universiti Utara Malaysia

Meanwhile, subsidiary status and establishment type offer insight into governance structure, decision-making autonomy, and institutional flexibility. These variables serve as key inefficiency determinants in the stochastic frontier models used in this study and provide a critical link between IO theory and empirical modeling. The following sub-sections examine key firm-specific determinants firm size and EOS, location, input tariff exposure (steel and cement), subsidiary status, and establishment type each of which plays a distinct role in shaping inefficiency patterns within the Malaysian property sector.

### 2.6.1 Firm Size

Firm size is a central determinant of efficiency in the property development sector, particularly due to the capital-intensive and long-duration nature of construction projects. From an IO perspective, firm size is a structural characteristic that affects conduct and performance through its influence on cost behavior, market strategy, and resource coordination. In this context, total assets serve not only as a proxy for firm scale, but also for strategic depth reflecting the firm's capacity to undertake multiple large-scale projects, leverage financial resources, and withstand market fluctuations.

Larger firms may realize economies of scale (EOS) by spreading fixed costs across more output, improving bargaining power with contractors and suppliers, and gaining easier access to financing all of which can enhance both production and cost efficiency. As argued by Scherer (1980), scale advantages are particularly pronounced in industries with high fixed costs and cyclical demand, where large firms can better absorb shocks and operate more predictably. Caves (1992) also highlights that internal specialization and

capital allocation improve with size, supporting superior project execution and cost control.

However, the IO literature also warns against an uncritical view of scale advantages. Beyond a certain point, firms may encounter diseconomies of scale, including coordination inefficiencies, bureaucratic delays, and asset underutilization. In property development, where projects are complex, multi-phased, and location-dependent, excessive size may hinder responsiveness, leading to operational slack or strategic inertia. These opposing forces make firm size a nonlinear determinant of efficiency offering benefits up to a point, but posing risks when expansion is not matched by internal adaptability.

Universiti Utara Malaysia

In the Malaysian context, Aziz et al. (2006) find that larger property developers tend to outperform smaller firms in project delivery and financial management, owing to their stronger capital base and diversified operations. These empirical observations align with IO theory and the theory of the firm, which posit that asset-rich firms are more capable of achieving higher efficiency levels through economies of scale. Firm size commonly measured by total assets thus remains a widely accepted proxy for structural scale in the literature, offering insight into a firm's capacity to reduce costs, absorb risk, and coordinate production activities more effectively. As such, size continues to be a prominent explanatory factor in studies examining production and cost inefficiency,

especially in sectors characterized by high fixed investment and strategic asset accumulation, such as real estate development.

Similarly, Jaafar et al. (2015) emphasized that managerial capabilities, often more developed in larger organizations, are crucial for translating strategic resources into actual performance, particularly in navigating Malaysia's complex regulatory landscape. Abu Jarad et al. (2010) further observed that developers with more formalized organizational structures and clearer strategic orientation attributes commonly associated with larger firms exhibited stronger performance outcomes. These studies collectively suggest that firm size, while not a guarantee of efficiency, enhances a firm's potential to utilize resources effectively and adapt to institutional and market pressures.

Universiti Utara Malaysia

Firm size is widely regarded as a significant determinant of efficiency, particularly in capital-intensive industries such as property development. From the industrial organization perspective, Demsetz (1973) argued that firm size and profitability often reflect superior efficiency rather than mere market power, a position further supported by Peltzman (1977) and Shepherd (1985). These scholars suggest that larger firms may achieve greater efficiency through better resource utilization, access to capital, and economies of scale.

### 2.6.2 Firm Age

Firm age is commonly used as a proxy for organizational experience, operational maturity, and cumulative learning all of which may contribute positively to efficiency. From the perspective of IO and firm theory, older firms may enjoy dynamic capabilities built over time, including institutional knowledge, better-developed routines, and long-standing relationships with suppliers, regulators, and financial institutions. These characteristics are expected to improve production efficiency, particularly in industries that require long project cycles and high coordination, such as property development.

However, the relationship between age and efficiency is not necessarily linear. While younger firms may suffer from coordination challenges or limited market experience, older firms may face organizational inertia, overstaffing, or declining flexibility factors that erode both technical and cost efficiency. As emphasized by Coad (2009), firm growth and performance do not improve indefinitely with age; rather, aging firms may struggle to adapt to new technologies or changing market conditions, leading to declining marginal returns on experience. This is particularly relevant in Malaysia's property sector, where long-established developers may rely on legacy practices that constrain innovation or delay project adaptation.

Despite the importance of age in the broader literature on firm dynamics, its use as an inefficiency determinant in stochastic frontier models remains limited, particularly in studies focused on Malaysia. Thus, by incorporating firm age and allowing for non-linear

effects (age squared), this study captures the potential duality of experience: as both an efficiency-enhancing and efficiency-reducing factor over time.

### 2.6.3 Ownership Concentration

Ownership concentration plays a pivotal role in shaping firm efficiency by influencing managerial control, monitoring intensity, and strategic alignment. In the context of IO, particularly agency theory, concentrated ownership can reduce agency costs by aligning the interests of controlling shareholders and managers. This alignment may lead to better oversight, quicker decision-making, and more disciplined cost control all of which enhance cost efficiency. However, when ownership is overly concentrated, particularly in family-dominated firms, there is also a risk of entrenchment, whereby dominant shareholders may engage in actions driven by conflicts of interest, potentially undermining firm efficiency and disadvantaging minority shareholders.

In Malaysia, ownership structures in the property sector are often characterized by family-led firms or closely held shareholdings, which creates both governance strengths and potential inefficiencies. Studies such as Demsetz and Lehn (1985) argue that ownership concentration is not exogenous but evolves in response to firm-specific risks, suggesting that its effect on efficiency may vary by context. Meanwhile, Claessens et al. (2002), in their study of East Asian corporations, highlight that concentrated ownership can either strengthen control or hinder transparency, depending on the institutional environment. Despite its prominence in corporate governance literature, the role of ownership

concentration in stochastic frontier efficiency models remains underexplored in Malaysia, making its inclusion in this study a valuable contribution to understanding how control structures influence both production and cost inefficiency.

### 2.6.4 Subsidiary and Group Structure

Notably, from an IO perspective, the formation of subsidiaries is often viewed as a strategic response to firm growth, diversification, and internal governance needs. As firms expand in relative size, they frequently face increasing complexity in managing operations across different markets, projects, and geographic areas. Meanwhile, to manage this complexity and reduce transaction costs, large firms often create subsidiaries either as legally separate entities or functionally distinct business units. This structural diversification allows firms to compartmentalize risk, specialize project execution, and coordinate across vertical segments of the value chain, such as land acquisition, construction, sales, or property management. As such, subsidiary status reflects a firm's structural choice in organizing production and administrative functions, often in response to economies of scale and scope.

In terms of production efficiency, subsidiaries may benefit from shared knowledge, internal resource pooling, and better task specialization, which can improve input utilization and reduce delays. However, they may also suffer from bureaucratic layering, coordination frictions, or conflicting priorities between parent and subsidiary units especially when autonomy is constrained. On the cost efficiency side, subsidiaries may

access internal financing or negotiate bulk procurement through their parent companies, improving cost structure. Yet, centralized decision-making or rigid approval hierarchies may lead to inefficiencies in project-level budgeting and responsiveness.

In the Malaysian property sector, many large developers operate through multiple subsidiaries, often organized around regional markets, project types, or investment vehicles. While this can provide operational flexibility and regulatory buffering, it can also introduce inefficiencies if inter-unit coordination becomes burdensome. Despite the prevalence of this structure, few empirical studies in Malaysia have examined how subsidiary status affects efficiency outcomes.

Universiti Utara Malaysia

Therefore, the relationship between firm structure and performance has been acknowledged in several studies, even if not directly within an SFA framework. Aziz et al. (2006) emphasize that large, diversified property developers in Malaysia often adopt subsidiary-based models to manage complex land banks, segment markets, and reduce risk exposure across geographically dispersed projects. This structural form allows for specialization and localized management, which can improve coordination and execution key inputs to production efficiency.

Similarly, Jaafar et al. (2007) highlight that Malaysian housing developers operating under group structures are better able to handle regulatory fragmentation, navigate

different local authority processes, and mobilize resources more effectively. This organizational flexibility supports both input efficiency and project turnaround time, particularly for firms with multiple ongoing developments.

Although the use of subsidiaries is widespread among large Malaysian property developers, there is a notable absence of empirical studies linking subsidiary status to efficiency outcomes, particularly using stochastic frontier approaches. The gap is not merely academic it is also data driven. Despite efforts to obtain subsidiary-level firm data from the Department of Statistics Malaysia (DOSM), access to comprehensive internal firm structure data remains restricted. As such, this study draws on publicly available disclosures from Bursa Malaysia-listed firms, where information on subsidiary structure is observable through annual reports and corporate announcements. This approach, while constrained by coverage, enables a meaningful assessment of how subsidiary formation used as a proxy for diversification and structural complexity affects production and cost efficiency in a sector where group-based strategies are common.

### 2.6.5 Establishment Types

Establishment type specifically, whether a firm is privately owned or government-linked (GLC) can significantly influence efficiency outcomes through differences in strategic behavior, regulatory alignment, and governance discipline. Within the IO framework, establishment type reflects deeper institutional characteristics that shape firm conduct,

including access to resources, risk-taking behavior, and market responsiveness. GLCs may benefit from preferential treatment in land acquisition, infrastructure approval, or financing, especially when aligned with government priorities in housing or national development plans. These advantages could lead to better cost efficiency, particularly in managing long-term capital costs or navigating regulatory processes.

However, public-sector-linked entities often operate under more complex governance layers, multiple stakeholder obligations, and bureaucratic procedures, which may constrain their flexibility and reduce production efficiency. In contrast, privately owned developers tend to exhibit greater autonomy and market responsiveness, allowing for faster decision-making, leaner project structures, and more aggressive cost control though often with tighter financial constraints and greater exposure to market volatility.

Universiti Utara Malaysia

Across various industry studies, private firms have consistently been found to outperform public-sector or state-linked firms in terms of efficiency, largely due to their stronger market orientation, leaner organizational structures, and performance-driven decision-making. This pattern holds across sectors such as manufacturing, utilities, and transport, where public firms may enjoy privileged access to resources but often operate under bureaucratic constraints, multi-stakeholder obligations, and weaker incentive alignment.

In the context of Malaysia's property industry, similar observations have been reported. For instance, Jaafar et al. (2007) and Abdul Aziz et al. (2006) found that private housing developers tend to be more efficient and responsive to market signals compared to their government-linked counterparts. These studies emphasize that private firms, driven by profit maximization and shareholder accountability, are generally more agile in project turnaround, cost control, and sales execution factors that directly affect both production and cost efficiency. In contrast, public-sector developers may be slowed by institutional processes, policy-driven mandates, and political oversight, which can reduce operational flexibility.

### 2.6.6 Location and Agglomeration Effects

Location plays a crucial role in shaping firm performance and efficiency within the real estate sector, particularly in land-intensive industries like housing development. The spatial fixity of real estate means that locational characteristics such as proximity to city centres, transport infrastructure, amenities, and zoning classifications are inseparable from the value, timing, and marketability of the final product. In Malaysia, Abdul Aziz, Ho, and Jaafar (2006) identify project location as one of the most significant competitive resources for private housing developers. Their study highlights that access to high-demand or strategically positioned land enables firms to achieve quicker sales, higher profit margins, and more predictable cash flows. This locational edge can translate into more efficient capital deployment and faster project turnaround, both of which enhance production and cost efficiency.

Universiti Utara Malaysia

From an IO perspective, location is an external structural condition that influences input access, market reach, and regulatory exposure. Firms situated in urban or infrastructure-rich areas may benefit from agglomeration effects, labor market depth, and streamlined logistics, while those in peripheral or underdeveloped regions often face higher costs and lower operational efficiency.

In addition to broad urban advantages, there is meaningful variation within urbanised regions, particularly between firms operating in central urban zones and those focused on suburban or fringe developments. One relevant indicator of this spatial differentiation is the number of residential projects completed annually in urban versus suburban areas, which can reflect a firm's locational strategy and market orientation. Firms with a greater concentration of projects in urban cores especially near Central Business Districts (CBDs) often benefit from more stable demand, higher land utilisation rates, and quicker approvals due to better-integrated infrastructure and regulatory coordination. Conversely, those operating predominantly in suburban or transitional zones may face different efficiency pressures, such as longer project timelines, infrastructure bottlenecks, or delayed absorption rates. As such, the spatial distribution of a firm's project portfolio serves as a proxy for location-based strategic positioning, which is theorised to influence both production efficiency and cost behaviour. This locational factor will be quantitatively operationalised in the empirical model based on firm-level development activity across urban and suburban zones.

Universiti Utara Malaysia

The significance of urban location, particularly proximity to the Central Business District (CBD), can also be contextualized through classic urban economics theory, most notably the monocentric city models developed by Alonso (1964), Muth (1969), and Mills (1972). These models posit that land values and economic activity are spatially organized around a central core (CBD), with accessibility influencing both residential and commercial land use patterns. In this framework, developers operating near the CBD benefit from superior accessibility, higher land productivity, and stronger market demand, while those located further from the core face declining land values and increased development uncertainty. This spatial variation affects not only profitability but also operational efficiency, making CBD proximity a meaningful structural variable in real estate performance. Integrating this spatial logic into the efficiency model allows the present study to capture how urban economic structure influences firm behavior and efficiency in Malaysia's property development sector.

Universiti Utara Malaysia

The importance of location is well-established in Malaysia's property industry and is not a novel consideration in market analysis or policy discourse. The Valuation and Property Services Department (JPPH) has long recognized the role of spatial variation in shaping property outcomes. In its Annual Property Market Report, JPPH classifies transaction data and development trends by state, district, and urban hierarchy, consistently highlighting locational factors such as proximity to urban centres, infrastructure access, and development corridors. These classifications reflect the institutional acknowledgment that real estate performance is geographically uneven, and that location remains a core determinant of market value, absorption rates, and development feasibility. The

integration of location as a structural variable in this study builds upon this established framework, while extending its application to firm-level efficiency analysis through the stochastic frontier approach.

### 2.6.7 Inputs Tariff Liberalization

In material-intensive industries such as property development and construction, input market conditions play a pivotal role in shaping firm-level efficiency. Among these, steel and cement stand out as the two most essential building materials. According to the Construction Industry Development Board (CIDB), reinforced steel (17.32%) and ready-mixed concrete and cement (14.91%) together account for over 32% of total material costs in residential construction. These two inputs form the structural core of most projects, with direct implications for project timelines, cost management, and resource utilization. Given their weightage in the Building Material Cost Index (BMCI), changes in their price or availability significantly impact both production efficiency through material planning and usage and cost efficiency, especially through procurement strategies and contract pricing.

Universiti Utara Malaysia

The liberalization of Malaysia's steel and cement industries unfolded gradually, culminating in the removal of price controls and import restrictions in 2008. Prior to that, both sectors were subject to extensive government regulation, including import tariffs, licensing requirements, and price ceilings aimed at protecting local producers. These interventions, while stabilizing prices in the short term, created market inefficiencies such as distorted pricing signals, material shortages, and uneven access especially during

housing booms. Between 2004 and 2008, the Malaysian government progressively dismantled these controls. Thus, by June 2008, Approved Permits (APs) for steel imports were abolished, and prices for steel bars and cement were allowed to be determined by market forces. The stated policy intent was to reduce material bottlenecks, encourage competition, and support the broader construction ecosystem.

From an IO perspective, this liberalization represents a structural shift in input market dynamics, directly influencing firm behavior. Input tariffs, when in place, act as cost distortions particularly for small- and mid-sized developers with limited bargaining power. In terms of production efficiency, restricted access to affordable inputs can delay project execution or force overuse of suboptimal materials. In terms of cost efficiency, firms facing higher input prices are less able to optimize cost structures, especially when price controls prevent substitution or timing flexibility.

Universiti Utara Malaysia

The relevance of trade liberalization for firm performance in developing economies is clearly outlined by Tybout (2000), who emphasizes that outcomes depend on institutional quality, firm heterogeneity, and input market structures. In previously protected sectors such as Malaysia's steel and cement industries, liberalization can significantly affect firm efficiency. Tybout argues that reducing barriers on intermediate goods encourages resource reallocation, procurement adjustments, and cost improvements, leading to productivity gains. These effects are especially relevant in input-intensive sectors like property development.

Amiti and Konings (2007) provide one of the most relevant empirical studies on input market liberalization, examining the effects of trade reforms on Indonesian manufacturing firms. Using firm-level panel data and disaggregated tariff rates on both outputs and intermediate inputs, they find particularly imported materials had a significantly greater positive impact on productivity than output tariff reductions. Firms more dependent on imported input experienced the largest gains, driven by lower input costs, improved resource allocation, and access to higher-quality materials. Their findings underscore the importance of input-side liberalization in enhancing firm performance, particularly in input-intensive industries. This evidence is especially pertinent to the Malaysian property sector, were steel and cement function as critical intermediate goods.

While influential, the Melitz (2003) model provides a perspective centered on firm heterogeneity in export performance. It posits that trade liberalization triggers a reallocation of resources toward more productive firms, which survive and expand into export markets, while less efficient firms exit. This dynamic has been validated across various export-oriented manufacturing sectors. However, the Melitz framework primarily addresses output-side liberalization and firm selection in global markets, offering limited relevance to intermediate input liberalization or to domestic, non-exporting sectors such as property development. In the Malaysian context, where firms in the housing sector operate largely within domestic markets and face high dependence on key construction inputs, the assumptions underlying Melitz are less applicable. Instead, firm performance is shaped more by input costs, accessibility, and regulatory constraints than by export dynamics.

Universiti Utara Malaysia

Although lower input tariffs are commonly associated with reduced production costs and enhanced firm competitiveness, their actual impact can vary considerably depending on firm-specific factors such as capabilities, strategic orientation, and adaptability. Recent literature emphasizes the importance of heterogeneity in firm responses to trade liberalization, suggesting that only firms with sufficient absorptive capacity or flexibility may fully capitalize on improved input access (Amiti & Konings, 2007; Topalova & Khandelwal, 2011). As such, understanding how downstream firms adjust to input-side liberalization whether through productivity gains, cost efficiency improvements, or operational restructuring is critical to capturing the broader implications of trade reform. In input-intensive sectors like real estate development, where intermediate goods such as steel and cement constitute a substantial share of total costs, the efficiency effects of tariff reductions are particularly salient.

Universiti Utara Malaysia

## 2.7 Research Gap

Although the Malaysian property development sector has received considerable attention in relation to housing policy, market dynamics, and firm-level financial outcomes, empirical studies that rigorously assess firm-level efficiency remain limited. First, most existing research does not apply frontier-based econometric methods, such as Stochastic Frontier Analysis (SFA), to disentangle technical inefficiency from allocative inefficiency. In contrast, studies from countries such as Korea, Taiwan, and Spain have increasingly adopted dual-frontier models to evaluate how firms utilize inputs and manage costs over time. The absence of such methodological approaches in the Malaysian context

limits our understanding of the internal performance dynamics of property firms, particularly in relation to their production and cost behavior.

Third, the liberalization of steel and cement tariffs during the 2008-2009 period represented a significant policy shift with direct implications for construction input costs. However, no study to date has systematically examined whether this tariff reform led to measurable improvements in firm-level efficiency, especially among listed developers whose cost structures are highly exposed to material price fluctuations.

Fourth, existing literature does not sufficiently account for firm heterogeneity such as size, ownership concentration, subsidiary status, age, location, and establishment type in explaining efficiency outcomes. These structural characteristics are central to understanding how firms respond to policy changes and competitive pressures, particularly within a market that exhibits both institutional constraints and ownership concentration.

Universiti Utara Malaysia

These research gaps highlight the need for a more rigorous, panel-data-based efficiency analysis that integrates both production and cost frontiers, incorporates economies of scale, evaluates the effects of input market liberalization, and captures firm-specific characteristics. This study aims to fill these gaps in alignment with its four objectives and contribute to the empirical literature on firm performance in emerging property markets,

while also informing policy debates surrounding housing supply, cost efficiency, and the role of listed developers in Malaysia's property industry.

## 2.8 Summary

This chapter outlined the key theories and empirical studies relevant to firm efficiency in the property sector. It highlighted how Industrial Organization (IO) theory, X-efficiency, and New Institutional Economics (NIE) explain variations in firm performance, focusing on factors such as firm structure, market conditions, and institutional quality. The review also identified common sources of inefficiency including ownership patterns, subsidiary structures, and regulatory constraints. A comparative synthesis of Malaysian and international evidence informs the specification of the empirical models in subsequent chapters.

Universiti Utara Malaysia

These theoretical and empirical insights provide the basis for the empirical framework developed in Chapter 3. The next chapter outlines the specification of the stochastic frontier models, defines the input and output variables, and introduces the firm-level determinants used to estimate production and cost inefficiency.

# CHAPTER THREE

# METHODOLOGY

## 3.0 Introduction

In the previous chapters, the study established the importance of analyzing efficiency in the Malaysian residential property sector. Chapter One outlined the background, policy context, and research motivations, while Chapter Two reviewed key theoretical and empirical contributions related to firm efficiency, economies of scale, and the influence of structural and policy factors particularly the liberalization of construction material tariffs. Thus, these chapters justified the need for a robust analytical framework to evaluate how property firms utilize resources and respond to industry-specific challenges.

Universiti Utara Malaysia

The chapter is organized into three main components. First, it presents the stochastic production frontier model, which incorporates firm-specific and policy-related variables into the inefficiency effects function to evaluate technical efficiency. Second, it introduces the stochastic cost frontier model, estimating cost inefficiency based on input prices and output levels. Third, it examines economies of scale to assess whether larger firms achieve cost advantages or encounter diseconomies as they expand. In aggregate, these models provide the empirical foundation for analyzing firm-level efficiency in relation to structural characteristics and policy reforms.

## 3.1 Production Efficiency Analysis

In this study, property firms are conceptualized as developers operating within competitive markets and utilizing multi-input, multi-output production technology. The notion of efficiency and its counterpart, inefficiency is deeply rooted in production economics and has important normative and empirical implications. While conventional theory assumes firms operate on the production frontier efficiently converting inputs into maximum possible output real-world firms often deviate from this ideal. Such deviations may arise from X-inefficiency (Leibenstein, 1966), allocative inefficiency, or constraints related to firm structure, information asymmetries, and market imperfections. These factors can result in suboptimal input combinations, underutilization of resources, or ineffective cost management. As a result, not all property firms reach technically efficient production levels, even if they remain operational or profitable. This empirical reality reinforces the need for a stochastic frontier approach to disentangle true inefficiency from random shocks and firm-specific heterogeneity.

Universiti Utara Malaysia

To estimate firm-level production efficiency, this study applies a stochastic frontier model that separates the error term into two components: a symmetric random error ($V_{it}$) capturing statistical noise, and a one-sided non-negative term ($U_{it}$) representing technical inefficiency. Inefficiency scores are estimated using the conditional expectation method of Jondrow et al. (1982). Thus, to account for variation across firms and over time, the inefficiency term is modeled as a function of observable firm characteristics, following Battese and Coelli (1995).

This framework integrates panel data from Malaysian property developers over the 2000-2020 period to estimate technical efficiency and its firm-level determinants. Using a stochastic frontier model, we assess how efficiently firms transform inputs into outputs and how structural and policy-related factors such as firm size, ownership structure, and tariff liberalization contribute to inefficiency. This empirical approach provides a basis for the next section, where we outline the conceptual and econometric foundations of efficiency analysis in the property sector.

### 3.1.1 Conceptual Framework: Efficiency in the Property Sector

The property development sector is a critical component of Malaysia's economic and urban development agenda (NAPIC, 2024). It contributes significantly to national output by stimulating activity in related sectors such as construction, finance, and building materials, while also serving a vital social function by delivering housing and commercial infrastructure. Despite its strategic importance, the sector is frequently affected by inefficiencies arising from regulatory bottlenecks, escalating input costs, market fluctuations, and firm-level structural heterogeneity (Cagamas, 2013). These inefficiencies often manifest in resource misallocation, cost overruns, project delays, and ultimately, diminished productivity across the industry.

In this study, production efficiency is defined as a firm's ability to maximize output measured by sales revenue given a set of inputs comprising labor, capital, and materials.

A firm is considered technically efficient when it operates on the production frontier, utilizing the minimum required inputs to produce a given level of output. Conversely, firms that operate below this frontier are deemed inefficient due to underutilization of resources or suboptimal production processes. In the context of property development, such inefficiencies may be attributed to poor project coordination, limited access to financing, supply chain disruptions, or ineffective cost management.

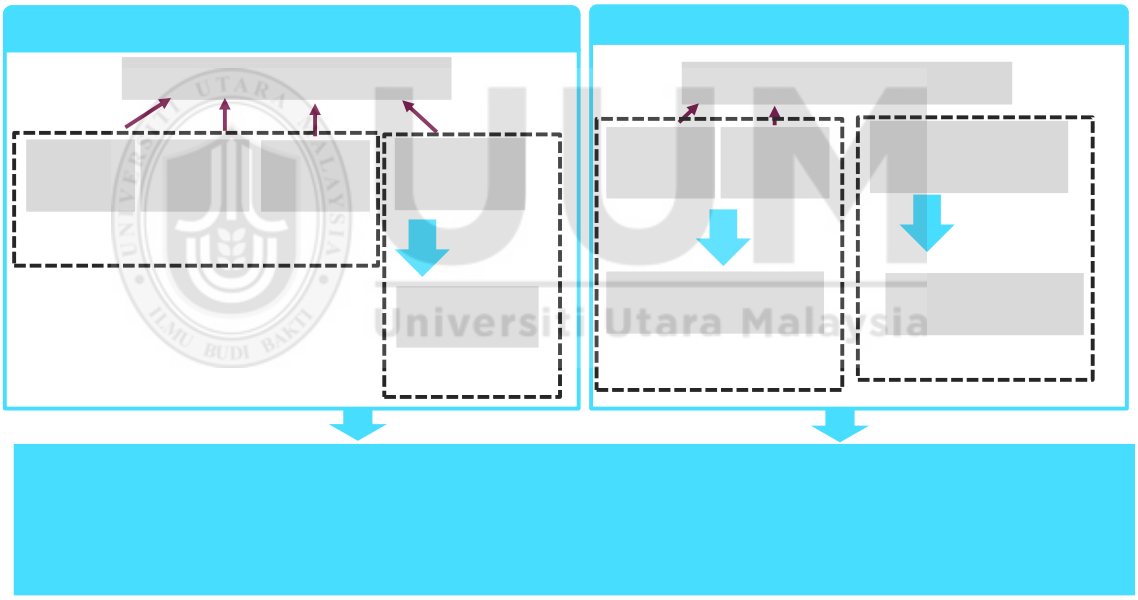
Given its institutional complexity and developmental dynamics, the property development sector is particularly well-suited for an in-depth efficiency analysis. It is both capital- and land-intensive, characterized by long project cycles and shaped by regulatory approvals, zoning constraints, and volatile construction input costs. The sector is also inherently cyclical, responding to macroeconomic conditions, interest rate movements, and speculative demand. These factors contribute to wide variations in how firms organize production, allocate resources, and respond to market signals resulting in significant heterogeneity in efficiency across firms.

The figure below (Figure 3.1) outlines the methodological framework employed in this study. It operationalizes the conceptual understanding of firm efficiency by adopting a dual estimation strategy that encompasses both production and cost efficiency models. The approach begins with the specification of a stochastic production frontier to estimate technical efficiency, followed by a cost frontier model to evaluate allocative and overall cost efficiency. Both models incorporate firm-specific characteristics and policy-related

Universiti Utara Malaysia

variables as inefficiency determinants. The framework culminates in the estimation of economies of scale (EOS), derived from the cost function, to assess the potential for efficiency gains through scale adjustments. This structure provides a coherent and systematic link between theoretical constructions, empirical modeling, and policy-relevant outcomes.

**Figure 3.1: Methodological Framework for Efficiency Analysis**



The methodological approach adopted in this study is grounded in a priori developments within the field of efficiency analysis. Seminal contributions such as Aigner, Lovell, and Schmidt (1977), Meeusen and van den Broeck (1977), and the later refinements by Schmidt and Lovell (1979), as well as Battese and Coelli (1995) have established the

stochastic frontier framework as a robust tool for estimating firm-level inefficiency. These models provide the theoretical underpinnings and econometric structure on which this study is based.

However, while these approaches are widely applied in agriculture, manufacturing, and services, their application to the property development sector remains relatively limited, particularly in the Malaysian context. This study therefore aims to make a distinct empirical contribution by applying the stochastic frontier framework to a panel of Malaysian property firms. In doing so, it not only tests the applicability of established models in a new industrial setting but also extends the literature by incorporating tariff liberalization variables (steel and cement) as inefficiency determinants, along with firm-specific structural attributes.

Universiti Utara Malaysia

This dual contribution anchored in established theory and extended through empirical innovation positions the study as both methodologically rigorous and contextually relevant to the Malaysian property industry. To operationalize this contribution, the study adopts a stochastic frontier approach to estimate firm-specific technical efficiency scores. The inefficiency effects are then modeled as a function of firm-level characteristics, including firm size, ownership concentration, establishment type, age, and subsidiary status. Additionally, the analysis incorporates external policy variables specifically, the liberalization of steel and cement tariffs which influence input prices and are expected to have a direct impact on production efficiency.

This conceptual foundation shapes the empirical strategy of the study. Specifically, it guides the application of a stochastic frontier model to measure technical efficiency across property firms, while also modeling the underlying drivers of inefficiency over time. These include structural firm-level factors (such as size, ownership concentration, age, and establishment type) as well as external policy variables most notably, the liberalization of steel and cement tariffs. The next section presents the formal econometric specification of the production frontier model used in the analysis.

### 3.1.2 Definitions of Technical and Cost efficiency

Technical efficiency (Equation 2.4) refers to a firm's ability to obtain the maximum output from a given set of inputs. In the context of this study, a property firm is technically efficient if it can convert labor, capital, and material inputs into housing output (sales) with minimal waste. This concept, first formalized by Farrell (1957), is central to the estimation of production frontiers, where the distance of each firm from the frontier represents its relative efficiency level.

Cost efficiency (Equation 2.8), on the other hand, considers not only the input-output relationship but also the prices of those inputs. A firm is cost efficient if it can produce a given level of output at the lowest possible cost, considering prevailing input prices. It integrates both technical efficiency and allocative efficiency the latter being the firm's ability to choose the optimal mix of inputs given their relative prices. In mathematical

Universiti Utara Malaysia

terms, cost efficiency can be decomposed as the product of technical and allocative efficiency.

In the context of the property sector, both types of efficiency are crucial. Technical inefficiency may manifest as construction delays, poor project management, or underutilization of resources. Cost inefficiency may reflect an inability to optimize input costs, especially when affected by policy changes such as tariff liberalization on steel and cement. This study estimates both technical and cost efficiency using stochastic frontier models to capture these dimensions across firms and over time.

### 3.1.3 Application of Dual Efficiency Framework

As discussed in Chapter Two, technical and cost efficiency capture different but complementary aspects of firm performance. Technical efficiency reflects a firm's ability to maximize output from a given set of inputs (Farrell, 1957; Schmidt & Sickles, 1984), while cost efficiency extends this by considering the cost-minimizing behavior of firms in relation to input prices (Battese & Coelli, 1995). This study applies both measures within a unified empirical framework to better understand the performance of property firms in Malaysia. The dual approach allows for a more comprehensive assessment of efficiency by distinguishing between pure technical inefficiency and allocative inefficiency, offering deeper insights into how firm-specific and policy-related factors affect performance.

The concept of technical efficiency, rooted in the work of Farrell (1957), refers to a firm's ability to produce the maximum possible output from a given set of inputs. However, this measure alone does not account for the prices of those inputs or whether they are used in cost-minimizing proportions. Cost efficiency extends this analysis by incorporating allocative efficiency, which reflects a firm's ability to select the optimal mix of inputs based on their relative prices. As such, a firm may be technically efficient but still cost inefficient if it overuses expensive inputs or underutilizes cheaper alternatives. Evaluating both dimensions allows for a clearer diagnosis of performance gaps.

This study adopts the time-varying stochastic frontier model proposed by Battese and Coelli (1995) to estimate firm-level technical efficiency in the Malaysian property sector. The model is suited to panel data and allows for inefficiency to vary over time and across firms. The stochastic production frontier is defined as a translog function of three key inputs: labor, capital, and materials. The composite error term includes a symmetric disturbance ($V_{it}$) capturing statistical noise and a one-sided term ($U_{it}$) representing firm-specific inefficiency.

The inefficiency effects are modelled as a function of observable firm characteristics, including firm size, location, ownership concentration, age, subsidiary status, establishment type, and exposure to tariff liberalization in steel and cement. This structure enables the analysis to assess not only how efficiently firms transform inputs into outputs but also how internal structures and external policy conditions influence performance.

Universiti Utara Malaysia

While the Malaysian property sector has experienced consistent growth over the past two decades (see Chapter 1), this expansion does not necessarily imply that firms are operating efficiently. In theory, efficiency is treated as a normative benchmark suggesting that firms which fail to use inputs effectively should eventually exit the market. However, in practice, particularly in capital-intensive and regulation-heavy sectors such as property development, firms may persist or even grow despite operating below the efficient frontier. This can occur due to access to strategic resources, favorable regulatory positioning, or institutional relationships (Ball, 2003; Somerville, 1999). Recognizing this disconnect between theoretical efficiency and market survival underscores the importance of empirical efficiency estimation, which offers a more realistic assessment of firm performance within the structural and institutional context of Malaysia's property sector. The following section operationalizes this framework through the specification of the stochastic frontier production model.

Universiti Utara Malaysia

## 3.2 Stochastic Frontier Production Model

First, for the estimation of firm-level efficiency, this study draws on two key extensions of the stochastic frontier model: Battese and Coelli (1992) and Battese and Coelli (1995). The model developed in BC1992 introduces time-varying inefficiency, allowing efficiency scores to evolve over time a feature that aligns well with the research intention to examine firm performance over an extended period. However, while BC1992 captures dynamic efficiency patterns, it does not account for observable firm characteristics that may influence inefficiency.

Secondly, to address this limitation, the BC1995 model is employed, which extends the BC1992 framework by modelling the inefficiency term as a function of firm-specific explanatory variables. This specification enables inefficiency to be explained using structural and policy-related factors, such as firm size, ownership concentration, establishment type, and exposure to construction material tariffs. The combination of BC1992's dynamic structure and BC1995's inefficiency effects model enhances the explanatory power of the analysis, making it both methodologically robust and policy relevant. The subsequent section specifies the functional form of the stochastic production frontier using a translog formulation to capture flexible input relationships.

### 3.2.1 Functional Form: Translog Production Function

This study adopts the translog (transcendental logarithmic) production function as the functional form for estimating the stochastic frontier. The translog specification is a second-order flexible functional form that allows for variable elasticities of substitution among inputs and accommodates interactions between them. Compared to the restrictive Cobb-Douglas form, the translog function is better suited for capturing the complex, nonlinear relationships that characterize production processes in the property development sector, where input combinations, scale, and technology vary across firms and over time.

The stochastic translog production frontier is specified as follows:

$$Ln\, Y_i = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln M_{it} + \frac{1}{2}\beta_{11}(\ln L_{it})^2 + \frac{1}{2}\beta_{22}(\ln K_{it})^2 + \frac{1}{2}\beta_{33}(\ln M_{it})^2 + \beta_{12}(\ln L_{it}\ \ln K_{it}) + \beta_{13}(\ln L_{it}\ \ln M_{it}) + \beta_{23}(\ln K_{it}\ \ln M_{it}) + V_{it} - U_{it} \quad (3.1)$$

where,

$Y_i$ is the output (sales revenue) of firm i at time t,

$L_{it}, K_{it}, M_{it}$ and represent labor, capital, and material inputs, respectively,

$\beta_0$ is the constant or intercept term,

$\beta_1, \beta_2, \beta_3$ are the first-order coefficients measuring the elasticities of output with respect to each input,

$\beta_{11}, \beta_{22}, \beta_{33}$ are the second-order coefficients (squared terms) that allow for curvature in the production surface,

$\beta_{12}, \beta_{13}, \beta_{23}$ are the cross-partial (interaction) coefficients capturing substitution effects between inputs,

$V_{it} \sim N(0, \sigma_V^2)$ is a two-sided random error term capturing statistical noise,

$U_{it} \geq 0$ is a one-sided non-negative error term capturing firm-specific technical inefficiency.

Therefore, the use of the translog production function (3.1) has several important implications for the analysis of efficiency in the property sector. First, unlike the Cobb-Douglas form, the translog allows for non-constant returns to scale, which is crucial for evaluating whether larger firms in the industry benefit from increasing scale economies or face diminishing returns. This flexibility enables the estimation of firm-specific scale efficiency and supports later computation of economies of scale. Second, the model accommodates input interaction effects through cross-partial terms. These allow the

Universiti Utara Malaysia

estimation to capture substitution or complementarity between inputs, such as how firms might trade-off between labor and materials depending on project complexity or scale. Lastly, the translog form supports firm heterogeneity in production behavior, making it particularly suitable for the Malaysian property sector, where firms differ widely in size, structure, and resource allocation. Reflecting this variability in the model strengthens the robustness and relevance of the efficiency estimates derived.

This specification is consistent with the stochastic frontier modeling framework proposed by Battese and Coelli (1995) and is particularly appropriate for modeling production in a capital-intensive and heterogeneous industry such as property development. It also provides the flexibility required for later estimating economies of scale, which is one of the key objectives of this study.

Universiti Utara Malaysia

### 3.2.2 Empirical Specification

First, the stochastic frontier production function adopted in this study follows Battese and Coelli (1995), who introduced a model with time-varying inefficiency effects, specified for panel data with observations on a sample of *N* firms over *T* time periods. The model assumes an exponential stochastic frontier specification, expressed as:

$$Y_{it} = \exp(x_{it}\beta + V_{it} - U_{it}) \quad (3.2)$$

where,

$Y_{it}$ denotes the production at the *i*-th observation $(t = 1, 2, \dots, T)$ for the *i*-th firm $(i = 1, 2, \dots, N)$,

$x_{it}$ is a (*1 x k*) vector of values of known functions of inputs of production and other explanatory variables associated with the *i*-th firm at the *t*-th observation,

β is a (*k x 1*) vector of unknown parameters to be estimated,

$V_{it} \sim N(0, \sigma_v^2)$ is a two-sided symmetric error term capturing statistical noise,

$U_{it} \geq 0$ is a one-sided non-negative error term representing technical inefficiency.

The inefficiency term $U_{it}$ is modelled as a function of firm-specific explanatory variables, following the inefficiency effects model proposed by Battese and Coelli (1995):

$$U_{it} = z_{it}\delta + W_{it} \quad (3.3)$$

where,

$z_{it}$ is a (*1 x m*) vector of variables explaining inefficiency (e.g., firm size, ownership, location),

δ is an (*m x 1*) vector of parameters to be estimated,

$W_{it}$ is a truncated-normal random variable with mean zero and variance $\sigma_u^2$,

such that $W_{it} \geq -z_{it}\delta$.

Universiti Utara Malaysia

Equation (3.2) defines the stochastic production frontier in terms of observed output, while Equation (3.3) explicitly models the inefficiency component as a function of firm-specific characteristics. In this framework, some explanatory variables in the inefficiency model may also appear in the production function, consistent with the assumption that inefficiency effects are stochastic and may depend on factors influencing production behavior.

This structure generalizes several well-known models in stochastic frontier literature. For example, when the first *z*- variable in the inefficiency model is set to one and all other δ -

coefficients are zero, the model simplifies to the specification proposed by Stevenson (1980) and further developed in Battese and Coelli (1988, 1992). In cases where all δ - coefficients are equal to zero, the inefficiency term becomes independent of firm-specific variables, resulting in the standard half-normal model introduced by Aigner, Lovell, and Schmidt (1977). Additionally, if the model incorporates interaction terms between firm-specific variables and inputs, it becomes a non-neutral stochastic frontier, consistent with the framework suggested by Huang and Liu (1994).

Second, the distributional assumption for $U_{it}$ implies that $U_{it}$ follows a truncated normal distribution with mean $z_{it}\delta$ and variance $\sigma_u^2$ . This specification differs from Reifschneider and Stevenson (1991), where the inefficiency effects are assumed to follow a truncated distribution with a non-negative mean. In contrast, BC1995 allows for a mean $z_{it}\delta$ that may be negative for some observations, which adds flexibility in modelling heterogeneity in inefficiency. It is further assumed that $U_{it}$ and $V_{it}$ are independently distributed for all i = 1, 2, …, N and t =1, 2, …, T. While this is a simplifying assumption, it is commonly applied in the stochastic frontier literature.

Third, the model parameters are estimated using the method of Maximum Likelihood Estimation (MLE) method. The likelihood function and its derivatives with respect to the model parameters are provided in Battese and Coelli (1993). The variance terms are reparametrized as

$$\sigma_s^2 \equiv \sigma_v^2 + \sigma_u^2 \text{ and } \gamma \equiv \sigma_u^2 / \sigma_s^2, \quad (3.4)$$

where $\gamma$ indicates the proportion of total variance attributable to inefficiency. This re-parameterization facilitates hypothesis testing on the presence of inefficiency and improves numerical stability in maximum likelihood estimation. The estimation procedure is implemented using LIMDEP version 9.0 (Greene, 2007), which provides robust routines for estimating stochastic frontier models with time-varying inefficiency effects. LIMDEP's built-in SFA module allows for the specification of both the Battese and Coelli (1992, 1995) models, ensuring consistent and efficient computation of the MLE parameters and firm-level inefficiency scores.

Following estimation, firm-specific technical efficiency scores are derived from the conditional expectation of $U_{it}$ , given the composed error term $\epsilon_{it} = V_{it} - U_{it}$ , using the method proposed by Jondrow et al. (1982). The technical efficiency (TE) for each firm is computed as:

$$TE_{it} = \exp(-\hat{u}_{it}) \quad (3.5)$$

where $\exp(-\hat{u}_{it})$ denotes the estimated technical efficiency (TE) score for firm *i* at time *t*. In the stochastic frontier framework, $\hat{u}_{it}$ represents the non-negative inefficiency component of the composed error term. The negative exponential transformation ensures that the resulting TE values fall strictly within the unit interval (0,1], with values closer to 1 indicating firms operating nearer to the production frontier and lower values reflecting greater inefficiency.

Universiti Utara Malaysia

This specification (3.5) implies that technical efficiency is a monotonic decreasing function of the composed inefficiency term $\hat{u}_{it}$ . The deterministic component, $z_{it}\,\delta$, captures the systematic influence of firm-specific characteristics on inefficiency, while the stochastic term $W_{it}$ introduces firm-year-specific random variation, typically assumed to follow a truncated-normal distribution to ensure non-negativity of inefficiency.

The exponential functional form ensures that the estimated efficiency scores lie in the interval $0 < TE_{it} \leq 1$, where a value of 1 denotes full technical efficiency, and values closer to 0 indicate higher degrees of inefficiency. This formulation enables the empirical identification of the marginal effects of covariates on inefficiency, while allowing for time-varying and cross-sectional heterogeneity in the efficiency distribution.

Universiti Utara Malaysia

### 3.2.3 Comparative Framework for Inefficiency Modeling

First and foremost, this study adopts a stochastic frontier modeling approach to estimate technical efficiency and identify its firm-level determinants. Two established panel data specifications are considered: Battese and Coelli (1992), which models inefficiency as time-invariant, and Battese and Coelli (1995), which extends the earlier specification by allowing inefficiency to vary over time and be influenced by exogenous variables.

Secondly, the BC92 model assumes that inefficiency effects are specific to each firm but constant across time. It does not incorporate firm-specific variables as explanatory factors

for inefficiency, making it appropriate for cases where the objective is to estimate technical efficiency scores without analyzing the drivers of inefficiency. In contrast, the BC95 specification models inefficiency as a function of both time and firm-specific characteristics, including size, ownership structure, age, and exposure to input cost policy changes such as steel and cement tariff liberalization. This one-step model integrates the inefficiency effects directly into the estimation of the frontier, thus avoiding potential bias from two-stage procedures and enhancing the statistical efficiency and interpretability of parameter estimates.

Thus, given the availability of panel data for 76 Malaysian property firms over a 21-year period (2000-2020), and the research aim of understanding structural and policy-related factors influencing efficiency, the BC95 model is used as the primary estimation framework. However, the BC92 model is also estimated for comparative purposes, and its results are presented in the empirical analysis chapter to assess the robustness of findings across alternative model structures.

Universiti Utara Malaysia

The estimation of both models is carried out using the method of maximum likelihood. The likelihood function and its partial derivatives with respect to model parameters are detailed in Battese and Coelli (1993). The variance terms are reparametrized as

$$\sigma_s^2 \equiv \sigma_v^2 + \sigma_u^2 \text{ and } \gamma \equiv \sigma_u^2 / \sigma_s^2 , \qquad (3.6)$$

where $\gamma$ represents the proportion of total variance attributed to inefficiency. This framework provides a statistically rigorous basis for estimating firm-level efficiency while accounting for noise and heterogeneity in the data.

Table 3.1 presents a comparison between the Battese and Coelli (1992) and Battese and Coelli (1995) stochastic frontier models. While both are foundational approaches in efficiency analysis, the BC95 model offers enhanced flexibility by allowing inefficiency to vary across both firms and time, and to be systematically explained by firm-specific and policy-related variables. This distinction is particularly important in the context of this study, which utilizes panel data from Malaysian property firms over a 21-year period to investigate how structural characteristics (such as firm size and ownership) and external factors (such as tariff liberalization) influence production inefficiency. The ability of the BC95 model to incorporate these explanatory variables directly into the estimation process makes it a more robust and theoretically consistent choice for achieving the research objectives.

Universiti Utara Malaysia

Table 3.1: Comparative Features of the BC92 and BC95 Stochastic Frontier Models

| Feature | BC92 | BC95 |
|---|---|---|
| Inefficiency treatment | Time-invariant inefficiency | Time-varying inefficiency |
| Applicable Panel Structure | Suitable for cross-sectional or short-panel data | Designed for long panels where inefficiency may vary over time |
| Distribution of inefficiency | Assumes half-normal | Assumes truncated-normal distribution, with inefficiency modeled as a function of explanatory variables $Z_{it}$ |
| Model structure | Typically estimated using two-step or one-step SFA | One-step stochastic frontier with inefficiency effects directly incorporated |
| Appropriateness | Appropriate when no explanatory variables are used for inefficiency | Appropriate when the objective is to identify factors influencing inefficiency |

*Adapted and enhanced based on Battese & Broca, 1997.

Universiti Utara Malaysia

### 3.2.4 Empirical Model Selection

This study applies the translog stochastic frontier production function to evaluate the technical efficiency of Malaysian property firms, using the framework developed by Battese and Coelli (1995). The model is estimated using firm-level panel data from 2000 to 2020, consisting of 76 publicly listed firms, resulting in 1,596 firm-year observations. The production function accounts for three inputs: labor, capital, and materials, and allows for flexible substitution patterns and non-constant returns to scale.

The translog stochastic frontier production function is specified as follows:

$$ln\ Y_{it} = \beta_0 + \beta_1 lnL_{it} + \beta_2 lnK_{it} + \beta_3 lnM_{it}$$
$$+ \tfrac{1}{2}\beta_{11}(lnL_{it})^2 + \tfrac{1}{2}\beta_{22}(lnK_{it})^2 + \tfrac{1}{2}\beta_{33}(lnM_{it})^2 + \beta_{12}(lnL_{it}\ lnK_{it}) +$$
$$\beta_{13}(lnL_{it}lnM_{it}) + \beta_{23}(lnK_{it}lnM_{it})$$
$$+ V_{it} - U_{it}, \qquad (3.7)$$

where,

$Y_{it}$ = Output of firm *i* at time *t*, measured by total sales (in RM).

$Labor_{it}$= Number of employees and officers.

$Capital_{it}$= Fixed assets, including land, buildings, machinery, vehicles.

