



05-4506832



pustaka.upsi.edu.my



Perpustakaan Tuanku Bainun
Kampus Sultan Abdul Jalil Shah



PustakaTBainun



ptbupsi

SPATIAL MODELING OF REGIONAL CONSUMER SERVICES INDUSTRY IN SHANDONG PROVINCE



05-4506832



pustaka.upsi.edu.my



Perpustakaan Tuanku Bainun
Kampus Sultan Abdul Jalil Shah

XIE AILIANG



PustakaTBainun



ptbupsi

SULTAN IDRIS EDUCATION UNIVERSITY

2025



05-4506832



pustaka.upsi.edu.my



Perpustakaan Tuanku Bainun
Kampus Sultan Abdul Jalil Shah



PustakaTBainun



ptbupsi

**SPATIAL MODELING OF REGIONAL CONSUMER SERVICES INDUSTRY IN
SHANDONG PROVINCE**

XIE AILIANG

THESIS PRESENTED TO QUALIFY FOR A DOCTOR OF PHILOSOPHY

**FACULTY OF HUMAN SCIENCES
SULTAN IDRIS EDUCATION UNIVERSITY**

2025



Please tick (✓)

Project Paper

Masters by Research

Master by Mixed Mode

PhD

INSTITUTE OF GRADUATE STUDIES**DECLARATION OF ORIGINAL WORK**

This declaration is made on the3rd.....day of....Nov.....20..25...

i. Student's Declaration:

I, Xie Ailiang, P20211002726, Faculty of Human Sciences (PLEASE INDICATE STUDENT'S NAME, MATRIC NO. AND FACULTY) hereby declare that the work entitled Spatial Modeling of Regional Consumer Services Industry in Shandong Province

_____ is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person.

Xie Ailiang

Signature of the student

ii. Supervisor's Declaration:

I Associate Professor Dr. Fauziah Che Leh (SUPERVISOR'S NAME) hereby certifies that the work entitled Spatial Modeling of Regional Consumer Services Industry in Shandong Province

_____ (TITLE) was prepared by the above named student, and was submitted to the Institute of Graduate Studies as a * partial/full fulfillment for the conferment of Doctor of Philosophy (PLEASE INDICATE THE DEGREE), and the aforementioned work, to the best of my knowledge, is the said student's work.

2025.12.24

Date

Fauziah Che Leh
Puan Fauziah Dr Fauziah Che Leh
Jabatan Geografi dan Alam Sekitar
Fakulti Sains Kemajuan
Universiti Pendidikan Sultan Idris

Signature of the Supervisor





INSTITUT PENGAJIAN SISWAZAH / INSTITUTE OF GRADUATE STUDIES

BORANG PENGESAHAN PENYERAHAN TESIS/DISERTASI/LAPORAN KERTAS PROJEK
DECLARATION OF THESIS/DISSERTATION/PROJECT PAPER FORM

Tajuk / Title: Spatial Modeling of Regional Consumer Services Industry in Shandong Province

No. Matrik /
Matric's No.: P20211002726

Saya / I am: Xie Ailiang
(Nama Pelajar / Student's Name)

mengaku membenarkan Tesis/Disertasi/Laporan Kertas Projek (Kedoktoran/Sarjana) ini disimpan di Universiti Pendidikan Sultan Idris (Perpustakaan Tuanku Bainun) dengan syarat-syarat kegunaan seperti berikut: -
acknowledged that Universiti Pendidikan Sultan Idris (Tuanku Bainun Library) reserves the right as follows: -

1. Tesis/Disertasi/Laporan Kertas Projek ini adalah hak milik Universiti Pendidikan Sultan Idris.
The Thesis/Dissertation/Project Paper is the property of Universiti Pendidikan Sultan Idris.
2. Perpustakaan Tuanku Bainun dibenarkan membuat Salinan untuk tujuan rujukan dan pendidikan.
Tuanku Bainun Library has the right to make copies for the purpose of reference and education.
3. Perpustakaan dibenarkan membuat salinan Tesis/Disertasi/Laporan Kertas Projek ini sebagai bahan pertukaran antara Institusi Pengajian Tinggi.
The library has the right to make copies of the thesis/Dissertation/Project Paper for academic exchange.
4. Sila tandakan (✓) bagi pilihan kategori di bawah / Please tick (✓) for category below: -

☒	AKSES TERBUKA OPEN ACCESS	Saya bersetuju bahawa Tesis/Disertasi/Kertas Projek boleh diterbitkan sebagai salinan fizikal atau akses terbuka dalam talian. <i>I agree that the Thesis/Dissertation/Project Paper may be published as a physical copy or open access online.</i>
☐	*TERHAD *LIMITED	Mengandungi maklumat terhad seperti yang dinyatakan oleh organisasi/institusi di mana penyelidikan dijalankan. (Perpustakaan akan menyekat akses sehingga ____ tahun). <i>Contains restricted information as specified by the organization/institution where the research was conducted. (Library will restrict access until ____ years).</i>
☐	*SULIT *CONFIDENTIAL	Mengandungi maklumat sulit di bawah Akta Rahsia Rasmi 1972. <i>Contains confidential information under the Official Secrets Act 1972.</i>
☐	EMBARGO	Tesis/Disertasi/Kertas Projek ini tertakluk kepada tempoh embargo selama 2 tahun atas sebab-sebab berikut: This Thesis/Dissertation/Project Paper is subject to an embargo period of 2 years for the following reasons:

*Nota / *Notes:

- i. Jika tiada pilihan yang ditandai, pilihan pertama akan dilaksanakan secara automatik.
If no option is marked, the first option will be automatically implemented.
- ii. Jika Tesis/Disertasi/Kertas Projek ini dikategorikan sebagai **SULIT** atau **TERHAD**, sila lampirkan surat dari pihak berkuasa/organisasi yang berkaitan dengan menyatakan alasan dan tempoh tesis ini perlu diklasifikasikan sebagai **TERHAD** atau **SULIT**. / If the Thesis/Dissertation/Project Paper is categorized as **CONFIDENTIAL** or **LIMITED**, kindly attach a letter from the relevant authority/organization stating the reason and duration for the thesis should be classified as **LIMITED** or **CONFIDENTIAL**.

Xie Ailiang

(Tandatangan Pelajar/ Signature)

Prof Muzie Ur Fauziah Che Lai
Jabatan Geografi dan Alam Sekitar
Fakulti Sains Kemasyarakatan
Universiti Pendidikan Sultan Idris

(Tandatangan Penyelia / Signature of Supervisor)
& (Nama & Cop Rasmi / Name & Official Stamp)

Tarikh: 2025.12.24

Tarikh: 2025.12.24



ACKNOWLEDGEMENT

First and foremost, I wish to express my deepest gratitude to my main supervisor, Profesor Madya Dr. Fauziah Binti Che, for her exceptional guidance, patience, and unwavering support throughout my doctoral journey