$Material_{it}$= Cost of sales and administrative expenses, net of labor and capital costs.

$V_{it}$= Random error term, assumed to be independently and identically distributed as ($V_{it} \sim N(0, \sigma_v^2)$.

$U_{it}$= Non-negative technical inefficiency term representing the shortfall from the production frontier.

The inefficiency term $U_{it}$ is modeled as a function of firm-specific variables:

$$U_{it} = \delta_0 + \delta_1 ln(Total\ Asset_{it}) + \delta_2 Location_{it} + \delta_3 SteelTariff_{it}$$
$$+ \delta_4\ CementTariff_{it} + \delta_5\ OwnershipConcentration_{it}$$
$$+ \delta_6\ Establishment_{it} + \delta_7 Subsidiary_{it} + \delta_8 \ln(Age_{it}) + w_{it} \qquad (3.8)$$

*Where $w_{it}$ is a truncated normal distribution error term, $w_{it} \sim N^+(0, \sigma_u^2)$*

In this specification, $U_{it}$ represents the non-negative inefficiency component, while $W_{it}$ is a normally distributed random error term truncated at zero. The explanatory variables

are firm-level characteristics hypothesized to influence technical inefficiency. These include firm size (log of total assets), geographic distribution of projects (location), trade policy indicators (steel and cement tariff rates), corporate structure variables (ownership concentration, establishment type, and subsidiary status), and firm age. This one-step estimation framework, proposed by Battese and Coelli (1995), allows inefficiency effects to be estimated simultaneously with the frontier function, improving efficiency and consistency in parameter estimation.

The variables used in the inefficiency effects model (Equation 3.8) are summarised in Table 3.2 below. The selection of these firm-specific and policy-related variables is grounded in previous empirical studies within the construction and real estate sectors. Notably, You and Zi (2007), in their analysis of construction firms in Korea, incorporated firm-level characteristics into stochastic frontier models to explain efficiency variation. Similarly, Dzeng and Wu (2013), in their study of real estate developers in Taiwan, emphasized the influence of ownership structure, firm age, and market exposure on performance outcomes.

Universiti Utara Malaysia

Table 3.2: Definitions of Inefficiency Variables

| Variable | Description |
|---|---|
| TotalAsset | Proxy for firm size, measured as the natural logarithm of total assets (ln). |
| Location | Share of projects located in a specific region or state, representing geographic concentration. |
| SteelTariff | Import tariff rate applied to steel products (%). |
| CementTariff | Import tariff rate applied to cement products (%). |
| OwnershipConcentration | Percentage of shares held by the top three shareholders (%) |
| Establishment | Dummy variable: 1 = private firm; 0 = state-owned (GLC) |
| Subsidiary | Dummy variable: 1 = firm has a construction subsidiary; 0 = otherwise |
| Age | Firm age in years, measured in natural logarithm (ln). |

***Note:*** *All monetary values are expressed in constant Ringgit Malaysia (RM), adjusted using the GDP deflator with base year 2000.*
*The variable ln denotes the natural logarithm.*

Universiti Utara Malaysia

In addition, De Jorge-Moreno, De Jorge-Huertas, and Rojas-Carrasco (2016) examined technical efficiency in the Spanish construction sector and identified capital intensity, workforce skill levels, and macroeconomic shocks as key determinants of efficiency. Their findings also suggest that firm age can positively influence efficiency, while firm size may not have a statistically significant effect. These precedents support the inclusion of structural and institutional variables as key determinants of production inefficiency in the Malaysian property sector.

These variables are included to evaluate how firm characteristics and regulatory changes influence inefficiency across firms and over time. The following section describes the dataset used to estimate the production frontier and inefficiency effects models specified above.

## 3.3 Property Industry Data Set

The dataset used in this study is constructed from the audited financial statements and disclosures of property firms listed on Bursa Malaysia between 2000 and 2020. Although there were 99 firms classified under the property sector as of 2020, only 76 firms had consistent and complete financial records available throughout the study period. This resulted in a balanced panel of 1,596 firm-year observations.

The data include firm-level information on output, inputs, costs, ownership, firm age, and the geographic distribution of development projects. Monetary values are deflated using the GDP deflator, with the year 2000 set as the base year to adjust for inflation and ensure comparability across time. This approach to standardizing monetary variables over a long panel is consistent with practices in previous frontier efficiency studies, such as You and Zi (2007), who emphasize the importance of deflation for capturing real firm performance trends over time.

Universiti Utara Malaysia

The selection of the 2000-2020 period is both strategic and empirically relevant. First, the starting point in 2000 reflects the post-recovery phase following the 1997/98 Asian Financial Crisis a critical period in which Malaysian property firms underwent significant restructuring, recapitalization, and regulatory adjustments. Focusing on this post-crisis era allows the study to examine efficiency dynamics under more stable macroeconomic conditions, while still capturing long-term industry evolution. Second, the endpoint of 2020 marks the onset of the COVID-19 pandemic, which introduced exceptional market

disruptions and policy responses. Thus, by ending the dataset prior to the full economic fallout of the pandemic (which began in earnest in 2021), the analysis avoids contamination of efficiency estimates by exogenous shocks that could distort long-run firm behavior and structural relationships.

Notably, the number of listed property firms fluctuated significantly during the study period. In 2000, there were approximately 120 property firms listed on Bursa Malaysia. This number peaked at 147 firms by 2010, before declining to 88 firms in 2015, and modestly recovering to 99 firms by 2020. These fluctuations reflect broader trends in the market, including post-crisis restructuring, industry consolidation, and policy-driven liberalization affecting firm survival and listing status.

Universiti Utara Malaysia

Besides, Ball et al. (2010), in their examination of the UK housing market, argue that firm-level data in real estate development may reflect cyclical and location-specific effects that are not fully corrected through deflation alone. This highlights the importance of contextualizing firm performance within broader market dynamics, particularly in highly cyclical industries such as property development.

This highlights the importance of contextualizing firm performance within broader market dynamics, particularly in highly cyclical industries such as property development. In line with this, Dzeng and Wu (2013) emphasize the complexity of real estate markets, noting that firm performance is not only shaped by internal efficiency factors but also by

institutional environments, regulatory frameworks, and macroeconomic volatility. Their findings further support the rationale for incorporating firm-specific variables and sector-specific policy shocks such as tariff liberalization in efficiency models aimed at capturing real-world heterogeneity in property sector performance.

The construction of input, output, and cost variables in this study follows the methodological guidance of You and Zi (2007), who emphasize the importance of consistent and inflation-adjusted firm-level data in stochastic frontier analysis. In line with their framework, the variables used here capture labor, capital, and material inputs, as well as output and total cost, using deflated monetary values to enable comparability over time. While the underlying structure draws from their established approach, the variables have been adapted to reflect the characteristics of Malaysia's property development sector, including sector-specific cost structures and reporting practices. Table 3.3 presents the definitions of the main variables used in the production efficiency model.

Universiti Utara Malaysia

Table 3.3: Definitions of Inputs, Output and Costs

| Category | Variable | Definitions |
|---|---|---|
| Input | Labor | Number of employees and officers |
| Input | Capital | Land, buildings, equipment, machinery, and transportation assets |
| Input | Materials | Total operating expenses minus labor and capital costs (in RM) |
| Output | Sales | Annual gross sales revenue (in RM) |
| Cost | Total Cost | Sum of all input costs (Labor + Capital + Material) expressed in RM |

This dataset forms the empirical basis for estimating both the stochastic production frontier and the inefficiency determinants, providing a comprehensive view of firm behavior in Malaysia's property development sector over two decades.

### 3.3.1 Choice of Properties Input and Output

The primary data used in this study are derived from the financial statements and transaction records of Malaysian property development firms listed on the Kuala Lumpur Stock Exchange, covering the period from 2000 to 2020. All monetary variables are adjusted using the GDP deflator, with the year 2000 as the base year. The GDP deflator is a broad measure of price inflation that reflects changes in the overall price level of goods and services in the economy. This adjustment ensures that all financial figures are expressed in real (constant) terms, allowing for meaningful comparisons across firms and overtime. This deflation method is consistent with the approach used by You and Zi (2007), who highlight the importance of controlling inflation in panel data efficiency studies to accurately assess real performance trends.

In line with the profitability hypothesis widely discussed in Industrial Organization literature, this study assumes that property firms behave as profit-maximizing entities operating under competitive market conditions. Firms are presumed to maximize output (proxied by sales revenue) by utilizing a combination of three primary inputs: labor, capital, and materials (Table 3.2). Labor input is proxied by the number of employees and officers reported in company filings, while capital is represented by the book value of

tangible fixed assets such as land, buildings, machinery, and vehicles. Material inputs are calculated as total operating costs net of labor and capital costs. This input-output structure forms the basis of the stochastic frontier production model applied in the efficiency analysis.

### 3.3.2 Inputs

Firstly, based on production theory, inputs consist of land, labor, capital and entrepreneurship. Production theory examines how firm, and industries transform inputs into outputs, and it highlights the relationships between key factors like labor, capital, and materials. Second, in the Malaysian property industry, labor, capital, and materials are interconnected to drive the success of property firms. Labor plays a crucial role, with skilled professionals such as property managers, architects, and engineers ensuring efficient operations, while unskilled workers handle maintenance and physical tasks.

While, capital is vital for financing property acquisitions, development projects, and technological advancements like Building Information Modeling (BIM) and smart property systems. Furthermore, materials, including construction supplies and furnishings, directly impact the quality and appeal of properties, with firms increasingly adopting sustainable and eco-friendly options. The balance and optimization of these factors are essential for property firms to thrive in Malaysia's competitive market.

Ball (2003) argued that housebuilding is well known as a cyclical industry with variations in output and prices driven by cycles in the housing market. Such volatility is typical of a consumer durable or investment goods industry where the existing stock of a good is far greater than the current output of it. New housing represents only a relatively small percentage of all the houses bought and sold in mature housing markets.

Property development, like the broader construction sector, remains highly labor-intensive and persistently constrained by skill shortages. This observation is consistent with findings by Jaafar et al. (2006) and Abdul Kadir et al. (2006), who highlight the Malaysian construction industry's heavy reliance on labor and the recurring difficulties in sourcing and retaining skilled workers. These constraints have significant implications for production efficiency, as labor quality and availability directly affect project timelines, costs, and output consistency at the firm level.

Universiti Utara Malaysia

Besides, the property industry particularly the residential sub-sector is characterized by a high degree of complexity, stemming from its fragmented structure and the interdependence between various stakeholders. One example of this is the interaction between developers and materials producers, especially in the diffusion of innovation. Rather than following a straightforward, linear trajectory, the adoption of new building materials tends to unfold recursively. Technological advances are influenced not only by innovation itself but also by regulatory approval, market acceptability, and firm-level risk tolerance. These factors feed back into how materials producers modify, delay, or

accelerate development. As a result, innovation in housebuilding is shaped by a continuous and iterative process of adjustment between technical supply and shifting market demand reflecting the broader institutional and economic complexity of the sector.

The categorization of inputs in the property sector reflects practices commonly found in other industries, such as insurance. For instance, Cummins et al. (1996) define four input types: acquisition inputs (primarily agent labor), managerial and administrative labor, fixed capital, and financial equity capital. Building on this, Cummins and Zi (1997, 1998) streamline the input structure into three broader categories labor, financial capital, and materials. A further refinement is offered by Cummins et al. (1998), who subdivide labor into two components: office labor and agent labor, while continuing to treat capital and materials as distinct inputs.

Universiti Utara Malaysia

Building on this framework, Karim and Jhantasana (2005) also define labor input as consisting of two components: home office labor ($X_1$), which includes staff and executive agents, and agent labor ($X_2$), defined as the number of active agents. Their third input, financial capital ($X_3$), refers to the amount of equity capital, consistent with Cummins et al. (1998). A fourth input, labeled business services ($X_4$), encompasses materials and physical capital expenditures, excluding direct labor costs associated with selling and servicing insurance policies.

These classifications highlight the adaptability of input definitions across sectors and provide conceptual support for defining labor, capital, and materials as primary inputs in property sector efficiency analysis. Furthermore, by incorporating interaction terms among these inputs within the translog functional form, this study captures potential complementarities or substitution effects. This allows for a more flexible and realistic representation of production technology, especially in an industry like property development where input relationships are not always linear.

### 3.3.3 Output

As shown in Table 3.3, output in this study is defined as annual sales revenue, which serves as a proxy for the total value of products and services delivered by property firms. This includes gross sales and other operating revenue, net of discounts, returns, and allowances. The use of sales as an output variable is consistent with previous efficiency studies. While physical output measures such as the number of housing units developed may be accessible, they often fail to capture the variation in project size, value, and complexity. In contrast, sales revenue integrates both quantity and quality dimensions of output, reflecting not just the number of units delivered, but also their market value, location, and type. This makes revenue a more comprehensive indicator of firm-level performance, especially in an industry where projects can vary significantly in scale and scope. Therefore, using sales as the primary output variable offers a more robust basis for evaluating production efficiency in the property sector.

Universiti Utara Malaysia

Similarly, Dzeng and Wu (2013), in their study of real estate developers in Taiwan, employed sales-based performance indicators to evaluate firm efficiency. Their analysis emphasized the relevance of financial output measures such as annual revenue in capturing the operational scale, strategic positioning, and market effectiveness of firms. This reinforces the suitability of using sales as a proxy for output, particularly in industries like property development where products are heterogeneous, and project values vary significantly. These precedents provide empirical justification for adopting sales as the output. According to production theory, output represents the quantity of goods or services produced by a firm using a set of inputs such as labor, capital, and materials.

This approach aligns with established practices in efficiency analysis, particularly in sectors characterized by heterogeneous outputs or limited access to standardized physical production data. In such contexts, financial outputs like sales revenue serve as a meaningful proxy for firm performance. Sales reflect not only the volume of output but also its market value, quality, and acceptance factors that are especially relevant in the property sector, where projects differ widely in type, scale, and location. As such, using sales as the output variable offers a theoretically consistent and empirically robust measure of production outcomes within the stochastic frontier framework.

Thus, from the perspective of production theory, output is the result of transforming inputs such as labor, capital, and materials. In this study, sales revenue is adopted as a monetary proxy for output, as it reflects both the volume and value of development activities

Universiti Utara Malaysia

especially relevant in the property sector where physical measures of output may not fully capture project heterogeneity.

### 3.4 Correlates of Property Firms' Production Inefficiency

First, to identifies the factors influencing production inefficiency among Malaysian property firms, this study incorporates a set of firm-specific and policy-related variables into the inefficiency effects model, following the Battese and Coelli (1995) specification. The dependent variable represents the firm-level technical inefficiency term ($U_{it}$) obtained from the estimated stochastic production frontier, while the explanatory variables capture both structural and policy dimensions that may affect inefficiency. These include firm size, location, ownership concentration, firm age, subsidiary status, and establishment type (private vs. state-linked), as well as two key policy indicators: steel and cement tariff liberalization.

Universiti Utara Malaysia

Secondly, this study adopts the method of maximum likelihood estimation (MLE), as proposed by Battese and Coelli (1995), for the simultaneous estimation of both the stochastic production frontier and the associated inefficiency effects model. This unified approach enables the joint estimation of production parameters and inefficiency determinants within a single framework, ensuring statistical efficiency and internal consistency.

Third, maximum likelihood estimates are obtained for both the production frontier and inefficiency components defined in Equations (3.1) and (3.2). Given the relatively large number of variables and parameters in the translog specification, several generalized likelihood-ratio (LR) tests are conducted to assess the validity of restrictions imposed on the model. These tests determine whether a more parsimonious functional form can adequately represent the data or if the full translog specification is required to capture firm-level production behavior and inefficiency patterns.

In this study, production inefficiency is modelled following Battese and Coelli (1995), where the non-negative inefficiency term is specified as $U_{it} = z_{it}\delta + W_{it}$ . The vector $z_{it}$ incorporates firm-specific and policy-related characteristics firm size, location, ownership concentration, age, subsidiary status, establishment type, and steel and cement tariff variables that systematically influence how far a firm operates from the production frontier. Through the parameter vector δ, each of these variables captures structural or policy conditions that may either reduce inefficiency (agglomeration advantages, scale-related coordination) or increase it (organizational frictions, governance constraints, limited absorptive capacity). The term $W_{it}$ represents random variation in inefficiency over time. This specification allows the SFA model to distinguish persistent, observable determinants of technical inefficiency from idiosyncratic noise, providing a structured explanation for deviations from the frontier.

Universiti Utara Malaysia

### 3.4.1 Research Hypotheses on Production Inefficiency

Based on the theoretical framework and prior empirical findings, the following hypotheses specify the expected relationships between firm-specific and policy variables and production inefficiency among Malaysian property firms:

i. Firm Size (Total Assets): Larger firms are expected to exhibit lower inefficiency due to economies of scale, stronger financial capacity, and operational stability.

ii. Location of Residential Projects: The effect of location is ambiguous. Firms focused in urban areas may benefit from infrastructure and demand agglomeration, while suburban-oriented firms may gain from lower land and construction costs.

iii. Steel and Cement Tariff Rates: Higher tariff rates are likely to raise material input costs and increase inefficiency. Conversely, tariff liberalization may reduce inefficiency by lowering production costs.

iv. Ownership Concentration: Higher concentration is expected to improve monitoring and reduce inefficiency through better governance.

v. Firm Age: Older firms are hypothesized to have lower inefficiency due to institutional learning, managerial experience, and reputation effects.

vi. Subsidiary Status: Firms with construction-related subsidiaries are expected to be more efficient due to vertical integration and better internal coordination.

vii. Establishment Type: The effect is uncertain. While private firms may respond better to market incentives, public firms might benefit from regulatory support, resulting in mixed expected outcomes.

Universiti Utara Malaysia

These hypotheses collectively provide the basis for empirically testing the structural and policy determinants of production efficiency within the stochastic frontier framework described earlier.

The eight explanatory variables included in the inefficiency effects model can be categorized into six conceptual groups based on their theoretical relationship with firm-level production inefficiency. These groups reflect key dimensions of firm behavior and policy context: (i) firm growth and scale (Total Assets), (ii) market structure and spatial orientation (Location), (iii) input cost and trade liberalization effects (Steel Tariff and Cement Tariff), (iv) ownership structure (Ownership Concentration), (v) organizational characteristics (Subsidiary and Establishment), and (vi) firm lifecycle dynamics (Age). The description and expected relationships of these variables with production inefficiency are summarized in Table 3.4.

Universiti Utara Malaysia

Table 3.4: Variables and Expected Relationships with Production Inefficiency

| Variables | Explained | Expected Sign |
|---|---|---|
| Asset | Total assets of the firm (proxy for firm size) | Negative |
| Location | Share of residential projects located in urban versus suburban areas. | Positive/Negative |
| Steel Tariff | Import tariff rate applied to steel products. | Positive |
| Cement Tariff | Import tariff rate applied to cement products. | Positive |
| Ownership | Ownership concentration (percentage of shares held by top three shareholders). | Negative |
| Age | Firm age in years (logarithmic form). | Negative |
| Subsidiary | Dummy variable: 1= firm has construction subsidiary; 0 = otherwise. | Negative |
| Establishment | Dummy variable: 1 = privately owned; 0 = state-owned. | Positive/Negative |

### 3.4.2 Firm Size

Firm size, measured by the natural logarithm of total assets (lnTA) as specified in Table 3.4, plays a fundamental role in shaping both production efficiency and strategic market behavior in the Malaysian residential property sector. From an industrial economics perspective, larger firms are expected to operate closer to the production frontier due to their ability to exploit economies of scale, standardize processes, and leverage superior access to capital and technology. These advantages typically translate into lower average production costs, enhanced project management capacity, and greater resilience to cyclical or policy-induced shocks.

However, from an IO perspective especially under the SCP framework firm size carries strategic implications beyond cost-efficiency. Large firms, as represented in Tier 5 (> RM2 billion) of Table 3.5, often act as market leader, not merely participants. Their presence contributes to a more concentrated market structure, where a relatively small number of developers control a significant share of urban land supply, premium projects, and capital-intensive developments. These firms influence inter-firm dynamics by setting pricing benchmarks, pre-empting land acquisition, and shaping design, branding, and buyer expectations.

Table 3.5: Firm Size Classification of Malaysian Property Developers (2000-2020).

| Tier | Asset Range (RM mil) | No. of Firms | Example Firms (Selected) |
|---|---|---|---|
| 1 | < 200 | 8 | Firm 1, Firm 8, Firm 15 |
| 2 | 201-500 | 23 | Firm 12, Firm 27, Firm 40 |
| 3 | 501-1,000 | 19 | |
| 4 | 1,001-2,000 | 15 | |
| 5 | > 2,000 | 11 | Firm 3, Firm 21, Firm 63 |
| **Total** | | 76 | |

Furthermore, this structural dominance is visibly reflected in the Malaysia House Price Index (MHPI) published by NAPIC, which has shown steady increases over the past two decades, particularly in high-growth urban corridors. Larger developers, through their scale economies, capital access, and branding power, exert considerable influence over price formation in both primary markets (new project launches) and, indirectly, in secondary markets. Such influence often induces smaller firms (Tiers 1 and 2) to emulate the pricing strategies and project typologies of these dominant players, reinforcing a leader follower dynamic in project location, design intensity, and affordability segmentation.

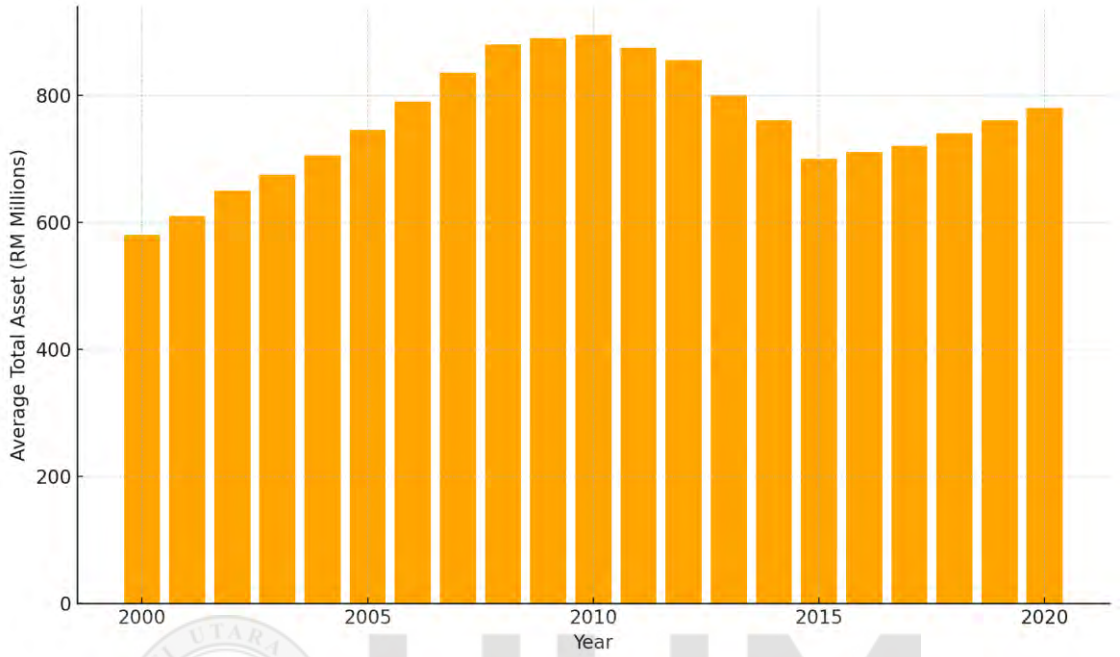
Empirical studies support this theoretical expectation. For example, You and Zi (2007) and Dzeng and Wu (2013) found a negative relationship between firm size and technical inefficiency in the construction and real estate industries in Korea and Taiwan,

respectively. Similarly, De Jorge-Moreno et al. (2016) found that firm size played a significant role in explaining technical efficiency in the Spanish construction sector, with larger firms tending to perform more efficiently due to better capital allocation and scale-related advantages. These findings reinforce the hypothesis that, as firms grow, they are likely to become more production efficient.

Figure 3.2 illustrates the trend in average total assets of listed property firms on Bursa Malaysia over the period 2000 to 2020. The vertical axis represents average total assets (in RM millions), while the horizontal axis captures the timeline in annual increments. The data reveal a rising trend in average firm size from 2000 through 2010, consistent with a phase of market expansion, asset accumulation, and increasing corporate consolidation in the post-Asian Financial Crisis recovery. This growth corresponds with a peak in the number of listed property firms around 2010 (147 firms), reflecting both heightened investor confidence and a favourable property cycle.

Universiti Utara Malaysia

**Figure 3.2: Average Total Asset of Listed Property Firms, Malaysia (2000-2020).**




Universiti Utara Malaysia

Following 2010, the average total assets continue to rise modestly, despite a sharp decline in the number of listed firms down to just 88 in 2015. This divergence suggests that industry consolidation and selective delisting removed smaller or underperforming firms from the market, leaving behind larger, more capitalized developers. The observed rise in average firm size during a period of declining firm count supports the hypothesis that larger firms became more dominant, possibly benefiting from scale economies, superior financing access, and enhanced resilience to market shocks.

Therefore, as of 2020, although the number of listed firms modestly recovered to 99, the average total asset value remained elevated, indicating the sustained presence of large,

capital-intensive firms within the sector. This indicates that capital-intensive firms have retained their position, reinforcing the notion of a two-tier market structure where only the most financially robust firms continue to operate at scale. Overall, this trend underscores the importance of firm size as a structural factor in explaining production efficiency and supports the inclusion of total assets as a key input variable in the stochastic frontier model.

### 3.4.3 Location

Location, as defined in Table 3.4, represents the proportion of residential projects developed in urban versus suburban areas by each property firm. This measure was constructed annually by calculating the share of projects completed in each zone based on disclosures in the firms' annual reports from 2000 to 2020. To supplement these firm-level data, additional information on project location, licensing status, property type, and price range was obtained from the Ministry of Local Government Development (KPKT), which maintains official records of all licensed residential developments in Malaysia. This institutional cross-verification ensures that the classification of projects by district, state, and urban or suburban category conforms to regulatory standards, thereby enhancing the reliability and validity of the location variable employed in this study.

Table 3.6 operationalizes this variable, where the dominant location type is determined by comparing the number of projects in each area. The second and third columns represent the number of residential projects developed by each firm each year, categorized into

Universiti Utara Malaysia

urban and suburban locations, respectively. The third and fourth columns illustrate the procedure used to construct the Location variable for the inefficiency effects model. The Urban Share (%) column quantifies the proportion of a firm's residential projects located in urban areas, while the Dominant Location column categorizes the firm based on this share. A firm is classified as "Urban" if most of its projects are concentrated in urban locations, providing a basis for assigning spatial attributes in the inefficiency estimation. For example, Firm 3, which completes four urban and one suburban project each year, is classified as urban-dominant for that period. This classification follows the rule that when the share of urban projects exceeds 50%, the firm is assigned an "Urban" location status in the inefficiency effects model. The approach ensures consistency by distinguishing firms based on actual project distribution rather than applying a predefined threshold.

Table 3.6: Classification of Firm-Level Location Dominance Based on Annual Residential Project Distribution

| **Firm ID** | **Urban Projects (x)** | **Suburban Projects (y)** | **Urban Share (%)** | **Dominant Location** |
|---|---|---|---|---|
| **Firm 1** | 3 | 1 | 75.00 | Urban |
| **Firm 2** | 1 | 1 | 50 | Urban |
| **Firm 3** | 4 | 1 | 80 | Urban |
| **.** | . | . | . | . |
| **.** | . | . | . | . |
| **Firm N** | x | y | $\left(\frac{x}{(x+y)}\right)$ x 100 | Urban/Suburban |

Table 3.6 illustrates the method used to classify firms by dominant project location, based on the proportion of residential developments completed in urban versus suburban areas. The urban share (%) is computed using:

$$Urban\ Share\ (\%) = \left(\frac{x}{x+y}\right)\ x\ 100 \qquad (3.9)$$

Where:
**x** is the number of urban projects.
**y** is the number of suburban projects each year.

This proportion is used to determine the firm's Location status in the inefficiency effects model. A firm is classified as "Urban" for a given year if more than 50% of its residential projects are in urban areas. This method allows the model to capture spatial influences on efficiency based on actual development activity, rather than administrative or nominal location labels.

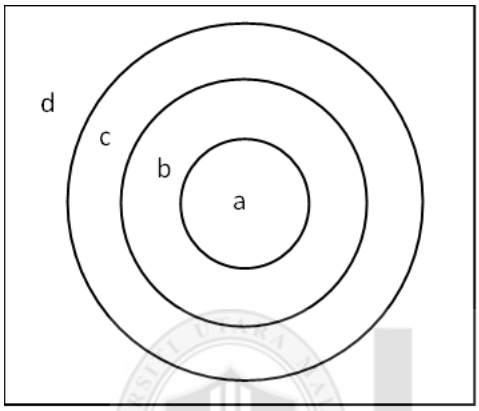
Universiti Utara Malaysia

Notably, to classify firms into urban and suburban categories, expert consultation was sought from the Valuation and Property Services Department (JPPH). Based on their guidance, the original four-tier classification from Figure 3.3, CBD, middle, outer, and fringe zones was consolidated into two broader categories for analytical purposes. Specifically, the CBD and middle zones were grouped under the urban category, while the outer and fringe zones were classified as suburban. This reclassification ensures consistency with spatial planning practices and facilitates integration into the inefficiency effects model.

This model, as developed in this study, assumes that land situated closest to the city center holds the highest strategic valued assumption grounded in classical urban economic

theory. Central locations typically offer superior access to infrastructure, labor markets, essential services, and concentrated demand. Historically, urban areas that developed around ports or railheads reflected this spatial hierarchy, as firms sought to minimize transport and coordination costs by locating them centrally.

**Figure 3.3: Classification of Residential Areas**




Legend (Petunjuk):
a – *Utama/Pusat Bandar* (Core/Central Business District (CBD)
b – *Pertengahan* (Middle/Inner City)
c – *Pinggir Bandar* (Outer)
d – *Luar Bandar* (Fringe)

Universiti Utara Malaysia

In the context of property development, proximity to urban cores continues to shape firms' project siting and operational strategies. Accordingly, the model incorporates this spatial dimension by classifying each firm's dominant project location urban or suburban on an annual basis. Here, location is operationalized not merely as a geographic identifier, but as a strategic indicator of resource accessibility and market positioning, calibrated to support the estimation of inefficiency effects.

Table 3.7 provides further clarity by outlining the composite weighting used to construct the urban dominant factor, which captures the institutional and spatial dimensions influencing a firm's locational strategy. This factor plays a critical role in distinguishing firms with urban-centric operations, thereby enhancing the explanatory power of the inefficiency model.

Table 3.7: Construction of Urban Dominance Factor Based on Institutional and Spatial Dimensions

| | **Component** | **Weight (%)** | **Justification** |
|---|---|---|---|
| 1. | Residential Project Location | 50% | Based on firm-level spatial development data (2000–2020); reflects actual urban/suburban development patterns |
| **Urban Dominance Factor** | | | |
| 2. | Land Code Variation | 20% | Adjusts for institutional complexity between Peninsular Malaysia and East Malaysia (Sabah & Sarawak) |
| 3. | Agglomeration & Industrial Economics | 15% | Captures productivity gains from clustering, infrastructure access, and spatial market concentration (IO framework) |
| 4. | Registration Procedures | 10% | Reflects improvements under MyMudah, KPKT, and local government efforts to simplify land registration |
| 5. | Digitalization of Land Records | 5% | Rewards states with fully digitized land registry systems. |
| | TOTAL | 100 | |

In addition, Table 3.7 outlines the construction of the Urban Dominance Factor, which integrates both spatial development patterns and institutional characteristics across

regions. While the primary criterion is based on the firm's urban share of projects (50% weight), the inclusion of supporting institutional dimensions such as land code variation, agglomeration effects, and administrative efficiency ensures a more nuanced classification. This becomes especially important in borderline cases where firms exhibit a balanced (50:50) distribution between urban and suburban projects. In such instances, the additional components of the Urban Dominance Factor provide contextual depth to resolve classification ambiguity. Consequently, this approach enhances the robustness of the Location variable used in the inefficiency effects model by reflecting not only project geography but also regulatory complexity and spatial-economic positioning.

Universiti Utara Malaysia

While the residential project location (Row 1) accounts for the core spatial distribution of firm activity, Rows 2 to 5 introduce critical institutional and structural dimensions that allow the model to capture spatial variation more comprehensively. These dimensions strengthen the explanatory value of the Urban Dominance Factor by incorporating regulatory diversity, economic geography, and administrative infrastructure all of which influence firm behavior but may not be directly observable through project data alone.

**i. Row 2: Land Code Variation (20%)**

This component accounts for differences in legal and institutional frameworks across Peninsular Malaysia, Sabah, and Sarawak. Each of these regions operates under distinct land administration systems the National Land Code (1965) in Peninsular Malaysia, versus the Sabah Land Ordinance (1930) and Sarawak Land Code (1958) in East Malaysia. The assigned weight of 20% reflects the overall institutional complexity these

legal variations introduce into firm operations. Within this, Peninsular Malaysia is weighted more heavily (20%) due to its centralized and standardized land code, which applies across multiple states but still carries bureaucratic variation at the local level. In contrast, Sabah and Sarawak are implicitly weighed at 15% each, reflecting their autonomous land regimes and regulatory fragmentation, which differ significantly from the national framework. This breakdown ensures that land code variation reflects not only legal diversity but also the practical implications of land administration on firm-level development strategies.

**ii. Row 3: Agglomeration & Industrial Economics (15%)**

This component reflects the productivity gains associated with agglomeration economies, a central concept in both urban economics and industrial organizations. Urban regions that feature dense infrastructure networks, population concentration, and strategic access to trade flows create economies of scale through labor pooling, service specialization, and supplier proximity. The 15% weightage assigned to this component captures both the spatial clustering effect and the industrial-economic importance of urbanized, port-connected regions.

Specifically, states that host major seaports, including Johor (Johor Port), Penang (Penang Port), Selangor and Kuala Lumpur (Port Klang), Pahang (Kuantan Port), Sabah (Sabah Port), and Sarawak (Kuching Port) are given greater emphasis due to their established roles in supporting trade, logistics, and industrial activity. Property developers in these regions benefit from enhanced access to input materials, faster logistics coordination, and

broader market reach. In contrast, states located far from primary ports are assigned a lower implied weight of 10%, as they are less likely to benefit from the same level of agglomeration intensity or industrial concentration.

Eventually, through the distinction between port-centric and inland states, this component strengthens the spatial dimension of the Urban Dominance Factor, ensuring that the model reflects both geographical positioning and economic function. It aligns with the broader objective of treating location not merely as a geographic tag, but as a proxy for resource access, infrastructure quality, and spatial competitiveness, all of which are relevant to firm-level efficiency.

**iii. Row 4: Registration Procedures (10%)**

This component captures spatial variation in land registration efficiency, reflecting the uneven implementation of regulatory reforms across Malaysian states. It is informed by national initiatives such as MyMudah, which aims to reduce regulatory burdens on businesses, and PEMUDAH, a public-private task force focused on streamlining government service delivery. These efforts, alongside reforms by KPKT and local governments, collectively aim to simplify and expedite the property registration process, particularly by addressing procedural inefficiencies at multiple institutional levels. The 10% weight assigned to this component reflects its strategic relevance in influencing developer preferences particularly in regions where higher administrative efficiency helps to reduce transaction costs and regulatory uncertainty.

Universiti Utara Malaysia

The weighting is calibrated using data from the World Bank's Doing Business (2022) indicators and Khazanah (KRI, 2019), specifically the number of procedures required for land and property registration. States such as Kuala Lumpur, which have streamlined procedures and digitized workflows, are assigned a higher relative weight (10%), recognizing their strategic advantage in terms of speed, predictability, and attractive investors. In contrast, states with more bureaucratic steps or longer approval chains are implicitly weighed at 5%, acknowledging the additional institutional friction that may deter development or elongate project timelines.

This differentiation ensures that the model captures the institutional accessibility of a location, not just its spatial characteristics. Thus, by linking regulatory burden with firm strategy, the component reinforces the Urban Dominance Factor as a holistic indicator that incorporates both geographic and procedural determinants of firm behavior.

Universiti Utara Malaysia

**iv. Row 5: Digitalization of Land Records (5%)**

This component reflects the technological advancement and institutional modernization of land administration systems across states. In support of the government's agenda to streamline public service delivery and enhance production efficiency, states that have achieved full digitalization of land records notably Kuala Lumpur are assigned a 5% weight within the Urban Dominance Factor.

Digitalization enables quicker land transactions, improved data accuracy, and reduced administrative bottlenecks, all of which facilitate smoother project execution. These

improvements contribute directly to production efficiency by minimizing delays, optimizing resource coordination, and enhancing workflow predictability during the property development process. Although this component carries a relatively small weight, it serves as a proxy for institutional agility and operational readiness, which are increasingly important in urban-based development environments. Thus, including this factor allows the model to account for unobserved enablers of production efficiency that stem from digital governance infrastructure reinforcing the classification of digitally advanced states as urban-dominant and strengthening the spatial-explanatory robustness of the inefficiency effects model.

Consistent with the World Bank (2020) and Khazanah Research Institute (2019), the locational distribution of property projects reflects both regulatory efficiency and market concentration. Urban-centric developers benefit from institutional agglomeration advantages, yet such concentration can also reproduce structural inefficiencies through rising input costs and constrained land supply.

Universiti Utara Malaysia

### 3.4.4 Liberalization in Steel and Cement

Section 3.4.4 introduces two key policy-related variables: steel tariff liberalization and cement tariff liberalization, both representing major reforms in Malaysia's construction input markets. These policy measures sought to reduce material costs and enhance industrial competitiveness by integrating domestic firms into regional and global supply chains. Within the context of this study, the liberalization of steel and cement tariffs is

modeled as an external policy shock influencing input prices and, consequently, firm-level production inefficiency in the property development sector.

As highlighted in Table 3.4, this study incorporates steel and cement tariffs as key policy-related variables that may influence firm-level production inefficiency. These materials represent critical inputs in residential construction, and their costs are directly shaped by government-imposed tariffs. Bank Negara Malaysia (2008) noted that the liberalization of steel and cement controls in mid-2008 was introduced to address supply bottlenecks and rising material costs, aiming to enhance industry competitiveness and resource allocation efficiency. In this study, higher tariff levels are expected to increase input costs and hinder efficient project delivery, particularly for firms operating under tight cost margins. To obtain the relevant tariff data, permission was formally requested and granted by the Royal Malaysian Customs Department (JKDM) and the Ministry of International Trade and Industry (MITI), providing access to historical records on steel and cement import tariffs from 2000 to 2020.

The average steel and cement tariff variables were constructed using the principal HS codes governing long steel products (HS 7214.10910 and 7214.20910) and cement products (HS 2523.29000 and 2523.10000), based on official historical tariff schedules obtained from the Royal Malaysian Customs Department (JKDM) and the Ministry of International Trade and Industry (MITI). As summarized in Table 3.8, steel import tariffs declined from approximately 31% in 2010 to 20% by 2020, while cement tariffs fell from

Universiti Utara Malaysia

about 21% to 13% over the same period, mirroring Malaysia's post-2008 liberalisation of construction material controls. In this study, these tariff series are incorporated as continuous policy variables within the inefficiency function of the stochastic frontier model, allowing the econometric specification to capture how exogenous changes in input-related trade policy influence firm-level production inefficiency (Table 3.8). Thus, by modelling tariffs as determinants of the one-sided inefficiency term $U_{it}$ the analysis tests whether reductions in material protection particularly for steel and cement, which represent major cost components in residential development are associated with improvements in technical efficiency after controlling for firm-specific characteristics and unobserved heterogeneity.

**Table 3.8: Average Import Tariff Rates for Steel and Cement Products (2010-2020)**

| Product Group | HS Code | Product Description | Tariff Rate (%) in 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| Steel | 7214.10910 | Steel bars and billets | 30.35 | 25.60 | 20.25 |
| | 7214.20910 | Long steel bars | 31.75 | 25.00 | 20.35 |
| | | Average Steel Tariff | 31.00 | 25.00 | 20.00 |
| Cement | 2523.29000 | Portland cement (other) | 21.25 | 10.00 | 10.00 |
| | 2523.10000 | White cement | 20.15 | 15.35 | 15.15 |
| | | Average Cement Tariff | 21.00 | 13.00 | 13.00 |

Sources: Adopted JKDM, Malaysia

Universiti Utara Malaysia

The liberalization of Malaysia's steel and cement markets unfolded progressively from the early 2000s to the mid-2010s, representing a substantive shift in the structure of upstream input markets with direct implications for downstream developers. Steel tariffs declined from 40.75% in 2000 to 20.36% by 2017, while cement tariffs fell from 30.17% to 15.71%, consistent with Malaysia's broader AFTA and WTO commitments to dismantle protectionist barriers. From an IO perspective, these reductions transformed the underlying cost structure and competitive dynamics of key material suppliers by lowering effective entry barriers, heightening the threat of import-based rivalry, and eroding the market power previously enjoyed by domestically sheltered incumbents. Through altering relative input prices, the reforms were expected to correct allocative distortions, strengthen competitive discipline along the construction value chain, and reduce the degree of cost pass-through behaviour that had historically insulated upstream firms from efficiency pressures. Given the centrality of steel and cement in developers' production technologies, these policy adjustments constitute a clear exogenous shock to input-market structure one fully consistent with IO predictions on cost efficiency, economies of scale, and heterogeneous firm responses to changes in market conditions.

In recognising the central role of material inputs in construction production processes, this study specifies steel and cement tariffs as key determinants of the production inefficiency term in the stochastic frontier framework. CIDB (2012) indicates that reinforcement steel and ready-mixed concrete together account for more than 29% of total material costs in residential construction, highlighting their structural weight in developers' production technology. Consistent with the Battese and Coelli (1995) formulation, production

inefficiency is expressed as $u_{it} = z_{it}\,\delta + w_{it}$ with steel and cement tariffs entering the vector $z_{it}$ as firm-specific environmental variables that capture exogenous input-cost conditions. Incorporating these tariff measures directly into the inefficiency function enables the model to identify how changes in steel and cement pricing driven by tariff liberalisation affect firms' deviations from the production frontier. This approach links material cost dynamics to observed production inefficiency in a manner that is theoretically grounded and empirically appropriate for the Malaysian residential property sector.

This specification is supported by New Trade Theory, particularly Krugman (1980, 1991) and Krugman & Obstfeld (2003), which emphasize that in industries characterized by increasing returns to scale and monopolistic competition, tariff protection can insulate firms from competitive pressures, allowing inefficiencies to persist. Conversely, trade liberalization forces firms to reorganize production, optimize input use, and improve efficiency to remain competitive. Complementing this, Tybout (2000) provides empirical evidence from developing countries showing that input market reforms, including tariff reductions, are most effective when firms possess sufficient absorptive capacity and face competitive pressure. Within this context, Malaysia's steel and cement tariff liberalization is interpreted not only as a cost-reduction policy but also as a structural catalyst for improving firm-level production efficiency especially for developers with higher exposure to material-intensive construction and the ability to respond strategically to input price signals.

Universiti Utara Malaysia

Thus, consistent with both theoretical predictions and empirical evidence, this study posits a negative and statistically significant relationship between input tariff rates and production efficiency. Lower steel and cement tariffs are expected to reduce input costs, thereby enhancing firms' ability to convert resources into output more effectively leading to lower inefficiency scores within the stochastic frontier framework.

### 3.4.5 Ownership Concentration

As presented in Table 3.4, ownership concentration is measured by the percentage of shares held by the largest three shareholders in a firm. This variable captures the degree of control exerted by major shareholders and reflects internal governance strength. Theoretically, higher ownership concentration can reduce agency problems by aligning the interests of managers with those of dominant shareholders, thereby enhancing monitoring and decision-making efficiency. This view aligns with IO theory, particularly within the SCP framework, which posits that ownership and market structure can shape firm behavior and performance outcomes. Ownership concentration may limit managerial discretion and incentivize cost control and strategic focus, ultimately improving productive efficiency.

This governance mechanism may positively influence a firm's operational focus and strategic alignment, leading to lower inefficiency. However, empirical findings show mixed results. While some studies suggest that high ownership concentration strengthens governance and improves efficiency (Sulong & Nor, 2010; Sulong & Ahmed, 2011),

Universiti Utara Malaysia

others argue that excessive concentration may result in entrenchment or the expropriation of minority shareholders, thereby reducing efficiency. Nonetheless, in the context of the Malaysian property sector, where family and institutional ownership structures are prevalent, concentrated ownership is generally expected to be associated with lower inefficiency.

The relationship between ownership structure and firm performance has been extensively explored in the literature. Early studies by Demsetz and Villalonga (2001), Lemmon and Lins (2003), Leng (2004), and Kapopoulos and Lazaretou (2007) examined how different forms of ownership concentrated, institutional, foreign, or managerial affect corporate efficiency and governance. These studies highlight the multifaceted impact of ownership structure, often suggesting that ownership concentration can either enhance or undermine performance depending on the institutional and market context.

Universiti Utara Malaysia

### 3.4.6 Firm Age

As defined in Table 3.4, firm age is measured by the number of years a property firm has been operating in the industry. This variable serves as a proxy for organizational maturity, experience, and accumulated knowledge over time. From a production efficiency standpoint, older firms are generally expected to be less inefficient due to their familiarity with market dynamics, established relationships with suppliers and regulators, and better-developed internal processes. These characteristics often translate into improved decision-making, better resource allocation, and enhanced resilience to operational risks.

The inclusion of firm age as an inefficiency determinant is grounded in both theory and empirical research. Older firms may have had more time to adopt and internalize best practices, develop reputational capital, and optimize operational systems. Empirical studies in the construction and property sectors, such as those by Dzeng and Wu (2013), support the notion that firm experience positively contributes to efficiency, particularly in environments with complex regulatory frameworks and long project cycles, as is typical in Malaysia.

This consideration also finds theoretical support in the industrial organization (IO) literature, particularly within the theory of the firm. Scholars such as Scherer, F. M. (1980) have emphasized that older firms are more likely to achieve technical and managerial efficiency due to accumulated learning and institutional adaptation. Moreover, firm age may reflect market tenure and organizational survival capacity, both of which signal resilience and operational capability. These insights strengthen the expectation that a negative relationship exists between firm age and production inefficiency, where older firms are more likely to perform closer to the efficiency frontier.

### 3.4.7 Subsidiary

As defined in Table 3.4, subsidiary status is a binary variable indicating whether a property firm has one or more construction-related subsidiaries. This variable is used to proxy for vertical integration within the firm structure. From the perspective of production

economics and transaction cost theory (Williamson, 1985), vertical integration can help reduce inefficiencies associated with market transactions by internalizing procurement, project management, and coordination processes that would otherwise be contracted out.

Firms with subsidiaries in construction-related services are likely to benefit from reduced search and contracting costs, streamlined workflows, better quality control, and enhanced information flow between project phases. These efficiencies arise from minimizing opportunism, asset specificity, and information asymmetries factors emphasized in Williamson's transaction cost framework as drivers for internalizing certain operations.

In the context of the Malaysian property sector, where project delivery timelines and regulatory coordination are critical, firms with integrated subsidiaries may be better equipped to manage complex, multi-stage residential developments. Such integration is expected to lead to lower inefficiency by reducing coordination failures, improving responsiveness to market and regulatory demands, and enhancing overall project execution. Therefore, a negative relationship is hypothesized between subsidiary status and production inefficiency.

While the use of a binary variable to represent subsidiary status is common in empirical studies due to its simplicity and clarity, it may not fully reflect the varying degrees of vertical integration across firms. For instance, the size, function, or strategic role of a subsidiary may differ significantly. While more disaggregated ownership measures such

as equity integration indices or proportional shareholdings are commonly employed in studies with detailed firm-level disclosures, their application is often restricted in emerging market contexts like Malaysia due to data availability constraints, non-disclosure practices, and limited public access to firm-specific ownership records. Given that access to subsidiary-level financial and operational data is restricted under confidentiality regulations, the use of a dummy variable remains a practical and justifiable methodological choice for this study.

### 3.4.8 Firm Establishment

As presented in Table 3.4, establishment type is measured as a binary variable distinguishing between privately owned firms and government-linked or state-owned developers. This classification captures potential institutional and ownership-related differences that may influence production inefficiency. From the perspective of the theory of the firm and industrial organization, private firms are exposed to stronger competitive pressures and profit-driven incentives, which should drive them closer to the production frontier.

According to production theory, private firms face market-based discipline, leading to leaner operations, higher responsiveness to cost pressures, and greater motivation to maximize efficiency. In contrast, government-linked companies (GLCs) may have broader mandates such as affordable housing provision, regional equity, or compliance with socio-political objectives. These additional goals can weaken the emphasis on cost

minimization and pure production efficiency. However, GLCs may also enjoy privileged access to land, financing, and regulatory support, which can offset inefficiencies in other areas.

The empirical literature reports mixed evidence: some studies find private firms outperform public firms in efficiency, while others emphasize the institutional stability and long-term orientation associated with public ownership. In Malaysia, where GLCs play a significant role in the housing and construction markets, firm performance reflects not only ownership form but also governance quality and institutional alignment (Gomez et al., 2018; Gomez & Jomo, 1999). Consistent with broader privatization literature (Megginson & Netter, 2001; Boycko, Shleifer, & Vishny, 1996), the efficiency implications of establishment type are context-dependent shaped by regulatory structures, market discipline, and the strategic objectives of state-linked firms.

Universiti Utara Malaysia

In the Malaysian context, the expected effect of establishment type remains ambiguous: government-linked firms may gain efficiency advantages from preferential access to land and finance, but they may also face soft budget constraints and broader socio-political objectives that weaken efficiency discipline. In this study, the positive coefficient observed for establishment type suggests that the latter effect may dominate, with GLCs tending toward higher production inefficiency relative to private firms, even though the result is not statistically significant.

In addition to analyzing production efficiency, this study extends the empirical framework to assess cost efficiency through a stochastic cost frontier approach. While production efficiency evaluates how well firms convert inputs into output, cost efficiency captures how effectively firms minimize costs given their input prices and output levels. This dual-model strategy offers a more comprehensive assessment of firm performance by accounting for both technical capability and cost management. The next section outlines the specification of the stochastic cost frontier and the associated inefficiency determinants.

### 3.5 Stochastic Costs Frontier

Building on the production efficiency framework, this study extends the analysis to the stochastic cost frontier, recognizing that firms may not only use inputs inefficiently in producing output but also incur excess costs relative to the minimum feasible level. The cost frontier approach complements the production model by explicitly incorporating input prices, thereby capturing inefficiencies arising from both technical and allocative sources. This dual framework is particularly relevant to the property sector, where cost structures are shaped by material price volatility, labor intensity, and capital investment dynamics.

The following sections introduce the stochastic frontier cost model, with a translog cost function used to allow for flexible substitution between inputs and to estimate economies of scale. In line with Battese and Coelli (1995), the model incorporates firm-specific

Universiti Utara Malaysia

inefficiency determinants, consistent with those applied in the production analysis, ensuring methodological continuity and enabling cross-model comparisons.

### 3.5.1 Functional Form for Translog Costs

The cost frontier in this study adopts a translog cost function, appropriate for a single-output and multi-input setting involving three input categories: labor, capital, and materials. This flexible functional form captures second-order interactions among input prices and allows for non-constant elasticities of substitution, making it particularly suitable for analyzing the cost behavior of heterogeneous firms in the Malaysian property sector.

Universiti Utara Malaysia

The cost efficiency measure is derived from a cost function in which total cost depends on input prices and output quantities. Following Altunbas et al. (2000), the stochastic cost frontier is specified using a flexible translog functional form with a composite error term comprising a two-sided random error representing statistical noise and a one-sided error capturing cost inefficiency. This study adopts a similar stochastic frontier framework to estimate firm-level cost efficiency in the Malaysian property sector.

Building on this foundation, the present study applies a stochastic frontier cost function to estimate firm-level cost efficiency in the Malaysian residential property sector. Consistent with Zheng and Wu (2013), the model captures heterogeneity in input prices and firm-specific characteristics while explicitly incorporating a composite error structure

that distinguishes inefficiency from random shocks. By adopting a translog cost function, the specification allows flexible substitution among inputs and facilitates the estimation of economies of scale, while accommodating firm-level heterogeneity in cost structures.

Hence, for the *i*th firm, the cost function is modeled as follows:

$$\ln c_i = \ln c\ (y_i, w_i; \beta) + \ \varepsilon_i \tag{3.10}$$

Where $c_i$ is the observed total cost of production for firm *i*; $y_i$ is the vector of output for firm *i*; $w_i$ is the vector of input prices for firm *i* and $\beta$ is a vector of parameters. $\varepsilon_i$ is a two-component error term that for the *i*th firm can be written as follows:

$$\varepsilon_i = \ u_i + v_i \tag{3.11}$$

Where $u_i$ is a one-sided inefficiency measure ($u_i \geq 0$) and generally assumed to be distributed half normally. $u_i$ represents the individual firm's deviations from the efficient cost frontier and serves as a proxy for both technical and allocative efficiency. $v_i$ is a statistical noise and assumed to be normally distributed with zero mean and variance $\sigma_v^2$.

### 3.5.2 Empirical Specification

This study employs a stochastic cost frontier framework to evaluate firm-level cost efficiency, with the primary objective of assessing how effectively property developers allocate resources and control expenditures under differing market and institutional conditions. Whereas production frontier models measure technical efficiency in transforming inputs into outputs, the cost frontier is more suitable for this analysis because

Universiti Utara Malaysia

it explicitly incorporates input prices and captures a firm's ability to minimize costs for a given level of output.

Property development firms operate within a multi-input, single-output framework, using labor, capital, and materials to deliver residential projects. These firms function in an environment characterized by regulatory complexity, fluctuating input prices, and scale-driven operations, making cost minimization a strategic imperative for sustainability and competitiveness.

In this study, cost efficiency is modeled using a translog cost function estimated via stochastic frontier analysis, which enables the decomposition of total deviation from the cost frontier into a random error term and a non-negative inefficiency component. The model also incorporates firm-specific characteristics as inefficiency determinants, allowing us to capture structural, organizational, and policy-related drivers of cost efficiency across firms.

The translog cost function is assumed to define the input use across all developers in the sample. Although this functional form can be demanding in terms of degrees of freedom, it is preferred due to its flexibility. It imposes no a priori restrictions on substitution among inputs and permits both economies and diseconomies of scale to emerge across different output levels. Greene (1980) identifies the translog function as one of the most frequently adopted functional forms for measuring efficiency.

Universiti Utara Malaysia

The empirical estimation of the stochastic cost frontier in this study is based on the time-varying inefficiency effects model developed by Battese and Coelli (1995), consistent with the specification used for the production efficiency analysis. This single-step estimation technique simultaneously models the cost frontier and the firm-specific inefficiency determinants, thereby improving statistical efficiency and avoiding the potential bias associated with two-stage methods.

The model is estimated using firm-level panel data for 76 Malaysian property firms over the period 2000-2020. The dependent variable is the logarithm of total cost, while explanatory variables include input prices (labor, capital, materials), output level, and their interaction and squared terms. The inefficiency term is modeled as a function of firm-level characteristics total assets, ownership structure, location, firm age, and tariff exposure ensuring methodological coherence with the production frontier model.

Universiti Utara Malaysia

As with the production frontier, the composed error term $\varepsilon_i = V_i + U_i$ allows for the separation of random noise from firm-specific inefficiency. Maximum likelihood estimation (MLE) is employed to estimate both the frontier coefficients (β) and inefficiency determinants (δ) simultaneously. The variance components of the composite error term are expressed in terms of total variance ($\sigma^2 = \sigma_U^2 + \sigma_V^2$) and the inefficiency ratio ($\gamma = \frac{\sigma_U^2}{\sigma^2}$), where γ represents the proportion of the total variance in the composed error that is attributable to inefficiency, following the standard stochastic frontier specification.

The inclusion of the same inefficiency variables used in the production model such as firm size, location, ownership concentration, establishment type, firm age, subsidiary status, and tariff indicators permits a comparative interpretation of the sources of inefficiency from both a production and cost perspective. This integrated empirical strategy strengthens the robustness of the study's findings and contributes to a more comprehensive understanding of firm behavior in the Malaysian property sector.

### 3.5.3 Estimation of Cost Efficiency

This section presents the estimation of cost efficiency scores derived from the stochastic frontier cost model described in Sections 3.5.1 and 3.5.2. Using the Maximum Likelihood Estimation (MLE) approach, firm-specific cost inefficiencies are computed as the conditional expectation of the one-sided error term, following the method of Jondrow et al. (1982). These efficiency scores measure the extent to which firms deviate from the minimum attainable cost, given their input prices and output levels.

The estimation also produces key parameters, including the gamma (γ) statistic, which measures the proportion of total variance attributable to inefficiency. Likelihood-ratio (LR) tests are used to evaluate whether the inclusion of inefficiency effects significantly improves model fit compared to a standard cost function without inefficiency. The analysis further examines the variation in cost efficiency across firms and over time, with emphasis on the influence of structural characteristics and input price dynamics.

### i. Model Specification Details

The empirical estimation of the translog stochastic cost frontier model is based on firm-level panel data from Malaysian residential property developers between 2000 and 2020. The model includes one output and three input price variables, capturing the multi-input cost structure of firms in the sector.

Output Variable:

y: (Sales Revenue)

Represents the total annual sales of each property firm and serves as a proxy for output quantity. Measured in Malaysian Ringgit (RM), this variable reflects the total value of completed residential development projects.

Input Price Variables:

$w_1$: (Price of Labor)

Calculated as total wages and salaries divided by the number of employees (including directors and regular staff), representing the average compensation cost per worker.

$w_2$: (Price of Capital)

Measured as the ratio of capital-related expenses (including utility costs, rents, depreciation, maintenance, and insurance) to the book value of capital assets (land, buildings, equipment, and vehicles). This provides a firm-level approximation of the user cost of capital.

$w_3$: (Price of Materials)

Universiti Utara Malaysia

Assigned a value of unity (1) to serve as the numeraire input price. This normalization is standard in translog cost frontier models, allowing estimation of relative input price effects while ensuring model identification.

We estimate the following translog stochastic cost frontier for the property's developers in the sample.

$$\ln C_{it} = \beta_0 + \sum_{j=1}^{n} \beta_j \ln y_{jit} + \sum_{k=1}^{m} \beta_k \ln w_{kit}$$

$$+\frac{1}{2}\sum_{j=1}^{n}\sum_{l=1}^{n} \beta_{jl}(\ln y_{jit})(\ln y_{lit})$$

$$+\frac{1}{2}\sum_{k=1}^{m}\sum_{p=1}^{m} \beta_{kp}(\ln w_{kit})(\ln w_{pit})$$

$$+\sum_{j=1}^{n}\sum_{k=1}^{m} \beta_{jk}(\ln y_{jit})(\ln w_{kit})$$

$$+\beta_t t + v_{it} + u_{it} \qquad (3.12)$$

Where the variables and parameters are defined as follows:

$C_{it}$ : total cost of firm i at time t

$y_{jit}$ : output variable j of firm i at time t

Universiti Utara Malaysia

$w_{kit}$ : Input price k for firm i at time t

t : Time trend

β : Parameters to be estimated

$v_{it} \sim N(0, \sigma_v^2)$ : Random noise

$u_{it} \geq 0$ : Cost inefficiency component

The composed error term $\varepsilon_{it} = v_{it} + u_{it}$ distinguishes random noise from firm-specific cost inefficiency, enabling the estimation of firm-level cost efficiency scores.

**ii. Symmetry Conditions**

To ensure that the translog function adheres to the properties of a well-behaved cost function, symmetry conditions are imposed on the second-order terms:

$\beta_{kp} = \beta_{pk}$ , ∀ k, p=1,2,3

$\beta_{1k} = \beta_{k1}$, ∀ k =1,2,3

These restrictions reduce the number of independent parameters to be estimated, improve estimation efficiency, and ensure that the Hessian matrix remains symmetric for economic interpretation.

Thus, following Battese and Coelli (1995) and Karim (2001), the cost inefficiency term $u_{it}$ is modeled as a function of firm-specific characteristics, input cost pressures, and time trends. The specification includes continuous variables such as total assets, location, tariffs, ownership concentration, and firm age, alongside binary indicators for establishment type and subsidiary status. A linear and quadratic time trend is also included

Universiti Utara Malaysia

to capture potential shifts in inefficiency over time. The disturbance term $w_{it}$ is assumed to follow a truncated normal distribution with non-negative support.

$$u_{it} = \gamma_0 + \gamma_1 Establish_{it} + \gamma_2 Subsidiary_{it} + \sum_{j=1}^{6} \delta_j Z_{jit} + \gamma_t t + \gamma_{t2} t^2 + w_{it} \quad (3.13)$$

where:

$Z_{jit}$ includes: ln (Assets), Location (Urban share), Steel Tariff, Cement Tariff, Ownership Concentration and, ln (Age) .

Establishment $_{it}$: Dummy variable = 1 if private firm, 0 if state-owned.

Subsidiary$_{it}$: Dummy variable = 1 if firm has construction subsidiary, 0 otherwise.

$t =$ Linear time trend

$t^2 =$ Captures non-linear temporal variation in inefficiency.

$w_{it}$ = Random noise term following a truncated normal distribution with non-negative support.

Universiti Utara Malaysia

For the cost frontier, the inefficiency effects model incorporates the same firm-specific and time-varying variables as defined in Section 3.7, namely $lnAssets$, Location (urban share), Steel Tariff, Cement Tariff, Ownership Concentration, ln Age, $Establishment_{it}$, $Subsidiary_{it}$, a linear time trend (t), and its squared term ($t^2$). The stochastic term $w_{it}$ is assumed to follow a truncated normal distribution with non-negative support.

The specification of the inefficiency effects model in Equation (3.13) reflects the assumption that variations in firm-level inefficiency are systematically influenced by observable characteristics. Specifically, the model accounts not only for the presence of inefficiency in input usage for a given level of output, but also for heterogeneity across

firms in terms of their structural and policy-related attributes. The inefficiency term is modeled as a function of firm type (private or state-owned, represented by a dummy variable), location dominance (urban vs. suburban), firm size (proxied by total assets), and other relevant firm-specific factors. Additionally, a time trend and its squared term are included to allow for potential non-linear changes in inefficiency over time, capturing both improvements and setbacks in cost efficiency throughout the study period.

The $u_{it}$ terms in Equation (3.13) imply that, for a given level of outputs and quasi-fixed inputs, the observed total costs are higher than the minimum attainable costs if firms were fully efficient in their input utilization. Accordingly, firm-level cost efficiency is defined as:

$$CE_{it} = \exp(-U_{it}) \quad (3.14)$$

Universiti Utara Malaysia

In the context of Malaysian property firms, the estimated cost efficiency scores (Equation 3.14) reflect the degree to which a firm be able to minimize its costs given its observed input prices and output levels. A cost efficiency (*CE*) score of 1.00 indicates that the firm is operating on the cost frontier that is, it is fully cost-efficient. In contrast, a *CE* score of, for example, 0.70 would imply that the firm could have reduced its total costs by 30% to achieve the same level of output using the optimal input mix.

While this efficiency interpretation is standard across industries, the nature of the property sector introduces unique features:

i. In the Malaysian property sector, unlike banking or insurance where inputs such as labor, capital, and technology are standardized, and outputs are intangible property developers manage heterogeneous physical assets, project-based operations, and high capital intensity. Consequently, efficiency variation across firms is more pronounced, reflecting differences in project size, location, resource procurement, and construction cycles.

ii. Property developers often face regulatory delays, land acquisition constraints, and supply chain disruptions (particularly in steel and cement) that elevate cost inefficiency, even when their internal structures and strategic choices align with cost-minimizing principles of the firm.

iii. Furthermore, the presence of government-linked developers (GLCs) and public–private joint ventures introduce institutional factors that influence cost behavior. These firms may experience policy-driven objectives, procurement rigidities, or differing accountability structures factors not typically observed in privately owned sectors such as banking or insurance.

In this study, the distribution of cost efficiency scores across firms and over time offers insights into how effectively property developers manage input costs. Firms that remain consistently closer to the cost frontier are likely to demonstrate superior procurement capacity, project management, and adaptability to input price fluctuations including those arising from tariff reforms relative to their peers.

## 3.6 Input and Output Specification for the Cost Model

The firm-level dataset employed for both the production and cost frontier estimations was derived from the annual reports of 76 property development firms listed on Bursa Malaysia covering the period 2000-2020. The data were compiled from Bursa Malaysia's online repository and company investor-relations websites, providing consistent information on total assets, sales revenue, labor, capital, and input costs. Monetary values were deflated to constant 2015 Malaysian Ringgit (RM) using GDP deflators published by the Department of Statistics Malaysia (DOSM) to ensure comparability across years. This unified dataset forms the empirical basis for estimating both production and cost efficiency within a consistent panel framework.

Universiti Utara Malaysia

Consistent with the discussion in Section 3.3, this study utilizes firm-level financial and operational data for Malaysian residential property developers over the period 2000-2020. The dataset is compiled primarily from audited financial statements and transaction disclosures of firms listed on Bursa Malaysia (KLSE). Within the stochastic cost frontier framework, it is assumed that each firm minimizes total production costs for a given level of output, conditional on prevailing input prices and technological constraints.

Table 3.9 presents the operational definitions of all variables used in the cost efficiency model, grouped into four main categories: input quantities, input prices, output, and total costs. Under input quantities, the model includes labor, capital, and materials. Labor is defined as the number of directors and regular employees, serving as a proxy for

workforce size. Capital comprises physical fixed assets such as land, buildings, machinery, and transport vehicles, reflecting long-term investments in production capacity. Materials are measured as the residual cost component derived from total operating expenses, specifically: the sum of cost of sales and selling and administrative expenses, net of labor and capital costs thereby capturing intermediate inputs such as construction materials and services.

Table 3.9: Input and Output Specification for the Stochastic Cost Frontier Model

| | Variable | Definition |
|---|---|---|
| **Input quantity** | Labour | Number of directors and regular employees. |
| | Capital | Total fixed assets including land, buildings, equipment, machinery, and transportation vehicles. |
| | Materials | Cost of sales plus selling and administrative expenses, minus labor and capital costs. |
| **Input price** | Labour price (PL) | Total salaries and wages divided by the number of employees. |
| | Capital price (PK) | (Utility expenses+rents+depreciation+maintenance expenses+insurance) divided by total capital stock. |
| | Materials price (PM) | Assigned a value of 1 (unity) to serve as the numeraire input price in the translog cost function. |
| **Output** | Sales (Y) | Annual gross sales revenue (in RM), representing total output. |
| **Costs** | Total Cost (C) | Sum of the products of input prices and corresponding input quantity. |

The second column lists input prices corresponding to each input category. The price of labor is calculated by dividing total salaries and wages by the number of employees. The price of capital is measured as the ratio of total fixed-asset operating expenses including utilities, rents, depreciation, maintenance, and insurance to the annual average book value

of capital. The price of materials is set to unity (1), consistent with the approach adopted by You and Zi (2007), on the rationale that materials consist of heterogeneous components typically reported in monetary rather than physical units.

To satisfy the linear homogeneity property of the cost function namely, that if all input prices double, total costs also double then one input price must be normalized to unity. Following You and Zi (2007), the material price is set equal to one and treated as the numeraire. This normalization ensures that only relative input prices enter the translog cost specification, thereby simplifying estimation and avoiding redundancy among the price variables.

Universiti Utara Malaysia

In line with this structure, the output variable is defined as annual sales revenue, serving as a proxy for the scale and value of real estate development activity undertaken by each firm each year. The total cost is computed as the sum of all input costs, expressed as the product of each input's quantity and its corresponding price. Collectively, these definitions form the empirical foundation of the translog cost function used to estimate firm-level cost efficiency.

The output variable is defined as annual sales revenue, which serves as a proxy for the volume and value of real estate development activity undertaken by the firm in each year. Finally, total cost is computed as the sum of all input costs, expressed as the product of

each input's quantity and its corresponding price. This structure forms the basis for the translog cost function used to estimate firm-level cost efficiency.

### 3.6.1 Input Quantities

In line with standard cost frontier and production theory, this study adopts a three-input framework to model the cost structure of Malaysian property development firms. As summarized in Table 3.5, the input quantities consist of each representing a fundamental factor of production. Labor input is measured by the number of directors and regular employees, capturing the human capital deployed in the firm's operations. Capital input is defined as the value of physical fixed assets, including land, buildings, equipment, and transport vehicles, which are essential for sustaining long-term productive capacity. Material input is calculated residually as the portion of operational costs that cannot be attributed directly to labor or capital, encompassing intermediate goods and services such as construction materials, subcontracted works, and related expenses.

Universiti Utara Malaysia

Within the translog stochastic cost frontier framework, the use of three input quantities allows flexible estimation of input substitution, interaction effects, and economies of scale. This approach reflects the cost-intensive structure of the property sector, where labor and materials represent major cost components. The chosen inputs are consistent with economic theory and accurately reflect the production and cost behavior of Malaysian property developers.

### 3.6.2 Input Prices

Input prices play a central role in the estimation of the stochastic cost frontier, as they directly influence the cost-minimizing behavior of firms. In cost frontier models, firms are assumed to face exogenously given input prices and are expected to select input combinations that minimize total cost for a given level of output. As detailed in Table 3.5, this study incorporates three distinct input price variables labor price, capital price, and material price to capture the economic cost of resource utilization in property development activities.

The labor price is measured as the average wage per employee, capturing the overall cost of employing both skilled and unskilled workers. This metric is especially relevant in Malaysia's labor-intensive construction and real estate sectors, where wage structures significantly influence project cost dynamics. The capital price is defined as the ratio of fixed-asset operating expenditures such as depreciation, utility expenses, maintenance, and insurance to the average book value of fixed assets. This reflects both the opportunity cost and the user cost of capital, capturing depreciation, operational charges, and risk-adjusted returns required to sustain capital utilization.

In contrast, the material price is standardized at unity, consistent with the convention used in prior studies (You & Zi, 2007), where material inputs are recorded in monetary rather than physical units. This normalization serves as a modeling simplification to ensure parameter identification within the translog cost function framework. Despite this, the

Universiti Utara Malaysia

model retains the ability to capture the relative influence of material input quantities on total cost through interaction terms and second-order effects.

From the perspective of the theory of the firm, particularly under cost minimization behavior, firms operate under technological constraints and face input markets with varying price structures. Incorporating firm-specific input prices enables the cost function to differentiate between efficient and inefficient firms not only in terms of quantity utilization, but also in terms of their responsiveness to input cost conditions. This specification is particularly relevant in the Malaysian property sector, where fluctuations in building material prices, wage rates, and financing costs such as those influenced by tariff liberalization can significantly affect firm-level cost structures and efficiency outcomes.

Universiti Utara Malaysia

### 3.6.3 Output and Total Costs

The output variable, defined as annual sales revenue, is a critical component in modeling cost efficiency, particularly in industries like property development where firms produce heterogeneous and capital-intensive products. In the context of Malaysian property firms, sales serve as a robust proxy for production output, capturing not only the volume of completed residential units but also their market valuation and demand responsiveness. This is especially relevant given that listed property developers are required to report sales figures annually, ensuring consistency and comparability across firms and over time. Prior studies, such as Dzeng and Wu (2013) in Taiwan and You and Zi (2007) in Korea, have

similarly adopted sales-based output measures in cost efficiency studies of the construction sector, supporting the validity of this approach where physical output data may be difficult to standardize.

The total cost variable, defined as the sum of all input costs (each calculated as the product of input quantity and corresponding input price), is the dependent variable in the translog stochastic cost frontier. Within this framework, the total cost function represents the minimum cost required to produce a given level of output, conditional on input prices and firm-specific characteristics. The cost frontier thus serves as a benchmark for identifying deviations, inefficiencies where actual costs exceed the theoretical minimum. This relationship is fundamental to cost frontier analysis and aligns with the theory of the firm, which postulates that firms aim to minimize costs for given outputs and prices, subject to technological constraints. Through the estimation of firm-level deviations from the efficient frontier, the model captures both allocative and technical inefficiencies, revealing differences in cost performance across Malaysian property developers.

Universiti Utara Malaysia

## 3.7 Correlates of Property Firms' Cost Inefficiency

This section examines the firm-specific and policy-related factors that may explain differences in cost inefficiency among Malaysian property developers. Building upon the stochastic cost frontier model discussed in the previous sections, the inefficiency effects model follows the one-step estimation approach proposed by Battese and Coelli (1995), which allows inefficiency scores to be modeled as a function of observable explanatory

variables. These determinants include firm size, ownership concentration, location, firm age, subsidiary status, establishment type (public or private), as well as two key policy variables: steel and cement tariff rates, which affect input costs. The rationale for each variable is grounded in economic theory, the theory of the firm, and empirical evidence from prior studies in real estate, construction, and other cost-intensive sectors.

In Equation (3.13), each firm-specific and policy variable enters the cost inefficiency term $u_{it}$ to explain systematic deviations from the minimum attainable cost. Establishment type and subsidiary status capture structural differences in governance and resource access, while the continuous variables in $Z_{jit}$ including firm size, ownership concentration, location, and the nonlinear age terms (lnAge and $lnAge^2$) reflect how scale, market positioning, and organizational life-cycle dynamics influence cost divergence from the frontier. The quadratic age specification allows inefficiency to rise or fall at different stages of firm maturity, capturing potential learning gains or structural rigidity. Steel and cement tariff variables represent policy-driven input cost conditions that shape firms' ability to manage materials efficiently. Collectively, these determinants allow the model to attribute cost inefficiency to identifiable economic, organizational, and policy mechanisms rather than random noise.

### 3.7.1 Research Hypotheses on Cost Inefficiency

In line with the unified empirical framework adopted in this study, the same explanatory variables used for production inefficiency are applied in the analysis of cost inefficiency.

This approach enables consistency across models and facilitates comparison of how each factor affects efficiency through distinct channels. The following hypotheses are proposed regarding cost inefficiency:

i. Firm Size (Total Assets): Larger firms are expected to exhibit lower cost inefficiency due to superior resource allocation, stronger financial flexibility, and the ability to spread fixed costs over higher outputs.

ii. Location of Residential Projects**:** The effect of location is ambiguous. Urban-based firms may face higher land, labor, and regulatory costs, whereas suburban or regional firms may benefit from lower development costs and land availability.

iii. Steel and Cement Tariff Rates**:** Higher input tariffs are expected to increase cost inefficiency by raising material expenses, while tariff liberalization is anticipated to reduce inefficiency through lower input costs.

iv. Ownership Concentration: A higher concentration of ownership is expected to reduce cost inefficiency by strengthening monitoring mechanisms and managerial accountability.

Universiti Utara Malaysia

v. Firm Age: Older firms are hypothesized to have lower cost inefficiency due to accumulated managerial experience, learning-by-doing, and established operational systems.

vi. Firm $Age^2$ ($LnAge^2$): A nonlinear relationship is expected between firm age and cost inefficiency. Initially, inefficiency declines with age, but beyond a certain threshold, structural rigidity and legacy costs may cause inefficiency to rise again.

vii. Subsidiary Status: Firms with construction-related subsidiaries are expected to achieve lower cost inefficiency by leveraging internal supply chains, coordination advantages, and economies of scope.

viii. Establishment Type: The direction of the effect is uncertain. Private firms may be more cost-conscious due to market competition, while public or government-linked firms may benefit from preferential financing and regulatory support.

Table 3.10 outlines the definitions and expected relationships of the variables used in the cost inefficiency model. Each variable represents a theoretical link to firm behavior or market structure, helping to assess how firm characteristics and external factors affect deviations from cost efficiency.

Table 3.10: Variables and Expected Relationships with Cost Inefficiency

| **Variables** | **Explained** | **Expected Sign** |
|---|---|---|
| lnAsset | Natural Log of Total Asset (firm Size proxy) | Negative |
| lnLocation | Primary Location of Residential Project | Positive |
| Steel Tariff | Steel Import Tariff rate (percentage) | Positive |
| Cement Tariff | Cement Import Tariff rate (percentage) | Positive |
| Ownership | Ownership concentration (top 3 shareholder) | Negative |
| lnAge | Natural Log of Firm Age (in years) | Negative |
| $lnAge^2$ | Squared of lnAge | Positive |
| Subsidiary | 1 if the firm has construction Subsidiary; 0 otherwise | Negative |
| Establishment | 1 if the firm is privately owned; 0 if state-owned | Negative |

### 3.7.2 Firm Size

From the perspective of the theory of the firm, larger organizations are generally better positioned to minimize per-unit production costs through economies of scale and scope (Caves & Barton, 1991). Such firms typically enjoy superior access to financing, stronger bargaining power in procurement, and the capacity to invest in advanced technologies and professional expertise. Within the stochastic cost frontier framework, cost efficiency reflects a firm's ability to achieve a given level of output at the lowest feasible cost,

conditional on input prices and technology. Hence, larger firms are expected to display lower cost inefficiency, as their scale advantages enable more effective resource allocation and smoother absorption of input-price fluctuations.

In the context of Malaysia's property development industry particularly among firms listed on firm size is closely associated with total asset base, market capitalization, and overall development capacity. Larger, publicly listed firms typically enjoy broader access to capital markets, enhanced credibility with institutional investors, and stronger bargaining power with suppliers and regulators. These advantages enable such firms to undertake large-scale residential and mixed-use developments, optimize procurement through bulk purchasing, and invest in technological upgrades and skilled human capital. From the standpoint of the theory of the firm and cost minimization behavior, these characteristics facilitate more efficient input allocation, better absorption of fixed overheads, and greater ability to stabilize production costs amid market fluctuations thereby reducing cost inefficiency.

Universiti Utara Malaysia

While the studies by Abdul Aziz (2007) and Jaafar et al. (2006) do not directly measure efficiency, they offer empirical observations that support this relationship. Their findings show that larger Malaysian property developers especially those listed on KLSE tend to demonstrate stronger financial capabilities, broader project portfolios, and more institutionalized governance structures. These characteristics, although not evaluated through stochastic frontier models, are consistent with the factors that theoretically

contribute to lower cost inefficiency. Therefore, their work provides valuable contextual grounding for including firm size as a key determinant in the cost inefficiency model of this study.

In line with industrial organization theory, larger firms may also have greater bargaining power in input markets and may be more resilient to cost shocks due to diversified operations. Hence, we expect a negative relationship between firm size (measured by the natural logarithm of total assets) and cost inefficiency indicating that as firm size increases, cost inefficiency tends to decline.

### 3.7.3 Location

Location plays a critical role in determining a firm's cost structure, particularly in an industry like property development where land availability, labor costs, infrastructure, and demand density vary significantly across geographic areas (Somerville, 1999). From an industrial organization perspective, urban concentration may lead to agglomeration economies, where proximity to suppliers, skilled labor, and complementary industries lowers production and transaction costs. In contrast, suburban operations may benefit from lower land and construction costs, though they may face logistical and market access challenges.

Furthermore, a firm's strategic location choice reflects broader competitive behavior, where firms may cluster in high-demand urban zones to maximize visibility and client

access or expand into suburban regions to leverage cost advantages. These spatial decisions often trade-off between input cost minimization and revenue maximization. In the context of Malaysia, many listed property developers tend to concentrate their activities in key urban regions such as Kuala Lumpur, Penang, and Johor Bahru where infrastructure density, population size, and market liquidity tend to support higher property values and consistent sales (KRI, 2019). This urban focus may improve efficiency through scale and exposure but may also expose firms to higher cost pressures due to land scarcity and elevated construction expenses.

This pattern aligns with the earlier classification of urban zones, particularly central business districts (CBDs), which are associated with both high-value opportunities and elevated input costs. Firms operating in CBDs benefit from enhanced market visibility and access but may face intense competition for limited resources and incur significantly higher operating costs. Supporting this, the World Bank (2020) subnational report highlights that Kuala Lumpur outperforms other major Malaysian cities such as Penang and Johor Bahru in terms of property registration efficiency, with shorter processing times and fewer procedural steps. This institutional advantage enhances transaction certainty and reduces administrative burdens for property developers, thereby reinforcing the strategic and economic appeal of urban-based operations despite the associated higher land and construction costs.

Universiti Utara Malaysia

Therefore, to operationalize this classification, location is measured as a dominant area indicator based on the number of residential projects developed in urban versus suburban zones. Using firm-level project data registered with the Ministry of Housing and Local Government (KPKT), each firm-year observation is categorized as urban-dominant or suburban-dominant, depending on the majority share of residential project activity. This method ensures consistency with spatial distribution data and aligns with classifications used by national authorities such as NAPIC. The same classification for firm location dominance, as presented earlier in Table 3.4 for the production inefficiency model, is retained in the cost inefficiency analysis to maintain methodological consistency and comparability across models.

Universiti Utara Malaysia

### 3.7.4 Steel and Cement Tariff Liberalization

Steel and cement tariffs influence firms' ability to minimize total production costs given prevailing input prices. Higher input tariffs distort relative price signals, resulting in suboptimal input combinations and increased cost inefficiency particularly for firms engaged in material-intensive construction. In contrast, tariff liberalization reduces input prices and mitigates allocative distortions, thereby allowing firms to re-balance their factor proportions and operate nearer to the cost-minimizing frontier (Amiti & Koning, 2007). Given that steel and cement collectively account for a substantial share of material input costs in residential projects (CIDB, 2012), changes in tariff rates are expected to

exert a direct effect on firm-level cost behavior.[3] This relationship is consistent with trade theory, which suggests that input market liberalization enhances allocative efficiency through more competitive pricing and improved resource reallocation.

As discussed in Section 3.4.4 (Table 3.8), steel and cement tariffs are incorporated into the BC95 inefficiency specification as policy-related determinants of firm-level cost inefficiency. In the Battese and Coelli (1995) framework, inefficiency is modelled as $u_{it} = z_{it}\,\delta + w_{it}$, where tariff variables enter the vector $z_{it}$ to capture the systematic influence of input-market policy on firms' cost performance. Given that steel and cement constitute major cost components in residential development, tariff-induced price changes directly affect firms' cost structures and their ability to minimize costs relative to the frontier. Higher tariffs raise the effective price of key materials, reduce cost flexibility, and heighten vulnerability to budget overruns effects that are especially binding for firms with tighter cost margins or weak bargaining power in procurement. Access to historical tariff records from the Royal Malaysian Customs Department and the Ministry of International Trade and Industry (MITI) enables these policy shocks to be modelled explicitly, allowing the BC95 structure to distinguish how exogenous input-market regulations contribute to persistent cost inefficiency after controlling for random noise and firm-specific characteristics.

[3]Refer to Appendix Table A.1 for the detailed weightage of building materials as reported by CIDB (2012).

From a firm-theoretic and IO perspective, the impact of tariff liberalization on cost inefficiency is inherently heterogeneous across firms (Carlton & Perloff, 2005). Larger developers those operating closer to minimum efficient scale are better positioned to internalize input cost reductions because they possess superior procurement capabilities, stronger bargaining leverage, more integrated coordination systems, and greater flexibility in reallocating resources across projects (Ball, 2006). Such firms are able to convert reductions in steel and cement tariffs into meaningful cost savings, thereby lowering their distance from the cost frontier. In contrast, medium or less integrated firms often lack the absorptive capacity needed to capitalize on tariff-induced price changes; limited scale, weaker supply-chain integration, and higher coordination frictions dilute the efficiency gains available from liberalization. Consequently, economies of scale mediate the firm-level adjustment process, reinforcing the expectation that tariff reforms will yield uneven improvements in cost efficiency across the industry.

Universiti Utara Malaysia

### 3.7.5 Ownership Concentration

Ownership concentration, particularly among the largest shareholders, has been shown to influence firm performance and operational decision-making. In the Malaysian context, Sulong and Nor (2008) provide empirical evidence that ownership structure and governance mechanisms significantly affect firm value. Their findings indicate that concentrated ownership can enhance internal monitoring and align management interests with those of the principal shareholders, which may contribute to more efficient resource use and tighter cost control.

In relation to cost inefficiency, this implies that firms with higher ownership concentration may be better positioned to reduce inefficiencies through effective oversight and governance discipline. Specifically, controlling shareholders have the incentive to limit wasteful spending and enforce accountability, thereby improving cost efficiency. However, there remains a possibility that excessive concentration could result in entrenchment behavior or expropriation of minority interests, potentially leading to inefficiencies if governance checks are weak.

This study builds on Sulong and Nor's (2008) findings by examining whether ownership concentration among the top three shareholders is associated with reductions in cost inefficiency among Malaysian property development firms. The expected relationship is negative, suggesting that increased concentration leads to better cost control. From a theoretical standpoint, ownership concentration can have dual implications for cost efficiency. On one hand, concentrated ownership particularly in the hands of founders or families can enhance internal monitoring, reduce principal-agent conflicts, and align managerial decisions with long-term objectives. These dynamics are expected to foster tighter cost control and improved efficiency. On the other hand, when ownership is excessively concentrated, particularly in environments with limited external oversight, it may lead to entrenchment or the pursuit of private benefits, potentially increasing inefficiency.

Universiti Utara Malaysia

In the Malaysian property development sector, many listed firms are family-owned or closely held, reflecting a common corporate structure where founders or family members retain controlling stakes. This structure can lead to long-term strategic commitments and reputational stewardship, as noted by Abdul Aziz et al. (2007) in their review of corporate governance practices in the Malaysian construction industry. Similarly, Sulong and Nor (2008), and Sulong and Ahmed (2011), found that ownership concentration among major shareholders improves governance and firm value among Malaysian listed companies though the specific link to efficiency outcomes remains underexplored.

While several studies in Malaysia have explored the relationship between ownership structure and firm performance (Sulong & Nor, 2008; Sulong & Ahmed, 2011), most of these investigations emphasize firm value, dividend policy, or earnings management, rather than cost inefficiency per se. In this sense, ownership concentration has been linked to improved corporate governance and tighter monitoring mechanisms, which may lead to better financial discipline and lower agency costs.

Therefore, the direct relationship between ownership concentration and cost inefficiency especially in the context of Malaysian property development firms remains underexplored. Given the capital-intensive and regulation-sensitive nature of the property sector, ownership concentration may play a strategic role in shaping firm behavior, particularly in how resources are allocated, and costs are controlled.

Universiti Utara Malaysia

Specifying ownership concentration as a determinant in the cost inefficiency model, this study extends the existing literature by examining whether majority shareholder control influences cost-minimizing behavior.

### 3.7.6 Firm Age and Nonlinear Effects on Cost Inefficiency

Firm age, measured as the number of years a company has been in operation, is a widely recognized determinant of cost efficiency (Coad, 2009). Older firms are generally assumed to benefit from accumulated experience, learning-by-doing, and long-standing relationships with suppliers, subcontractors, and clients. These advantages can enhance procurement efficiency, reduce search and coordination costs, and contribute to more stable input sourcing ultimately lowering cost inefficiency.

Universiti Utara Malaysia

The theoretical underpinnings of this relationship are well established in the Jovanovic (1982) model of firm growth, where firms learn about their cost structure and efficiency levels over time. Efficient firms grow and survive, while inefficient firms tend to exit the market. This dynamic leads to a natural correlation between firm age and efficiency, as older firms are typically those that have successfully navigated competitive pressures and optimized internal processes. Moreover, Malerba (1992) supports this view by emphasizing learning-by-doing, where accumulated experience enables firms to refine their production and cost management practices over time.

Although many empirical studies have examined firm age in relation to performance, limited research in Malaysia has explicitly linked firm age to cost inefficiency particularly in the property sector. However, previous works such as Abdul Aziz et al. (2007) and Sulong and Nor (2008) offer relevant contextual foundations. For instance, Abdul Aziz et al. emphasize the maturity and long-term market participation of Malaysian property developers, many of which have operated for decades. Their research highlights how sustained presence in the industry is associated with accumulated project management experience, greater access to financial resources, and improved strategic planning factors that align closely with the theoretical underpinnings of learning-by-doing and firm lifecycle dynamics.

Therefore, from an Industrial Organization (IO) perspective, firm age reflects not only operational maturity but also structural embeddedness within the market, which can influence bargaining power, institutional memory, and resource stability. As noted by Coad (2009), firm age is associated with increased survivability, cumulative knowledge, and strategic learning, all of which reinforce the capacity to manage input costs and respond to market dynamics. Accordingly, a negative relationship between firm age and cost inefficiency is expected, particularly during the early to mid-stages of a firm's life cycle.

In addition, to account for potential nonlinearities in the age–inefficiency relationship, the squared term of firm age ($lnAge^2$) is included in the inefficiency model. This

specification is consistent with the theory of the firm, which recognizes that efficiency gains from age may not follow a strictly linear path. It is hypothesized that the relationship between firm age and cost inefficiency is nonlinear. A negative coefficient on lnAge would indicate that as firms become older, cost inefficiency initially decreases, driven by learning effects, accumulated managerial experience, and improved resource coordination. In contrast, a positive coefficient on $lnAge^2$ would suggest that beyond a certain age, cost inefficiency increases, possibly due to reduced organizational flexibility, structural rigidities, or increasing regulatory constraints.

The combined statistical significance and opposite signs of lnAge and $lnAge^2$ provide evidence of a U-shaped cost inefficiency pattern, where cost efficiency improves with firm age up to an optimal point, after which further aging is associated with declining performance. This interpretation is broadly aligned with Karim's (2001) study on banking efficiency across selected ASEAN countries, where time-related variables were found to be statistically significant with opposite signs, suggesting that inefficiency increased over time at a decreasing rate. While the estimated nonlinear pattern in her model differs, both findings emphasize the importance of capturing dynamic and nonlinear trajectories in firm performance. Accordingly, modeling both lnAge and $lnAge^2$ allows the inefficiency function to reflect lifecycle effects that are theoretically and empirically relevant for long-established firms in the property sector.

Universiti Utara Malaysia

### 3.7.7 Subsidiary

In this study, subsidiary status is modelled as a binary explanatory variable in the cost inefficiency effects equation, taking the value 1 if the firm owns a construction-related subsidiary and 0 otherwise. Although the variable is specified as a dummy, its inclusion captures an important organizational dimension vertical integration which can have significant implications for cost efficiency in the property development sector.

From the perspective of transaction cost economics (Williamson, 1985), vertically integrated firms may internalize transactions that would otherwise be conducted through the market, thereby reducing opportunistic behavior, coordination failures, and contractual rigidities. In the context of Malaysian property firms, owning a construction-related subsidiary could, in theory, enhance operational control, streamline procurement, and reduce delays factors that can contribute to lower production costs and improved cost efficiency.

Empirically, this specification enables the model to test whether firms with integrated supply chains (via subsidiaries) experience systematically lower cost inefficiency, after controlling for output levels, input prices, and other structural firm characteristics. Although this binary variable does not capture the degree or scope of subsidiary operations, it offers a meaningful way to differentiate between organizational structures and their potential influence on firm-level efficiency.

However, empirical findings on this relationship are mixed. While some studies report that vertical integration contributes positively to firm performance and cost efficiency, others caution that managing multiple subsidiaries may increase organizational complexity, lead to inefficiencies in resource allocation, and dilute managerial focus particularly in firms without robust internal coordination mechanisms (Lypczynski et.al, 2017). The potential for diseconomies of scale and added overheads may offset the benefits of integration if not properly managed.

In the Malaysian context where many listed property firms adopt conglomerate business models with multiple business units under common ownership the role of subsidiaries is particularly relevant. Prior studies (Abdul Aziz & Jahn Kassim, 2011) have highlighted the strategic benefits of internalizing construction capabilities within larger development firms, although these studies have not directly assessed cost inefficiency. This research builds upon that foundation by formally incorporating subsidiary status into a stochastic cost frontier framework, allowing for a more precise assessment of its efficiency impact.

This study incorporates subsidiary status as a dummy variable in the inefficiency effects model to empirically test whether firms with construction-related subsidiaries experience systematically higher or lower cost inefficiency. Although the variable captures only the presence (not the number or scope) of subsidiaries, it serves as a proxy for organizational structure and internal capability. Given the mixed evidence, no strict directional

Universiti Utara Malaysia

hypothesis is imposed, and the empirical results are expected to shed light on whether integration leads to net efficiency gains or losses in the Malaysian property sector.

Although detailed data on the number and type of subsidiaries are reported in the Annual Economic Survey by the Department of Statistics Malaysia (DOSM), access to this micro-level information is restricted due to data protection policies. As such, this study adopts a binary proxy (dummy variable) for subsidiary status, indicating whether a property firm owns at least one construction-related subsidiary. While this variable does not capture the full spectrum of subsidiary complexity, it enables a consistent and legally compliant representation of organizational structure across the sample. This decision reflects the broader trade-off between data richness and confidentiality compliance often encountered in firm-level empirical research.

Universiti Utara Malaysia

### 3.7.8 Firm Establishment

Firm establishment type is included as a binary variable in the cost-inefficiency model, coded as 0 for state-owned or government-linked companies (GLCs) and 1 for privately owned firms. This classification captures potential differences in managerial incentives, ownership structure, and resource access, each of which can influence cost-efficiency outcomes.

From an agency-theory perspective (Jensen & Meckling, 1976), the separation of ownership and control in GLCs may give rise to principal-agent problems, where managers face weaker monitoring and limited exposure to market discipline. In contrast, private firms particularly those with concentrated ownership tend to exhibit stronger cost-control behavior, as residual claimants directly internalize the costs of inefficiency. Hence, agency theory predicts that private firms should display lower cost inefficiency relative to GLCs.

Empirical evidence supports this theoretical distinction. Jaafar, Raofuddin, and Syed Abu Bakar (2018) find that business sustainability strategies differ markedly between private and GLC developers in Malaysia: private firms adopt market-responsive, profit-oriented practices, whereas GLCs often operate under broader social or institutional mandates. These strategic and governance contrasts justify treating establishment type as a potential determinant of cost inefficiency. Nevertheless, empirical research quantifying how such institutional differences translate into cost-efficiency outcomes remains limited. By incorporating firm establishment into the inefficiency-effects model, this study provides an initial quantitative assessment of how governance form shapes operational performance in Malaysia's mixed development landscape.

Although simplified, the binary specification enables identification of structural cost differences between public and private developers. The expected relationship is ambiguous: while GLCs may benefit from scale economies and preferential access to

Universiti Utara Malaysia

resources, their governance and incentive constraints may offset these advantages. The empirical analysis therefore tests whether these opposing forces produce statistically significant differences in cost inefficiency between the two establishment types.

### 3.8 Estimation of Scale Economies

Economies of scale (EOS) in the property development sector are estimated as the reciprocal of the cost elasticity with respect to output, derived from the translog stochastic cost frontier. In general, economies of scale describe the proportionate increase in output resulting from a proportional increase in all inputs. When the elasticity of cost with respect to output is less than one, firms experience increasing returns to scale; conversely, values greater than one indicate diseconomies of scale. A value equal to one reflects constant returns to scale.

Universiti Utara Malaysia

Economies of scale (EOS) are estimated as the reciprocal of the elasticity of total cost with respect to output, following the translog cost framework proposed by Christensen, Jorgenson, and Lau (1973) and later applied in stochastic frontier models (Altunbas et al., 2000; Karim, 2001). This formulation expresses EOS as the inverse of cost elasticity along the expansion path, where input prices are held constant, and cost minimization is achieved at each output level.

The interpretation of EOS in this study is consistent with the duality principles outlined by Hanoch (1975), where the cost function is treated as the dual representation of the underlying production technology. This allows scale properties to be evaluated directly from the estimated cost frontier rather than from a production function. Following Caves, Christensen, and Diewert (1982), economies of scale are assessed along the expansion path under the assumption that firms minimize costs for any given output level. Furthermore, Caves, Christensen, and Tretheway (1984) emphasize that EOS measures should reflect how marginal cost behaves relative to average cost, thereby distinguishing between scale-related efficiency gains and cost increases arising from coordination or organizational complexity. Therefore, the estimated EOS values obtained from the translog stochastic cost frontier reflect not only the curvature of the cost function but also the structural scale characteristics of firms in the property development sector.

Universiti Utara Malaysia

For the translog cost frontier function that we used, the cost elasticities are:

$$\frac{\partial \ln C\,(y,w)}{\partial \ln y} = \beta_y + \beta_{yy} ln\, y + \sum_{j=1}^{m} \beta_y\, w_j\, lnw_j \tag{3.15}$$

Where:

$C(y,w)$ : Total production cost as a function of output y and input prices w

$\beta_y$ : First-order coefficient on ln y

$\beta_{yy}$ : Second-order coefficients on $(ln\, y)^2$

$\beta_y w_j$ : Cross-partial coefficients for interactions between output and each input $w_j$

$lny$ : Natural logarithm of output (Sales)

$\ln w_j$ : Natural logarithm of input prices $j$

Equation (3.15) describes how total cost responds to proportional changes in output. The term $\beta_{yy} ln_y$, effects the scale responsiveness of cost, indicating whether the cost elasticity increases or decreases as firms expand output. When this term (together with the interaction components $\beta_y w_j \ lnw_j$) results in a lower cost elasticity at higher output levels, total cost rises less than proportionately with output. This condition corresponds to economies of scale, where expanding production reduces average cost. Conversely, a rising cost elasticity would imply diminishing scale benefits.[4]

The scale elasticity (SC) is then calculated as the reciprocal of the sum of cost elasticities with respect to output:

$$SC\ (y, w) = \left[\sum_{i=1}^{n} \frac{\partial \ln C\ (y, w)}{\partial \ln y_i}\right]^{-1} \quad (3.16)$$

In the single output case (Sales), Equation (3.16) simplifies to:

[4] Tier 4

$$\frac{\delta\ inC}{\delta \ln Y} = \beta_y\ + 2\beta_{yy} lnY + \ \beta_{yL} lnPL + \beta_{yK} lnPK + \beta_{yM} lnM$$

$$E_Y = -0.131 + 2(0.046)(12.39474412) - 0.072(3.80241315) + 0.016(-1.964068719) - 0.022(0.811360526)$$

$$E_Y = 0.686267681$$

$$\text{EOS} = \frac{1}{E_Y} = \frac{1}{0.686267681}$$

$\approx$ 1.46 (IRS)

$$SC(y,w) = \left(\frac{\partial lnC(y,w)}{\partial lny}\right)^{-1}$$

(3.17)

Increasing returns to scale (IRS) or economies of scale are present when the scale elasticity (SC) is greater than 1, indicating that a proportionate increase in output leads to a less-than-proportionate increase in total cost. Conversely, decreasing returns to scale (DRS) or diseconomies of scale occur when SC is less than 1, meaning that costs rise more quickly than output. Constant returns to scale (CRS) are observed when SC is equal to 1, implying that cost and output increase proportionately. This EOS measure forms the basis for the scale economy results presented in Chapter 4 (Table 4.24).

In a typical production setting, these dynamics are often represented by a U-shaped long-run cost curve. At low levels of output, SC > 1 suggests the presence of increasing returns to scale as firms begin to spread fixed costs. As output approaches an optimal level, SC converges to 1, indicating constant returns to scale. Beyond this point, as firms expand further, SC < 1 reflects decreasing returns to scale, often caused by coordination inefficiencies, bureaucratic complexity, or capacity constraints. This U-shaped pattern helps identify the scale at which firms operate most efficiently.

This approach mirrors the methodology used by Karim (2001) in his seminal study of banking efficiency across ASEAN countries, where economies of scale were computed using the reciprocal of the cost elasticity derived from a translog cost function within a

stochastic frontier framework. Although his study focused on the financial sector, the underlying econometric logic flexible functional form, firm heterogeneity, and policy sensitivity makes it an appropriate precedent for analyzing cost dynamics and scale behavior in other regulated, capital-intensive industries such as property development.

To examine how economies of scale evolve across the property development sector, firms are stratified by total asset size into distinct categories. For each asset group, the scale elasticity (SC) is computed based on the estimated parameters from the translog cost frontier model, which allows for flexible substitution among inputs and varying returns to scale. This stratified estimation enables a granular assessment of how cost efficiency responds to firm size, thereby revealing the thresholds at which increasing returns to scale diminish and potential diseconomies emerge.

Universiti Utara Malaysia

## 3.9 Summary

This chapter has outlined the econometric strategy employed to evaluate the performance of Malaysian property development firms through the lens of production and cost efficiency. Utilizing the stochastic frontier framework specifically the Battese and Coelli (1995) inefficiency effects model the study applies both production and cost frontiers to capture firm-level deviations from optimal behavior. This dual-frontier approach enables the simultaneous examination of technical (output-oriented) and allocative (cost-oriented) inefficiencies.

Firm-specific and policy-driven determinants, including firm size, age, ownership concentration, establishment type, subsidiary status, geographic project dominance, and tariff liberalization in steel and cement, are incorporated as explanatory variables in both inefficiency models. These controls are grounded in economic theory, particularly the theory of the firm and industrial organization, offering structural insight into the efficiency behavior of property firms.

In addition, the chapter outlines the empirical formulation for estimating economies of scale (EOS) derived from the translog cost function. Through the estimation of cost elasticity with respect to output, the study identifies whether firms operate under increasing, constant, or decreasing returns to scale. This extension not only enriches the analysis of firm efficiency but also contributes to the policy discourse on optimal firm size and market structure in Malaysia's property development sector.

Universiti Utara Malaysia

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.0 Introduction

Chapter Four presents the empirical analysis and results obtained from the application of stochastic frontier models to the Malaysian residential property development sector over the period 2000-2020. The chapter is organized into three main components: production efficiency, cost efficiency, and economies of scale. Collectively, these analyses provide a comprehensive assessment of firm performance, encompassing both input-output efficiency and cost minimization behavior.

The first part (Section 4.1) estimates the stochastic production frontier within a translog framework to measure technical efficiency and to identify the underlying firm-specific and policy-related determinants of inefficiency. This analysis highlights the extent to which property developers transform inputs into outputs relative to the best-practice frontier. The second part (Section 4.6) turns to the stochastic cost frontier, which evaluates firms' ability to achieve cost minimization given prevailing output levels and input prices, thereby providing an assessment of cost efficiency in relation to structural and institutional conditions. The final part (Section 4.10) addresses economies of scale by deriving cost elasticities from the translog cost function, enabling an examination of whether firms operate under increasing, constant, or decreasing returns to scale, with implications for industry structure and competitive behavior.

Universiti Utara Malaysia

The empirical results from the production, cost, and scale specifications jointly establish the foundation for evaluating how firm characteristics, ownership structures, and market reforms shape efficiency outcomes. This synthesis provides a deeper understanding of firm behavior and market structure in Malaysia's property sector, consistent with the industrial organization perspective adopted in this study. The discussion therefore begins with the estimation of the production frontier, which forms the basis for measuring technical efficiency and analyzing the determinants of inefficiency.

## 4.1 Estimation of the Production Frontier and Technical Efficiency

This section presents the empirical findings on production efficiency among Malaysian residential property firms, based on the stochastic frontier analysis (SFA) framework. The estimation utilizes a translog production frontier, allowing for firm-level heterogeneity and input interaction effects. The analysis is structured as follows: Section 4.2.1 provides the descriptive statistics of the dataset, offering an overview of the key variables and their distributions. Section 4.2.2 reports the parameter estimates obtained through Maximum Likelihood Estimation (MLE) of the translog production frontier model. Section 4.2.3 discusses model performance and validity with the appropriateness of the inefficiency specification. Section 4.2.3 summarizes the distributional characteristics of technical efficiency scores derived from the estimated model. Finally, Section 4.4 explores the association between technical efficiency and firm-specific characteristics using non-parametric correlation analysis.

Universiti Utara Malaysia

### 4.1.1 Descriptive Statistics for the Production Frontier Model

This section presents the descriptive statistics for the variables used in the production frontier model, focusing on key measures such as means, standard deviations, and value ranges. The dataset includes firm-level inputs labor, capital, and materials and output (sales), along with external factors such as location, ownership concentration, and input tariffs. These summary statistics offer initial insights into the distribution and variability of the data, providing a foundation for the subsequent efficiency estimation using the stochastic frontier analysis (SFA) framework.

Table 4.1 presents the summary statistics for the variables used in the production efficiency model. The output is measured by firm-level sales revenue ($Y$), while the primary input variables include labor ($L$), capital ($K$), and materials ($M$). Therefore, a key observation from the descriptive statistics is the substantial variation in input variables particularly labor, capital, and materials. This variation is expected and reflective of the heterogeneous nature of Malaysia's residential property sector. Firms in the dataset include both standalone companies and those operating under larger corporate groups.

The descriptive statistics in Table 4.1 reveal substantial variation in labor, capital, and material inputs across firms, reflecting the structural diversity of Malaysia's residential property sector. This heterogeneity stems from the coexistence of large integrated development groups and smaller, project-based firms. For instance, labor input ranges from 237 to over 138,000 employees, indicating differences between firms with in-house

construction teams and those relying on outsourced labor. Capital and material expenditures also vary widely due to differences in project scale, development models, and asset ownership strategies.

Table 4.1: Summary of Descriptive Statistics for the Production Frontier Model

| Description | Unit | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|
| Sales | RM | 295770.3 | 604696.8 | 124424 | 6746343 |
| Labor | Person | 1139 | 8659 | 237 | 138445 |
| Capital | RM | 311156.3 | 472242.8 | 387,956 | 5571596 |
| Materials | RM | 195257.3 | 442211.3 | 18560 | 4825976 |
| Total Assets | RM | 1378518 | 2880861 | 559242 | 30056048 |
| Location | Percentage | 86.83 | 5.5 | 75 | 95 |
| Steel Tariff | Percentage | 29.1 | 6.1 | 20.36 | 40.75 |
| Cement Tariff | Percentage | 20.14 | 4.64 | 15.71 | 30.17 |
| Ownership | Percentage | 47.04 | 15.98 | 49.28 | 82.72 |
| Firm Age | Year | 37.7 | 21.91 | 1 | 135 |

This empirical pattern is consistent with international findings. In Korea, You and Zi (2007) observed that construction firms with integrated operations such as subsidiaries managing core inputs performed more effectively under volatile conditions. In Taiwan, Dzeng and Wu (2013) identified cost inefficiencies among firms heavily reliant on external suppliers, highlighting the transaction cost risks of excessive outsourcing. Similarly, in Spain, Moreno et al. (2014) found that vertically integrated developers were more resilient during financial downturns, underscoring the strategic advantage of internal control over key resources.

The summary statistics for total assets, as presented in Table 4.1, reveal a wide dispersion across firms, ranging from approximately RM 559,000 to over RM 30 million, with a mean of RM 1.38 billion. This significant variation indicates the presence of firms with markedly different financial capacities and operational scales. In the context of IO, firm size influences not only a developer's internal efficiency but also its ability to set prices, pre-empt land acquisition, engage with regulatory bodies, and shape the behavior of smaller firms. Larger firms, with deeper financial buffers, are more likely to engage in multi-phase, high-risk projects, benefit from economies of scale, and exert strategic influence over competitors. Smaller firms, by contrast, often follow the pricing benchmarks, spatial positioning, and product types set by market leaders reflecting a follower dynamic in market conduct.

Universiti Utara Malaysia

As shown in Table 4.1, firm age ranges from 1 to 135 years, with a mean of 37.70 years, indicating substantial heterogeneity in lifecycle stages across property firms in Malaysia. Notably, the minimum age of one year is not anomalous but reflects structural realignments following the 1997/98 Asian Financial Crisis, during which the Malaysian government promoted mergers and acquisitions (M&A) particularly in the banking sector. This policy direction indirectly influenced conglomerate restructuring, including the formation of new property subsidiaries or holding companies as part of broader corporate realignment.

In addition to core production inputs, firm-specific characteristics such as ownership concentration, firm age, subsidiary status, and establishment type serve as important explanatory variables in accounting for heterogeneity in production efficiency across firms. High ownership concentration can enhance internal governance by aligning managerial incentives and reducing agency costs. However, it may also lead to strategic inertia, particularly in older firms with centralized control. In this study, ownership concentration is measured using the CR3 ratio the shareholding percentage of the top three shareholders. As shown in Table 4.1, CR3 values range from 49.28% to 82.72%, with a mean of 47.04%, reflecting moderate to high control levels and considerable variation across firms.

The variable for subsidiary status (1 = subsidiary, 0 = otherwise) captures whether a firm operates within a larger corporate group. Subsidiaries may benefit from centralized planning, shared capital access, and strategic coordination, though this can come at the cost of reduced autonomy in responding to local efficiency challenges. In this sample, 97.6% of firms are subsidiaries, highlighting the dominance of group-level governance in the Malaysian property sector.

Similarly, establishment type (1 = private, 0 = state-owned) distinguishes firms by institutional ownership. Private developers typically focus on profit maximization, while state-owned firms may be guided by broader policy objectives, affecting input use and strategic decisions. Including these categorical variables allows the model to capture

Universiti Utara Malaysia

institutional heterogeneity that influences production efficiency beyond input levels. Together with continuous variables like firm size and age, they provide a more comprehensive view of how ownership and organizational structure shape firm performance within the stochastic frontier framework.

The inclusion of firm age, subsidiary status, and establishment type in the stochastic frontier model reflects institutional factors highlighted by Cagamas (2014). State-linked developers often operate under socio-economic mandates, potentially affecting efficiency, while private firms tend to prioritize profitability and cost control.

The input variables and firm-level covariates jointly constitute the empirical specification of the stochastic production frontier model. This framework estimates firm-level efficiency by evaluating how inputs are transformed into output, conditional on heterogeneity arising from institutional characteristics and policy-related factors. The subsequent section reports the estimation results, including technical efficiency scores and the marginal effects of these determinants on firm performance within Malaysia's residential property sector.

### 4.1.2 Maximum Likelihood Estimates of the Translog Stochastic Production Frontier

This section reports the maximum likelihood estimates of the translog stochastic production frontier, estimated under the Battese and Coelli (1992, 1995) framework for

time-varying inefficiency. The translog specification provides a flexible functional form that captures both first-order input elasticities and higher-order substitution possibilities, while simultaneously allowing inefficiency to evolve over time. Estimation is conducted using a balanced panel of 76 Malaysian residential property firms over the period 2000-2020.

In addition to the core production inputs of labor, capital, and materials, the inefficiency component is specified as a function of firm-level and policy-related variables, including firm size, ownership concentration, age, geographic location, and tariff reforms on steel and cement. Results are presented for two benchmark specifications: the baseline frontier without inefficiency determinants (BC1992) and the extended frontier incorporating inefficiency effects (BC1995). The discussion is organized around three key dimensions: estimated input elasticities, second-order translog coefficients, and the role of inefficiency determinants.[5]

Universiti Utara Malaysia

The maximum likelihood estimates for the translog production frontier and inefficiency model are presented in Table 4.2. The interpretation focuses on two key components:

(i) the marginal effects of input variables labor, capital, and materials on output.

(ii) the second-order term and input interactions.

[5] BC92 refers to the Battese and Coelli (1992) specification of the stochastic frontier model without firm-specific inefficiency determinants, where inefficiency is time-varying but not linked to covariates. BC95 denotes the Battese and Coelli (1995) inefficiency-effects model, in which inefficiency is parameterized as a function of firm-level and policy-related variables.

Firstly, to evaluate whether the inclusion of firm-specific inefficiency determinants significantly enhances the explanatory power of the model, a Likelihood Ratio (LR) test was conducted. This test compares the restricted baseline model without inefficiency determinants (BC92) against the extended model that incorporates these variables (BC95). The log-likelihood values for the BC92 and BC95 models are -1505.738 and -1299.2981, respectively. Based on the LR formula, the test statistic is calculated as:

$$LR = -2(ln\, L_{BC92} - lnL_{BC95}) = -2(-1505.738 + 1299.2981) = 412.88$$

Universiti Utara Malaysia

Table 4.2: Maximum-Likelihood Estimates for Parameters of the Translog Stochastic Frontier Production Function Model

| Variables | Model BC92 | | Model BC95 | |
|---|---|---|---|---|
| | Coefficient | Std. Error | Coefficient | Std. Error |
| lnL | 0.435*** | 0.118 | 0.346*** | 0.125 |
| lnK | 0.151* | 0.0831 | -0.185* | 0.101 |
| lnM | -0.505*** | 0.0701 | -1.023*** | 0.074 |
| $L^2$ | -0.006 | 0.006 | -0.001 | 0.005 |
| $K^2$ | -0.006 | 0.005 | -0.004 | 0.005 |
| $M^2$ | 0.0853*** | 0.003 | 0.077*** | 0.003 |
| L.K | 0.057*** | 0.010 | 0.033*** | 0.011 |
| L.M | -0.0764*** | 0.007 | -0.051*** | 0.007 |
| K.M | -0.022*** | 0.006 | 0.011* | 0.006 |
| Constant | 7.410*** | 0.590 | 14.008*** | 0.752 |
| Inefficiency Model | | | | |
| lnTA | | | -1.191*** | 0.181 |
| Location | | | -0.132*** | 0.028 |
| Steel Tariff | | | -0.155*** | 0.055 |
| Cement Tariff | | | 0.099 | 0.069 |
| Ownership | | | -0.003 | 0.005 |
| Establishment | | | 0.588 | 0.420 |
| Subsidiary | | | -0.125 | 0.449 |
| lnAge | | | 1.175*** | 0.265 |
| Constant | | | 23.746*** | 3.460 |
| Variance Parameter | | | | |
| Usigma | | | -0.051 | 0.233 |
| Vsigma | | | -1.880*** | 0.068 |
| /lnsigma2 | 0.951*** | 0.035 | | |
| /ilgtgamma | -19.06 | 723.3 | | |
| /mu | 0.196 | 0.207 | | |
| /eta | -0.015 | 0.026 | | |
| Sigma_u | 0.364*** | 0.023 | 0.975*** | 0.113 |
| Sigma_v | 0.478*** | 0.015 | 0.391*** | 0.013 |
| Lambda | 0.761*** | 0.033 | 2.49*** | 0.114 |
| sigma2 | 0.386 | 0.014 | | |
| Gamma | 0.000 | 0.000 | 0.86 | |
| sigma_u2 | 0.000 | 0.000 | | |
| sigma_v2 | 0.386 | 0.014 | | |
| Hausman Test | 6.63 | | | |
| Log likelihood | -1505.738 | | -1299.2981 | |
| Observation | 1596 | | 1596 | |
| Number of years | 21 | | 21 | |

Note: BC92=Battese and Coelli(1992) refers to the time-invariant inefficiency model; BC95=Battese and Coelli(1995) refers to the time-varying inefficiency model with firm-specific determinants.

***, ** and * denote statistical significance at the 1, 5 and 10 levels, respectively

Universiti Utara Malaysia

Since the estimated value of gamma (γ) is 0.000, the null hypothesis lies on the boundary of the parameter space, violating the regularity conditions required for standard likelihood ratio (LR) inference. Accordingly, critical values firm the mixed chi-square distribution, as provided by Kodde and Palm (1986), are employed. At the 1% significance level and with 8 restrictions, the critical value is 15.51. Given that the computed LR statistic substantially exceeds this threshold, the null hypothesis that the inefficiency determinants are jointly insignificant is decisively rejected. This result validates the BC95 specification and confirms that the inclusion of firm-level structural and policy variables significantly improves the explanatory power of the stochastic frontier model.

In addition to the joint significance of the inefficiency determinants, a second hypothesis test was conducted to examine whether technical inefficiency is statistically present in the production process. Specifically, a likelihood ratio (LR) test was used to test the null hypothesis $H_0 : \gamma = 0$, where $\gamma$ represents the share of total variance attributable to inefficiency. The LR test compares the unrestricted BC95 model with a restricted version in which the inefficiency variance is set to zero (equivalent to a standard translog model estimated by OLS). The resulting LR statistic is 412.88, which exceeds the critical value of 2.705 from the mixed chi-square distribution at the 1% significance level, based on the Kodde and Palm (1986) boundary condition (as cited in Coelli et al., 2005, p. 259). This result confirms that inefficiency effects are not only influenced by firm-specific characteristics but are also statistically present in the industry, validating the application of the stochastic frontier framework for analyzing productivity in Malaysia's property development sector.

Universiti Utara Malaysia

**i) The marginal effects of input variables labor, capital, and materials on output**

The first-order coefficients from the translog production function reflect the marginal effects of labor, capital, and materials. In both BC92 and BC95 models, labor (*lnL*) has a positive and significant impact on output 0.435 in BC92 and 0.346 in BC95 underscoring its central role in the labor-intensive nature of Malaysia's residential property sector. The slightly lower coefficient in BC95 may indicate variation in labor efficiency across firms and over time, possibly influenced by subcontracting practices, informal labor usage, and regional labor market differences.

These findings align with concerns from the Construction Industry Development Board (CIDB) and the Malaysia Productivity Corporation (MPC), which have noted that Malaysia's construction productivity remains low relative to regional peers such as Taiwan, Japan, and South Korea. As highlighted in Chapter One, this productivity gap is a persistent structural issue. Despite policy initiatives under the Construction Industry Transformation Programme (CITP) including workforce certification, IBS adoption, and digitalization progress remains limited, particularly among smaller developers constrained by labour-intensive methods and fragmented supply chains. Consistent regional evidence reinforces this pattern. For Taiwan, Dzeng and Wu (2013) report that average cost efficiency is only 0.78, with significant inefficiency arising from excess equipment investment, subcontracting layers, and weak financial structures. For South Korea, You and Zi (2007) find that post-crisis construction inefficiency is driven largely by allocative inefficiency, with firms unable to adopt optimal input mixes due to leverage pressures and governance weaknesses. For Japan, Park et al. (2015) show that the

country's average efficiency score is 0.775, lower than Korea (0.861), and that productivity stagnation is driven by a sharp decline in technical efficiency change (TECI), reflecting organizational frictions such as multi-tiered subcontracting chains, rising coordination costs, and dispersed project responsibilities that offset gains from Japan's strong technological base. Collectively, these regional findings mirror Malaysia's own structural productivity challenges particularly its reliance on labour-intensive processes, limited mechanization, and fragmented supply networks.

The coefficient for capital (ln*K*) is positive and weakly significant in BC92 (0.151) but becomes negative and statistically significant in BC95 (-0.185). This reversal is both theoretically and empirically meaningful. In the baseline BC92 model absent firm-level inefficiency controls capital appears to have a modest positive contribution to output. However, once time-varying inefficiency is explicitly modeled in BC95, capital emerges as a potential source of inefficiency. This shift may reflect structural issues such as overcapitalization, utilized machinery, or capital tied up in projects experiencing delayed execution. This pattern is consistent with regional evidence. You and Zi (2007) show that, in the South Korean construction industry, firms with larger asset bases tend to exhibit lower cost and allocative efficiency, particularly after the Asian financial crisis, as overinvestment and leverage constraints reduce their ability to use capital productively. Allocative inefficiency, rather than pure technical inefficiency, explains most of the low-cost efficiency observed in Korean contractors.

Universiti Utara Malaysia

In contrast, smaller or mid-sized firms may struggle to fully leverage capital assets due to bureaucratic delays, limited financing channels, or the absence of integrated project delivery systems. This challenge is often more pronounced among state-linked or state-owned developers, particularly those mandated to develop within their respective regions (Perak, Pahang, Sarawak) under specific socio-political or public housing agendas. These firms may face restricted market flexibility, slower project turnover, and limited exposure to demand-driven opportunities, thereby reducing the marginal productivity of capital.

Materials (ln*M*) show a negative and highly significant coefficient in both models, with an even stronger effect in BC95 (-0.505, $p < 0.01$ in BC92; -1.023, $p < 0.01$ in BC95). Empirically, this is a critical result, indicating that increased material input is associated with a reduction in output, contrary to standard production theory. This unexpected relationship may be attributed to wastage, inefficient material procurement, or price volatility, particularly for steel and cement both of which are subject to global commodity trends and national policy shifts. The steeper negative coefficient in BC95 suggests that material inefficiency may have worsened over time or varied significantly across firms, likely due to differences in supply chain integration, contractor management, or project execution methods. In practice, firms with weaker procurement systems or less control over subcontracted work may incur higher material usage without proportional gains in output, thus increasing technical inefficiency.

Universiti Utara Malaysia

In summary, the first-order coefficients from the translog production frontier reveal distinct patterns in the marginal effects of core inputs. Labor remains a central driver of output, consistent with the sector's reliance on human capital across various construction stages. However, the changing signs and magnitudes of capital and material inputs between BC92 and BC95 highlight deeper structural inefficiencies. Capital turns from a weakly positive to a significantly negative contributor once inefficiency is modeled, suggesting poor capital utilization or financial rigidity among certain firms. More critically, materials consistently exhibit a large negative marginal effect, indicating that input quantity does not translate proportionally into output underscoring inefficiencies in procurement, usage, and supply chain management. These findings collectively support the need for firm-level transformation in input allocation, inventory systems, and cost control mechanisms within Malaysia's residential property development industry.

**ii) Second-Order Terms and Input Interactions**

Universiti Utara Malaysia

The second-order terms in the translog production function reflect the local properties of the production technology, particularly the presence of diminishing or increasing marginal returns. In the BC95 model, the coefficients on the squared terms for labor ($L^2$) and capital ($K^2$) are negative (-0.001 and -0.004, respectively), indicating the presence of diminishing marginal returns to both inputs. This is consistent with the standard production theory, where input additions eventually yield smaller output gains. Conversely, the squared term for materials ($M^2$) is positive and highly significant (0.077), suggesting a nonlinear response to material input, possibly reflecting overuse or scale misalignment. This may suggest input overuse or inefficiencies at higher material volumes, aligning with the negative first-order coefficient on materials observed earlier.

Second-order and interaction terms offer deeper insights into input dynamics. The positive and statistically significant coefficient for $M^2$ suggests the presence of non-linear effects, indicating that firms with moderate material usage may achieve higher efficiency compared to those using extremely high or low material quantities. This non-linearity likely reflects a balance between adequate material provisioning and avoidance of wastage particularly important in an industry prone to overordering and on-site inefficiencies.

The estimated curvature in capital and labor terms ($K^2$ , $L^2$ ) further reflects the challenges of scaling inputs efficiently during boom cycles. Capital-intensive expansion strategies, such as aggressive land banking or premature machinery investment, may not have translated into output as effectively especially in firms lacking coordinated project execution. These second-order effects confirm the value of a flexible translog specification, capturing how firm performance responds not just to input levels, but to the quality and timing of input deployment, especially under cyclical demand conditions.

Interaction terms such as LK (labor-capital) are positive and significant, suggesting complementarity between labor and capital. This implies that capital investments tend to be more productive when accompanied by an adequate and well-coordinated workforce, particularly in firms that manage construction activities in-house rather than relying on external contractors. In contrast, LM (labor-material) and KM (capital-material) show mixed or negative signs, reflecting weaker or inconsistent synergies between materials

Universiti Utara Malaysia

and the other inputs possibly due to on-site wastage, fragmented procurement, or inadequate labor planning.

Importantly, capital in the property sector is not homogenous. Some firms accumulate capital through public equity offerings, which is then actively channelled into construction activities, enabling more responsive project execution and better capital-to-output conversion. In contrast, other firms rely heavily on passive capital appreciation from landbanks, which inflates the balance sheet but does not directly translate into output especially when the land remains undeveloped or is held for speculative purposes. This heterogeneity in capital source and deployment may explain why capital is not uniformly productive across firms.

Universiti Utara Malaysia

Similarly, the KM (capital-material) interaction shows mixed or negative signs, reflecting the inefficiencies that arise when capital assets are not effectively tied to real-time material deployment. This interpretation is strongly supported by You and Zi's (2007) analysis of South Korea's construction industry, which shows that firms experienced substantial allocative inefficiency in the *post-crisis* period particularly in achieving the optimal capital-material mix because they lacked the technological capability and organizational readiness needed to adjust to sudden changes in input costs. Their findings highlight how financial pressures, fragmented project structures, and weak coordination systems resulted in capital equipment being under-utilised or poorly matched to material requirements. A similar mechanism appears in Malaysia's *post-liberalization*

environment, where reductions in steel and cement tariffs did not translate into improved efficiency because many firms lacked the capability to re-optimize their input combinations. As in post-crisis Korea, Malaysian developers especially smaller firms continue to operate with low IBS adoption, labour-intensive methods, and limited digital integration, all of which hinder the efficient alignment of capital and materials. These structural constraints weaken the capital-output relationship and help explain persistent inefficiencies despite ongoing reforms under CITP 2021-2025.

International comparisons reinforce this mechanism. Park et al. (2018), using DEA and the Malmquist Productivity Index, report that Korean construction firms achieve higher average efficiency (0.861) than Japanese (0.775) and Chinese (0.639) firms, reflecting more effective utilisation of labour, capital, and material inputs. Yet, China recorded the strongest productivity growth (5.5%) far exceeding Korea (0.9%) driven by rapid technological advancement despite its lower baseline efficiency. This contrast highlights a critical insight relevant to Malaysia: *efficiency improvements require both better input coordination and continuous technological upgrading*. Dynamic gains from industrialized systems, mechanization, and digital tools matter as much as, if not more than, static efficiency gains. Without such capability-building, firms remain trapped in the same pattern observed in the KM interaction where capital and materials fail to complement each other effectively leading to persistent inefficiencies despite policy reforms.

Universiti Utara Malaysia

The shift in the capital coefficient under BC95 aligns with expectations from transaction cost economics and industrial organization theory. These results suggest that variations in capital efficiency are systematically associated with firm-specific and institutional factors, consistent with predictions from both frameworks. Factors such as asset specificity, institutional rigidity, and coordination failures may impair capital productivity, reinforcing the importance of firm structure, strategic orientation, and regulatory environment in shaping input efficiency over time.

### 4.1.3 Model Performance and Diagnostic Validity

Assessing model performance and diagnostic validity is essential to ensure that the estimated stochastic frontier accurately captures the underlying production technology and inefficiency structure. A well-specified model not only improves the reliability of efficiency estimates but also strengthens the empirical credibility of inferences drawn from firm-level and policy-related determinants. Diagnostic tests help verify the appropriateness of the functional form, the significance of inefficiency effects, and the overall robustness of the model specification. To establish the reliability of the stochastic production frontier specification, likelihood ratio (LR) tests were applied to evaluate model performance and diagnostic validity.

The test results, presented in Table 4.3, decisively reject all null hypotheses at the 1% level, thereby confirming both the appropriateness of the translog functional form and the statistical significance of inefficiency effects. These findings affirm that inefficiency is

not random but systematically linked to observable firm-specific and policy-related factors. The BC95 model is therefore retained as the preferred specification, offering a more robust and theoretically consistent basis for analyzing the production efficiency of Malaysia's residential property firms.

Table 4.3: Likelihood Ratio Tests for Production Frontier Model Comparison and Inefficiency Specification

| **LR Test Description** | **Null hypothesis $H_0$** | **Test Statistic** |
|---|---|---|
| LR test -Basic Model (BC92) | β3 = β4 = β5 = 0 | 138.142*** (0.000) |
| LR test-Inefficiency Model (BC95) | γ = δ1 = δ2 = …= δ10 = 0 | 274.661*** (0.000) |
| LR test - BC92 vs BC95 | δ1 = δ2 = …= δ10 = 0 | 412.88*** (0.000) |

Notes:
1.*** denotes significance at the 1 percent level.
2. The LR statistic is calculated as $LR = -2[\ln(L_{restricted}) - \ln(L_{unrestricted})]$

Consistent with econometric procedures outlined by Coelli et al. (2005) and Kumbhakar and Lovell (2000), three nested model comparisons were executed. The first test assessed whether the inclusion of second-order input terms in the translog production function (BC92) significantly enhanced model fit over a more restrictive Cobb-Douglas form. The second test evaluated the presence of inefficiency by testing the joint null hypothesis that $\gamma = 0$ and all inefficiency-related parameters in the extended model (BC95) are equal to zero. The third and most comprehensive test compared BC92 with BC95 to determine whether the inclusion of inefficiency determinants significantly improved explanatory power.

In addition, the LR tests evaluate three key aspects of model specification. First, they test whether including second-order input terms in the translog specification (BC92) is justified. Second, they assess whether inefficiency is present by testing the joint null that $\gamma = 0$ and all inefficiency-related parameters in the BC95 model. Third, they compare the restricted BC92 model with the full BC95 model to evaluate the joint contribution of inefficiency determinants. As shown in Table 4.3, all null hypotheses are rejected at the 1% level, confirming the appropriateness of the translog form and the statistical significance of inefficiency effects in explaining output variation across firms.

Ultimately, the LR test applied to the BC92 model strongly rejects the null hypothesis that second-order input terms are jointly insignificant absent ($H_0$: $\beta_3 = \beta_4 = \beta_5 = 0$), with a test statistic of 138.142 ($p < 0.001$). This confirms that deviations from the production frontier are not purely random and that the translog functional form offers a better representation than a restricted Cobb-Douglas specification. More critically, the LR test applied to the extended BC95 model decisively rejects the joint null hypothesis that inefficiency is absent and that firm-specific characteristics including size, location, tariff exposure, ownership, and firm age do not affect inefficiency ($H_0 : \gamma = \delta_1 = \delta_2 = \cdots = \delta_{10} = 0$), with a test statistic of 274.661 ($p < 0.001$). Given that $\gamma$ lies on the boundary of the parameter space, the appropriate critical values for this LR test are derived from Kodde and Palm (1986), as implemented in the stochastic frontier framework by Battese and Coelli (1988). The rejection of the null confirms that inefficiency is not only statistically present but also significantly influenced by firm-level heterogeneity.

Universiti Utara Malaysia

**i. Likelihood Ratio (LR) Test**

$$LR = -2(lnL_{restricted} - lnL_{unrestricted}) = -2(-1505.738 + 1299.2981) = 412.8798 \quad (4.1)$$

To test whether the inclusion of year effects and inefficiency determinants significantly improves model fit, compare the LR statistic to a chi-square distribution:

$$\chi^2_{0.01,8} = 20.09$$

Since: 412.88 > 20.09

The LR statistics are highly significant, confirming that the BC95 model significantly improves fit compared to BC92.

Thus, use the chi-square distribution table at df = 8:

| Significant Level | Critical Value ($\chi^2$) |
|---|---|
| 5% (0.05) | 15.51 |
| 1% (0.01) | 20.09 |

The likelihood ratio (LR) test yields a value of 412.88 based on eight additional inefficiency determinants in the BC95 model. This far exceeds the 1% critical chi-square value of 20.09 (df = 8), confirming that the inclusion of firm-specific variables significantly enhances the model's fit relative to the restricted BC92 specification.

Moreover, while the significant negative coefficient for Vsigma (-1.880)*** suggests that environmental noise decreased over time, possibly due to incremental sectoral stabilization and improved market maturity-specific inefficiency, indicated by the

Universiti Utara Malaysia

insignificant Usigma, shows no systematic trend of improvement. This stagnation highlights the resilience of internal inefficiency in the face of gradual macroeconomic recovery.

Additionally, the Hausman test statistic ($\chi^2 = 6.63$, $p = 0.676$) supports the assumption of random effects, indicating that firm-specific effects are not systematically correlated with the explanatory variables. This result affirms the consistency and efficiency of the maximum likelihood estimates used in the stochastic frontier model.

### ii. Spearman Correlation

Table 4.4 presents the Spearman's rank correlation between efficiency scores obtained from the Battese and Coelli (1992) (BC92) and Battese and Coelli (1995) (BC95) models. The correlation coefficient is -0.0506, indicating a weak and negative relationship between the two sets of efficiency estimates. Although the coefficient is small and statistically insignificant, it offers useful insights into the differences in efficiency rankings produced by the two models.

Universiti Utara Malaysia

Table 4.4: The Spearman correlation for cross section, EBC92 and EBC95.

| Model | BC92 | BC95 |
|---|---|---|
| BC92 | 1.0000 | |
| BC95 | -0.0506 | 1.0000 |

Therefore, Spearman's rank correlation is employed to assess the ordinal association between the efficiency scores obtained from the BC92 and BC95 models. Given the bounded nature and potential skewness of efficiency scores, Spearman offers a non-parametric and robust measure to evaluate whether firm efficiency rankings are preserved across models.

The weak negative correlation suggests that firms ranked highly in terms of efficiency under the BC92 model, which assumes time-invariant inefficiency, do not consistently retain similar rankings when inefficiency is allowed to vary over time under the BC95 specification. This finding underscores the importance of accounting for temporal variation in firm performance, particularly in the Malaysian residential property sector, which is subject to cyclical fluctuations, regulatory changes, and evolving cost structures. For instance, the liberalization of steel and cement tariffs, fluctuating housing demand, and shifting government incentives for affordable housing all contribute to a dynamic operating environment. Furthermore, property development in Malaysia often unfolds in multi-phase projects over extended timelines, where efficiency can vary depending on project stage, resource mobilization, and market timing.

Building on the SCP framework, this section investigates how firm-level heterogeneity contributes to variations in production efficiency across Malaysia's residential property sector. With incorporating key structural attributes such as firm size, ownership structure, subsidiary status, and geographic location into the inefficiency model, the analysis sheds

Universiti Utara Malaysia

light on how market structure and organizational conduct influence technical performance outcomes.

### 4.1.4 Distribution of Technical Efficiency Scores

Table 4.5 presents the summary statistics of technical efficiency scores estimated using two stochastic frontier models: Battese and Coelli (1992) and Battese and Coelli (1995). The BC92 model assumes time-invariant inefficiency, producing cross-sectional efficiency estimates for each firm. In contrast, the BC95 model allows inefficiency effects to vary over time, making it more suitable for panel data and for capturing firm-level performance dynamics across the 2000-2020 study period.[6]

Table 4.5: Summary Statistics of Technical Efficiency Scores under BC92 and BC95 Models

| Model | Observations | Mean Technical Efficiency | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| EBC92 | 1,596 | 0.890 | 0.033 | 0.822 | 0.937 |
| EBC95 | 1,596 | 0.650 | 0.208 | 0.00027 | 0.956 |

Moreover, Table 4.5 highlights distinct differences in the distribution of technical efficiency (TE) scores derived from the BC92 and BC95 stochastic frontier models. Under the BC92 specification, which assumes time-invariant inefficiency and excludes firm-

[6] *Note: EBC92 and EBC95 refer to the estimated technical efficiency scores derived from the BC92 and BC95 stochastic frontier models, respectively. The BC92 model does not account for firm-specific inefficiency determinants, while BC95 incorporates time-varying inefficiency effects based on firm characteristics.*

specific heterogeneity, the average TE score is relatively high at 0.890, with a narrow standard deviation of 0.033. This suggests that, in the absence of time-varying effects, most firms appear to operate close to the production frontier, potentially overstating sectoral efficiency.

However, this static representation likely obscures substantial differences in firm performance over time. In contrast, the BC95 model, which incorporates time-varying inefficiency effects and firm-level characteristics, produces a lower mean TE score of 0.650 and a much wider dispersion (standard deviation = 0.208), with efficiency ranging from 0.00027 to 0.956. This broader distribution reveals considerable heterogeneity in firm efficiency, reinforcing the empirical importance of modeling inefficiency as a dynamic, firm-specific process.

Universiti Utara Malaysia

Furthermore, the wider dispersion in technical efficiency scores under the BC95 model reveals structural inefficiencies that are obscured in the more constrained BC92 specification. The presence of extremely low efficiency scores near zero indicates that a significant subset of firms is operating far from the production frontier, likely due to firm-specific constraints such as poor resource allocation, governance weaknesses, or project delays. This level of heterogeneity suggests that sector-wide averages, like the high mean TE in BC92, can be misleading when firm-level realities are ignored. In this regard, BC95 not only offers a statistically superior fit, but also surfaces critical performance disparities

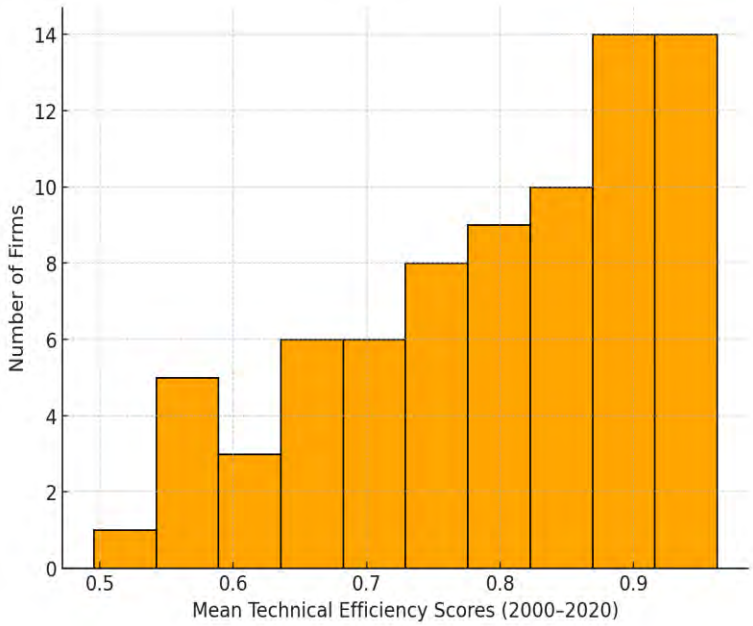
that have direct implications for targeted policy interventions, such as those related to firm capacity building, regulatory reform, or access to efficient input markets.

Figure 4.1 presents the distribution of firm-level mean production efficiency scores estimated using the BC95 time-varying stochastic frontier model. The histogram reveals substantial heterogeneity across the 76 residential property firms. While a notable number of firms cluster in the upper efficiency range (above 0.90), a considerable portion fall between 0.70 and 0.90, with a long-left tail indicating several firms operating below 0.60. The skewed distribution suggests that only a subset of firms consistently approach the production frontier, whereas many firms exhibit moderate to low efficiency levels.

Furthermore, the histogram reveals a pronounced clustering of firms in the 0.80-0.95 range, suggesting that a substantial share of developers operate proximate to the efficiency frontier. This concentration is indicative of competitive pressures and scale-related learning effects that discipline firm-level input use. Nonetheless, the distribution exhibits a noticeable left tail: a subset of firms records mean efficiency levels below 0.65, signaling persistent X-inefficiency likely rooted in structural rigidities, managerial slack, or suboptimal resource allocation.

Universiti Utara Malaysia

Figure 4.1: Distribution of Mean Technical Efficiency Scores of Residential Property Firms (2000-2020)




This pattern reflects the presence of significant asymmetries in operational capabilities, resource management, and adaptability to structural or regulatory changes within the sector. The broad dispersion in efficiency outcomes supports the econometric findings from Table 4.5, where the BC95 model yielded a wider standard deviation (SD = 0.208), and a lower average efficiency (mean = 0.65) compared to the BC92 model. Importantly, the histogram visually confirms that the BC95 model captures underlying performance variation that would otherwise be masked by a static inefficiency structure.

## 4.2 Technical Efficiency Scores of Property Firms

This section presents the technical efficiency (TE) scores of residential property firms in Malaysia for the period 2000 to 2020. The scores are estimated from the stochastic frontier

production function using the Battese and Coelli (1995) time-varying inefficiency specification. The analysis evaluates efficiency levels across different time periods and firm groups, highlighting variations in performance that stem from differences in scale, age, ownership structure, and project location. These descriptive results provide an empirical basis for identifying systematic efficiency patterns, while also setting the stage for the subsequent examination of the econometric determinants of production inefficiency in Section 4.3.

While the overall TE scores provide a quantitative measure of how closely firms operate relative to the estimated production frontier, they do not explain the sources of variation in efficiency across firms. To uncover these underlying drivers, this section evaluates how firm-specific characteristics such as size, ownership concentration, age, subsidiary status, establishment type, and location as well as policy-related factors like tariff liberalization on key construction materials (steel and cement), are associated with firm-level differences in technical efficiency.

The interpretation is grounded in an IO framework, which posits that both internal firm structures and external policy conditions influence productive performance. As a result, by systematically decomposing inefficiency along these structural and institutional dimensions, the analysis reveals persistent gaps in operational efficiency and identifies strategic leverage points for firm-level improvements and policy-level reform. Each of the following subsections isolates a single determinant of inefficiency, presenting relevant

Universiti Utara Malaysia

empirical evidence across the 2000-2020 study period and critically evaluating its contribution to firm performance outcomes within the residential property sector.

### 4.2.1 Firm Size and Technical Efficiency Scores

Firm size, measured by the natural logarithm of total assets (lnTA), is a key determinant of variation in technical efficiency (TE) among property developers. Larger firms are expected to exhibit higher efficiency scores because their broader asset base enables economies of scale, stronger bargaining power in procurement, and more effective coordination of inputs. In contrast, smaller firms typically face resource and scale constraints, limiting their capacity to operate close to the production frontier.

Universiti Utara Malaysia

Table 4.6 presents the distribution of TE scores across firm-size tiers for Malaysian residential property developers over 2000-2020. The results indicate a clear inverse relationship between firm size and efficiency: smaller firms (Tier 1 and Tier 2) consistently record higher mean TE values-above 0.85, while the largest firms (Tier 5) exhibit the lowest average scores, ranging between 0.61 and 0.65. Efficiency among the largest developers also shows greater volatility, as reflected in higher standard deviations and lower minimum scores.

Table 4.6: Technical Efficiency Scores by Firm Size Tier, 2000-2020

| | | | Technical Efficiency | | | |
|---|---|---|---|---|---|---|
| | | | 2000 - | 2006 - | 2011 - | 2016 - |
| SIZE | Firms | | 2005 | 2010 | 2015 | 2020 |
| **Tier 1** | 8 | Mean | 0.929 | 0.912 | 0.901 | 0.916 |
| | | SD | 0.061 | 0.048 | 0.034 | 0.028 |
| | | Min | 0.797 | 0.785 | 0.826 | 0.830 |
| | | Mx | 0.993 | 0.991 | 0.944 | 0.954 |
| **Tier 2** | 23 | Mean | 0.858 | 0.867 | 0.875 | 0.883 |
| | | SD | 0.108 | 0.082 | 0.062 | 0.068 |
| | | Min | 0.567 | 0.622 | 0.652 | 0.590 |
| | | Max | 0.993 | 0.991 | 0.953 | 0.950 |
| **Tier 3** | 19 | Mean | 0.769 | 0.794 | 0.792 | 0.812 |
| | | SD | 0.138 | 0.106 | 0.096 | 0.087 |
| | | Min | 0.505 | 0.523 | 0.552 | 0.553 |
| | | Max | 0.993 | 0.971 | 0.952 | 0.939 |
| **Tier 4** | 15 | Mean | 0.784 | 0.768 | 0.741 | 0.773 |
| | | SD | 0.139 | 0.121 | 0.136 | 0.118 |
| | | Min | 0.460 | 0.548 | 0.445 | 0.460 |
| | | Max | 0.993 | 0.974 | 0.962 | 0.947 |
| **Tier 5** | 11 | Mean | 0.657 | 0.635 | 0.608 | 0.640 |
| | | SD | 0.102 | 0.117 | 0.123 | 0.139 |
| | | Min | 0.477 | 0.426 | 0.413 | 0.412 |
| | | Max | 0.919 | 0.905 | 0.893 | 0.883 |

**Notes:**

1. Firm size tiers are defined based on total asset value as reported in annual financial statements:
   *Tier 1 = Assets < RM 200 million
   *Tier 2 = RM 201 – 500 million
   *Tier 3 = RM 501 – 1 billion
   *Tier 4 = RM 1.01 – 2 billion
   *Tier 5 = > RM 2 billion
2. Technical efficiency (TE) scores are derived from the Battese and Coelli (1995) stochastic production frontier model using LIMDEP 9.0.
3. Higher TE values (closer to 1.00) indicate that firms operate nearer to the production frontier, while lower scores reflect greater technical inefficiency.

Universiti Utara Malaysia

These results suggest that scale expansion in the Malaysian property sector does not necessarily translate into higher technical efficiency. Instead, larger developers may experience managerial complexity, slower decision cycles, and project coordination inefficiencies, leading to scale diseconomies and X-inefficiency. Conversely, smaller firms being more flexible, regionally focused, and less encumbered by administrative layers appear better able to convert inputs into outputs efficiently.

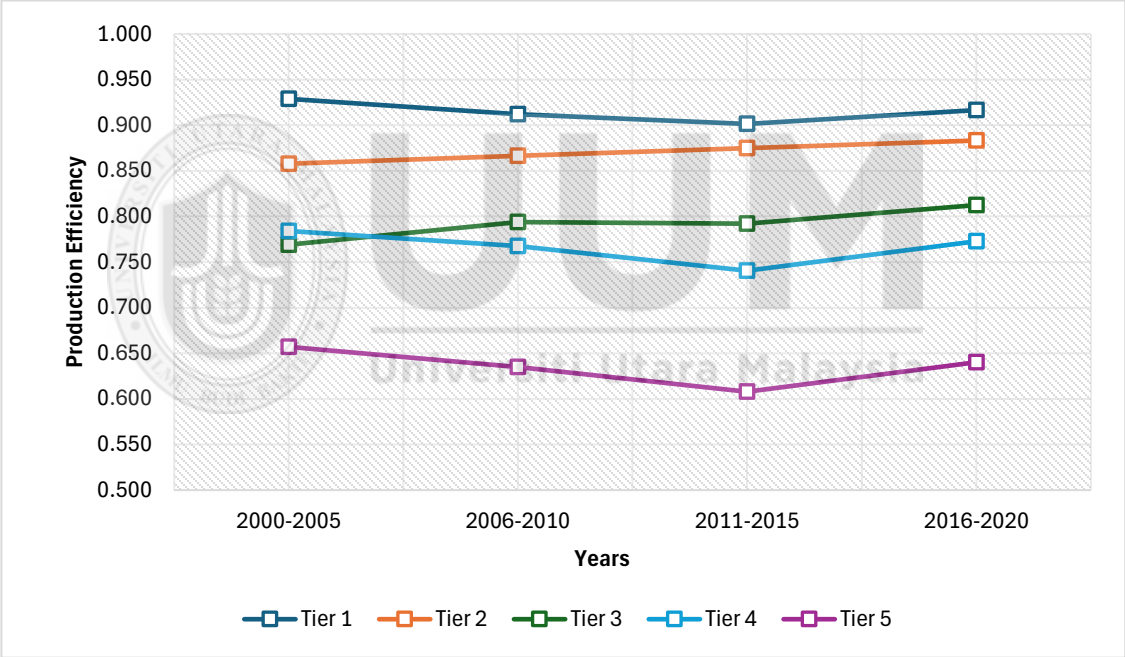
In addition, Figure 4.2 illustrates the trend of TE across five asset-based firm tiers from 2000 to 2020. Tier 1 firms (the smallest by asset size) consistently outperform other groups, maintaining technical efficiency above 0.90 throughout the two decades, with only minor fluctuations. Tier 2 firms show steady improvement, rising from approximately 0.86 in 2000-2005 to 0.88 in 2016-2020, reflecting incremental efficiency gains. Tier 3 firms, while starting below Tier 2, exhibit the most consistent upward trajectory, suggesting positive learning effects and operational refinement over time. In contrast, Tier 4 firms experience a dip during the 2011-2015 period before recovering slightly, indicating some volatility in production performance among mid-sized developers. Tier 5 firms (the largest by asset size) record the lowest efficiency levels throughout all sub-periods, with a declining trend until 2011-2015, followed by a modest rebound.

The observed negative size-efficiency relationship aligns with the notion that beyond a certain threshold, increasing firm scale can erode operational efficiency (Leibenstein,

Universiti Utara Malaysia

1966; Kumbhakar & Lovell, 2000). These empirical patterns provide an important precursor to the econometric analysis in Section 4.3, which examines whether firm-specific structural characteristics, including size, significantly explain production inefficiency within the BC95 framework.

**Figure 4.2: Trends in Technical Efficiency Scores by Firm Size Tier, 2000-2020**




### 4.2.2 Firm Age and Technical Efficiency Scores

Firm age, measured as the natural logarithm of years since establishment, represents a key determinant of technical efficiency (TE) among Malaysian property developers. Younger firms are generally expected to exhibit higher efficiency scores due to their greater

flexibility in adopting innovative building technologies, project management techniques, and market-responsive business models. In contrast, older firms often operate within more rigid organizational frameworks, characterized by established routines and hierarchical decision structures, which may slow their capacity to adjust to regulatory changes, market volatility, and cost fluctuations. Consequently, firm age may exert a nonlinear effect on efficiency improving with accumulated experience at early stages but declining once structural inertia and managerial rigidity set in.

Table 4.7 presents the trends in TE across two firm age groups: firms aged below 40 years (<40) and those aged 40 years and above (≥40). Younger firms consistently record higher average efficiency scores throughout the study period, with mean values declining modestly from 0.938 in 2000-2005 to 0.887 in 2016-2020. Despite this gradual reduction, younger firms remain closer to the estimated production frontier, reflecting superior adaptability, more efficient resource deployment, and a greater capacity to integrate new technologies and project management practices.

Conversely, older firms exhibit lower and more volatile efficiency scores, with means ranging between 0.727 and 0.773 and higher dispersion across sub-periods. This pattern indicates that accumulated experience alone does not necessarily guarantee sustained efficiency, as structural inertia and legacy processes may offset learning advantages. These findings align with the nonlinear age-efficiency relationship incorporated in the

Universiti Utara Malaysia

model (lnAge and ln$Age^2$), where efficiency improves with experience initially but eventually diminishes as organizational rigidity and coordination costs increase.

Table 4.7: Technical Efficiency Score by Firm Age, 2000-2020

| | | | Production Efficiency | | | |
|---|---|---|---|---|---|---|
| **AGE GROUP** | **Firms** | | **2000 - 2005** | **2006 - 2010** | **2011 - 2015** | **2016 - 2020** |
| **<40** | 26 | Mean | 0.938 | 0.914 | 0.888 | 0.887 |
| | | SD | 0.053 | 0.052 | 0.063 | 0.058 |
| | | Min | 0.760 | 0.751 | 0.719 | 0.674 |
| | | Max | 0.993 | 0.991 | 0.962 | 0.954 |
| **≥40** | 50 | Mean | 0.727 | 0.734 | 0.739 | 0.773 |
| | | SD | 0.116 | 0.119 | 0.137 | 0.135 |
| | | Min | 0.460 | 0.426 | 0.413 | 0.412 |
| | | Max | 0.991 | 0.946 | 0.938 | 0.944 |

Critically, the divergence in efficiency patterns underscores a central Industrial Organization insight: firm longevity does not necessarily translate into superior operational performance. Older property developers, though benefiting from established market positions, accumulated assets, and regulatory familiarity, often exhibit structural rigidity and path dependency, which limit their responsiveness to changes in cost conditions and policy reforms. Within the SCP framework, these firms operate under lower competitive pressure, resulting in X-inefficiency in Leibenstein's (1966) sense where internal slack persists despite available capacity to improve. This interpretation is

consistent with institutional assessments by CIDB and the MPC, which have repeatedly highlighted that the construction and property industry continues to experience low productivity growth and slow adoption of technology. In contrast, younger and mid-tier firms more adaptive and less constrained by legacy processes tend to align inputs more efficiently with output demand and operate closer to the production frontier. Strengthening competitive intensity and fostering technological upgrading across the industry are therefore essential to convert firm longevity and market stability into sustained productive efficiency.

### 4.2.3 Ownership Concentration and Technical Efficiency Scores

Ownership concentration, measured by the share of equity held by the three largest shareholders (CR3), is considered an important governance factor in the property sector. In theory, higher concentration can improve technical efficiency (TE) by aligning managerial incentives with controlling shareholders, while dispersed ownership may weaken monitoring and increase agency costs.

Table 4.8 provides descriptive evidence on the relationship between ownership concentration and TE. Firms are grouped into three categories: low (<30%), medium (30-50%), and high (>50%) concentration. The results show that firms with low ownership concentration consistently achieve higher efficiency scores, rising from 0.849 in 2000-2005 to 0.897 in 2016-2020. Therefore, firms with high ownership concentration (>50%) record the lowest mean scores, ranging from 0.734 to 0.769, with greater variability (SD

> 0.13). This pattern suggests that firms with high ownership concentration, often family- or founder-controlled, operate further from the production frontier. In IO terms, such concentration may foster managerial entrenchment and X-inefficiency, as governance rigidity reduces competitive discipline. Agency theory similarly highlights how dominant shareholders can exacerbate principal-agent conflicts, weakening incentives for cost minimization and innovation.

Table 4.8: Technical Efficiency Score by Ownership Concentration, 2000-2020.

| | | | Technical Efficiency | | | |
|---|---|---|---|---|---|---|
| **Ownership Concentration** | **Firms** | | **2000 - 2005** | **2006 - 2010** | **2011 - 2015** | **2016 - 2020** |
| **Low (<30%)** | 9 | Mean | 0.849 | 0.878 | 0.887 | 0.897 |
| | | SD | 0.132 | 0.067 | 0.050 | 0.044 |
| | | Min | 0.505 | 0.685 | 0.786 | 0.803 |
| | | Max | 0.993 | 0.974 | 0.962 | 0.947 |
| **Medium (30-50%)** | 31 | Mean | 0.821 | 0.833 | 0.831 | 0.862 |
| | | SD | 0.133 | 0.121 | 0.112 | 0.096 |
| | | Min | 0.477 | 0.426 | 0.413 | 0.412 |
| | | Max | 0.993 | 0.991 | 0.953 | 0.954 |
| **High (>50%)** | 36 | Mean | 0.769 | 0.752 | 0.734 | 0.748 |
| | | SD | 0.144 | 0.131 | 0.141 | 0.132 |
| | | Min | 0.460 | 0.518 | 0.445 | 0.445 |
| | | Max | 0.993 | 0.991 | 0.952 | 0.937 |

Critically, these findings suggest that higher ownership concentration may hinder production efficiency, particularly in environments where succession planning, internal monitoring, and transparency are weak. The results support agency theory arguments that

dispersed or moderately concentrated ownership structures may lead to better alignment between managerial decisions and performance outcomes. In the Malaysian context, where many residential developers remain family-led or founder-controlled, this raises important governance considerations. The findings align with prior studies (Claessens et al., 2000; Sulong & Nor, 2008) that warn of entrenchment effects in highly concentrated firms, reinforcing the importance of institutional reform, board independence, and performance-driven accountability mechanisms.

### 4.2.4 Subsidiary Structure and Technical Efficiency Scores

Subsidiary structure represents an important organizational characteristic that may influence technical efficiency (TE) in property firms. Developers that operate through affiliated construction subsidiaries are expected to achieve higher efficiency scores, as vertical integration reduces transaction costs, strengthens coordination across project stages, and internalizes procurement advantages. Standalone firms, in contrast, face greater dependence on external contractors and market-based transactions, which can increase search, negotiation, and enforcement costs, thereby limiting their ability to operate close to the production frontier.

Furthermore, Table 4.9 highlights a substantial performance gap between subsidiary and non-subsidiary firms in terms of production efficiency. Non-subsidiary firms consistently recorded the highest efficiency levels, with mean scores exceeding 0.96 in both 2000-2005 and 2006-2010. This group also showed minimal variation (SD = 0.033-0.066),

indicating tightly aligned input-output performance and strong technical optimization. In contrast, firms operating through subsidiary structures displayed significantly lower and more volatile efficiency levels throughout the observed periods, starting at 0.783 and rising modestly to 0.812 by 2016-2020. The wider standard deviation and lower minimum values among subsidiaries reflect greater heterogeneity and inefficiencies in resource allocation or coordination.

Table 4.9: Technical Efficiency Score by Subsidiary, 2000-2020

| | | | Technical Efficiency | | | |
|---|---|---|---|---|---|---|
| **Subsidiary Types** | **Firms** | | **2000 - 2005** | **2006 - 2010** | **2011 - 2015** | **2016 - 2020** |
| **None-Subsidiary** | 7 | Mean | 0.965 | 0.960 | | |
| | | SD | 0.066 | 0.033 | | |
| | | Min | 0.746 | 0.914 | | |
| | | Max | 0.993 | 0.991 | | |
| **Subsidiary** | 69 | Mean | 0.783 | 0.791 | 0.789 | 0.812 |
| | | SD | 0.136 | 0.132 | 0.136 | 0.127 |
| | | Min | 0.460 | 0.426 | 0.413 | 0.412 |
| | | Max | 0.993 | 0.974 | 0.962 | 0.954 |

Therefore, firms without subsidiaries exhibit exceptionally high average production efficiency, with mean scores of 0.965 in 2000-2005 (n = 7) and 0.960 in 2006-2010 (n = 2), highlighting their consistent proximity to the production frontier despite the limited sample size. Their performance is also more stable, reflected in lower standard deviations

and tighter efficiency bounds. These firms likely operate under focused project scopes, flatter managerial structures, and fewer inter-unit coordination costs factors conducive to efficiency. In contrast, subsidiary firms (n = 69) report consistently lower mean efficiency scores across all periods, ranging from 0.783 to 0.812, with much higher dispersion and wider performance gaps.

These findings suggest that subsidiary formation, while often pursued for diversification or market expansion, may introduce additional layers of complexity, coordination costs, and internal misalignment, particularly in property development where project cycles and input flows are highly sensitive. In the context of TCE perspective, the presence of subsidiaries could imply attempts to internalize transactions and reduce external market risks but at the potential cost of internal bureaucratic frictions or diluted managerial focus.

Universiti Utara Malaysia

### 4.2.5 Firm Establishment and Technical Efficiency Scores

Firm establishment is defined as a binary variable distinguishing privately owned developers from government-linked companies (GLCs). Establishment type is expected to influence technical efficiency (TE) through differences in market discipline and institutional support. Private firms typically face stronger profit incentives and competitive pressures, which should drive them closer to the production frontier. GLCs, by contrast, may be subject to broader policy objectives and soft budget constraints that reduce efficiency discipline, although their access to land, finance, and regulatory support can partially offset these disadvantages. Comparing TE scores across establishment types

provides evidence on how ownership structures shape efficiency outcomes in Malaysia's property sector.

Table 4.10 examines the production efficiency patterns of property firms in Malaysia based on establishment type distinguishing between state-owned enterprises or government-linked companies (GLCs) and privately held firms across four time periods from 2000 to 2020. This classification offers important insights into how institutional ownership structures influence operational efficiency in the property development sector. While both groups demonstrate efficiency scores below the frontier, private firms consistently outperform their state-owned counterparts across all periods, with higher average efficiency and narrower standard deviations.

Table 4.10: Technical Efficiency Scores by Firm Establishment, 2000-2020

Universiti Utara Malaysia

| Establishment Types | Firms | | Technical Efficiency | | | |
|---|---|---|---|---|---|---|
| | | | 2000 - 2005 | 2006 - 2010 | 2011 - 2015 | 2016 - 2020 |
| **State-Owned/GLC** | 3 | Mean | 0.830 | 0.763 | 0.752 | 0.773 |
| | | SD | 0.221 | 0.209 | 0.222 | 0.205 |
| | | Min | 0.477 | 0.426 | 0.413 | 0.412 |
| | | Max | 0.991 | 0.962 | 0.962 | 0.950 |
| **Private** | 73 | Mean | 0.798 | 0.797 | 0.792 | 0.814 |
| | | SD | 0.137 | 0.129 | 0.133 | 0.123 |
| | | Min | 0.460 | 0.505 | 0.445 | 0.445 |
| | | Max | 0.993 | 0.991 | 0.962 | 0.954 |

Therefore, private firms exhibit relatively stable and moderately rising efficiency scores (from 0.798 in 2000-2005 to 0.814 in 2016-2020), state-owned firms show more fluctuation and underperformance, with their efficiency declining from 0.830 to 0.752 between 2000 and 2015, before rebounding slightly to 0.773 in the final period. The markedly higher standard deviations among GLCs also reflect greater internal inefficiencies and performance volatility, possibly due to bureaucratic structures, misaligned incentives, or weaker competitive pressure.

The wider dispersion and lower minimum scores among GLCs suggest structural and managerial inefficiencies, possibly due to bureaucratic processes, lower profit incentives, or institutional inertia. Strategically, this comparison underscores the need for greater performance benchmarking within GLCs and supports broader calls for governance reform and market discipline to enhance production efficiency. The temporal trends also suggest that efficiency gaps may persist unless organizational capabilities and accountability mechanisms are strengthened, particularly in state-linked entities.

The findings of this study indicate that GLCs consistently underperform relative to private developers in terms of production efficiency, particularly in the utilization of labor, capital, and materials. This underperformance is often attributed to internal rigidity, slower decision-making processes, and coordination challenges that limit operational responsiveness.

Universiti Utara Malaysia

### 4.2.6 Technical Efficiency Score by Firms Size to Steel Tariff Liberalization

Table 4.11 presents the distribution of technical efficiency scores by firm-size tier during Malaysia's steel tariff liberalisation periods; pre-liberalisation (2000-2008) and post-liberalisation (2009-2020). Across both phases, the results reveal a persistent inverse relationship between firm size and technical efficiency. Smaller developers (Tiers 1-2) operate closest to the production frontier, with mean scores above 0.90, reflecting leaner organisational structures and quicker adjustment to steel price fluctuations.

Table 4.11: Technical Efficiency by Firm Size in the Pre- and Post-Steel Tariff Liberalization Periods, 2000-2020.

| Firm Tier | Firms | | Technical Efficiency | |
|---|---|---|---|---|
| | | | **Pre-Liberalization (2000-2008) Tariff 40.75% to 30.35%** | **Post-Liberalization (2009-2020) Tariff 30.35% to 20.67%** |
| Tier 1 | 8 | Mean | 0.925 | 0.880 |
| | | SD | 0.051 | 0.082 |
| | | Min | 0.845 | 0.691 |
| | | Max | 0.992 | 0.932 |
| Tier 2 | 23 | Mean | 0.858 | 0.876 |
| | | SD | 0.096 | 0.060 |
| | | Min | 0.659 | 0.710 |
| | | Max | 0.986 | 0.945 |
| Tier 3 | 19 | Mean | 0.775 | 0.802 |
| | | SD | 0.123 | 0.085 |
| | | Min | 0.581 | 0.643 |
| | | Max | 0.979 | 0.922 |
| Tier 4 | 15 | Mean | 0.785 | 0.723 |
| | | SD | 0.129 | 0.151 |
| | | Min | 0.558 | 0.352 |
| | | Max | 0.980 | 0.927 |
| Tier 5 (Large) | 11 | Mean | 0.649 | 0.626 |
| | | SD | 0.105 | 0.118 |
| | | Min | 0.515 | 0.480 |
| | | Max | 0.890 | 0.845 |
| | 76 | Mean | 0.800 | 0.792 |

Universiti Utara Malaysia

In contrast, the largest firms (Tier 5) consistently record lower efficiency levels-below 0.65 on average-indicating enduring coordination frictions, multi-project complexity, and scale-induced managerial rigidities. Within the BC92/BC95 stochastic frontier framework, the stability of these tier-specific efficiency patterns across both tariff regimes suggests that inefficiency is largely structural and not substantially influenced by short-term shifts in input tariffs. This implies that firm-level agility and input utilisation capabilities, rather than size, remain the dominant determinants of technical efficiency throughout the liberalisation period.

These findings indicate that tariff liberalisation did not uniformly improve sectoral efficiency; instead, it appears to have widened structural asymmetries between small and large firms. Larger developers despite stronger capital access and vertical integration remain constrained by complex project portfolios, bureaucratic procurement processes, and slower adjustment to input cost changes, resulting in persistent X-inefficiency. In contrast, smaller firms benefit from leaner organisational structures and more localised operations, enabling quicker responses to steel price fluctuations. From an Industrial Organization perspective, this pattern reflects diseconomies of scale and reinforces the SCP insight that market power and resource endowments do not automatically confer productive advantage; rather, efficiency depends on internal organisational capabilities and the capacity to adapt effectively to input market reforms such as tariff liberalisation.

Universiti Utara Malaysia

In addition to the descriptive patterns, the stochastic frontier results in Table 4.2 provide econometric support for the role of input market liberalization. The negative and statistically significant coefficient on the steel tariff variable (STariff) indicates that lower import tariffs on steel inputs contributed to higher production efficiency among property firms. This finding aligns with theoretical and empirical literature emphasizing the productivity-enhancing effects of trade liberalization through both firm selection and within-firm upgrading (Melitz, 2003). In the Malaysian context, the liberalization of steel imports after 2008 appears to have improved resource allocation efficiency, particularly for firms with flexible procurement systems and better absorptive capacity.

In the Malaysian context, steel tariff reductions lower marginal input costs and may incentivize capital deepening or process improvements, particularly among more efficient firms. This finding also aligns with Krugman's (1980) new trade theory, where access to cheaper intermediate inputs enhances firm-level competitiveness and scale efficiency critical in an imperfectly competitive sector like residential property development.

Moreover, the result is consistent with empirical work by Amiti and Konings (2007), who demonstrate that input tariff reductions more so than output tariff reductions generate stronger productivity gains, particularly when firms possess sufficient absorptive capacity. Larger firms in the Malaysian sample (Tier 5), by virtue of their capital base and operational flexibility, appear to capitalize on steel liberalization more effectively than their smaller counterparts (Tiers 1 and 2) a pattern confirmed by the tiered results in Table

4.11. This suggests that firm heterogeneity conditions the efficiency returns from liberalization, as predicted by the Melitz framework and reaffirmed by studies such as Goldberg et al. (2010) and Topalova & Khandelwal (2011).

Finally, these findings affirm that liberalization alone is insufficient to boost sector-wide production efficiency without addressing firm-level structural barriers. The translog specification underscores that interaction effects between input variables and tariff shocks are not neutral; they are mediated by firm characteristics such as size, capital endowment, and operational integration. Thus, for policy interventions like steel tariff reform to be broadly effective, they must be complemented by institutional support particularly for small and medium-sized developers (Tiers 1 and 2), in areas such as material sourcing, cost management, and technology adoption. These firms often lack the internal capabilities that enable larger firms (Tier 5) to buffer against input volatility, reinforcing the need for targeted policy mechanisms that account for firm heterogeneity.

A supplementary Welch's t-test was conducted to assess whether the observed changes in technical efficiency around the steel tariff liberalisation period were statistically significant. Consistent with the patterns in Table 4.11, the results indicate no meaningful differences in mean TE for mid-sized developers (Tier 3), whose efficiency increased only slightly from 0.775 in the pre-liberalisation period to 0.802 post-liberalisation, and for large developers (Tier 5), whose mean TE declined marginally from 0.649 to 0.626. Although the descriptive results show modest improvements for Tier 2 firms (0.858 to

Universiti Utara Malaysia

0.876) and small declines for Tier 1 (0.925 to 0.880) and Tier 4 firms (0.785 to 0.723), these adjustments were statistically insignificant based on the Welch's t-test. This confirms that technical efficiency dynamics were not primarily driven by changes in steel tariff levels. The findings support the IO perspective that input price liberalisation alone does not materially shift firms' proximity to the production frontier, particularly in a sector characterised by heterogeneous project structures, coordination frictions, and varied organisational capabilities. Accordingly, sustained improvements in technical efficiency require broader structural upgrading such as improved input coordination, digitalisation of project processes, and more sophisticated management systems rather than reliance on tariff reductions applied to a single input such as steel.

### 4.2.7 Cement Tariff and Technical Efficiency Scores

The results in Table 4.2 show that the cement tariff variable (CTariff) is statistically insignificant, indicating that cement tariff liberalisation did not translate into measurable improvements in production efficiency among Malaysian property firms. This outcome reflects the structural characteristics of Malaysia's cement market, which remains domestically concentrated and only weakly exposed to import competition, thereby limiting the pass-through of tariff reductions to downstream developers.

Table 4.12 reinforces this interpretation: smaller firms (Tiers 1-3), which are typically more sensitive to input price movements, did not exhibit notable increases in technical efficiency during the post-liberalisation period. Instead, efficiency levels remained largely

stagnant, suggesting that reductions in cement tariffs did not materially alleviate production constraints. Two sectoral features help explain this muted response. First, the cement supply chain is dominated by a handful of major producers YTL, Hume, and CIMA creating limited competitive pressure and weak price transmission even after tariff adjustments. Second, cement accounts for only about 2.34% of total residential construction costs (CIDB, 2012), meaning its influence on firm-level production efficiency is inherently modest compared to more cost-intensive inputs such as steel reinforcement and ready-mixed concrete.

Table 4.12: Technical Efficiency by Firm Size in the Pre- and Post-Cement Tariff Liberalization Periods, 2000-2020.

| Firm Tier | Firms | | Technical Efficiency | |
|---|---|---|---|---|
| | | | **Pre-Liberalization (2000-2008) Tariff 30.17% to 20.83%** | **Post-Liberalization (2009-2020) Tariff 20.83% to 15.71%** |
| Tier 1 | 8 | Mean | 0.925 | 0.880 |
| | | SD | 0.051 | 0.082 |
| | | Min | 0.845 | 0.691 |
| | | Max | 0.992 | 0.932 |
| Tier 2 | 23 | Mean | 0.858 | 0.876 |
| | | SD | 0.096 | 0.060 |
| | | Min | 0.659 | 0.710 |
| | | Max | 0.986 | 0.945 |
| Tier 3 | 19 | Mean | 0.775 | 0.802 |
| | | SD | 0.123 | 0.085 |
| | | Min | 0.581 | 0.643 |
| | | Max | 0.979 | 0.922 |
| Tier 4 | 15 | Mean | 0.785 | 0.723 |
| | | SD | 0.129 | 0.151 |
| | | Min | 0.558 | 0.352 |
| | | Max | 0.980 | 0.927 |
| Tier 5 (Large) | 11 | Mean | 0.649 | 0.626 |
| | | SD | 0.105 | 0.118 |
| | | Min | 0.515 | 0.480 |
| | | Max | 0.890 | 0.845 |
| | 76 | Mean | 0.800 | 0.792 |

Universiti Utara Malaysia

The production efficiency trends in Table 4.12 show that cement tariff liberalisation did not generate broad efficiency improvements across firm-size tiers. Only mid-sized developers (Tiers 2 and 3) experienced modest increases in technical efficiency during the post-liberalisation period, reflecting limited but observable gains in input utilisation. By contrast, Tier 1 firms despite their agility and localised project focus recorded a decline in mean efficiency, while the largest developers (Tiers 4 and 5) also experienced deterioration in their post-2009 production efficiency levels. This suggests that neither small nor large firms were able to internalise cement input cost reductions effectively. The translog estimates reinforce this pattern, as the interaction terms involving cement tariffs are weak or statistically insignificant, indicating that cement price liberalisation did not meaningfully influence the labour-capital-material input mix, especially among firms with either very small operational scales or highly complex multi-project structures.

Universiti Utara Malaysia

The limited efficiency response to cement tariff liberalisation reflects deeper structural rigidities within Malaysia's concentrated cement supply chain. CIDB Malaysia (2012) indicates that cement accounts for only 2.34% of total material inputs far below the weightage of steel reinforcement and ready-mixed concrete meaning tariff reductions exert only marginal cost pressure on developers' production decisions. This interpretation is consistent with Chia et al. (2012), who document declining value-added content and a rising reliance on bought-in materials in Malaysia's construction sector, signaling weak competitive pass-through from upstream suppliers to downstream firms. Within such an environment, even substantial tariff adjustments are insufficient to overcome coordination

frictions and market-structure constraints, particularly for smaller and mid-tier developers with limited bargaining power.

Consistent with the evidence in Table 4.12, only mid-tier developers (Tiers 2-3) registered marginal efficiency gains following cement tariff liberalisation, while Tier 1 firms showed little change and larger developers (Tiers 4-5) recorded further declines. These patterns point to structural rather than price-driven drivers of efficiency: organisational rigidities, coordination frictions, and supply-chain concentration overshadow the marginal cost effects of cement input reductions. The insignificant CTariff coefficient in the BC95 model reinforces that tariff adjustments were too small and too weakly transmitted through a concentrated upstream market to influence firms' labour-capital-material allocation in any meaningful way. Taken together, the results confirm that cost-side reforms in narrowly weighted inputs like cement are insufficient to shift sector-wide production efficiency in a highly intermediated, material-dependent industry. Accordingly, attention must now turn to location-based factors, where spatial agglomeration, demand concentration, and regional regulatory environments may better explain the heterogeneity in production efficiency across Malaysian property firms.

Universiti Utara Malaysia

### 4.2.8 Location and Technical Efficiency Scores

Table 4.13 presents the distribution of technical efficiency scores across three broad geographic categories Core, Inner, and Sabah & Sarawak over the period 2000-2020. The results reveal a clear spatial disparity in efficiency performance, with firms located in

Inner regions (urbanized West Malaysian states outside Kuala Lumpur) consistently outperforming those in Core zones and Sabah & Sarawak. Inner-region firms show steady improvement in mean TE, rising from 0.828 in 2000-2005 to 0.850 in 2016-2020, with relatively low standard deviations, suggesting consistent efficiency gains possibly driven by moderate urban agglomeration, better infrastructure, and accessible factor markets.

Table 4.13: Technical Efficiency Score by Location, 2000-2020

| | | Technical Efficiency | | | |
|---|---|---|---|---|---|
| **Location** | **Firms** | **2000 - 2005** | **2006 - 2010** | **2011 - 2015** | **2016 - 2020** |
| Core | 11 | 0.657 | 0.635 | 0.608 | 0.640 |
| | | 0.102 | 0.117 | 0.123 | 0.139 |
| | | 0.477 | 0.426 | 0.413 | 0.412 |
| | | 0.919 | 0.905 | 0.893 | 0.883 |
| Inner | 62 | 0.828 | 0.835 | 0.831 | 0.850 |
| | | 0.130 | 0.106 | 0.101 | 0.090 |
| | | 0.460 | 0.523 | 0.516 | 0.539 |
| | | 0.993 | 0.991 | 0.962 | 0.954 |
| Sabah & Sarawak | 3 | 0.733 | 0.677 | 0.656 | 0.661 |
| | | 0.152 | 0.032 | 0.131 | 0.101 |
| | | 0.586 | 0.611 | 0.445 | 0.460 |
| | | 0.989 | 0.722 | 0.855 | 0.787 |

Universiti Utara Malaysia

Therefore, firms located in the Core region which includes Kuala Lumpur and Selangor exhibit persistently lower and more volatile efficiency levels, with mean scores hovering around 0.64 in the final period. This outcome likely reflects congestion effects, escalating land and labor costs, and coordination frictions typical of mature urban markets. In Sabah and Sarawak, efficiency remains structurally constrained by geographic dispersion, logistics bottlenecks, and weaker institutional capacity, resulting in a decline from 0.733 to 0.661. Collectively, these results reveal a spatially segmented production landscape consistent with industrial organization theory: efficiency advantages accrue not merely from urban proximity but from an optimal balance between agglomeration economies and manageable cost structures conditions most evident among firms in the Inner region.

The spatial patterns in Table 4.13 also point toward important firm location interactions that influence technical efficiency beyond firm-specific characteristics. For firms in the Core zone, low technical efficiency despite proximity to administrative and financial centers may reflect deeper structural inefficiencies, including regulatory complexity, high land costs, and bureaucratic project cycle challenges often encountered by state-linked developers and large conglomerates based in the Klang Valley. In contrast, the relatively better performance of Inner-region firms, which include many mid-sized and private firms, suggests stronger alignment with localized market demand, leaner organizational structures, and more efficient resource deployment.

Universiti Utara Malaysia

Meanwhile, the fluctuating technical efficiency in Sabah and Sarawak highlights persistent spatial diseconomies, where even capable firms may be constrained by logistical delays, fragmented supply chains, and limited access to skilled labor or industrial inputs. These findings underscore that location is not merely a passive attribute but interacts actively with firm strategy, institutional reach, and infrastructure access in shaping technical efficiency outcomes.

The observed spatial disparities in technical efficiency particularly the underperformance of Core and East Malaysia firms can be further contextualized using World Bank indicators on subnational competitiveness and business regulation. According to the World Bank's subnational reports (2020), urbanized but heavily regulated states like Selangor and Kuala Lumpur face higher procedural burdens, land conversion delays, and fragmented permitting systems. These frictions likely undermine the assumed agglomeration benefits in the Core zone, especially for large, public-sector developers.

Universiti Utara Malaysia

## 4.3 Correlates of Property Firms' Production Inefficiency

As specified in Chapter Three, this section presents the empirical findings on the firm-specific and policy-related factors associated with production inefficiency. Employing the Battese and Coelli (1995) time-varying inefficiency framework, the analysis estimates how structural characteristics such as firm size, location, ownership concentration, firm age, subsidiary status, and establishment type influence firms' deviation from the efficient production frontier. In addition, the impact of steel and cement tariff liberalization is

examined to evaluate whether input market reforms contributed to production efficiency gains. The results provide critical insights into how organizational structures and policy environments jointly shape firm-level performance in Malaysia's residential property sector.

Table 4.2 presents the maximum likelihood estimates of the inefficiency effects model based on the BC95 specification, where technical inefficiency is regressed on a set of firm-level and policy-related explanatory variables. The results reveal several statistically significant determinants of production inefficiency among Malaysian property firms. Firm size (lnTA), location, steel tariff liberalization, and firm age (lnAge) all exhibit coefficients that are significant at the 1% level, highlighting their strong association with efficiency outcomes. Specifically, the negative coefficients for lnTA, location, and steel tariff suggest that larger firms, firms located in more urbanized or connected areas, and those benefiting from reduced steel input tariffs tend to operate more efficiently. Conversely, the positive and significant coefficient for lnAge implies that older firms exhibit higher levels of technical inefficiency, potentially reflecting structural inertia or outdated operational practices.

Furthermore, other variables, including cement tariff liberalization, ownership concentration, establishment type (public vs. private), and subsidiary status, do not show statistically significant effects at conventional levels. While these variables remain relevant for discussion particularly in terms of institutional and strategic considerations

Universiti Utara Malaysia

their coefficients should be interpreted with caution due to wide standard errors and statistical insignificance. These findings provide a foundation for the subsequent sections, which examine the effects of each variable in greater detail, beginning with firm size.

### 4.3.1 Firm Size and Production Inefficiency

Firm size, measured by the natural logarithm of total assets (lnTA), exhibits a statistically significant and negative relationship with production inefficiency. This indicates that larger property firms tend to operate closer to the production frontier, reflecting higher technical efficiency relative to smaller firms. The result aligns with classical industrial organization theory, where scale advantages such as better access to capital, more experienced project management, and superior procurement capacity enable larger firms to optimize input utilization and reduce inefficiencies.

Universiti Utara Malaysia

The coefficient for firm size (measured as the natural logarithm of total assets, lnTA) is negative and statistically significant at the 1% level (-1.191), indicating that larger firms tend to be more technically efficient. Specifically, a 1% increase in firm total assets is associated with an estimated 1.19% reduction in production inefficiency. This finding supports the hypothesis that economies of scale are at play within the Malaysian property sector, where larger developers enjoy lower marginal costs, better financing terms, and more efficient resource allocation.

From an industrial organization perspective, this result is consistent with the SCP paradigm, where firm size confers strategic advantages in terms of conduct (project sequencing, procurement efficiency) and access to capital. Large firms often exhibit stronger internal governance structures, superior project coordination capabilities, and the ability to absorb input shocks more effectively contributing to their higher technical efficiency.

Within the Malaysian context, dominant firms in the upper asset tiers frequently operate across multiple regions, benefit from integrated design-build-sell models, and maintain long-term supplier relationships that streamline production activities. These scale-related advantages not only lower production costs but also enhance the ability to deliver projects within time and budget constraints. Therefore, policies that enable scaling among mid-sized developers such as facilitating land bank access or easing credit constraints may offer a pathway toward broader sector-wide efficiency gains.

Universiti Utara Malaysia

### 4.3.2 Location and Production Inefficiency

As shown in Table 4.2, the coefficient for Location is negative and statistically significant at the 1% level (-0.132), indicating that firms situated in more strategic or urbanized regions tend to exhibit higher production efficiency. Specifically, firms located in better-connected, infrastructure-rich areas experience an estimated 13.2% reduction in inefficiency relative to those operating in peripheral or less developed regions. This finding is consistent with the agglomeration and market-access advantages emphasized in

industrial organization theory, where spatial concentration facilitates better access to skilled labor, input suppliers, and financing networks enhancing resource allocation and lowering production inefficiency.

This finding underscores the role of spatial dynamics and agglomeration economies in shaping firm-level productivity. In line with industrial economics literature, location affects access to skilled labor, material supply chains, and regulatory efficiency all of which influence a firm's ability to minimize technical waste. Urban and growth corridor regions (such as Klang Valley, Penang, and Iskandar Malaysia) offer concentrated markets, better service infrastructure, and institutional support, thereby allowing firms to operate closer to the production frontier.

Universiti Utara Malaysia

Moreover, the result reinforces the significance of geographic positioning as a determinant of firm conduct and market interaction, particularly in a sector as spatially dependent as residential property development. In practice, firms located in these zones are more likely to benefit from faster approval processes, advanced digital infrastructure, and proximity to subcontractor networks all of which reduce inefficiency in project execution.

### 4.3.3 Steel Tariff and Production Inefficiency

Table 4.2 reports a negative and statistically significant coefficient for the Steel Tariff variable (-0.155), significant at the 1% level. This suggests that reductions in steel tariffs

are associated with a notable improvement in production efficiency. Specifically, a one-unit decline in tariff rates corresponds to an estimated 15.5% reduction in technical inefficiency among residential property firms. This finding underscores the efficiency-enhancing role of input market liberalization, particularly for high-cost materials such as steel, which account for a substantial share of construction expenses. Consistent with industrial organization theory and trade liberalization literature (Amiti & Konings, 2007; Pavcnik, 2002), the result indicates that cost-side reforms can enhance firm competitiveness when supported by sufficient absorptive capacity and scale efficiency.

In the Malaysian context, steel represents a critical input in residential construction, accounting for a substantial portion of total material costs (steel reinforcement and metal sections). The liberalization of steel tariffs particularly after 2008 was aimed at enhancing industry competitiveness and lowering construction costs. The significant negative coefficient here suggests that firms were able to partially translate these cost savings into more efficient production processes. Larger or more advanced firms may have had the absorptive capacity to respond effectively to price changes by optimizing procurement strategies, improving inventory turnover, and accelerating project timelines.

Universiti Utara Malaysia

### 4.3.4 Cement Tariff and Production Inefficiency

Unlike the case of steel, the coefficient for Cement Tariff in Table 4.2 is positive (0.099) but statistically insignificant, suggesting that changes in cement tariff rates do not have a systematic or robust association with production inefficiency among Malaysian property

firms during the study period. While the estimated direction implies a potential increase in inefficiency following tariff reductions, the lack of statistical significance indicates that tariff policy alone may have had limited traction in a highly concentrated cement market. This finding reinforces the view that input liberalization yields weaker efficiency effects when market competition and price transmission mechanisms remain structurally constrained.

This finding points to several important mechanisms in the relationship between tariff liberalization and firm-level performance. First, cement, unlike steel, is produced and distributed within a localized and highly concentrated market structure dominated by a few major suppliers. High transportation costs and regional production monopolies limit the spatial integration of cement markets, thereby diluting the pass-through of tariff reductions to end-users. Consequently, efficiency gains from liberalization are uneven, with firms in less accessible or supply-constrained regions facing persistent input cost disparities. These structural rigidities underscore the IO perspective that policy-induced price reforms are only effective when competitive transmission mechanisms function efficiently across the supply chain.

Second, the effectiveness of tariff reform is conditional not only on policy changes but also on the industry's internal capacity to leverage those changes. The insignificance of the cement tariff variable suggests that, on average, firms in the sector may lack the procurement agility or input substitution flexibility needed to benefit fully from lower

Universiti Utara Malaysia

cement import duties. This echoes findings from trade productivity literature (Tybout, 2000) that stress the importance of absorptive capacity and complementary reforms such as competition policy and supply chain integration in realizing the potential of liberalization.

Eventually, the result indicates that tariff reform alone is insufficient to drive efficiency improvements unless accompanied by broader structural adjustments and industry modernization. Policymakers aiming to enhance efficiency through input cost reduction must therefore consider the differentiated impact across material types and firm capabilities.

Universiti Utara Malaysia

### 4.3.5 Ownership Concentration and Production Inefficiency

The coefficient for Ownership Concentration in Table 4.2 is negative (-0.003), suggesting a slight association between higher ownership concentration and lower production inefficiency. However, the effect is statistically insignificant, indicating that variations in shareholder dominance do not have a consistent or robust influence on technical efficiency across firms in the Malaysian property sector.

Therefore, theoretical literature in corporate governance often associates concentrated ownership with improved monitoring, reduced agency costs, and more aligned incentives (Shleifer & Vishny, 1997), these benefits may not fully translate into operational

efficiency in practice especially within family-owned or tightly held firms. In Malaysia, where many property developers remain family-controlled or have intergenerational leadership structures, concentrated ownership may lead to entrenchment effects rather than performance-driven discipline.

Moreover, the lack of significance may reflect the complex trade-offs inherent in ownership structures. On one hand, high concentration could lead to quicker decision-making and long-term strategic alignment; on the other, it may discourage innovation, resist process reforms, or prioritize short-term capital preservation over production efficiency. These ambiguities are particularly salient in an industry where technical execution is influenced as much by operational competence as by governance structure. In this sector, governance-related efficiency gains may be contingent on other complementary mechanisms such as board independence, project management capability, and internal controls none of which are directly captured by ownership shares alone.

Finally, from a policy standpoint, this suggests that improving firm efficiency requires more than just ownership restructuring. Regulatory or institutional efforts should focus on professionalizing management practices and enhancing operational transparency, rather than relying solely on shareholder concentration as a proxy for control quality.

Universiti Utara Malaysia

### 4.3.6 Firm Subsidiaries and Production Inefficiency

Table 4.2 reports the estimated coefficients for two structural dummy variables: Subsidiary status and Establishment type (public vs. private). Although both coefficients are statistically insignificant at conventional levels, their signs and magnitudes offer meaningful insights into how firm structure may influence production inefficiency across Malaysia's residential property sector.

The coefficient for Subsidiary status is negative (-0.125), indicating that firms operating as subsidiaries of larger corporate groups tend to exhibit lower inefficiency than their stand-alone counterparts. This suggests that intra-group coordination, access to shared resources, and centralized procurement mechanisms may contribute to more streamlined operations and better input utilization.

Universiti Utara Malaysia

While the result is not statistically significant, the negative coefficient aligns with expectations from industrial organization and transaction cost theory, suggesting that group-affiliated firms may experience coordination benefits and lower marginal costs through shared infrastructure, knowledge transfer, and centralized procurement. Nonetheless, the large standard error indicates significant heterogeneity across group structures. In some cases, vertical or horizontal integration may generate internal efficiencies; in others, excessive centralization or bureaucratic control within parent firms may offset these gains. This mixed outcome reflects the dual nature of group affiliation as

both a potential source of efficiency and a channel for managerial rigidity in Malaysia's property sector.

### 4.3.7 Establishment Types and Production Inefficiency

While the coefficient for Establishment type (where private firms are coded as 1) is not statistically significant, its positive sign (0.588) suggests that, on average, private listed firms may exhibit higher production inefficiency than their state-linked counterparts. Although the effect lacks statistical precision, the direction is theoretically meaningful when viewed through the lens of industrial organization: private developers, operating under stronger profit pressures and more aggressive market positioning, may undertake riskier or more speculative projects that temporarily reduce technical efficiency. Conversely, government-linked firms often benefit from scale, preferential financing, and more stable project pipelines, partially offsetting inefficiencies arising from bureaucratic management.

Universiti Utara Malaysia

Specifically, this tentative finding supports the hypothesis that private developers operating within more fragmented and diversified ownership structures may face higher coordination costs, diluted control rights, and decentralized decision-making, particularly in projects with long gestation periods. Such organizational features, including crossholdings, board interlocks, and family-based control, while not directly captured in the model, are structurally embedded in Malaysia's property sector. These features can

weaken managerial oversight and slow project execution, thereby contributing to the observed inefficiency among privately listed firms relative to state-linked developers.

In the of perspective SCP, these firms may adopt strategies that emphasize flexibility, speculative land banking, or portfolio expansion, but such conduct may lead to inefficiencies in resource allocation and execution timeliness. This contrasts with state-linked developers, which despite assumptions of bureaucratic inertia may benefit from centralized planning, clearer institutional mandates, and preferential access to land or financing, contributing to lower technical inefficiency.

In addition, this tentative finding raises critical institutional considerations. State-owned or Government Link Companies (GLCs) despite perceptions of bureaucratic sluggishness may benefit from preferential access to land, capital, and regulatory approvals, which streamline large-scale project execution and enhance technical efficiency. In contrast, private firms, while generally perceived as more agile, may operate under higher market volatility and financing constraints, especially in regions with oversupply or tight credit environments.

Therefore, the insignificance of both structural variables does not diminish their conceptual importance. Rather, it highlights the institutional heterogeneity within each group and the limitations of binary classifications in fully capturing structural performance dynamics. What appears to matter more is not the legal form or ownership

Universiti Utara Malaysia

label per se, but how firms operationalize their structural position through managerial efficiency, coordination mechanisms, and internal incentives.

### 4.3.8 Firm Age and Production Inefficiency

Firm age, proxied by the natural logarithm of years since establishment (lnAge), displays a positive and statistically significant coefficient (1.175) in Table 4.12. This result implies that older firms tend to exhibit higher levels of production inefficiency, with a 1% increase in firm age associated with a 1.18% increase in inefficiency. This finding is both statistically robust and conceptually revealing, as it challenges the traditional view that experience necessarily leads to superior operational performance.

Universiti Utara Malaysia

In the context of Malaysia's residential property sector, this inefficiency-age relationship is likely reflective of institutional and organizational inertia. Many older firms are family-owned enterprises, often in their second or third generation of leadership, where continuity may take precedence over innovation. As these firms grow in legacy, they may accumulate bureaucratic layers, resist technology adoption, or rely on outdated project delivery models. While institutional memory and relationship capital can be advantageous, they may also constrain agility, responsiveness, and process optimization factors that are crucial for maintaining technical efficiency in a competitive, cost-sensitive industry.

Moreover, older firms may operate under entrenched business models, favoring familiar contractors, conventional procurement methods, and traditional financing structures. These preferences can hinder experimentation with newer, potentially more efficient methods, such as Industrialized Building Systems (IBS), digital project management tools, or modular design frameworks. In contrast, younger firms often leaner and more entrepreneurial may be more willing to adopt streamlined workflows, automate manual tasks, and integrate vertically to gain control over costs and timelines.

The result also has a deeper policy implication. Government-linked initiatives often rely on established developers for large-scale housing delivery under affordable or public-private schemes. However, if older firms are structurally less efficient, this raises questions about the long-run productivity and fiscal sustainability of relying on legacy players. Incentivizing innovation, setting efficiency benchmarks, and creating entry space for more dynamic mid-tier firms could help rebalance the sector toward higher technical performance.

In summary, the significant positive association between firm age and production inefficiency suggests that maturity alone does not guarantee operational excellence. In fact, without structural renewal or technological investment, age may become a source of rigidity. This finding reinforces the need for both firm-level transformation and policy realignment to ensure that legacy does not come at the expense of efficiency.

Universiti Utara Malaysia

## 4.4 Cost Frontier Model and Efficiency Estimation

This section presents the empirical findings on cost efficiency among Malaysian residential property firms, based on the stochastic frontier analysis (SFA) framework. The estimation employs a translog cost frontier, which accommodates multiple input prices and allows for flexible substitution patterns and firm-level cost heterogeneity. The analysis is structured as follows: Section 4.4.1 provides descriptive statistics of the cost efficiency scores across firms and time. Section 4.4.2 reports the parameter estimates obtained through Maximum Likelihood Estimation (MLE) of the translog stochastic cost frontier model. Section 4.4.3 evaluates the model's performance and validity, including post-estimation diagnostics and the appropriateness of the inefficiency specification. Finally, Section 4.7 examines the relationship between cost inefficiency and firm-specific characteristics using non-parametric correlation analysis.

Universiti Utara Malaysia

### 4.4.1 Descriptive Statistics for the Cost Frontier Model

Table 4.14 presents the descriptive statistics for the 76 property firms included in the sample over the period 2000-2020. All financial values are reported in Malaysian Ringgit (RM). The average Total Cost incurred by the firms was RM360,709,000, with substantial variation across the sample, reflecting differences in firm size and project scale. The average Sales amounted to RM295,770,300, with a maximum of RM6,746,343,000, indicating a wide dispersion in revenue-generating capacity among Malaysian developers. In terms of firm characteristics, the average Total Assets stood at RM1,378,518,000, with the largest firm holding assets exceeding RM30 billion. The average Firm Age was 37

years, with the oldest firm operating for more than a century (135 years), demonstrating that the industry is dominated by mature, long-established developers.

Table 4.14: Summary of Statistics for Cost Efficiency Model

| Variable | Descriptions | Unit | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|---|---|
| Total Cost | Total Cost | RM | 360709.1 | 532484.9 | 195183.5 | 6030807 |
| X1 | Sales | RM | 295770.3 | 604696.8 | 124423.5 | 6746343 |
| X2 | Prices of Labor | RM per employee | 51.7 | 50.9 | 41.8 | 832.5 |
| X3 | Prices of Capital | RM per asset unit | 0.7 | 3.2 | 0.2 | 49.9 |
| X4 | Prices of Material | RM | 6.1 | 34.2 | 1.5 | 1017 |
| Z1 | Asset | RM | 1378518 | 2880861 | 559242 | 30056048 |
| Z2 | Location | % | 86.83 | 5.5 | 75 | 95 |
| Z3 | Steel Tariff | % | 29.1 | 6.1 | 20.36 | 40.8 |
| Z4 | Cement Tariff | % | 20.14 | 4.64 | 15.71 | 30.17 |
| Z5 | Ownership Concentration | % | 47.04 | 15.98 | 6.20 | 82.72 |
| Z6 | Firm Age | Year | 37.7 | 21.91 | 1 | 135 |
| Z7 | $Age^2$ | $Year^2$ | 12.37 | 4.00 | 1 | 24.10 |

Among the input prices, the price of labor (X2) averages RM51.70 per employee, with relatively moderate dispersion, indicating stable wage structures across firms. In contrast, both the price of capital (X3) and the price of materials (X4) display substantial variability, with material prices ranging from as low as RM1.50 to more than RM1,000 per unit. Such wide dispersion in material costs reflects pronounced differences in procurement practices, construction methods, and supply-chain positioning. Firms sourcing materials

through specialized contractors, importing higher-grade inputs, or operating in more volatile regional markets experience significantly higher input prices, consistent with CIDB and MPC findings on heterogeneous cost structures within Malaysia's construction and property value chain.

Notably, regarding inefficiency determinants, firm size (Z1) measured by total assets averages RM1.38 billion, but the large standard deviation signals a skewed distribution, with some firms exceeding RM30 million in assets. The location variable (Z2) shows that, on average, firms operate in areas with an 86.83% urban share, consistent with the sector's urban-centric focus. The steel (Z3) and cement tariffs (Z4) average 29.1% and 20.14%, respectively, across the study period, capturing the effect of liberalization policies over time.

Universiti Utara Malaysia

Ownership concentration (Z5) averages 47.04%, indicating that nearly half of the equity in most firms is controlled by dominant shareholders, a typical pattern in Malaysia's property sector. The average firm age (Z6) is 37.7 years, with some firms operating for over a century highlighting the presence of well-established, legacy developers. Meanwhile, the squared of firm age, $Age^2$ (Z7), exhibits a mean value of 12.37, reflecting the inclusion of nonlinear age effects in the model. This term allows the analysis to capture potential diminishing efficiency returns among older firms, as maturity and experience may eventually be offset by structural rigidity, institutional path dependence, or slower innovation adoption.

### 4.4.2 Maximum Likelihood Estimates of the Stochastic Cost Frontier Model

The maximum likelihood estimates of the translog stochastic cost frontier, defined in Equation (3.9), are reported in Table 4.15. The results indicate that firm-level cost behavior is systematically driven by output levels and input prices, consistent with the duality properties of the cost function. The statistical significance of several linear, quadratic, and cross-product terms highlights the appropriateness of the translog specification in capturing curvature, substitution effects, and scale properties inherent in developers' cost structures. In particular, the estimated coefficients on labor and material prices, together with their higher-order interactions, reveal heterogeneous cost elasticities across firms, thereby validating the econometric relevance of the translog form in modelling cost relationships in the property sector.

Universiti Utara Malaysia

Therefore, to evaluate the significance of including firm-level inefficiency determinants, a likelihood ratio (LR) test was conducted. The null hypothesis assumes that all inefficiency parameters are jointly equal to zero. The log-likelihood of the restricted model (constant inefficiency) was -1053.3289, while the full model yielded -1350.5502. The resulting LR statistics are:

$$LR = -2(lnL_0 - lnL_1) = -2(-1053.3289 + 1350.5502) = 594.44$$

Thus, with 9 degrees of freedom (equal to the number of inefficiency variables), this statistic far exceeds the chi-square critical value of 16.92 at the 5% level. As a result, the null hypothesis is rejected, confirming that the inclusion of structural and policy-related variables significantly improves the explanatory power of the cost inefficiency model.

Table 4.15: Maximum Likelihood Estimates for the Translog Stochastic Cost Frontier Model

| | Coefficient | Std. Error | t-ratio |
|---|---|---|---|
| Cost Function | | | |
| lnSale | -0.131 | 0.133 | -0.980 |
| lnPL | 0.670 | 0.180 | 3.820*** |
| lnPK | -0.131 | 0.100 | -1.390 |
| lnPM | -0.450 | 0.100 | -4.96*** |
| (lnSale)2 | 0.046 | 0.010 | 8.70*** |
| (lnPL)2 | 0.026 | 0.020 | 1.530 |
| (lnPK)2 | -0.010 | 0.004 | -2.77*** |
| (lnPM)2 | -0.033 | 0.004 | -9.320*** |
| PLPK | -0.012 | 0.014 | -0.890 |
| PLPM | 0.031 | 0.013 | 2.280** |
| PKPM | 0.030 | 0.006 | 4.900*** |
| SPL | -0.072 | 0.020 | -3.920*** |
| SPK | 0.016 | 0.010 | 2.080** |
| SPM | -0.022 | 0.007 | -3.160* |
| Constant | 7.20 | 0.940 | 7.67*** |
| Inefficiency Model | | | |
| lnTAsset | 0.164 | 0.05 | 3.60*** |
| lnLOC | -1.010 | 0.728 | -1.39 |
| STariff | 0.05 | 0.02 | 2.36** |
| CTariff | -0.03 | 0.022 | -1.3 |
| Ownership | 0.011 | 0.003 | 4.05*** |
| LnAge | 2.80 | 1.72 | 1.62* |
| $(LnAge)^2$ | -0.331 | 0.215 | -1.54 |
| Subsidiary | 3.52 | 15.10 | 0.23 |
| Establishment | -0.301 | 0.120 | -2.50** |
| Constant | -7.75 | 15.563 | -0.50 |
| Variance Parameter | | | |
| U sigma | -3.30 | 0.854 | -3.840*** |
| V sigma | -1.21 | 0.058 | -20.70*** |
| Sigma_u | 0.194 | 0.830 | 2.34** |
| Sigma_v | 0.546 | 0.016 | 34.24*** |
| Lambda | 0.360 | 0.095 | 3.72*** |
| /lnsigma2 | -0.714 | 0.825 | 10.63*** |
| /ilgtgamma | 0.471 | 0.22 | 2.14** |
| /mu | 1.256 | 0.141 | 8.89*** |
| /eta | -0.016 | 0.003 | -6.52*** |
| Sigma2 | 0.49 | 0.065 | |
| Gamma | 0.616 | 0.052 | |
| Sigma_u2 | 0.301 | 0.065 | |
| Sigma_v2 | 0.188 | 0.01 | |
| Log likelihood | | 594.44 | |

Note: The dependent variable is ln (Total Cost). Coefficients are estimated using the Battese and Coelli (1995) time-varying inefficiency model. ***, ** and * denote statistical significance at the 1, 5 and 10 levels, respectively.

Universiti Utara Malaysia

Furthermore, to assess the appropriateness of including firm-level inefficiency effects, a likelihood ratio (LR) test was conducted. Comparing the log-likelihood values of the restricted model (with constant inefficiency) and the full model (with inefficiency effects modeled as a function of firm characteristics), the LR statistic was calculated as 594.44. This value far exceeds the chi-square critical value of 16.92 at the 5% significance level (with 9 degrees of freedom), leading to a rejection of the null hypothesis that all inefficiency parameters are jointly zero. The test confirms that firm-specific and policy-related characteristics such as asset size, ownership structure, location, and tariff reforms significantly explain variation in cost inefficiency, thereby statistically justifying the extended inefficiency effects model.

In addition, among the input prices, labor cost (lnPL) emerges as a statistically significant and positive determinant of total cost, with a coefficient of 0.670 ($p < 0.01$). This suggests that labor expenses have a substantial and direct impact on the cost structure of property firms, reinforcing the sector's labor-intensive nature. In contrast, the coefficient on capital cost (lnPK) is negative (-0.131) but statistically insignificant, implying that capital expenditures do not exert a strong marginal influence on total cost in this sample. Most notably, material cost (lnPM) has a significant and negative coefficient of -0.450 ($p < 0.01$), indicating that increases in material prices are associated with reductions in total cost a counterintuitive but not uncommon result in translog models, which may reflect cost-reducing strategies such as bulk procurement, input substitution, or increased operational efficiency in response to material price shocks. These results highlight the

Universiti Utara Malaysia

heterogeneous role of input prices in shaping firm-level cost dynamics in the Malaysian property sector.

### i. Estimated First-Order Parameters of the Cost Frontier Function

The first-order terms in the translog stochastic cost frontier model represent the elasticities of total cost with respect to output and input prices, offering insight into the marginal impact of each factor on firm-level cost behavior. These coefficients, presented in Table 4.15, highlight both the economic significance and asymmetry in cost responsiveness across different inputs.

The coefficient on lnSales (-0.131) is negative but statistically insignificant, suggesting that total cost does not increase proportionally with output. This could reflect unexploited scale economies or cost rigidity in project delivery. In other words, cost increases do not strongly track increases in sales, implying that firms may face difficulty in adjusting input usage efficiently as production scales up a possible symptom of fragmented operations or poor cost forecasting.

Furthermore, among the input prices, the price of labor (lnPL) has a positive and highly significant coefficient (0.670), indicating that labor is the most cost-sensitive input. A 1% increase in labor price leads to a 0.67% increase in total cost, holding other factors constant. This underscores the labor-intensive nature of Malaysia's property development process and reflects the sector's high dependency on manual labor, particularly low-skilled foreign workers. The strong cost elasticity also suggests that firms may have

limited flexibility in adjusting workforce input in response to wage changes, reinforcing earlier findings by the Malaysia Productivity Corporation (MPC) on labor rigidity and low productivity.

Interestingly, the coefficient on the price of capital (lnPK) is negative (-0.131) and not statistically significant, suggesting that capital price variations do not exert a strong or consistent influence on total cost. This may reflect underutilization of capital assets or the fact that many firms rely on subcontracted equipment and machinery, thus buffering the direct cost impact of capital price fluctuations.

The price of materials (lnPM) also has a negative and statistically significant coefficient (-0.450), which at first glance appears counterintuitive. However, in a translog model, first-order terms are interpreted in conjunction with second order and interaction terms. The negative sign may imply input substitution or stockpiling behavior, where firms pre-purchase materials in response to anticipated price increases, or it may reflect volume discounts among larger firms. This pattern could also indicate inefficiencies in procurement processes, where cost controls are not directly aligned with material price movements.

Eventually, the first-order coefficients provide important insight into input cost structure and firm behavior. The strong cost sensitivity to labor, coupled with weak or inverse responsiveness to capital and materials, suggests that Malaysian property firms may

Universiti Utara Malaysia

benefit from restructuring input mixes, enhancing labor productivity, and adopting more adaptive procurement strategies to improve cost efficiency.

### ii. Second-Order Terms and Input Interactions

The second-order terms and interaction coefficients in the translog cost function provide insight into the curvature of the cost frontier and the relationships between input prices and output levels. The coefficient for the squared output term, $(lnSale)^2$, is positive and highly significant 0.460 ($p < 0.01$), indicating a convex cost frontier and suggesting that marginal costs increase as output expands. This curvature effect reflects rising cost pressure at higher output levels, possibly due to capacity constraints or diminishing operational flexibility.

In addition, among the squared input terms, $(lnPL)^2$ is positive (0.026) but not statistically significant, whereas both $(lnPK)^2$ and $(lnPM)^2$ are negative and significant (-0.010 and -0.033, respectively). These results imply that capital and material inputs exhibit diminishing marginal cost effects, consistent with economies of input substitution or scaling. In terms of cross-price interactions, PKPM (capital-material) and PLPM (labor-material) are positive and statistically significant, suggesting complementarity between these inputs higher prices in one may lead to increased cost effects from the other, possibly due to co-dependence in construction processes. Meanwhile, PLPK is statistically insignificant, indicating a weaker interaction effect between labor and capital inputs.

Universiti Utara Malaysia

The interaction terms between output and input prices (SPL, SPK, and SPM) offer additional insights. The negative and significant coefficient on SPL (-0.072) suggests that increasing labor costs are associated with a reduction in marginal cost as output increases possibly reflecting labor efficiency gains at larger scale. Conversely, SPK is positive and significant (0.020), implying that capital cost sensitivity increases with output. The negative coefficient on SPM -0.020 ($p < 0.01$) again reflects scale-related material efficiency, potentially due to bulk purchasing or reduced wastage in larger projects.

This result aligns with observations in regional studies. For instance, You and Zi (2007) noted persistent labor inefficiencies in Korea's post-crisis construction sector, partly due to inflexible labor structures. In contrast, Park et al. (2018) document labor productivity gains in Japan's property industry, driven by digitalization and industrialized building systems. In Malaysia's case, the negative SPL interaction highlights a critical dynamic: while larger firms can absorb labor costs more efficiently, the underlying dependence on low-cost labor may still inhibit long-term productivity transformation.

Universiti Utara Malaysia

### 4.4.3 Model Performance and Diagnostic Validity

The performance of the translog stochastic cost frontier model is supported by several key diagnostic indicators. Both the inefficiency term ($\sigma_u$ = 0.200) and the noise term ($\sigma_v$ = 0.100) are statistically significant at the 5% level and 1% respectively, confirming that the model effectively separates systematic cost inefficiency from random disturbances.

The significance of these variance parameters validates the stochastic frontier approach in capturing firm-level cost behavior in Malaysia's residential property sector.

A critical diagnostic measure, gamma (γ), is estimated at 0.616, indicating that approximately 61.6% of the total variation in observed costs is attributable to persistent inefficiency, while the remaining 38.4% is explained by statistical noise or transitory shocks. This moderate-to-high gamma value suggests that inefficiency is not only present but also economically meaningful, justifying the inclusion of firm-specific and policy-related determinants in the inefficiency effects model.

Further confirmation of model validity is provided by the likelihood ratio (LR) test, which compares the log-likelihoods of the restricted (constant inefficiency) and full models. The calculated LR statistic of 594.44 far exceeds the chi-square critical value of 16.92 at the 5% level with 9 degrees of freedom.

The log-likelihood of the full stochastic cost frontier model with inefficiency effects ($lnL_1$ = 1350.5502) is substantially higher than that of the restricted model without inefficiency ($lnL_0$ = –1053.3289). The resulting LR test statistic, calculated as:

$$LR = -2(lnL_0 - lnL_1) = -2(-1053.3289 + 1350.5502) = 594.44$$

Thus, this test decisively rejects the null hypothesis that γ = 0 (i.e., that there are no inefficiency effects) at any conventional significance level. The result confirms that the

inclusion of inefficiency effects modeled through observable firm-level characteristics significantly improves the explanatory power and fit of the stochastic cost frontier model.

The variance decomposition supports this conclusion. The inefficiency variance ($\sigma^2_u$) is estimated at 0.301, while the statistical noise variance ($\sigma^2_v$) is lower, at 0.188. The lambda ($\lambda$) ratio defined as the ratio of $\sigma_u$ to $\sigma_v$ is also sizeable at 0.400, further reinforcing the presence of inefficiency effects. Together, these parameters provide robust evidence that firm-level behavioral and structural differences meaningfully affect cost efficiency outcomes in the industry.

Universiti Utara Malaysia

This strong diagnostic outcome reinforces the empirical validity of the Battese and Coelli (1995) stochastic frontier framework applied in this chapter. It confirms that cost inefficiency is a meaningful and systematic component of firm behavior, rather than mere statistical noise. The model's robustness not only supports the detailed interpretation of firm-level inefficiency determinants but also strengthens the analytical foundation for the next section, which explores the presence and variation of economies of scale (EOS) across different categories of residential property firms in Malaysia.

Altogether, these diagnostics demonstrate that the stochastic cost frontier model is statistically robust, empirically well-specified, and suitable for analyzing cost behavior in a sector characterized by high input variability and firm heterogeneity. The statistically significant variance components ($\sigma_u$ and $\sigma_v$) confirm that the model is not mis specified,

while the gamma value of 0.616 highlights that inefficiency is not merely a statistical artifact but a substantive component of firm-level cost variation. This reinforces the validity of interpreting cost deviations as stemming from underlying structural, managerial, or policy-related factors rather than from random disturbances alone.

Moreover, the strongly significant LR test provides formal evidence that firm-specific characteristics including scale, age, ownership structure, and input market exposure are crucial in explaining inefficiency patterns. This strengthens the model's theoretical grounding in the Battese and Coelli (1995) inefficiency effects framework and positions it as an appropriate tool for diagnosing institutional and organizational weaknesses in the Malaysian residential property sector.

Universiti Utara Malaysia

### 4.4.4 Distribution of Cost Efficiency Scores

The distribution of cost efficiency scores across the full sample reveals considerable heterogeneity. While the average CE is 0.375, the standard deviation is 0.175, indicating substantial variation in cost performance among firms. The most efficient firm in the sample achieved a CE score of 0.968, while the least efficient recorded a score as low as 0.087. This widespread reflects the diversity of operational practices, input management strategies, and structural capabilities across the industry.

The skewed distribution suggests that a significant share of firms operate well below the cost frontier, with only a small number approaching optimal cost conditions. This asymmetry in cost efficiency is consistent with institutional constraints, uneven procurement capabilities, and variation in project complexity all of which merit further exploration in next section.

**Figure 4.3: Distribution of Firm-Level Mean Cost Efficiency (2000-2020)**

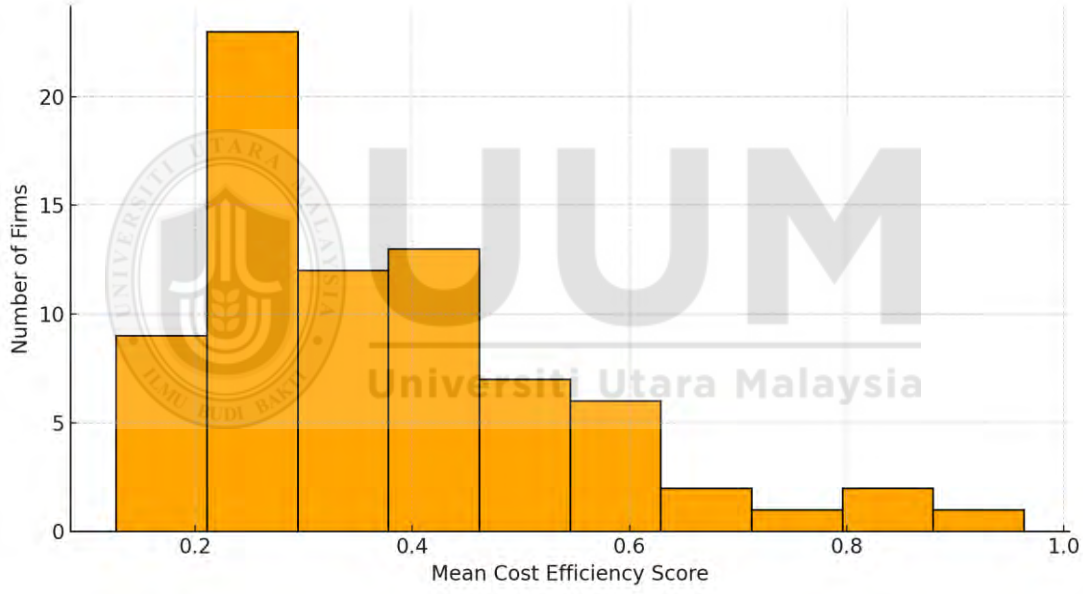



Figure 4.3 displays the histogram of average cost efficiency scores across 76 Malaysian residential property firms over the 2000-2020 period. The distribution is clearly right-skewed, with a significant concentration of firms recording low to moderate levels of cost efficiency. Most firms fall within the 0.2 to 0.5 range, suggesting that a large portion of the industry operates far from the optimal cost frontier.

Therefore, only a small number of firms attain high-cost efficiency (above 0.8), indicating that very few companies effectively manage input prices and output levels to minimize cost. Conversely, a considerable number of firms cluster near the lower end of the efficiency scale (below 0.3), reflecting widespread cost-related inefficiencies. This could be due to factors such as suboptimal procurement practices, reliance on outdated project management approaches, or exposure to volatile input markets without appropriate cost buffering mechanisms. The mean CE score of 0.375 further supports the conclusion that the industry suffers from systemic inefficiencies.

In comparative perspective, the average cost efficiency found in this study is substantially lower than in regional counterparts. Dzeng and Wu (2013) report an average CE score of 0.78 for Taiwanese construction firms, while You and Zi (2007) report 0.627 for Korean construction firms in the year 2000, following the Asian financial crisis. These benchmarks underscore the relatively weak cost efficiency performance of Malaysian property developers and point toward structural rigidities, limited procurement optimization, and underutilized input synergies as likely drivers of inefficiency. These findings set the stage for a more detailed interpretation of cost behavior in the sections that follow.

This observed asymmetry in cost efficiency distribution is critical: it suggests that inefficiency is not evenly spread but concentrated in a substantial portion of the market. These findings reinforce the relevance of exploring firm-specific structural and policy-

Universiti Utara Malaysia

related determinants of inefficiency in Section 4.6 and underscore the need for targeted reforms aimed at strengthening cost discipline in Malaysia's residential development sector.

## 4.5 Cost Efficiency Scores of Property Firms

This section presents the cost efficiency (CE) scores of Malaysian residential property firms for the period 2000-2020, estimated using the translog stochastic cost frontier model with time-varying inefficiency effects (Battese & Coelli, 1995). The analysis evaluates how efficiently firms manage production costs relative to the estimated cost frontier, providing insights into variations in cost performance across firms of different sizes, ownership structures, and geographic locations. Thus, by assessing the extent to which each firm operates near the minimum attainable cost for given input prices and output levels, the CE scores serve as an integrated indicator of both technical and allocative efficiency.

In addition, unlike technical efficiency which measures a firm's ability to transform inputs into output cost efficiency captures the firm's capacity to choose an optimal mix of inputs that minimizes cost under existing market conditions. Hence, it reflects the combined effect of input utilization and input price management. Within this framework, firm-level cost inefficiency is subsequently modeled as a function of several explanatory factors, including firm size, ownership concentration, firm age, subsidiary status, establishment type, location, and the liberalization of key material inputs (steel and cement tariffs).

Together, these components form the empirical basis for assessing structural, organizational, and policy influences on cost efficiency across Malaysia's property sector.

### 4.5.1 Firm Size and Cost Efficiency Score, 2000-2020

Table 4.16 presents the evolution of cost efficiency (CE) scores across five firm-size tiers, segmented by total assets, over four sub-periods from 2000 to 2020. Since CE values closer to 1.00 represent greater cost efficiency, the results reveal a clear positive relationship between firm size and cost efficiency. Larger developers (Tiers 4 and 5) consistently record higher CE scores, indicating their ability to operate nearer to the minimum cost frontier. For example, Tier 5 firms achieved an average CE score of 0.513 in 2000-2005 and 0.435 in 2016-2020, compared with Tier 1 firms, whose mean scores declined from 0.307 to 0.225 over the same period. Although efficiency levels fell slightly across all tiers, the relative advantage of larger firms underscores their scale economies, stronger procurement capacity, and superior cost coordination within Malaysia's property development industry.

This trend reinforces the presence of scale advantages among Malaysia's larger residential developers, where accumulated capital, organizational depth, and supplier bargaining power translate into superior cost efficiency. These firms are better positioned to absorb input price shocks and coordinate multiple projects, although some signs of marginal efficiency decline suggest emerging coordination frictions and bureaucratic overheads at very large scales. Conversely, smaller firms tend to exhibit weaker cost control due to

limited access to finance, narrower supplier networks, and higher sensitivity to material price fluctuations. The gradual decline in CE across all tiers nonetheless highlights industry-wide structural inefficiencies and persistent input market volatility, particularly after 2010, when material cost reforms and regulatory fragmentation intensified cost pressures sector-wide.

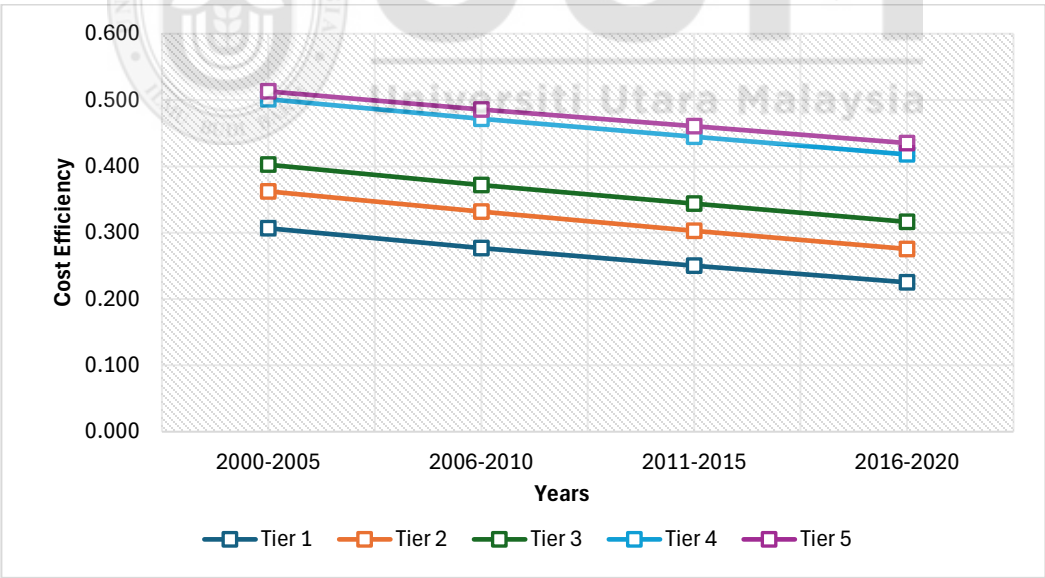
Table 4.16: Cost Efficiency Scores by Firm Size Tier, 2000-2020

| Firm Size | Firms | | Cost Efficiency 2000 - 2005 | 2006 - 2010 | 2011 - 2015 | 2016 - 2020 |
|---|---|---|---|---|---|---|
| **Tier 1** | 8 | Mean | 0.307 | 0.277 | 0.250 | 0.225 |
| | | SD | 0.143 | 0.144 | 0.144 | 0.143 |
| | | Min | 0.156 | 0.133 | 0.112 | 0.093 |
| | | Max | 0.670 | 0.643 | 0.619 | 0.594 |
| **Tier 2** | 23 | Mean | 0.362 | 0.332 | 0.303 | 0.276 |
| | | SD | 0.129 | 0.131 | 0.133 | 0.134 |
| | | Min | 0.182 | 0.158 | 0.135 | 0.113 |
| | | Max | 0.835 | 0.820 | 0.806 | 0.791 |
| **Tier 3** | 19 | Mean | 0.403 | 0.372 | 0.344 | 0.316 |
| | | SD | 0.154 | 0.160 | 0.165 | 0.169 |
| | | Min | 0.195 | 0.169 | 0.145 | 0.123 |
| | | Max | 0.968 | 0.965 | 0.962 | 0.959 |
| **Tier 4** | 15 | Mean | 0.501 | 0.472 | 0.445 | 0.418 |
| | | SD | 0.157 | 0.162 | 0.167 | 0.170 |
| | | Min | 0.248 | 0.220 | 0.193 | 0.168 |
| | | Max | 0.862 | 0.848 | 0.837 | 0.824 |
| **Tier 5** | 11 | Mean | 0.513 | 0.486 | 0.461 | 0.435 |
| | | SD | 0.193 | 0.194 | 0.194 | 0.192 |
| | | Min | 0.148 | 0.126 | 0.106 | 0.087 |
| | | Max | 0.709 | 0.684 | 0.662 | 0.639 |

Universiti Utara Malaysia

Figure 4.4 illustrates the cost efficiency (CE) trajectories of Malaysian residential property firms grouped into five asset-based tiers from 2000 to 2020. A clear inverse relationship emerges between firm size and inefficiency, whereby larger firms especially those in Tier 5 and Tier 4 consistently exhibit higher cost efficiency across all four sub-periods. In contrast, smaller firms, particularly those in Tier 1, display persistently lower CE scores and a steeper decline over time. This trend suggests that economies of scale play a critical role in shaping cost structures in the property sector. Larger firms are likely to benefit from bulk procurement, stronger supplier bargaining power, and more efficient project management systems.

Figure 4.4: Cost Efficiency Trends by Firm Size Tier, 2000-2020



Besides, from an IO perspective, this pattern supports the SCP paradigm: firm size (structure) influences strategic conduct (investment in cost-saving technologies), which ultimately affects performance (measured here as cost efficiency). The consistent tier ranking over time also suggests a form of structural inertia, where the advantages of scale are not easily eroded by smaller entrants. The overall decline in CE across all tiers signals rising input costs or systemic inefficiencies, but the scale advantage remains a key determinant in mitigating cost pressures.

### 4.5.2 Ownership Concentration and Cost Efficiency Score, 2000-2020

Table 4.17 presents the cost efficiency (CE) performance of firms grouped by ownership concentration levels: low (<30%), medium (30-50%), and high (>50%). The results indicate a clear and stable relationship between greater ownership concentration and higher cost efficiency throughout the period 2000-2020. Firms with high ownership concentration (typically characterized by strong family or institutional control) recorded the highest average CE scores in each sub-period, rising from 0.439 in 2000-2005 to 0.354 in 2016-2020. In contrast, firms with dispersed ownership (low concentration) consistently underperformed, with average CE scores dropping from 0.309 to 0.223 over the same timeframe.

Therefore, highly concentrated ownership often implies tighter control, reduced agency slack, and greater capacity to internalize transaction decisions, aligning with strategic behavior posited in IO theory and findings by Caves and Barton (1991). Conversely, firms

with dispersed ownership structures may suffer from diluted accountability and slower decision cycles, weakening their ability to manage costs effectively. The declining cost efficiency trend across all groups suggests systemic challenges in the industry, but the widening gap between high- and low-concentration firms points to the strategic premium conferred by concentrated control.

Table 4.17: Cost Efficiency Scores by Ownership Concentration Level, 2000-2020

| Ownership Concentration | Firms | | Cost Efficiency | | | |
|---|---|---|---|---|---|---|
| | | | 2000 - 2005 | 2006 - 2010 | 2011 - 2015 | 2016 - 2020 |
| **Low (<30%)** | 9 | Mean | 0.309 | 0.278 | 0.250 | 0.223 |
| | | SD | 0.088 | 0.086 | 0.084 | 0.081 |
| | | Min | 0.148 | 0.126 | 0.106 | 0.087 |
| | | Max | 0.460 | 0.424 | 0.394 | 0.364 |
| **Medium (30-50%)** | 31 | Mean | 0.420 | 0.391 | 0.363 | 0.337 |
| | | SD | 0.179 | 0.183 | 0.187 | 0.190 |
| | | Min | 0.160 | 0.137 | 0.116 | 0.096 |
| | | Max | 0.968 | 0.965 | 0.962 | 0.959 |
| **High (>50%)** | 36 | Mean | 0.439 | 0.409 | 0.381 | 0.354 |
| | | SD | 0.163 | 0.167 | 0.169 | 0.171 |
| | | Min | 0.156 | 0.133 | 0.112 | 0.093 |
| | | Max | 0.862 | 0.848 | 0.837 | 0.824 |

Universiti Utara Malaysia

Thus, from an Industrial Organization (IO) perspective, the results support the SCP paradigm that ownership structure affects conduct, and here, firms with dominant shareholders appear better positioned to exercise cost rationalization, enforce procurement discipline, and minimize transaction frictions. Unlike the risks of entrenchment highlighted in governance literature, this study finds no empirical evidence of deteriorating performance at high concentration levels, suggesting that in Malaysia's property sector characterized by family-led firms and high capital intensity concentrated ownership remains a strategic advantage rather than a liability in managing cost structures.

### 4.5.3 Firm Age and Cost Efficiency Score, 2000-2020

Table 4.18 categorizes firms into two groups based on age: those younger than 40 years and those aged 40 years or older. The analysis reveals a consistent pattern where older firms outperform younger ones in terms of cost efficiency (CE) across all time periods. Between 2000 and 2005, firms aged ≥40 recorded an average CE score of 0.445 compared to 0.359 for younger firms. This gap persisted into 2016-2020, with older firms averaging 0.363 and younger firms falling to 0.271. While the efficiency of both age groups declined over time reflecting sector-wide pressures such as rising input costs and regulatory complexity the performance gap between older and younger firms remained stable, suggesting structural differences in cost management capability.

Furthermore, from a theoretical perspective, these results align with the learning-by-doing hypothesis and cumulative firm experience as drivers of cost efficiency. Older firms tend

to benefit from more established routines, stronger supplier relationships, and institutional knowledge that supports better resource allocation and cost control. Their accumulated experience enables them to manage procurement cycles, project timelines, and regulatory compliance more effectively. In contrast, younger firms may face steeper learning curves, higher initial setup costs, and operational inefficiencies due to limited economies of experience. However, it is worth noting that the narrower standard deviation among younger firms also suggests more homogenous cost behavior potentially reflecting standardized business models or tighter managerial oversight due to their scale.

Table 4.18: Cost Efficiency Scores by Firm Age Group, 2000-2020

| | | | Cost Efficiency | | | |
|---|---|---|---|---|---|---|
| | | | **2000 - 2005** | **2006 - 2010** | **2011 - 2015** | **2016 - 2020** |
| **Age Group** | **Firms** | | | | | |
| **<40** | 26 | Mean | 0.359 | 0.327 | 0.298 | 0.271 |
| | | SD | 0.099 | 0.098 | 0.097 | 0.095 |
| | | Min | 0.148 | 0.126 | 0.106 | 0.087 |
| | | Max | 0.562 | 0.530 | 0.502 | 0.473 |
| **≥40** | 50 | Mean | 0.445 | 0.431 | 0.388 | 0.363 |
| | | SD | 0.188 | 0.205 | 0.194 | 0.198 |
| | | Min | 0.156 | 0.133 | 0.112 | 0.093 |
| | | Max | 0.968 | 0.965 | 0.962 | 0.959 |

Therefore, from an industrial organization perspective, these results reflect the accumulated strategic capabilities and resource control that older firms possess, reinforcing their position within the market structure as dominant players with lower marginal costs. However, the gradual decline in CE even among mature firms indicates that the advantages of age are counterbalanced by organizational rigidity, procedural bureaucracy, and slower adoption of new technologies such as digital systems and industrialized building systems (IBS). Younger firms, though less cost-efficient, display stronger adaptive capacity and operational flexibility but remain constrained by limited scale, weaker capital access, and institutional barriers. Overall, this pattern highlights a structural trade-off maturity provides cost discipline through experience and established routines, yet sustained efficiency growth increasingly depends on dynamic capabilities rather than static age-based advantages.

Universiti Utara Malaysia

### 4.5.4 Firm Subsidiaries and Cost Efficiency Score, 2000-2020

Table 4.19 compares the cost efficiency (CE) performance of firms based on their organizational structure specifically, whether they operate as independent entities (non-subsidiaries) or as part of a larger corporate group (subsidiaries). The results indicate that subsidiary firms consistently outperformed their non-subsidiary counterparts in terms of cost efficiency across all observed periods. For instance, in 2006-2010, subsidiary firms recorded a mean CE of 0.399, significantly higher than the 0.266 observed among non-subsidiaries. This pattern persisted through to 2016-2020, with subsidiaries achieving 0.332 compared to 0.225 (inferred based on the declining trend and missing entry) for non-subsidiaries.

Subsidiary firms demonstrate higher cost efficiency because group affiliation enhances coordination and reduces transaction costs. Access to centralized procurement, financing, and managerial expertise allows them to operate at lower average costs and respond more effectively to market shocks. From an industrial organization perspective, this reflects internal economies of scale and stronger governance control within group structures. However, when central oversight becomes excessive, coordination benefits may diminish, leading to slower decision-making and weaker cost discipline.

Table 4.19: Cost Efficiency Scores by Subsidiary, 2000-2020

| | | | Cost Efficiency | | | |
|---|---|---|---|---|---|---|
| **Subsidiary Types** | **Firms** | | **2000 - 2005** | **2006 - 2010** | **2011 - 2015** | **2016 - 2020** |
| **None-Subsidiary** | 7 | Mean | 0.386 | 0.266 | | |
| | | SD | 0.198 | 0.015 | | |
| | | Min | 0.197 | 0.243 | | |
| | | Max | 0.835 | 0.290 | | |
| **Subsidiary** | 69 | Mean | 0.419 | 0.399 | 0.366 | 0.332 |
| | | SD | 0.164 | 0.184 | 0.177 | 0.175 |
| | | Min | 0.148 | 0.126 | 0.106 | 0.087 |
| | | Max | 0.968 | 0.965 | 0.962 | 0.959 |

Universiti Utara Malaysia

### 4.4.5 Establishments and Cost Efficiency Score, 2000-2020

Table 4.20 compares the cost efficiency (CE) scores of state-owned or government-linked companies (GLCs) with privately owned firms across the period 2000-2020. The results show that private firms recorded marginally higher CE on average across all four sub-periods, with CE declining from 0.416 in 2000-2005 to 0.332 in 2016-2020. Similarly, state-owned firms saw a decline from 0.408 to 0.328 over the same period. Despite differences in ownership and governance structures, the cost efficiency performance of both groups appears relatively close, with overlapping trends across the study period. This is particularly interesting given the presumption that private firms driven by competitive pressures and profit-maximization goals should systematically outperform public firms in cost control.

**Table 4.20: Cost Efficiency Scores by Establishment Type, 2000-2020**

Universiti Utara Malaysia

| Establishment Types | Firms | | Cost Efficiency 2000 - 2005 | 2006 - 2010 | 2011 - 2015 | 2016 - 2020 |
|---|---|---|---|---|---|---|
| **State-Owned/GLC** | 3 | Mean | 0.408 | 0.379 | 0.363 | 0.328 |
| | | SD | 0.212 | 0.217 | 0.214 | 0.220 |
| | | Min | 0.231 | 0.204 | 0.178 | 0.153 |
| | | Max | 0.708 | 0.683 | 0.661 | 0.638 |
| **Private** | 73 | Mean | 0.416 | 0.396 | 0.366 | 0.332 |
| | | SD | 0.166 | 0.182 | 0.176 | 0.174 |
| | | Min | 0.148 | 0.126 | 0.106 | 0.087 |
| | | Max | 0.968 | 0.965 | 0.962 | 0.959 |

However, a deeper look at the data reveals some abnormal or counter-intuitive patterns. First, the sample size for state-owned firms is extremely small (n = 3), making the CE average less robust and more susceptible to outliers. The high standard deviations (above 0.21 in all periods) suggest substantial variability among GLCs, possibly due to differences in scale, project portfolio, or internal management autonomy. Second, the relatively narrow gap between state and private firms contradicts conventional expectations from the perspective of the industrial organization, where GLCs are typically associated with weaker cost discipline due to softer budget constraints, multi-objective mandates, and political oversight.

Third, the maximum CE scores for private firms consistently exceed 0.95, while GLCs never surpass 0.71 indicating that the most cost-efficient firms are found exclusively in the private sector. Taken together, while the average CE of GLCs appears competitive, this is likely driven by a small number of relatively efficient performers and does not necessarily reflect a broader structural parity between establishment types.

From an Industrial Organization (IO) perspective, this distinction may be attributed to differing conduct mechanisms: private developers, driven by shareholder expectations, competitive pressures, and market exposure, are more likely to pursue leaner structures, tighter procurement control, and innovation in cost management. In contrast, GLCs may operate under dual objectives balancing commercial viability with public policy mandates resulting in internal trade-offs, bureaucratic inertia, and slower responsiveness to material

Universiti Utara Malaysia

price fluctuations or market shifts. These findings align with the SCP paradigm, where organizational structure shapes managerial behavior, and ultimately, performance.

### 4.5.6 Steel Tariff and Cost Efficiency Score, 2000-2020

Table 4.21 reports the cost efficiency (CE) performance of property developers by firm-size tier during the pre- and post-steel tariff liberalisation periods. The results show a clear and persistent CE hierarchy, with larger firms (Tiers 4 and 5) consistently outperforming smaller developers. Prior to liberalisation, Tier 5 firms recorded a mean CE of 0.506 compared to only 0.299 among Tier 1 firms, reflecting the advantages of superior procurement systems, greater bargaining power, and more integrated project management capacities.

Universiti Utara Malaysia

Although CE declined across all tiers following tariff reductions driven in part by rising project complexity and coordination costs larger firms maintained their relative advantage, with Tier 5 posting a post-liberalisation CE of 0.453 versus 0.216 for Tier 1. These patterns indicate that steel tariff liberalisation did not narrow cost-efficiency disparities; instead, structural differences in scale, input coordination, and organisational capabilities continued to shape firms' relative cost performance.

Table 4.21: Cost Efficiency by Firm Size in the Pre- and Post-Steel Tariff Liberalization Periods, 2000-2020.

| Firm Tier | Firms | | Cost Efficiency | |
|---|---|---|---|---|
| | | | **Pre-Liberalization (2000-2008) Tariff 40.75% to 30.35%** | **Post-Liberalization (2009-2020) Tariff 30.35% to 20.67%** |
| Tier 1 | 8 | Mean | 0.299 | 0.216 |
| | | SD | 0.151 | 0.081 |
| | | Min | 0.161 | 0.115 |
| | | Max | 0.652 | 0.385 |
| Tier 2 | 23 | Mean | 0.354 | 0.295 |
| | | SD | 0.132 | 0.136 |
| | | Min | 0.188 | 0.137 |
| | | Max | 0.825 | 0.795 |
| Tier 3 | 19 | Mean | 0.394 | 0.336 |
| | | SD | 0.159 | 0.169 |
| | | Min | 0.200 | 0.148 |
| | | Max | 0.966 | 0.960 |
| Tier 4 | 15 | Mean | 0.486 | 0.476 |
| | | SD | 0.151 | 0.215 |
| | | Min | 0.254 | 0.196 |
| | | Max | 0.853 | 0.949 |
| Tier 5 (Large) | 11 | Mean | 0.506 | 0.453 |
| | | SD | 0.201 | 0.201 |
| | | Min | 0.153 | 0.108 |
| | | Max | 0.693 | 0.646 |
| | 76 | Mean | 0.406 | 0.356 |

Universiti Utara Malaysia

The pattern in Table 4.21 further indicates that smaller firms were disproportionately affected by cost pressures arising from steel tariff liberalisation. Tier 1 and Tier 2 developers experienced the sharpest declines in cost efficiency, reflecting their limited bargaining power, fragmented procurement arrangements, and reliance on subcontracted work, which magnify their exposure to input price volatility. In contrast, larger firms (Tiers 4 and 5) displayed relatively more stable CE performance despite their higher steel

intensity. Their scale-driven procurement systems, better capital buffers, and more diversified project portfolios likely enabled them to absorb steel price volatility more effectively, even though their mean CE levels still declined post-liberalisation. These outcomes highlight a structural asymmetry in Malaysia's property sector: smaller developers struggle to shield themselves from volatile liberalised input markets, while larger firms maintain a relative though diminishing cost advantage due to superior coordination and purchasing capabilities.

The Welch's t-test results further confirm that the observed decline in cost efficiency after steel tariff liberalisation was statistically insignificant across key firm-size tiers. For Tier 3 developers, mean cost efficiency decreased only marginally from 0.403 in the pre-liberalisation period (2000-2005) to 0.372 in the subsequent period (2006-2010) and this difference was not statistically significant ($t = 0.608$, $p = 0.547$). A similar pattern is observed for Tier 5 firms, where cost efficiency fell from 0.513 to 0.486 with the difference again statistically insignificant ($t = 0.327$, $p = 0.747$). This aligns with the results in Table 4.21, where all size tiers record lower mean cost efficiency in the post-liberalisation period (2009-2020), but the magnitude of these declines remains modest. Together, these findings reinforce the stochastic cost frontier estimates, in which the steel tariff variable is also insignificant, indicating that tariff liberalisation alone did not meaningfully influence firm-level cost efficiency. Instead, consistent with the broader Industrial Organization perspective, the effectiveness of price-side reforms depends on firm-specific characteristics particularly absorptive capacity, input coordination, and

Universiti Utara Malaysia

responsiveness to cost dynamics within Malaysia's institutional and operational environment.

### 4.5.7 Cement Tariff and Cost Efficiency Score, 2000-2020

Table 4.22 shows that cost efficiency declined across all firm-size tiers following cement tariff liberalisation, although the magnitude of change was relatively small. Smaller developers (Tier 1 and Tier 2) experienced more pronounced declines from 0.299 to 0.216 and from 0.354 to 0.295 respectively reflecting their reliance on conventional construction methods and limited ability to negotiate favourable material prices. Mid-sized firms (Tier 3) also recorded a modest reduction in mean CE from 0.394 to 0.336.

Universiti Utara Malaysia

In contrast, larger firms (Tiers 4 and 5) maintained higher cost efficiency levels throughout the period, with Tier 5 firms declining only from 0.506 to 0.453. This persistent CE gradient suggests that cement tariff liberalisation did not substantially alter cost performance patterns across the industry. The stability among larger firms reflects stronger procurement systems, better capital buffers, and more scalable input coordination, while smaller firms remain more exposed to input cost variations despite the relatively low-cost share of cement in total material inputs.

Table 4.22: Cost Efficiency by Firm Size in the Pre- and Post-Cement Tariff Liberalization Periods, 2000-2020.

| Firm Tier | Firms | | Cost Efficiency | |
|---|---|---|---|---|
| | | | **Pre-Liberalisation (2000-2008) Tariff 30.17% to 20.83%** | **Post-Liberalisation (2009-2020) Tariff 20.83% to 15.71%** |
| Tier 1 | 8 | Mean | 0.299 | 0.216 |
| | | SD | 0.151 | 0.081 |
| | | Min | 0.161 | 0.115 |
| | | Max | 0.652 | 0.385 |
| Tier 2 | 23 | Mean | 0.354 | 0.295 |
| | | SD | 0.132 | 0.136 |
| | | Min | 0.188 | 0.137 |
| | | Max | 0.825 | 0.795 |
| Tier 3 | 19 | Mean | 0.394 | 0.336 |
| | | SD | 0.159 | 0.169 |
| | | Min | 0.200 | 0.148 |
| | | Max | 0.966 | 0.960 |
| Tier 4 | 15 | Mean | 0.486 | 0.476 |
| | | SD | 0.151 | 0.215 |
| | | Min | 0.254 | 0.196 |
| | | Max | 0.853 | 0.949 |
| Tier 5 (Large) | 11 | Mean | 0.506 | 0.453 |
| | | SD | 0.201 | 0.201 |
| | | Min | 0.153 | 0.108 |
| | | Max | 0.693 | 0.646 |
| | 76 | Mean | 0.406 | 0.356 |

Universiti Utara Malaysia

These patterns suggest that the liberalisation of cement tariffs generated only limited and structurally asymmetric effects on firm-level cost efficiency. Smaller firms, despite being more directly exposed to cement price adjustments, experienced sharper CE declines (Tier 1: 0.299 to 0.216; Tier 2: 0.354 to 0.295), reflecting their vulnerability to input cost variations rather than any improvement in procurement efficiency. Larger firms, although benefiting from bulk purchasing and stronger supplier relationships, also recorded

reductions in CE (Tier 5: 0.506 to 0.453), indicating that coordination costs, rigid supply arrangements, and operational complexity diluted whatever marginal gains tariff reductions might have offered. From an Industrial Organization perspective, these outcomes highlight that the structural characteristics of Malaysia's cement supply chain including concentrated production, regionally fragmented distribution networks, and weak competitive pass-through constrained the transmission of liberalisation benefits, thereby limiting meaningful cost-efficiency improvements across firm sizes.

The efficiency score patterns across both steel and cement tariff phases show that neither form of input-price liberalisation generated substantive shifts in firm-level performance. Instead, the persistence of score differentials particularly the gap between small, mid-sized, and large developers suggests that structural and organisational factors dominate over marginal cost adjustments. This directs analytical attention toward *location-based determinants*, where agglomeration advantages, regional market depth, and state-level regulatory variation may play a more decisive role in shaping firm efficiency than tariff movements alone.

Universiti Utara Malaysia

### 4.5.8 Location and Cost Efficiency Score, 2000-2020

Table 4.23 presents cost efficiency (CE) scores by firm location, categorized into Core regions (Kuala Lumpur and Selangor), Inner regions (Peninsular Malaysia outside the Core), and Sabah & Sarawak (East Malaysia). The results reveal notable spatial disparities in CE performance. Firms operating in Sabah and Sarawak achieved the highest average

CE scores, consistently above 0.600 across all sub-periods. In contrast, firms located in Inner regions recorded the lowest CE scores, declining steadily from 0.387 in 2000-2005 to 0.300 in 2016-2020. Core region firms fell in between, with CE scores declining from 0.513 to 0.435. Standard deviations were highest in Sabah & Sarawak, indicating wider variation in firm performance, while inner regions exhibited more uniform inefficiency levels.

**Table 4.23: Cost Efficiency Scores by Location, 2000-2020**

| | | | Cost Efficiency | | | |
|---|---|---|---|---|---|---|
| **Location** | **Firms** | | **2000 - 2005** | **2006 - 2010** | **2011 - 2015** | **2016 - 2020** |
| **Core** | 11 | Mean | 0.513 | 0.486 | 0.461 | 0.435 |
| | | SD | 0.193 | 0.194 | 0.194 | 0.192 |
| | | Min | 0.148 | 0.126 | 0.106 | 0.087 |
| | | Max | 0.709 | 0.684 | 0.662 | 0.639 |
| **Inner** | 62 | Mean | 0.387 | 0.356 | 0.328 | 0.300 |
| | | SD | 0.139 | 0.141 | 0.143 | 0.145 |
| | | Min | 0.156 | 0.133 | 0.112 | 0.093 |
| | | Max | 0.968 | 0.965 | 0.962 | 0.959 |
| **Sabah & Sarawak** | 3 | Mean | 0.653 | 0.633 | 0.615 | 0.597 |
| | | SD | 0.276 | 0.287 | 0.294 | 0.300 |
| | | Min | 0.259 | 0.231 | 0.204 | 0.178 |
| | | Max | 0.862 | 0.848 | 0.837 | 0.824 |

Universiti Utara Malaysia

These spatial patterns offer several important insights. The strong CE performance of firms in Sabah & Sarawak may reflect leaner construction models, simplified project scopes, or region-specific institutional arrangements that allow more disciplined cost management despite higher logistical challenges. Conversely, firms in Inner regions, including mid-sized cities and satellite towns, may be caught between limited scale and increasing regulatory burdens, leading to persistently lower cost efficiency.

Interestingly, Core region firms, while facing high land and compliance costs, appear to benefit from better access to centralized procurement, infrastructure, and input markets, which may partly offset inefficiencies. These findings also align with broader agglomeration economics: while urban core proximity provides some efficiency advantages, institutional and geographic peripherality can create unexpected pockets of cost discipline. The variation across space reinforces the need for region-specific strategies including logistical reform, supply chain integration, and regulatory streamlining to address structural inefficiencies in geographically dispersed development zones.

Furthermore, from an industrial organization perspective, these findings reaffirm the SCP framework: location, as a structural factor, shapes firm behavior such as procurement flexibility, subcontractor coordination, and IBS adoption which in turn affects efficiency outcomes. Yet, the continued underperformance of firms in the Inner region highlights deeper structural issues. Despite over a decade of spatial policy initiatives under NCER

Universiti Utara Malaysia

and ECER, the intended efficiency gains have not materialized. This suggests that policy efforts have leaned too heavily on physical infrastructure while overlooking institutional reforms. Critical gaps remain in areas such as governance quality, centralized digital tendering systems, and strategic consolidation of smaller firms factors essential to achieving sustained efficiency improvements.

## 4.6 Correlates of Property Firm's Cost Efficiency

This section examines the firm-specific determinants associated with cost efficiency using the estimated inefficiency effects model under the BC95 specification. The analysis focuses on how structural, organizational, and policy-related factors influence the extent of cost inefficiency among Malaysian property firms. Specifically, the model incorporates variables such as firm size (*lnTotal Asset*), location (*lnLOC*), tariff liberalization (Steel and Cement tariffs), ownership concentration, establishment type, subsidiary status, and firm age ($lnAge$ and $lnAge^2$) to explain observed differences in cost efficiency across firms and over time. These variables are selected based on theoretical foundations in industrial organization and institutional economics, and their inclusion allows for a more granular understanding of inefficiency behavior beyond mere technical deviation from the frontier.

The estimated coefficients, presented in the lower panel of Table 4.15, reflect the marginal effects of each firm characteristic on cost inefficiency. Positive coefficients indicate a contribution to higher inefficiency (lower cost efficiency), while negative coefficients

suggest an improving effect on efficiency. The following subsections discuss the interpretation of these key correlates in greater detail. In line with the Battese and Coelli (1995) framework, the inefficiency model assumes that firm-specific characteristics influence the one-sided error term $u_{it}$, which captures deviations from the cost frontier. Thus, the sign and significance of each coefficient inform the direction and strength of each variable's impact on cost inefficiency.

The statistical significance of the variance parameters $\sigma_u$ (0.200, $p < 0.05$) and λ (0.400, $p < 0.01$) confirms that a meaningful portion of the total variance is attributed to inefficiency, validating the relevance of firm-specific effects in explaining cost deviations. The selection of firm-specific variables is guided by theoretical considerations from industrial organization and institutional economics, as well as empirical studies on efficiency in construction and property sectors.

Universiti Utara Malaysia

In addition, the estimated variance parameters confirm the appropriateness of the stochastic frontier framework. First, the gamma value of 0.616 (SE = 0.052) indicates that approximately 62% of the total residual variance is attributable to inefficiency rather than statistical noise supporting the presence of substantial cost inefficiency among firms. Second, the estimated value of $\sigma_u^2$ = 0.301 (0.065) represents the variance of the one-sided inefficiency component, reflecting systematic deviations from the cost frontier across firms. Third, the relatively smaller value of $\sigma_v^2$=0.188 (0.007) denotes the variance of the symmetric random error term, which captures external shocks and measurement errors.

Thus, these estimates confirm that firm-level inefficiency is a dominant source of variation in observed cost behavior, justifying the use of a stochastic frontier model over a conventional cost function. The following subsections interpret the estimated inefficiency determinants and discuss their implications for firm strategy and cost management in Malaysia's residential property sector.

### 4.6.1 Firm Size and Cost Inefficiency

The coefficient for firm size, proxied by the natural logarithm of total assets (lnTAsset), is positive and statistically significant (0.164; $t = 3.6$), indicating that larger firms tend to exhibit higher cost inefficiency. This finding appears counterintuitive at first glance, as larger firms are typically expected to benefit from economies of scale and stronger cost control mechanisms. However, in the context of Malaysia's residential property sector, the result is consistent with earlier observations in Section 4.5.1: Tier 1 and Tier 2 firms recorded persistently lower cost efficiency scores across all time periods.

Therefore, from an industrial organization perspective, this result aligns with Scherer's view that beyond a certain scale, diseconomies of coordination and internal control can set in particularly in sectors characterized by variable input markets and extended project cycles. Thus, rather than a linear relationship, the result suggests a threshold effect, where increasing size beyond a certain point led to diminishing cost efficiency. This reinforces the need for targeted managerial and policy strategies to help large firms streamline

procurement systems, adopt flexible input substitution frameworks, and reduce transaction layers in cost-related decision-making.

### 4.6.2 Location and Cost Inefficiency

As shown in Table 4.15, the coefficient for the location variable (ln LOC) is negative (-1.010), though statistically insignificant ($t$ = -1.39). This suggests that firms located in more urbanized or central regions may experience lower cost inefficiency, but the effect is not strong enough to be considered statistically conclusive. Nevertheless, this result aligns directionally with earlier descriptive findings in Section 4.5.8, where firms operating in Core regions such as Kuala Lumpur and Selangor demonstrated higher average cost efficiency than those in Inner regions or more peripheral areas.

Universiti Utara Malaysia

While the insignificance limits the strength of interpretation, the negative sign of the coefficient remains theoretically relevant. It indicates that urban-located firms may benefit from greater infrastructure connectivity, centralized procurement systems, and access to competitive input markets, which collectively contribute to better cost management. These advantages may help firms reduce inefficiencies in material handling, labor deployment, and project coordination.

Interestingly, from the perspective of agglomeration economics, this result echoes the logic that firms located within urban cores are better positioned to capture external

economies of scale, supplier networks, and labor market pooling. However, the broad spatial categorization used in the model Core, Inner, and East Malaysia may obscure variation within regions, such as firms in emerging corridors or secondary urban centers that face uneven access to input markets. The statistical insignificance may therefore reflect underlying regional heterogeneity rather than a lack of spatial influence altogether.

### 4.6.3 Steel Tariff and Cost Inefficiency

As reported in Table 4.15, the coefficient for steel tariff exposure (STariff) is positive and statistically significant (0.050; $t = 2.36$), indicating that greater exposure to steel input costs is associated with higher cost inefficiency. Interpreted marginally, this means that a one-unit increase in steel tariff exposure is associated with a 5.0% increase in cost inefficiency, holding other factors constant. This effect is both economically and statistically meaningful, particularly in a sector where steel accounts for a substantial share of total construction input costs, especially among firms involved in high-rise and structural-reinforced projects.

This finding is consistent with earlier trends highlighted in Section 4.5.6, where larger firms more dependent on steel demonstrated declining cost efficiency in the post-liberalization period. Rather than benefiting from improved input access or reduced tariffs, some firms may have been exposed to greater price volatility and lacked the internal systems to manage these fluctuations efficiently. The persistence of inefficiency

likely reflects weaknesses in procurement timing, lack of hedging strategies, and inflexible reliance on traditional steel-based construction methods.

### 4.6.4 Cement Tariff and Cost Inefficiency

As shown in Table 4.15, the coefficient for cement tariff exposure (CTariff) is negative but statistically insignificant (-0.030; $t$ = -1.30), suggesting that increased exposure to cement tariff liberalization is associated with a reduction in cost inefficiency, although the effect is not strong enough to be conclusive. Interpreted marginally, the estimate implies that a one-unit increase in cement tariff exposure is associated with a 3.0% reduction in cost inefficiency, ceteris paribus. This negative relationship though not statistically significant suggests that some firms may have responded to cement price liberalization by adjusting input strategies or benefiting from more competitive cement sourcing, particularly among small- and medium-sized developers who rely more heavily on conventional cement-intensive construction.

This finding complements the trends discussed in Section 4.5.7, where firms in lower tiers (Tiers 1 and 2) demonstrated higher cost efficiency over time, possibly due to more adaptable procurement practices and the use of traditional building techniques that allow greater flexibility in cement sourcing and application. The lack of statistical significance, however, may reflect the relatively lower volatility of cement prices compared to steel, or the more uniform availability of cement products across regions and firm types.

From a policy perspective, while the liberalization of cement tariffs does not appear to have had a disruptive effect on firm-level cost efficiency, its full benefits may have been constrained by market concentration in the domestic cement industry or limited innovation in material substitution. As such, the result points to the importance of complementary reforms including improved market transparency, expanded supplier networks, and standardization in cement-based systems to unlock potential efficiency gains from tariff reductions.

### 4.6.5 Ownership Concentration and Cost Inefficiency

According to Table 4.15, the coefficient for ownership concentration is positive and highly significant (0.011; $t = 4.05$), indicating that higher levels of ownership concentration are associated with increased cost inefficiency. Marginally interpreted, this result implies that a one-unit increase in the ownership concentration index is associated with a 1.1% increase in cost inefficiency, all else being equal. This finding runs counter to conventional expectations from agency theory, which typically associates concentrated ownership with tighter control, lower agency costs, and improved operational efficiency.

In the context of Malaysia's residential property sector, however, this result may reflect the unique dynamics of family-dominated firms and closely held corporate structures. High ownership concentration particularly when combined with centralized decision-making and legacy leadership may result in cost inefficiencies due to conservatism in procurement, resistance to innovation, or non-transparent subcontracting arrangements.

This is especially plausible in firms where ownership is tightly coupled with management, leading to reduced internal scrutiny over input costs and supplier relationships.

### 4.6.6 Firm Age and Cost Inefficiency

As reported in Table 4.15, the coefficient for firm age (ln Age) is positive (2.80; $t$ = 1.62) while the squared term ($LnAge^2$) is negative (-0.331; $t$ = -1.54). Although both are statistically significant at only modest levels, the signs and magnitudes suggest a nonlinear (inverted-U) relationship between firm age and cost inefficiency. Marginally interpreted, the positive linear term implies that as firms grow older, cost inefficiency tends to increase initially, likely due to structural inertia or outdated operational routines. However, the negative squared term indicates that this trend reverses beyond a certain age threshold, implying that older firms eventually stabilize and become more cost disciplined.

Universiti Utara Malaysia

Empirically, this pattern is consistent with descriptive trends discussed in Section 4.5.3, where firms aged 40 years and above demonstrated higher average cost efficiency. It also reflects the idea that longevity alone does not guarantee efficiency; instead, it is the ability to adapt and institutionalize cost-responsive behavior over time that matters. The nonlinear pattern observed here reinforces the importance of distinguishing between firm age as a proxy for experience versus as a marker of organizational rigidity.

### 4.6.7 Subsidiary and Cost Inefficiency

As shown in Table 4.15, the coefficient for subsidiary status is positive but statistically insignificant (3.520; $t$ = 0.23), indicating that no conclusive relationship can be established between a firm's subsidiary affiliation and its cost inefficiency. Although the coefficient suggests a positive association that is, subsidiary firms may exhibit slightly higher inefficiency the lack of statistical significance means this effect is not robust or generalizable across the sample.

This result contrasts with the descriptive patterns in Section 4.5.4, where subsidiary firms generally recorded higher cost efficiency across all periods compared to non-subsidiaries. The discrepancy may be attributed to the way the inefficiency term is specified in the cost frontier model, or to unobserved heterogeneity within the group of subsidiary firms such as differences in parent company governance, procurement autonomy, or project types. Additionally, the wide range of firm sizes and organizational structures among subsidiaries could dilute the average effect in a regression framework.

Universiti Utara Malaysia

Thus, from a theoretical standpoint, one would expect subsidiaries especially those within larger conglomerates or public-listed groups to benefit from shared services, centralized procurement, and internal oversight mechanisms that enhance cost control. However, the insignificant result here may suggest that these advantages are not uniformly realized across all firms, or that the model specification may need finer distinctions (full vs. partial subsidiaries, local vs. foreign group affiliation).

### 4.7.8 Establishment Types and Cost Inefficiency

As reported in Table 4.15, the coefficient for establishment type is negative and statistically significant (-0.301; $t$ = -2.50), indicating that private firms are associated with lower cost inefficiency relative to state-owned or government-linked companies (GLCs). Marginally interpreted, this means that being privately established is associated with a 30.1% reduction in cost inefficiency, holding other factors constant. This is consistent with classical firm theory and industrial organization perspectives, which suggest that private firms driven by market competition, profit maximization, and investor accountability tend to operate with tighter cost control.

This result aligns with descriptive trends observed in Section 4.5.5, where private firms consistently outperformed GLCs in cost efficiency across all periods. Despite the small sample size for state-owned firms, the inefficiency effect captured in the model is robust and significant. It reflects systemic challenges faced by GLCs, including bureaucratic procurement processes, multiple non-economic objectives, and often less flexible management structures. These factors can undermine cost responsiveness, even in firms with strong capital backing or access to large-scale projects.

Moreover, the interpretation of inefficiency determinants in Table 4.15 offers deeper insight into the structural and organizational drivers of cost inefficiency within Malaysia's residential property sector. Firm size, steel tariff exposure, ownership concentration, and establishment type emerged as statistically significant contributors to cost inefficiency,

reflecting challenges related to scale diseconomies, input price volatility, governance structures, and institutional rigidity. In contrast, other factors such as geographic location, subsidiary affiliation, and cement tariff exposure exhibited weaker or statistically inconclusive effects, suggesting more context-dependent or heterogeneous outcomes.

The inverted-U relationship observed for firm age underscores the dynamic nature of organizational learning, where early-stage inefficiencies may be offset over time by accumulated experience and process refinement. Collectively, these findings emphasize that cost efficiency is not merely a function of internal firm capability but is shaped by a complex interplay of structural conditions, policy environments, and strategic choices. Before concluding this chapter, the following section evaluates the robustness and validity of the estimated stochastic cost frontier through post-estimation diagnostics and model fit assessment.

Universiti Utara Malaysia

## 4.7 Economies of Scale

The estimation of economies of scale follows directly from the translog stochastic cost frontier framework. Output elasticities of cost are first obtained from the partial derivatives of the cost function with respect to output, as shown in Equation (3.15). These elasticities are then aggregated to derive the scale economy measure, expressed as the inverse of their sum in Equation (3.16). In the single-output case of this study, where sales serve as the output proxy, the measure simplifies to Equation (3.17). This formulation provides a rigorous and tractable basis for quantifying whether Malaysian residential

property developers operate under increasing, constant, or decreasing returns to scale, both at the aggregate level and across firm size categories.

The estimated EOS values are presented in Table 4.24. These values are derived using the translog stochastic cost frontier, where the output elasticity is computed from Equation (3.15) and its reciprocal taken as the scale elasticity (Equation 3.17). The results show strong economies of scale at the industry level (EOS=1.56), with smaller firms exhibiting the strongest scale advantages (EOS up to 1.82), and larger firms displaying diminishing but still positive scale benefits (EOS declining to 1.34 among firms with assets exceeding RM 2 billion). This pattern is consistent with international evidence for construction and property sectors (You & Zi, 2007; Dzeng & Wu, 2013; Park et al., 2018), where fixed development overheads are spread efficiently at lower scale levels, but coordination frictions and project complexity begin to constrain further gains at higher scales.

Universiti Utara Malaysia

The second research objective is addressed in this section through the estimation of economies of scale (EOS) for Malaysian residential property developers. The EOS estimates indicate the extent to which firms can reduce average costs as output expands, thereby serving as a measure of potential cost advantages associated with firm size. Reporting EOS by asset-size category provides direct evidence of whether developers are operating close to their scale-efficient frontier or whether scope remains to achieve further cost savings through expansion. In this respect, the EOS analysis extends the preceding

efficiency results by highlighting the structural cost–output relationship that underpins firm performance in the industry.

Table 4.24: Economies of Scale for Property Firms by Asset Size

| Asset Size (RM millions) | Observations | EOS Estimate | Interpretation |
|---|---|---|---|
| All Sample | 76 | 1.56 | Strong increasing returns to scale (IRS) industry-wide average |
| < 200 | 8 | 1.82 | Very high IRS: small firms benefit most from scaling up |
| 200-500 | 23 | 1.67 | Still strong IRS |
| 501-1000 | 19 | 1.57 | IRS, but slightly reduced |
| 1001-2000 | 15 | 1.46 | IRS approaching constant returns |
| > 2 bil | 11 | 1.34 | Still IRS, but diminishing |

Universiti Utara Malaysia

This approach is also aligned with Caves, Christensen, and Diewert (1982), who demonstrate that economies of scale can be evaluated along the cost-minimizing expansion path, if firms choose input combinations efficiently relative to prevailing factor prices. Furthermore, Caves, Christensen, and Tretheway (1984) emphasize that EOS reflects how marginal cost evolves relative to average cost: EOS greater than one indicates that total cost increases less than proportionately with output, consistent with increasing returns to scale (IRS), while EOS below one indicates diseconomies of scale due to rising coordination or organizational complexity. The elasticity formulation used here follows

the same translog derivative structure as outlined in Battese and Broca (1997), where second-order terms determine how cost responsiveness changes as firms expand output.

The sector exhibits consistent increasing returns to scale, with an average EOS of 1.56, meaning that a 1% increase in output raises cost by only 0.64%. Smaller firms (< RM200m) show the largest scale gains (EOS=1.82) due to the spreading of fixed development and compliance overheads. Larger firms (> RM2b) still benefit from scale (EOS=1.34), but the gains taper as coordination complexity and project-management layering increase.

The high scale elasticity (SC) values observed among smaller firms indicate the presence of substantial unrealized economies of scale. These strong increasing returns to scale are consistent with structural characteristics of the Malaysian property development sector namely, high fixed costs (land acquisition, compliance, and overhead) and underutilized capacity among small developers. This suggests that these firms stand to benefit significantly from output expansion, either through internal scaling, joint ventures, or process consolidation to lower average costs.

Importantly, Coelli et al. (2005) also note that EOS should not be interpreted in isolation from efficiency scores, as firms may experience scale economies while still being technically or cost inefficient due to poor input allocation or governance challenges. This observation is consistent with the findings of this study: despite benefiting from EOS,

Universiti Utara Malaysia

many larger firms in the sample recorded low-cost efficiency (CE) scores, suggesting that their scale advantages are undermined by structural inefficiencies. The joint interpretation of EOS, CE, and PE in this context provides a more complete understanding of firm behavior and highlights the importance of both expansion strategy and internal operational control in improving performance.

Moreover, these findings are consistent with previous Malaysian applications of translog-based scale economy models, particularly Karim (2001), who employed a similar Stochastic Frontier Analysis (SFA) framework to examine bank-level cost behavior. Although the sectoral contexts differ, the methodological parallel reinforces the robustness of using cost elasticity estimates to distinguish between increasing, constant, and decreasing returns to scale across heterogeneous firm environments. The comparable magnitudes of scale elasticity observed in this study (1.34-1.82) relative to Karim's estimates (0.87-1.35) further validate the application of the translog cost frontier in identifying realistic scale effects within Malaysia's property development sector.

Furthermore, the findings from this study reveal that Malaysian property developers exhibit increasing returns to scale (IRS), particularly among small and mid-sized firms, with diminishing but still positive scale effects as firms grow larger. This trend suggests the presence of an optimal firm size threshold beyond which cost savings begin to taper. These results are broadly consistent with the scale economy patterns identified by Park et al. (2018), who examined construction firm efficiency across Japan, Korea, and China.

Their DEA and Malmquist-based analysis found that while Japan's firms operated near constant returns to scale due to technological maturity and market saturation, firms in Korea and China experienced stronger scale economies during phases of growth, restructuring, and institutional reform. Collectively, these insights underscore that firm size and market conditions critically shape cost efficiency outcomes within the construction and property sectors, reaffirming the structural relevance of scale in Malaysia's development industry.

## 4.8 Comparing Production and Cost Efficiency Model

Firstly, while earlier Sections (4.2 and 4.6) examined the inefficiency determinants within the production and cost frontier frameworks separately, a direct comparison of the inefficiency models is essential to uncover deeper structural and behavioral insights about Malaysia's residential property firms. Despite being derived from the same firm-level panel data, the two models capture different aspects of inefficiency technical inefficiency (in terms of input-output transformation) versus cost inefficiency (in relation to input price minimization). Thus, by comparing the coefficients, signs, and significance levels across both frontiers, this section enables a critical evaluation of how firm-specific characteristics such as size (lnTAsset), ownership, location (LOC), and policy variables like steel and cement tariffs affect firms differently depending on the economic objective (production maximization versus cost minimization). This comparative analysis not only enhances the empirical robustness of the study but also contributes to the theoretical

Universiti Utara Malaysia

framing by identifying consistent versus divergent inefficiency patterns, thereby informing more targeted and nuanced policy implications in Chapter 5.

From Table 4.25, to deepen the interpretation of inefficiency determinants across both cost and production frontiers, this section presents three focused discussions (i to iii). Each highlight key empirical patterns, structural asymmetries, and strategic implications that are essential for understanding firm behavior and informing the policy direction.

**Table 4.25: Maximum Likelihood Estimates of Inefficiency Models from Cost and Production Frontiers**

| | Cost Frontier | | | Production Frontier | | |
|---|---|---|---|---|---|---|
| Inefficiency Model | Coefficient | Std. Error | t-ratio | Coefficient | Std. Error | t-ratio |
| lnTAsset | 0.164 | 0.05 | 3.6*** | -1.191 | 0.181 | -6.57*** |
| LOC | -1.010 | 0.728 | -1.39 | -0.132 | 0.028 | -4.71*** |
| STariff | 0.05 | 0.02 | 2.36** | -0.155 | 0.055 | -2.82*** |
| CTariff | -0.03 | 0.022 | -1.30 | 0.099 | 0.069 | 1.43 |
| Ownership | 0.011 | 0.003 | 4.05*** | -0.003 | 0.005 | -0.68 |
| lnAge | 2.80 | 1.720 | 1.62* | 1.175 | 0.265 | 4.43*** |
| Subsidiary | 3.52 | 15.1 | 0.23 | -0.125 | 0.449 | -0.28 |
| Establishment | -0.301 | 0.120 | -2.50** | 0.588 | 0.420 | 1.40 |
| Constant | -7.75 | 15.563 | -0.50 | 23.746 | 3.46 | 6.86*** |
| Variance Parameters | | | | | | |
| Usigma | -3.30 | 0.90 | -3.84*** | -0.052 | 0.233 | -0.22 |
| Vsigma | -1.21 | 0.10 | -20.7*** | -1.88 | 0.068 | -27.75 |

Notes: ***, ** and * denote statistical significance at the 1, 5 and 10 levels, respectively.

### i) Total Asset (lnTAsset) and Firm Size Efficiency Dynamics

The coefficient estimates for lnTAsset reveal a noteworthy divergence between production and cost frontiers. Specifically, larger firms are found to be more efficient in production (-1.191, $p < 0.01$), yet more inefficient in cost management (0.164, $p < 0.01$). This duality reflects a core theme in the Theory of the Firm, particularly in the context of

Coase's (1937) explanation of why firms exist to reduce transaction costs by internalizing market exchanges. As firms expand in scale, they benefit from technical coordination, resource integration, and economies of scale, all of which enhance production efficiency. However, this internal growth often comes at the cost of organizational complexity, which leads to rising internal transaction costs (Williamson, 1985). In Malaysia's property sector, this may include rigid procurement procedures, bureaucratic decision chains, or the slower adaptability of large conglomerates to localized market shifts.

From an IO perspective, this result suggests that market structure advantages associated with firm size such as bargaining power or access to capital do not necessarily translate into superior cost efficiency. Instead, larger firms might prioritize scale and project volume over granular cost control, thereby underutilizing their full cost advantage. This distinction is especially relevant in Malaysia's residential property sector, where large developers may be incentivized to pursue flagship or prestige projects rather than efficiency-driven planning. Strategically, this finding supports the need for targeted governance reforms within large property firms, focusing on improving internal cost discipline, enhancing project-level autonomy, and reducing organizational slack.

**ii) Steel Tariff (STariff) and Input Market Liberalization**

The effects of STariff are consistent and significant across both frontiers positive in the cost model (0.050, $p < 0.05$) and negative in the production model (-0.155, $p < 0.01$). These results indicate that steel tariff liberalization improves both production and cost efficiency, affirming the strategic value of reducing input barriers in the construction

supply chain. This is especially pertinent for Malaysia's property sector, where steel is a key material component, representing over 17% of material costs (CIDB, 2012). As a result, by lowering tariff barriers, firms gain access to cheaper and potentially higher-quality steel, which translates into smoother construction timelines and reduced unit costs per square foot both technically and financially.

These findings align with Amiti and Konings (2007), who argue that the benefits of trade liberalization depend heavily on firm absorptive capacity. In Malaysia's case, larger or better-managed firms may be more capable of adjusting procurement strategies, sourcing directly from global markets, or renegotiating local supply contracts in response to tariff reductions. From a transaction cost economics (TCE) angle, the removal of steel tariffs reduces external procurement frictions, such as price uncertainty, inventory holding, and reliance on intermediaries. In the long run, such liberalization fosters a more competitive and responsive construction ecosystem.

Universiti Utara Malaysia

**iii) Divergence in Firm Size Effects: Dual Structure of Malaysian Property Firms**

The divergence in the effect of firm size (lnTAsset) between the cost and production inefficiency models may also reflect the dual structural character of Malaysia's residential property sector. While larger firms demonstrate strong production efficiency, they remain cost inefficient an observation that goes beyond economies of scale and enters the realm of organizational behavior. Many large firms operate within diversified corporate groups, often with internal construction subsidiaries or joint development models, allowing them to coordinate inputs and workforce more effectively across projects. This enhances

production efficiency through resource pooling, technical planning, and project execution scale.

However, such organizational scale can also introduce layered cost structures, compliance burdens, and internal coordination delays contributing to cost inefficiency. In contrast, smaller and mid-tier developers may not enjoy technical scale but often exhibit leaner operations, tighter cost control, and agile financial discipline. These contrasting outcomes suggest the need for tier-sensitive policy interventions that go beyond "one-size-fits-all" regulations.

Universiti Utara Malaysia

## 4.9 Summary

This chapter has presented and analyzed the empirical results derived from the stochastic frontier production and cost models, alongside the estimation of economies of scale (EOS) for residential property firms in Malaysia. Addressing a notable gap in the literature, this study offers an integrated analysis that combines technical efficiency, cost efficiency, and scale behavior within a unified econometric framework an approach rarely applied to developing property markets.

The findings from the production efficiency (PE) model indicate that most firms operate relatively close to the production frontier, with moderate to high efficiency scores. However, the time-varying inefficiency captured by the BC95 specification revealed

meaningful variation across firms and periods, influenced by both external market conditions (business cycles, input market reforms) and internal firm attributes. Notably, larger firms and those in urbanized regions consistently outperformed others, lending empirical support to the relevance of scale economies and spatial agglomeration effects.

In contrast, the cost efficiency (CE) model uncovered widespread inefficiencies, with average CE scores significantly lower than those for production efficiency. This divergence underscores a key insight: while many firms are technically capable of delivering output, they do so at elevated costs. The CE results reveal that structural factors including firm size, age, ownership concentration, establishment type, and exposure to input tariff reforms (especially steel and cement) play a more substantial role in shaping cost inefficiency than technical inefficiency. The negative correlation between CE and PE further confirms that technical proficiency does not guarantee cost competitiveness, thereby pointing to persistent issues in procurement, resource coordination, and internal governance.

The economies of scale analysis add further nuance by showing that smaller and mid-sized firms operate under strong increasing returns to scale, suggesting untapped potential for cost reduction via expansion, collaboration, or operational optimization. While large firms continue to benefit from scale, their marginal gains appear to be diminishing implying a shift in focus from expansion toward internal efficiency improvements and process innovation.

Universiti Utara Malaysia

Finally, the results presented in this chapter offer a comprehensive and empirically grounded view of firm behavior in Malaysia's residential property sector. They highlight where inefficiencies persist, which firm characteristics matter, and how external policy shifts intersect with internal capabilities. More importantly, this integrated modelling approach provides a strong empirical foundation for interpreting firm performance through the lens of industrial organization theory, transaction cost economics, and spatial economics. These insights will serve as the analytical bridge to Chapter 5, where the strategic, institutional, and policy implications of these findings will be discussed in depth.

Universiti Utara Malaysia

# CHAPTER FIVE

# CONCLUSIONS AND RECOMMENDATIONS

## 5.0 Introduction

This chapter synthesizes the key empirical findings of this study, which aims to assess the efficiency and scale dynamics of Malaysia's residential property sector using firm-level panel data from 2000 to 2020. Specifically, the study estimates production efficiency, cost efficiency, and economies of scale (EOS) by applying stochastic frontier models to evaluate how efficiently property developers convert inputs into outputs and manage costs over time. The analysis connects these efficiency measures to broader industrial organization frameworks, examining how firm-specific characteristics, spatial heterogeneity, and the liberalization of key input markets (steel and cement) influence performance outcomes. Emphasis is placed on capturing firm-level variation, identifying structural inefficiencies, and interpreting the role of policy and market dynamics in shaping observed efficiency patterns.

This study models inefficiency as a function of firm-specific and policy-related determinants within the stochastic frontier framework. Using the Battese and Coelli (1995) time-varying inefficiency specification, the analysis integrates covariates such as firm size (log of total assets), ownership concentration, subsidiary status, establishment type (public vs. private), geographic location, and firm age to account for structural heterogeneity across firms. Additionally, tariff liberalization variables for steel and

cement are introduced to examine the impact of input market reforms on inefficiency. Incorporation of these factors into the inefficiency term enables the model to account for systematic variations in firm-level efficiency arising from both structural attributes and policy changes.

## 5.1 Summary of Study

This section summarizes the key empirical results presented in Chapter Four and outlines their broader implications as discussed in Section 5.2, with reference to the study's main research objectives.

Universiti Utara Malaysia

The first objective of this study was to estimate the production efficiency and cost efficiency of residential property firms in Malaysia using firm-level panel data from 2000 to 2020. A total of 76 firms, comprising publicly listed residential developers on Bursa Malaysia, were analysed over a 21-year period using a dual stochastic frontier approach. Specifically, a translog stochastic production frontier was applied to assess firms' ability to transform key inputs labor, capital, and materials into output (proxied by total sales), while a translog stochastic cost frontier was used to evaluate the extent to which firms minimized total cost given their output levels and input prices.

Empirical findings presented in Chapter Four reveal that mean production efficiency declined over time, from 0.589 during 2000-2005 to 0.504 in 2016-2020, suggesting a

gradual deterioration in firms' ability to utilize inputs effectively. Meanwhile, mean cost efficiency also showed a declining trend, falling from 0.307 in the early period to 0.225 by the final sub-period, although the decline was less steep than in production efficiency. These patterns reflect structural inefficiencies and possible limitations in adaptive capacity as the market evolved. Notably, while larger firms tended to exhibit relatively higher cost efficiency likely due to procurement scale and better financial management this advantage did not necessarily extend to production efficiency, where some smaller and mid-sized firms outperformed their larger peers. These findings are consistent with regional evidence: You and Zi (2007) and Dzeng and Wu (2013) show that scale-driven cost advantages in Korea and Taiwan do not automatically translate into productive efficiency, as organizational complexity and coordination frictions offset technological gains. Malaysia's pattern mirrors this dynamic, indicating that larger firms' procurement strength alone is insufficient to overcome underlying process rigidities and declining production efficiency.

Universiti Utara Malaysia

The second objective was to estimate the presence and magnitude of economies of scale (EOS) within Malaysia's residential property industry. Using parameter estimates from the translog stochastic cost frontier, EOS values were computed to assess whether cost savings were achieved as output increased. The results, as presented in Table 4.24, confirm the presence of strong increasing returns to scale (IRS) across the industry, with an EOS estimate of 12.5 for the full sample of 76 firms. When disaggregated by asset size, the highest EOS was observed among smaller firms with assets below RM200 million (14.9), indicating substantial potential for cost reductions through scaling. Mid-sized

firms (RM200-1000 million) also demonstrated strong scale advantages (11.36 and 12.5), while firms in the RM1001-2000 million range recorded slightly lower EOS (10.75), suggesting a gradual convergence toward constant returns.

However, EOS begins to moderate for firms in the RM1001-2000 million category (10.75) and falls further among the largest firms exceeding RM2 billion (8.55). From an IO perspective, this pattern aligns with the broader evidence from East Asia. You and Zi (2007) show that in South Korea, scale benefits materialise strongly among small and mid-sized contractors but diminish once firms grow too large and encounter coordination bottlenecks, bureaucratic layering, and rising managerial costs. Similarly, Dzeng and Wu (2013) document that Taiwanese construction firms experience lower marginal scale gains when organisational complexity increases, especially when multi-tier subcontracting and capital-material mismatches create additional transaction and coordination costs.

Universiti Utara Malaysia

The third objective aimed to determine the impact of input market liberalization specifically the removal of import tariffs on steel and cement on firm-level efficiency. In both the production and cost frontier models, time-varying steel and cement tariff variables were included as inefficiency determinants. The estimation results reveal a statistically significant negative coefficient on the steel tariff variable, suggesting that reductions in steel tariffs contributed to improved production efficiency across Malaysian residential property firms. This finding is reinforced by the results of a mean difference test, which show a notable improvement in average production efficiency scores post-

liberalization, with a statistically significant shift following the full liberalization of steel imports in 2008. A similar pattern was observed in cost efficiency, where the post-liberalization period also exhibited lower mean inefficiency, indicating firms became relatively more cost disciplined as input prices became more competitive and predictable.

These empirical patterns are strongly supported by input cost structure data from CIDB (2012), which highlights the critical importance of steel-related materials in residential construction: steel reinforcement (17.32%), ready-mixed concrete (12.57%), and steel and metal sections (7.76%) collectively represent over one-third of total material input costs. The statistically significant efficiency gains observed following steel tariff reductions thus reflect the high exposure of developers to steel-related input costs. In contrast, the cement tariff variable was statistically insignificant in both models, which is consistent with its relatively low-cost share (2.34%) and the limited competitive impact of liberalization due to market concentration. These findings support the conclusion that tariff liberalization only translates into meaningful efficiency improvements when it targets high-cost, high-volume inputs operating within contestable markets, echoing arguments from trade and productivity literature (Pavcnik, 2002; Amiti & Konings, 2007).

The fourth objective examined how firm structure captured through internal characteristics such as firm size, ownership concentration, subsidiary status, establishment type, firm age, and location influences efficiency outcomes. The findings reveal that these structural factors exert distinct and often contrasting effects on

production and cost efficiency. For example, firm size significantly improved cost efficiency ($\beta$ = -1.191, $t$ = -6.57) but increased production inefficiency ($\beta$ = 0.164, $t$ = 3.60), suggesting that larger firms benefit from procurement scale but may experience technical inefficiencies due to complexity or diminishing returns. This size efficiency divergence is consistent with Park et al. (2018), who show that while large construction firms in Japan, Korea, and China secure cost advantages through scale, these gains do not necessarily translate into higher technical efficiency due to coordination frictions and slower technological upgrading. A similar pattern is observed in the Spanish construction sector, where De Jorge Moreno et al. (2014) find that increases in firm size improve cost efficiency but simultaneously entrench technological rigidity. Within Malaysia, this pattern reinforces the cost-efficiency evidence reported by Karim (2001), who found that scale strengthens firms' cost positions without delivering corresponding improvements in production efficiency.

Universiti Utara Malaysia

Similarly, ownership concentration raised production inefficiency ($\beta$ = 0.011, $t$ = 4.05), consistent with agency theory and the Malaysian evidence of Sulong and Nor (2008) and Sulong and Ahmed (2011), who demonstrate that concentrated shareholdings weaken monitoring effectiveness and increase managerial discretion. This pattern also corresponds to Aghion and Tirole's (1997) distinction between *formal* and *real* authority, where principals who are overloaded or poorly informed gradually lose effective control to managers or sub-units, resulting in suboptimal decisions and higher operational inefficiency. In contrast, ownership concentration did not significantly affect cost

inefficiency, suggesting that concentrated owners influence organizational conduct more than day-to-day cost management.

Firm age was positively associated with inefficiency in both models, with a particularly strong effect in the cost frontier ($\beta$ = 1.175, $t$ = 4.43). This pattern is consistent with the view that older firms often develop more rigid organizational routines and slower adjustment mechanisms, characteristics consistent with Aghion and Tirole's (1997) distinction between *formal* and *real* authority. As firms expand and age, principals may retain formal authority but increasingly defer operational discretion to established managerial tiers due to information asymmetry and coordination demands, which can limit adaptive efficiency. Location significantly reduced cost inefficiency ($\beta$ = 1.175, $t$ = 4.43), reflecting the advantages of urban infrastructure, superior information flows, and greater administrative proximity. This pattern aligns with Ibrahim, Ahmad, and Wan Abd Aziz (2009), who show that urban planning environments particularly in Kuala Lumpur provide clearer regulatory signals, more predictable development controls, and better-coordinated technical requirements. From an Industrial Organization perspective, these features lower transaction costs and mitigate coordination frictions, enabling firms in urban jurisdictions to operate closer to the cost-minimising frontier. The evidence therefore indicates that spatial positioning is not merely geographic but structurally embedded in the institutional and planning regime, enhancing firms' ability to organize inputs efficiently.

Universiti Utara Malaysia

Subsidiary status and establishment type showed no significant effect on cost efficiency, although private firms exhibited higher production efficiency ($\beta$ = -0.301, $t$ = -2.50), consistent with evidence from Sulong and Nor (2008) that private-sector governance structures tend to impose stronger performance discipline than government-linked or institutionally governed entities.

Overall, the findings confirm that all four research objectives were empirically addressed and that the study's hypothesis were largely supported.

## 5.2 Policy Implications

There are several policy implications that can be made from resulting of the study.

First, the persistent gap between production efficiency and cost efficiency suggests the need for targeted productivity-enhancing interventions, especially among mid- and lower-tier firms. While larger developers tend to benefit from cost management advantages, the declining trend in production efficiency across the board reflects challenges in input utilization, labor productivity, and project coordination. Policymakers should consider expanding support for construction technology adoption (BIM, IBS), skills development programs, and digitalized project monitoring systems to enhance technical performance. Moreover, greater collaboration between public agencies such as CIDB, MPC, and private developers is needed to institutionalize best practices that improve operational workflows and reduce input wastage.

Second, the evidence of strong economies of scale among listed residential property firms indicates that scale expansion continues to offer cost advantages particularly for mid-tier developers with assets below RM1 billion. The EOS estimates, ranging from 11.36 to 14.9 in this group, suggest that productivity gains are still achievable through output growth and improved resource allocation. However, as firms surpass the RM2 billion threshold, the EOS estimate declines to 8.55, implying diminishing marginal benefits likely arising from managerial complexity, regulatory coordination costs, or overextension.

These findings call for tier-sensitive policy frameworks that do not uniformly encourage expansion but instead prioritize operational optimization at different stages of firm growth. For mid-sized firms, support should focus on enhancing scale efficiency through digital adoption, supply chain integration, and standardized project delivery systems. For the largest firms, where further scaling offers limited benefit, policy attention should shift toward promoting governance reform, lean management structures, and decentralized project execution models. In this way, economies of scale can be preserved without triggering diseconomies associated with unbalanced growth.

Third, the statistically significant efficiency gains observed following steel tariff liberalization suggest that input market reforms can enhance firm performance, particularly when they involve high-cost, high-volume materials like steel. Given that steel-related inputs account for over one-third of residential construction material costs, tariff reductions have the potential to substantially lower cost pressures and improve both

Universiti Utara Malaysia

production and cost efficiency at the firm level. These results justify continuing a selective liberalization approach that prioritizes strategic inputs with widespread downstream impact not only to reduce material costs, but also to incentivize more efficient input allocation and project planning within the industry.

In contrast, the absence of significant efficiency effects from cement tariff liberalization reflects structural rigidities in the domestic cement market namely low-price elasticity and limited market contestability. This finding highlights the need for complementary policy reforms beyond tariff reduction alone. For example, policymakers may consider strengthening competition policy, improving logistical infrastructure, or revisiting approval and import licensing mechanisms (CIDB's COA process) to ensure that liberalization efforts translate into actual input access and price responsiveness.[7] More broadly, the results emphasize that trade policy must be tailored to the input structure of each sector, and that tariff removal is most effective when combined with institutional reforms that address market structure, supplier dominance, and entry barriers.

Fourth, the contrasting effects of firm structure on production and cost efficiency suggest that internal organizational characteristics must be considered in policy design aimed at improving firm performance. The finding that larger firms exhibit superior cost efficiency,

[7] In 2018, CIDB Malaysia introduced reforms to the Certificate of Approval (COA) process to enhance transparency, reduce approval timelines, and support online submissions. These reforms included the implementation of the CIDB ePermit platform, risk-based import assessment procedures, and efforts to harmonize quality verification standards across construction materials. The objective was to streamline the importation of construction inputs, particularly steel and cement, and to reduce administrative delays that previously constrained procurement efficiency.

but lower production efficiency highlights the need for scale-sensitive management interventions. Policymakers should promote lean operational practices, decentralized decision-making, and project modularization for larger developers to overcome technical inefficiencies associated with coordination complexity and rigid hierarchies.

Furthermore, the positive relationship between ownership concentration and production inefficiency highlights structural weaknesses in internal governance that undermine market discipline within Malaysia's property industry. In family-controlled or closely held firms common across the sector concentrated control often results in managerial entrenchment and suboptimal strategic decisions, weakening competitive efficiency. In this regard, the Securities Commission Malaysia (MCCG, 2021), plays a pivotal role in promoting stronger governance standards. Reinforcing MCCG principles particularly those concerning board independence, disclosure transparency, and shareholder accountability can help mitigate agency conflicts, enhance managerial oversight, and ultimately strengthen allocative and operational efficiency across the sector.[8].

Meanwhile, the inefficiency effects linked to firm age and establishment type particularly among older or government-linked developers suggest the need for institutional rejuvenation mechanisms, such as performance-linked mandates, innovation-based

[8] Reforms promoting board independence and performance transparency have been implemented under Bursa Malaysia's Corporate Governance Guide (2021) and the Malaysian Code on Corporate Governance (MCCG). These frameworks require listed issuers to appoint independent directors, disclose board composition, and implement board evaluation mechanisms. However, enforcement and effectiveness remain uneven, particularly in industries with entrenched ownership structures and limited succession planning, such as the property development sector.

public-private partnerships, or gradual restructuring of non-performing development arms. Finally, the significant efficiency advantage observed in firms located in urban centers supports the integration of spatial policy with industry upgrading highlighting the importance of extending infrastructure, skilled labor access, and logistical support to developers in lagging regions to close the locational efficiency gap.

Fifth, the finding that older firms are significantly more inefficient particularly in terms of cost management ($\beta = 1.175$, $t = 4.43$), highlights a broader challenge of organizational rigidity and technological under-adoption within Malaysia's established property developers. These legacy firms, while institutionally prominent, often lag in embracing construction technologies such as Industrialized Building Systems (IBS), Building Information Modelling (BIM), and digital project integration tools. Given the property sector's extensive supply chain linkages with over 120 upstream and downstream industries, inefficiencies in older firms not only erode firm-level competitiveness but also constrain broader economic spillovers and industrial upgrading.

Given this challenge, policy interventions should focus on accelerating digital and industrial innovation within established firms, particularly through the mainstreaming of IBS and BIM adoption, as well as compliance with QLASSIC standards to improve quality assurance and benchmarking. Government agencies such as CIDB and KPKT should continue expanding grant schemes, technology matching programs, and technical training targeted at older developers, particularly those with a long-standing presence but

low innovation uptake. Embedding technology-linked eligibility criteria within affordable housing schemes, PR1MA tenders, or infrastructure-linked property developments may further incentivize modernization. These efforts would complement the Construction 4.0 Strategic Plan and align with Malaysia's long-term goals for a more productive, quality-driven, and technology-enabled property industry.

## 5.3 Contributions

This study contributes to the existing literature in several important ways. Methodologically, it extends the application of stochastic frontier analysis (SFA) to Malaysia's residential property sector, a domain where frontier-based efficiency studies remain scarce. The study employs a dual frontier approach based on a translog functional form to examine both production and cost efficiency over a 21-year panel of 76 listed property firms. The incorporation of firm-specific inefficiency determinants such as size, ownership, age, and location alongside time-varying steel and cement tariff variables, allows for a more granular analysis of how structural and policy factors jointly shape firm performance. This modeling framework advances the empirical treatment of regulatory impacts on sectoral efficiency and introduces new methodological ground for analyzing economies of scale (EOS) in property development.

The study also provides, in addition to methodological contributions, practical and policy-relevant insights. Empirically, it provides the first long-term panel-based evidence of persistent efficiency gaps, tier-based EOS patterns, and asymmetric outcomes from input

market liberalization. These findings contribute to policy discussions by supporting the case for tier-sensitive industrial interventions, modernization incentives for older firms, and stronger alignment between input cost reforms and institutional mechanisms such as CIDB's COA process. Through the integration of firm-level evidence with broader national initiatives including Construction 4.0, BIM and IBS frameworks, and QLASSIC standards the study demonstrates the role of the property sector in supporting productivity transformation, value chain modernization, and broader economic development objectives.

## 5.4 Limitation

While this study offers valuable insights into the efficiency dynamics of Malaysia's residential property firms, several limitations should be acknowledged. First, the analysis is based solely on publicly listed firms, which may not fully represent the broader developer landscape, particularly small and privately held firms. Second, while the stochastic frontier framework with a translog specification captures both production and cost inefficiencies, it relies on functional form assumptions and may not fully account for unobserved heterogeneity in managerial quality or firm behavior. Moreover, key institutional and behavioral factors such as subcontracting complexity, regulatory delays, or innovation capacity are not directly observable within the dataset. The study also focuses on the 2000-2020 period and thus does not capture post-pandemic shifts in material costs, labor availability, or digital transition. Lastly, while tariff liberalization is addressed through steel and cement inputs, other policy dimensions such as land access,

Universiti Utara Malaysia

housing finance regimes, and ESG compliance frameworks remain outside the model's scope.

## 5.5 Recommendation for Further Study

There are other methods that can be used to study firm-level efficiency, notably Data Envelopment Analysis (DEA), which offers a non-parametric alternative to the parametric approach employed in this study. DEA does not require a specific functional form or distributional assumptions, making it suitable for examining efficiency across heterogeneous production settings. Future research could apply DEA to enable more flexible benchmarking and assess robustness by comparing it with SFA-derived efficiency scores.

Universiti Utara Malaysia

In addition, Malmquist productivity indices can be incorporated within the DEA framework to evaluate changes in efficiency and productivity over time, offering a dynamic perspective that complements the static frontier estimates used in this study. Such extensions are especially relevant as Malaysia's property sector undergoes structural shifts driven by technological adoption, policy reforms, and sustainability considerations.

## 5.6 Summary

This chapter summarized the key findings of the study and translated them into relevant policy and research directions. The analysis showed that production and cost efficiency

varied widely across firms, with overall declining trends from 2000 to 2020. Economies of scale were evident among mid-sized firms, while the largest firms faced diminishing returns. The estimated results suggest several policy-relevant implications, including the need to boost firm productivity through digital tools, align scale strategies with firm size, improve the implementation of tariff reforms, address inefficiencies in older firms, and expand the use of technologies like IBS, BIM, and QLASSIC.

Universiti Utara Malaysia

## REFERENCES


Abdul Rashid Abdul Aziz Ho Shiew Yi Mastura Jaafar, (2006),"Competitive resources of private housing developers: the Malaysian perspective", *Journal of Engineering, Design and Technology*, Vol. 4: 1,71-80.

Abu Jarad, I., Yusof, N., & Mohd Shafiei, M. W. (2010). The organizational performance of housing developers in Peninsular Malaysia. *International Journal of Housing Markets and Analysis, 3*(2), 146-162.

Acs, Z., & Audretsch, D. (1987). Innovation, Market Structure, and Firm Size. *The Review of Economics and Statistics, 69*(4), 567-574. doi:10.2307/1935950

Acs, Z., & Audretsch, D. (1988). Innovation in Large and Small Firms: An Empirical Analysis. *The American Economic Review,78*(4), 678-690. Retrieved from http://www.jstor.org/stable/1811167

Aghion, P., & Tirole, J. (1997). Formal and real authority in organizations. *Journal of Political Economy, 105*(1), 1-29.

Aigner, D., Lovell, C. A. K., & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics, 6*(1), 21-37.

A. S. Adair, J. N. Berry & W. S. McGreal (1996) Hedonic modelling, housing submarkets and residential valuation, Journal of Property Research, 13:1, 67-83

Akhigbe, A., McNulty, J. E., & Stevenson, B. A. (2017). Does the form of ownership affect firm performance? Evidence from US bank profit efficiency before and during the financial crisis. *The Quarterly Review of Economics and Finance*, *64*, 120-129.

Alchian, A., & Demsetz, H. (1972). Production, Information Costs, and Economic Organization.*The American Economic Review, 62*(5), 777-795. Retrieved from http://www.jstor.org/stable/1815199

Ali, S. M., Salleh, N. M., & Hassan, M. S. (2008). *Ownership structure and earnings management in Malaysian listed companies: The size effect*. *Asian Journal of Business and Accounting, 1*(2), 89-116.

Altunbas, Y., Liu, M. H., Molyneux, P., & Seth, R. (2000). *Efficiency and risk in Japanese banking*. *Journal of Banking & Finance, 24*(10), 1605-1628.

Amiti, M., & Konings, J. (2007). Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia. *The American Economic Review, 97*(5), 1611-1638. Retrieved from http://www.jstor.org/stable/30034578

Anderson, R., Lewis, D., & Zumpano, L. (2000). X-inefficiencies in the residential real estate market: a stochastic frontier approach. *Journal of Real Estate Research*, *20*(1-2), 93-103.

Anderson, R., & Reeb, D. (2003). Founding-Family Ownership and Firm Performance: Evidence from the S&P 500. *The Journal of Finance, 58*(3), 1301-1328. Retrieved from http://www.jstor.org/stable/3094581

Anas, A., Arnott, R., & Small, K. (1998). Urban Spatial Structure. *Journal of Economic Literature, 36*(3), 1426-1464. Retrieved from http://www.jstor.org/stable/2564805

Arnott, R., & Lewis, F. (1979). The Transition of Land to Urban Use. *Journal of Political Economy,87*(1), 161-169. Retrieved from http://www.jstor.org/stable/1832214

Aubert, C., & Reynaud, A. (2005). The Impact of Regulation on Cost Efficiency: An Empirical Analysis of Wisconsin Water Utilities. *Journal of Productivity Analysis, 23*(3), 383-409. Retrieved from http://www.jstor.org/stable/41770191

Bailey, E., & Malone, J. (1970). Resource Allocation and the Regulated Firm. *The Bell Journal of Economics and Management Science, 1*(1), 129-142. doi:10.2307/3003026

Bain, J.S. (1956) *Barriers to New Competition.* Cambridge, MA: Havard University Press.

Baldwin, R., Cave, M., & Lodge, M. (2012). *Understanding regulation: theory, strategy, and practice*. Oxford University Press on Demand.

Ball, M. (1998). Institutions in British property research: A review. *Urban Studies*, *35*(9), 1501.

Ball, M. (2003). Markets and the structure of the housebuilding industry: An international perspective. *Urban Studies*, *40*(5-6), 897-916.

Ball, M. (2008). *Markets and institutions in real estate and construction* (Vol. 17). John Wiley & Sons.

Ball, M., Meen, G., & Nygaard, C. (2010). Housing supply price elasticities revisited: Evidence from international, national, local and company data. *Journal of Housing Economics*, *19*(4), 255-268.

Bank Negara Malaysia. (2000-2024). *Annual reports.* Kuala Lumpur, Malaysia: Bank Negara Malaysia.

Balassa, B. (1966). Tariff Reductions and Trade in Manufacturers among the Industrial Countries. *The American Economic Review,56*(3), 466-473. Retrieved from http://www.jstor.org/stable/1823779

Balassa, B., & Bauwens, L. (1987). Intra-Industry Specialisation in a Multi-Country and Multi-Industry Framework. *The Economic Journal, 97*(388), 923-939. doi:10.2307/2233080

Barlow, J., & King, A. (1992). The state, the market, and competitive strategy: the housebuilding industry in the United Kingdom, France, and Sweden. *Environment and Planning A*, *24*(3), 381-400.

Battese, G. E., & Coelli, T. J. (1992). Frontier production functions, technical efficiency and panel data: With application to paddy farmers in India. *Journal of Productivity Analysis, 3*(1-2), 153-169.

Battese, G. E., & Coelli, T. J. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics, 20*(2), 325-332.

Battese, G. E., & Broca, S. S. (1997). Functional forms of stochastic frontier production functions and models for technical inefficiency effects: A comparative study for wheat farmers in Pakistan. *Journal of Productivity Analysis, 8*(4), 395-414.

Baumol, W. (1962). On the Theory of Expansion of the Firm. *The American Economic Review, 52*(5), 1078-1087. Retrieved from http://www.jstor.org/stable/1812183

Baumol, W. (1977). On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry. *The American Economic Review, 67*(5), 809-822. Retrieved from http://www.jstor.org/stable/1828065

Universiti Utara Malaysia

Berger, A. (1995). The Profit-Structure Relationship in Banking--Tests of Market-Power and Efficient-Structure Hypotheses. *Journal of Money, Credit and Banking, 27*(2), 404-431. doi:10.2307/2077876

Berger, A., & Hannan, T. (1998). The Efficiency Cost of Market Power in the Banking Industry: A Test of the "Quiet Life" and Related Hypotheses. *The Review of Economics and Statistics, 80*(3), 454-465. Retrieved from http://www.jstor.org/stable/2646754

Bergstrand, J. (1989). The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade. *The Review of Economics and Statistics, 71*(1), 143-153. doi:1. Retrieved from http://www.jstor.org/stable/1928061 doi:1

Bernard, A., Jensen, J., Redding, S., & Schott, P. (2007). Firms in International Trade. *The Journal of Economic Perspectives, 21*(3), 105-130. Retrieved from http://www.jstor.org/stable/30033737

Bhagwati, J. (1968). More on the Equivalence of Tariffs and Quotas. *The American Economic Review, 58*(1), 142-146. Retrieved from http://www.jstor.org/stable/1831661

Bloch, H. (1974). Prices, Costs, and Profits in Canadian Manufacturing: The Influence of Tariffs and Concentration. *The Canadian Journal of Economics / Revue Canadienne D'Economique, 7*(4), 594-610. doi:10.2307/133940

Boycko, M., Shleifer, A., & Vishny, R. W. (1996). A theory of privatization. *The Economic Journal, 106*(435), 309-319

Bramley, G. (2002) Planning Regulation and Housing Supply in a Market System, in Housing Economics and Public Policy (eds T. O'Sullivan and K. Gibb), Blackwell Science Ltd, Oxford, UK.

Brennan, M., & Schwartz, E. (1982). Consistent Regulatory Policy under Uncertainty. *The Bell Journal of Economics, 13*(2), 506-521. doi:1. Retrieved from http://www.jstor.org/stable/3003470 doi:1

Bramley, G. (2003). Planning regulation and housing supply in a market system. *Housing Economics and Public Policy. United Kingdom: Blackwell Science Ltd*.

Bramley, G. (1993). Land-use planning and the housing market in Britain: the impact on housebuilding and house prices. *Environment and Planning A*, *25*(7), 1021-1051.

Bursa Malaysia. (2000-2020). *Annual reports of 76 listed property development companies* [Data set]. Kuala Lumpur: Bursa Malaysia.

Bustos, P. (2011). Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms. *The American Economic Review, 101*(1), 304-340. Retrieved from http://www.jstor.org/stable/41038790

Buzzelli, M. (2001). Firm size structure in North American housebuilding: persistent deconcentration, 1945–98. *Environment and Planning A*, *33*(3), 533-550.

Byrnes, P., Grosskopf, S., & Hayes, K. (1986). Efficiency and Ownership: Further Evidence. *The Review of Economics and Statistics, 68*(2), 337-341. doi:10.2307/1925517

Cagamas Berhad. (2013). *Housing the nation: Policies, issues and prospects.* Kuala Lumpur, Malaysia: Cagamas Berhad.

Caillaud, B., Guesnerie, R., Rey, P., & Tirole, J. (1988). Government Intervention in Production and Incentives Theory: A Review of Recent Contributions. *The RAND*

*Journal of Economics, 19*(1), 1-26. Retrieved from http://www.jstor.org/stable/2555394

Caves, R. E., & Barton, D. R. (1991). *Efficiency in U.S. Manufacturing Industries.* MIT Press.

Caves, D. W., Christensen, L. R., & Diewert, W. E. (1982). The economic theory of index numbers and the measurement of input, output, and productivity. *Econometrica, 50*(6), 1393-1414.

Caves, D. W., Christensen, L. R., & Tretheway, M. W. (1984). Economies of density versus economies of scale: Why trunk and local service airline costs differ. *The RAND Journal of Economics, 15*(4), 471-489.

Chia, F. C., Skitmore, M., Runeson, G., & Bridge, A. (2012). An analysis of construction productivity in Malaysia. *Construction Management and Economics, 30*(12), 1055-1069.

Chan, T. S. F. (1999). Residential construction and credit market imperfection. *The Journal of Real Estate Finance and Economics*, *18*(1), 125-139.

Cheshire, P., & Sheppard, S. (1995). On the Price of Land and the Value of Amenities. *Economica, 62*(246), new series, 247-267. doi:10.2307/2554906

Claessens, S., Djankov, S., & Lang, L. H. P. (2000). The separation of ownership and control in East Asian corporations. *Journal of Financial Economics, 58*(1-2), 81-112.

Clemhout, S. (1981). The impact of housing cyclicality on the construction of residential units and housing costs. *Land Economics*, *57*(4), 609-623.

Construction Industry Development Board (CIDB Malaysia). (2012). *Construction Industry Transformation Programme (CITP).* Kuala Lumpur: CIDB.

Coase, R. (1937). The Nature of the Firm. *Economica, 4*(16), new series, 386-405. doi:1. Retrieved from http://www.jstor.org/stable/2626876 doi:1

Coad, A. (2009). *The growth of firms: A survey of theories and empirical evidence*. Edward Elgar Publishing.

Coe, D., Helpman, E., & Hoffmaister, A. (1997). North-South R & D Spillovers. *The Economic Journal, 107*(440), 134-149. Retrieved from http://www.jstor.org/stable/2235275

Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). *An introduction to efficiency and productivity analysis* (2nd ed.). New York, NY: Springer.

Conover, W., & Iman, R. (1981). Rank Transformations as a Bridge Between Parametric and Nonparametric Statistics. *The American Statistician, 35*(3), 124-129. doi:10.2307/2683975

Cote, D (1989). Firm efficiency and Ownership Structure. The case of US Electric Utilities Using Panel Data. Annals of Public and Cooperative Economics, 60, 431-450.

Cox, D., & Harris, R. (1985). Trade Liberalization and Industrial Organization: Some Estimates for Canada. *Journal of Political Economy, 93*(1), 115-145. Retrieved from http://www.jstor.org/stable/1830504

Craswell, A. T., Taylor, S. L., & Saywell, R. A. (1997). Ownership structure and corporate performance: Australian evidence. *Pacific-Basin Finance Journal, 5*(3), 301-323.

Christensen, L. R., Jorgenson, D. W., & Lau, L. J. (1973). *Transcendental logarithmic production frontiers*. *The Review of Economics and Statistics, 55*(1), 28-45.

Department of Statistics Malaysia (DOSM). (2000-2024). *Statistical reports and time series data.* Putrajaya, Malaysia: Author.

Deardorff, A. (1980). The General Validity of the Law of Comparative Advantage. *Journal of Political Economy, 88*(5), 941-957. Retrieved from http://www.jstor.org/stable/1833142

Demsetz, H. (1969). Information and Efficiency: Another Viewpoint. *The Journal of Law & Economics, 12*(1), 1-22. Retrieved from http://www.jstor.org/stable/724977

Demsetz, H. (1983). The Structure of Ownership and the Theory of the Firm. *The Journal of Law & Economics, 26*(2), 375-390. Retrieved from http://www.jstor.org/stable/725108

Demsetz, H., & Villalonga, B. (2001). Ownership structure and corporate performance. *Journal of Corporate Finance, 7*(3), 209-233.

De Jorge Moreno, J., De Jorge Huertas, V., & Rojas Carrasco, O. (2014). Assessment of the efficiency of the Spanish construction industry using parametric methods: Case study. *Journal of Construction Engineering and Management, 140*(3), 04013064.

De Alessi, L. (1983). Property Rights, Transaction Costs, and X-Efficiency: An Essay in Economic Theory. *The American Economic Review, 73*(1), 64-81. Retrieved from http://www.jstor.org/stable/1803927

De Leeuw, F., & Ekanem, N. (1971). The Supply of Rental Housing. *The American Economic Review, 61*(5), 806-817. Retrieved from http://www.jstor.org/stable/1813143

De Loecker, J. (2011). Product Differentiation, Multiproduct Firms, and Estimating the Impact of Trade Liberalization on Productivity. *Econometrica,79*(5), 1407-1451. Retrieved from http://www.jstor.org/stable/41237781

Diewert, W. E. (1974). Applications of duality theory. In M. D. Intriligator & D. A. Kendrick (Eds.), *Frontiers of quantitative economics* (Vol. 2, pp. 106-171). North-Holland.

DiPasquale, D., & Wheaton, W. C. (1994). Housing market dynamics and the future of housing prices. *Journal of urban economics*, *35*(1), 1-27.

DiPasquale, D., & Wheaton, W. C. (1996). Urban Economics and Real Estate Markets. Prentice Hall, Englewood Cliffs, New Jersey.

DiPasquale, D. (1999). Why don't we know more about housing supply? *The Journal of Real Estate Finance and Economics*, *18*(1), 9-23.

Dunne, P., & Hughes, A. (1994). Age, Size, Growth and Survival: UK Companies in the 1980s. *The Journal of Industrial Economics,42*(2), 115-140. doi:10.2307/2950485

Dzeng, R.-J., & Wu, F.-B. (2013). Efficiency measurement of the construction industry in Taiwan: A stochastic frontier approach. *Construction Management and Economics, 31*(4), 335-344.

Economic Planning Unit. (2010). *Rancangan Malaysia Kesepuluh (2011-2015).* Putrajaya: Prime Minister's Department, Malaysia.

Economic Planning Unit. (2015). *Rancangan Malaysia Kesebelas (2016-2020): Pertumbuhan berpaksikan rakyat.* Putrajaya: Prime Minister's Department, Malaysia.

Economic Planning Unit. (2021). *Rancangan Malaysia Kedua Belas (2021-2025): Memperkukuh kemakmuran inklusif dan mampan.* Putrajaya: Prime Minister's Department, Malaysia.

Eisfeldt, A., & Papanikolaou, D. (2014). The Value and Ownership of Intangible Capital. *The American Economic Review, 104*(5), 189-194. Retrieved from http://www.jstor.org/stable/42920934

Epple, D., Gordon, B., & Sieg, H. (2010). A New Approach to Estimating the Production Function for Housing. *The American Economic Review, 100*(3), 905-924. Retrieved from http://www.jstor.org/stable/27871234

Evans, D. (1987a). The Relationship Between Firm Growth, Size, and Age: Estimates for 100 Manufacturing Industries. *The Journal of Industrial Economics, 35*(4), 567-581. doi:10.2307/2098588

Evans, D. (1987b). Tests of Alternative Theories of Firm Growth. *Journal of Political Economy, 95*(4), 657-674. Retrieved from http://www.jstor.org/stable/1833253

Evans, A. W. (1995). The property market: ninety per cent efficient? *Urban Studies*, *32*(1), 5-29.

Fabrizio, K., Rose, N., & Wolfram, C. (2007). Do Markets Reduce Costs? Assessing the Impact of Regulatory Restructuring on US Electric Generation Efficiency. *The American Economic Review,97*(4), 1250-1277. Retrieved from http://www.jstor.org/stable/30034091

Fama, E. (1980). Agency Problems and the Theory of the Firm. *Journal of Political Economy,88*(2), 288-307. Retrieved from http://www.jstor.org/stable/1837292

Fama, E., & Jensen, M. (1983). Separation of Ownership and Control. *The Journal of Law & Economics, 26*(2), 301-325. Retrieved from http://www.jstor.org/stable/725104

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society: Series A (General), 120*(3), 253-281.

Feenstra, R. (1994). New Product Varieties and the Measurement of International Prices. *The American Economic Review, 84*(1), 157-177. Retrieved from http://www.jstor.org/stable/2117976

Fleming, M. (1965). Costs and Prices in the Northern Ireland Construction Industry 1954-64. *The Journal of Industrial Economics, 14*(1), 42-54. doi:10.2307/2097650

Follain, J. (1979). The Price Elasticity of the Long-Run Supply of New Housing Construction. *Land Economics, 55*(2), 190-199. doi:10.2307/3146061

Foster, L., Haltiwanger, J., & Syverson, C. (2008). Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability? *The American Economic Review, 98*(1), 394-425. Retrieved from http://www.jstor.org/stable/29729976

Fried, H. O., Lovell, C. A. K., & Schmidt, S. S. (2008). *The measurement of productive efficiency and productivity growth* (2nd ed.). New York, NY: Oxford University Press.

Gatzlaff, D., & Tirtiroglu, D. (1995). Real Estate Market Efficiency: Issues and Evidence. *Journal of Real Estate Literature, 3*(2), 157-189. Retrieved from http://www.jstor.org/stable/44103296

Geroski, P., Machin, S., & Walters, C. (1997). Corporate Growth and Profitability. *The Journal of Industrial Economics, 45*(2), 171-189. Retrieved from http://www.jstor.org/stable/2950453

Gilbert, R., & Newbery, D. (1994). The Dynamic Efficiency of Regulatory Constitutions. *The RAND Journal of Economics, 25*(4), 538-554. Retrieved from http://www.jstor.org/stable/2555974

Glaeser, E., Gyourko, J., & Saks, R. (2005a). Why Is Manhattan So Expensive? Regulation and the Rise in Housing Prices. *The Journal of Law & Economics, 48*(2), 331-369. doi:1. Retrieved from http://www.jstor.org/stable/10.1086/429979 doi:1

Glaeser, E., Gyourko, J., & Raven E. Saks. (2005b). Why Have Housing Prices Gone Up? *The American Economic Review, 95*(2), 329-333. Retrieved from http://www.jstor.org/stable/4132842

Glaeser, E. L., Gyourko, J., & Saks, R. E. (2005). Urban growth and housing supply. *Journal of Economic Geography*, *6*(1), 71-89.

Goldberg, V. P. (1976). Regulation and administered contracts. *the Bell journal of economics*, 426-448.

Goldberg, P., Khandelwal, A., Pavcnik, N., & Topalova, P. (2010). Imported Intermediate Inputs and Domestic Product Growth: Evidence from India. *The Quarterly Journal of Economics, 125*(4), 1727-1767. Retrieved from http://www.jstor.org/stable/40961017

Gomez, E. T., Padmanabhan, T., Kamaruddin, N., Bhalla, S., & Fisal, F. (2018). *Minister of finance incorporated: Ownership and control of corporate Malaysia*. Petaling Jaya, Malaysia: Strategic Information and Research Development Centre (SIRD).

Gomez, E. T., & Jomo, K. S. (1999). *Malaysia's political economy: Politics, patronage and profits*. Cambridge University Press.

Goodman, A. C., & Thibodeau, T. G. (2008). Where are the speculative bubbles in US housing markets? *Journal of Housing Economics*, *17*(2), 117-137.

Greene, W. H. (2007). *LIMDEP version 9.0: Econometric modeling guide.* Plainview, NY: Econometric Software, Inc.

Greene, W. H. (2020). *Econometric analysis* (8th ed.). New York, NY: Pearson Education.

Green, R. K., Malpezzi, S., & Mayo, S. K. (2005). Metropolitan-specific estimates of the price elasticity of supply of housing, and their sources. *The American Economic Review*, *95*(2), 334-339.

Grimes, A., & Aitken, A. (2010). Housing supply, land costs and price adjustment. *Real Estate Economics*, *38*(2), 325-353.

Gurran, N., Phibbs, P., Yates, J., Gilbert, C., Whitehead, C., Norris, M., McClure, K., Berry, M., Maginn, P., Goodman, R. and Rowley, S. (2015) *Housing markets, economic productivity, and risk: international evidence and policy implications for Australia-Volume 2: Supplementary papers,* AHURI Final Report No.255. Melbourne: Australian Housing and Urban Research Institute Limited.

Guy, S. & Henneberry, J. (2000) Understanding urban development processes: integrating the economic and the social in property research, Urban Studies, 37, pp. 2399-2416.

Guy, S. & Henneberry, J. (Eds) (2002) Development and Developers: Perspectives on Property (Oxford: Blackwell Science/RICS).

Gyourko, J., & Saiz, A. (2006). Construction costs and the supply of housing structure. *Journal of regional Science*, *46*(4), 661-680.

Gyourko, J. (2009). Housing supply. *Annu. Rev. Econ.*, *1*(1), 295-318.

Universiti Utara Malaysia

Hahn, R. (2004). The Economic Analysis of Regulation: A Response to the Critics. *The University of Chicago Law Review, 71*(3), 1021-1054. Retrieved from http://www.jstor.org/stable/1600602

Hall, M., & Weiss, L. (1967). Firm Size and Profitability. *The Review of Economics and Statistics,49*(3), 319-331. doi:1. Retrieved from http://www.jstor.org/stable/1926642 doi:1

Halpern, L., Koren, M., & Szeidl, A. (2015). Imported Inputs and Productivity. *The American Economic Review, 105*(12), 3660-3703. Retrieved from http://www.jstor.org/stable/43821389

Haniffa, R. M., & Hudaib, M. (2006). Corporate governance structure and performance of Malaysian listed companies. *Journal of Business Finance & Accounting, 33*(7-8), 1034-1062.

Hanoch, G. (1975). *The elasticity of scale and the shape of average costs*. *American Economic Review, 65*(3), 492-497.

Hansen, G., & Wernerfelt, B. (1989). Determinants of Firm Performance: The Relative Importance of Economic and Organizational Factors. *Strategic Management Journal, 10*(5), 399-411. Retrieved from http://www.jstor.org/stable/2486469

Hayashi, F. (1982). Tobin's Marginal q and Average q: A Neoclassical Interpretation. *Econometrica, 50*(1), 213-224. doi:10.2307/1912538

Healey, P. (1991). Models of the development process: a review. *Journal of property research*, *8*(3), 219-238.

Healey, P. (1992). An institutional model of the development process. *Journal of property research*, *9*(1), 33-44.

Healey, P., & Barrett, S. (1990). Structure and Agency in Land and Property Development Processes: Some Ideas for Research. *Urban Studies, 27*(1), 89-103. Retrieved from http://www.jstor.org/stable/43084072

Healey, P. (1998). Regulating property development and the capacity of the development industry. *Journal of Property Research*, *15*(3), 211-227.

Helpman, E. (1984). A Simple Theory of International Trade with Multinational Corporations. *Journal of Political Economy, 92*(3), 451-471. Retrieved from http://www.jstor.org/stable/1837227

Hopenhayn, H. (1992). Entry, Exit, and firm Dynamics in Long Run Equilibrium. *Econometrica,60*(5), 1127-1150. doi:1. Retrieved from http://www.jstor.org/stable/2951541 doi:1

Hortaçsu, Ali, and Chad Syverson. "Cementing Relationships: Vertical Integration, Foreclosure, Productivity, and Prices." *Journal of Political Economy* 115, no. 2 (2007): 250-301.

Isa, Mohd Zailani, Voon, T.P, and Nasir, Mohd Asmah (2010). Housing Market Performance: A Comparative Study between Malaysia, England and Korea. 4th NAPREC Conference, National Institute of Valuation (INSPEN) Bangi, Malaysia.

Ibrahim, M., Ahmad, F., & Wan Abd Aziz, W. N. W. (2009). Exploiting town planning factors in land development: Case study of urban housing in Kuala Lumpur, Malaysia. *Journal of Facilities Management, 7*(4), 307-318.

Jaafar, M., Nuruddin, A. R., & Syed Abu Bakar, S. P. (2015). Managerial capabilities of housing developers: Building the competitive advantage of a firm. *International Journal of Construction Management, 16*(1), 1-12.

Jondrow, J., Lovell, C. A. K., Materov, I. S., & Schmidt, P. (1982). On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of Econometrics, 19*(2-3), 233-238.

Jordan, W. (1972). Producer Protection, Prior Market Structure and the Effects of Government Regulation. *The Journal of Law & Economics, 15*(1), 151-176. Retrieved from http://www.jstor.org/stable/725019

Joskow, P. (1972). The Determination of the Allowed Rate of Return in a Formal Regulatory Hearing. *The Bell Journal of Economics and Management Science, 3*(2), 632-644. doi:10.2307/3003042

Joskow, P. (1974). Inflation and Environmental Concern: Structural Change in the Process of Public Utility Price Regulation. *The Journal of Law & Economics, 17*(2), 291-327. Retrieved from http://www.jstor.org/stable/724893

Joskow, P. (1997). Restructuring, Competition and Regulatory Reform in the U.S. Electricity Sector. *The Journal of Economic Perspectives, 11*(3), 119-138. Retrieved from http://www.jstor.org/stable/2138188

Joskow, P. L. (2007). Regulation of natural monopoly. *Handbook of law and economics*, *2*, 1227-1348.

Joskow, P. L. (2014). Incentive regulation in theory and practice: electricity distribution and transmission networks. *In Economic Regulation and Its Reform: What Have We Learned?* (pp. 291-344). University of Chicago Press.

Jovanovic, B. (1982). Selection and the Evolution of Industry. *Econometrica, 50*(3), 649-670. doi:10.2307/1912606

Kapopoulos, P., & Lazaretou, S. (2007). Corporate ownership structure and firm performance: Evidence from Greek firms. *Corporate Governance: An International Review, 15*(2), 144-158.

Karim, M. (2001). Comparative Bank Efficiency across Select ASEAN Countries. *ASEAN Economic Bulletin, 18*(3), 289-304. Retrieved from http://www.jstor.org/stable/25773688

Khazanah Research Institute. (2015). *Making housing affordable*. Khazanah Research Institute.

Khazanah Research Institute. (2019). *Rethinking housing: Between state, market and society*. Khazanah Research Institute.

Klein, B., & Leffler, K. (1981). The Role of Market Forces in Assuring Contractual Performance. *Journal of Political Economy, 89*(4), 615-641. Retrieved from http://www.jstor.org/stable/1833028

Knittel, C. (2002). Alternative Regulatory Methods and Firm Efficiency: Stochastic Frontier Evidence from the U.S. Electricity Industry. *The Review of Economics and Statistics, 84*(3), 530-540. Retrieved from http://www.jstor.org/stable/3211569

Krugman, P. (1980). Scale Economies, Product Differentiation, and the Pattern of Trade. *The American Economic Review, 70*(5), 950-959. Retrieved from http://www.jstor.org/stable/1805774

Krugman, P. R., Obstfeld, M., & Melitz, M. J. (2018). *International economics: Theory and policy* (11th ed.). Pearson.

Kumbhakar, S. C., & Lovell, C. A. K. (2000). *Stochastic frontier analysis.* Cambridge, United Kingdom: Cambridge University Press.

Kugler, M., & Verhoogen, E. (2009). Plants and Imported Inputs: New Facts and an Interpretation.*The American Economic Review, 99*(2), 501-507. Retrieved from http://www.jstor.org/stable/25592447

Leng, A. C. A. (2004). The impact of corporate governance practices on firms' financial performance: Evidence from Malaysian companies. *ASEAN Economic Bulletin, 21*(3), 308-318.

Lemmon, M. L., & Lins, K. V. (2003). Ownership structure, corporate governance, and firm value: Evidence from the East Asian financial crisis. *The Journal of Finance, 58*(4), 1445-1468.

Lerner, A. (1952). Factor Prices and International Trade. *Economica, 19*(73), new series, 1-15. doi:10.2307/2549912

Levine, M. (2011). Regulation and the Nature of the Firm: The Case of U.S. Regional Airlines. *The Journal of Law & Economics, 54*(4), S229-S248. doi:10.1086/662993

Li, J., Chiang, Y. H., Choi, T. N. Y., & Man, K. F. (2013). Determinants of efficiency of contractors in Hong Kong and China: A panel data model analysis. *Construction Management and Economics, 139*(9), 1211-1223.

Li, H., Arditi, D., & Wang, Z. (2013). Transaction costs incurred by construction owners. *Engineering, Construction and Architectural Management, 21*(4), 444-458. https://doi.org/10.1108/ECAM-07-2013-0064[1]

Lileeva, A. (2008). Trade Liberalization and Productivity Dynamics: Evidence from Canada. *The Canadian Journal of Economics / Revue Canadienne D'Economique, 41*(2), 360-390. Retrieved from http://www.jstor.org/stable/25478282

Lipsey, R., & Lancaster, K. (1956). The General Theory of Second Best. *The Review of Economic Studies, 24*(1), 11-32. Retrieved from http://www.jstor.org/stable/2296233

Lerbs, O. W. (2014). House prices, housing development costs, and the supply of new single-family housing in German counties and cities. *Journal of Property Research*, *31*(3), 183-210.

Malaysia Productivity Corporation (MPC). (2019). *Productivity Report.* Petaling Jaya: MPC.

Malaysia Productivity Corporation (MPC). (2024). *Productivity Report.* Petaling Jaya: MPC.

Malpezzi, S., & Mayo, S. (1987). The Demand for Housing in Developing Countries: Empirical Estimates from Household Data. *Economic Development and Cultural Change, 35*(4), 687-721. Retrieved from http://www.jstor.org/stable/1153889

Malpezzi, S., & Mayo, S. (1997). Getting Housing Incentives Right: A Case Study of the Effects of Regulation, Taxes, and Subsidies on Housing Supply in Malaysia. *Land Economics, 73*(3), 372-391. doi:10.2307/3147174

Malpezzi, S., & Maclennan, D. (2001). The long-run price elasticity of supply of new residential construction in the United States and the United Kingdom. *Journal of Housing Economics*, *10*(3), 278-306.

Martin, S. (1988). Market Power and/or Efficiency? *The Review of Economics and Statistics,70*(2), 331-335. doi:1. Retrieved from http://www.jstor.org/stable/1928318 doi:1

Mayer, C. J., & Somerville, C. T. (2000). Residential construction: Using the urban growth model to estimate housing supply. *Journal of urban economics*, *48*(1), 85-109.

Mayo, S., & Sheppard, S. (2001). Housing supply and the effects of stochastic development control. *Journal of Housing Economics*, *10*(2), 109-128.

Mayo, S., & Sheppard, S. (1996). Housing supply under rapid economic growth and varying regulatory stringency: An international comparison. *Journal of Housing Economics*, *5*(3), 274-289.

McKean, R. (1964). Divergences between Individual and Total Costs within Government. *The American Economic Review, 54*(3), 243-249. Retrieved from http://www.jstor.org/stable/1818510

Meen, G. (2000). Housing cycles and efficiency. *Scottish Journal of Political Economy*, *47*(2), 114-140.

Meeusen, W., & Van Den Broeck, J. (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review, 18*(2), 435-444. doi:10.2307/2525757

Megginson, W. L., & Netter, J. M. (2001). From state to market: A survey of empirical studies on privatization. *Journal of Economic Literature, 39*(2), 321-389.

Melitz, M. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica, 71*(6), 1695-1725. Retrieved from http://www.jstor.org/stable/1555536

Miller, S. M., & Springer, T. M. (2006). *Cost improvements, returns to scale, and inefficiencies in real estate investment trusts. Journal of Real Estate Finance and Economics,* 32(2), 175-199.

Miller, S. M., & Springer, T. M. (2007). *Cost improvements, returns to scale, and cost inefficiencies for real estate investment trusts.* Working Paper No. 2007-05, University of Connecticut, Department of Economics.

Ministry of Housing and Local Government (KPKT). (2018). *National Housing Policy (NHP 2.0).* Putrajaya: KPKT.

Ministry of Investment, Trade and Industry Malaysia (MITI). (2000-2024)**.** *Annual reports.* Putrajaya, Malaysia: Author

Mohd Isa, Z. B., Tan, P. V., Shanti Rani, & Asmah Mohd Nasir. (2010, November). *Housing market performance: A comparative study between Malaysia, England and Korea*. Paper presented at the 4th NAPREC Conference, National Institute of Valuation (INSPEN), Selangor, Malaysia.

Montagna, C. (1995). Monopolistic Competition with Firm-Specific Costs. *Oxford Economic Papers, 47*(2), new series, 318-328. Retrieved from http://www.jstor.org/stable/2663562

Muller, R., & Rawana, D. (1990). Tariff-Limit Pricing, Relative Plant Scale, and the Eastman-Stykolt Hypothesis. *The Canadian Journal of Economics / Revue Canadienne D'Economique,23*(2), 323-331. doi:1. Retrieved from http://www.jstor.org/stable/135608 doi:1

Muth, R. (1961). Economic Change and Rural-Urban Land Conversions. *Econometrica, 29*(1), 1-23. doi:10.2307/1907683

Olsen, E. O. (1987). The demand and supply of housing service: a critical survey of the empirical literature. *Handbook of regional and urban economics*, *2*, 989-1022.

Pain, N., & Westaway, P. (1997). Modelling structural change in the UK housing market: a comparison of alternative house price models. *Economic Modelling*, *14*(4), 587-610.

Panzar, J., & Willig, R. (1977). Economies of Scale in Multi-Output Production. *The Quarterly Journal of Economics, 91*(3), 481-493. Retrieved from http://www.jstor.org/stable/1885979

Park, J.-L., Yoo, S.-K., Lee, J.-S., Kim, J.-H., & Kim, J.-J. (2015). Comparing the efficiency and productivity of construction firms in China, Japan, and Korea using DEA and DEA-based Malmquist. *KSCE Journal of Civil Engineering, 19*(2), 318–328.

Pavcnik, N. (2002). Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. *Review of Economic Studies, 69*(1), 245-276.

Peltzman, S., Levine, M., & Noll, R. (1989). The Economic Theory of Regulation after a Decade of Deregulation. *Brookings Papers on Economic Activity. Microeconomics, 1989*, 1-59. doi:1. Retrieved from http://www.jstor.org/stable/2534719 doi:1

Pieper, P. (1989). Why Construction Industry Productivity is Declining: Comment. *The Review of Economics and Statistics, 71*(3), 543-546. doi:10.2307/1926915

Pryce, G. (1999). Construction elasticities and land availability: A two-stage least-squares model of housing supply using the variable elasticity approach. *Urban Studies*, *36*(13), 2283-2304.

Potepan, M. J. (1996). Explaining intermetropolitan variation in housing prices, rents and land prices. *Real Estate Economics*, *24*(2), 219-245.

Quigley, J., & Raphael, S. (2005). Regulation and the High Cost of Housing in California. *The American Economic Review, 95*(2), 323-328. Retrieved from http://www.jstor.org/stable/4132841

Ray, S. C. (1999). Measuring scale efficiency from a translog production function. *Journal of Productivity Analysis, 11*(3), 183-194.

Roback, J. (1982). Wages, Rents, and the Quality of Life. *Journal of Political Economy, 90*(6), 1257-1278. Retrieved from http://www.jstor.org/stable/1830947

Romer, P. (1987). Growth Based on Increasing Returns Due to Specialization. *The American Economic Review, 77*(2), 56-62. Retrieved from http://www.jstor.org/stable/1805429

Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy, 82*(1), 34-55. Retrieved from http://www.jstor.org/stable/1830899

Rosenthal, S. (1999). Residential Buildings and the Cost of Construction: New Evidence on the Efficiency of the Housing Market. *The Review of Economics and Statistics, 81*(2), 288-302. Retrieved from http://www.jstor.org/stable/2646866

Rosenthal, S. S. (1999). Housing Supply: The Other Half of the Market a Note from the Editor. *The Journal of Real Estate Finance and Economics*, *18*(1), 5-7.

Rosenthal, S. S., & Strange, W. C. (2003). Geography, industrial organization, and agglomeration. *review of Economics and Statistics*, *85*(2), 377-393.

Samuelson, P. (1948). International Trade and the Equalisation of Factor Prices. *The Economic Journal, 58*(230), 163-184. doi:10.2307/2225933

Samuelson, P. (1949). International Factor-Price Equalisation Once Again. *The Economic Journal, 59*(234), 181-197. doi:10.2307/2226683

Salop, S. (1979). Monopolistic Competition with Outside Goods. *The Bell Journal of Economics, 10*(1), 141-156. doi:10.2307/3003323

Scherer, F. M., & Ross, D. (1990). *Industrial Market Structure and Economic Performance* (3rd ed.). Houghton Mifflin.

Scherer, Fredrich. Industrial Market Structure and Economic Performance. Chicago: Rand McNally, 1980.

Schmalensee, R. (1989). Good Regulatory Regimes. *The RAND Journal of Economics, 20*(3), 417-436. Retrieved from http://www.jstor.org/stable/2555580

Schmalensee, R. (1987). Collusion Versus Differential Efficiency: Testing Alternative Hypotheses. *The Journal of Industrial Economics, 35*(4), 399-425. doi:1. Retrieved from http://www.jstor.org/stable/2098580 doi:1

Schwert, G. (1981). Using Financial Data to Measure Effects of Regulation. *The Journal of Law & Economics, 24*(1), 121-158. Retrieved from http://www.jstor.org/stable/725206

Securities Commission Malaysia. (2021). *Malaysian Code on Corporate Governance (MCCG)*. Securities Commission Malaysia.

Sirmans, G., Macpherson, D., & Zietz, E. (2005). The Composition of Hedonic Pricing Models. *Journal of Real Estate Literature, 13*(1), 3-43. Retrieved from http://www.jstor.org/stable/44103506

Smith, L. (1984). Household Headship Rates, Household Formation, and Housing Demand in Canada. *Land Economics, 60*(2), 180-188. doi:10.2307/3145972

Somerville, C. T. (1999). The industrial organization of housing supply: Market activity, land supply and the size of homebuilder firms. *Real Estate Economics*, *27*(4), 669-694.

Somerville, C. T. (1999). Residential construction costs and the supply of new housing: endogeneity and bias in construction cost indexes. *The Journal of Real Estate Finance and Economics*, *18*(1), 43-62.

Somerville, C. T. (1996). The contribution of land and structure to builder profits and house prices. *Journal of Housing Research*, 127-141.

Somerville, C. T. (2002). Does the lender matter? Lender type and home office location and real estate development lending. *Canadian Journal of Administrative Sciences/Revue Canadienne des Sciences de l'Administration*, *19*(4), 321-332.

Stigler, G. (1971). The Theory of Economic Regulation. *The Bell Journal of Economics and Management Science, 2*(1), 3-21. doi:1. Retrieved from http://www.jstor.org/stable/3003160 doi:1

Sulong, Z., & Nor, F. M. (2008). Dividends, ownership structure and board governance on firm value: Empirical evidence from Malaysian listed firms. *Malaysian Accounting Review, 7*(2), 55-94.

Sulong, Z., & Ahmed, P. K. (2011). Ownership structure, board governance, dividends and firm value: An empirical examination of Malaysian listed firms. *International Journal of Business Governance and Ethics, 6*(2), 135-161.

Sutton, J. (1997). Gibrat's Legacy. *Journal of Economic Literature,35*(1), 40-59. Retrieved from http://www.jstor.org/stable/2729692

Universiti Utara Malaysia

Taggart, R. (1985). Effects of Regulation on Utility Financing: Theory and Evidence. *The Journal of Industrial Economics, 33*(3), 257-276. doi:10.2307/2098536

Tobin, J. (1969). A General Equilibrium Approach to Monetary Theory. *Journal of Money, Credit and Banking, 1*(1), 15-29. doi:10.2307/1991374

Toda, Y. (1976). Estimation of a Cost Function When the Cost Is Not Minimum: The Case of Soviet Manufacturing Industries, 1958-1971. *The Review of Economics and Statistics, 58*(3), 259-268. doi:10.2307/1924947

Topalova, P., & Khandelwal, A. (2011). Trade Liberalization and Firm Productivity: The Case of IndiaA. *The Review of Economics and Statistics, 93*(3), 995-1009. Retrieved from http://www.jstor.org/stable/23016091

Topel, R., & Rosen, S. (1988). Housing Investment in the United States. *Journal of Political Economy, 96*(4), 718-740. Retrieved from http://www.jstor.org/stable/1830471

Tybout, J. (1993). Internal Returns to Scale as a Source of Comparative Advantage: The Evidence. *The American Economic Review, 83*(2), 440-444. Retrieved from http://www.jstor.org/stable/2117705

Tybout, J. R. (2000). Manufacturing firms in developing countries: How well do they do, and why? *Journal of Economic Literature, 38*(1), 11-44.

Valuation and Property Services Department (JPPH), Ministry of Finance Malaysia. (2000–2024). *Property market reports.* Putrajaya, Malaysia: Author.

Vennet, R. (2002). Cost and Profit Efficiency of Financial Conglomerates and Universal Banks in Europe. *Journal of Money, Credit and Banking, 34*(1), 254-282. Retrieved from http://www.jstor.org/stable/3270685

Watkins, C. (2008) Microeconomic perspectives on the structure and operation of local housing markets, Housing Studies, 23, pp. 163-177.

Williamson, O. E. (1985). *The economic institutions of capitalism: Firms, markets, relational contracting.* New York, NY: Free Press.

Winston, C. (1993). Economic Deregulation: Days of Reckoning for Microeconomists. *Journal of Economic Literature, 31*(3), 1263-1289. Retrieved from http://www.jstor.org/stable/2728241

Wolf, C. (1979). A Theory of Nonmarket Failure: Framework for Implementation Analysis. *The Journal of Law & Economics, 22*(1), 107-139. Retrieved from http://www.jstor.org/stable/725215

World Bank. (2020). *Doing business in Malaysia 2020.* World Bank Group.

Yoshikawa, H. (1980). On the "q" Theory of Investment. *The American Economic Review, 70*(4),
739-743. Retrieved from http://www.jstor.org/stable/1803570

You, T., & Zi, H. (2007). The economic efficiency of the construction industry: A stochastic frontier approach. *Construction Management and Economics, 25*(8), 831-841.

**Appendices**

Table A.1: Weightage of Building Materials, CIDB Malaysia (2012)

| No. | Elements | Category 1 (Residential) |
|---|---|---|
| **1** | M1-Cement | 2.34 |
| **2** | M2-Aggregate | 0.00 |
| **3** | M3-Sand | 0.83 |
| **4** | M4-steel Reinforcement | 17.32 |
| **5** | M5-ready Mixedconcrete | 12.57 |
| **6** | M6-rick/Block/Board | 2.40 |
| **7** | M7-Roofing Tiles/Sheet | 0.86 |
| **8** | M8-Finishes (Wall&Floor) | 4.03 |
| **9** | M9-Ceiling Boards | 0.78 |
| **10** | M10-Internal plumbing | 1.73 |
| **11** | M11-Sanitary ware & Fitting | 0.91 |
| **12** | M12-Paint | 4.35 |
| **13** | M13-Glass | 0.78 |
| **14** | M14-Steel & Metal Section | 7.76 |
| **15** | M15-Timber | 5.18 |
| **16** | M16-Plywood | 2.66 |
| **17** | M17-Ironmongeries | 0.64 |
| | **Sub-Total** | **65.15** |
| **18** | **Labour** | **32.68** |
| **19** | **Plant** (1) | **2.17** |
| | **TOTAL** | **100** |

Source: CIDB, 2012

*(1) Machinery & Equipment.

Universiti Utara Malaysia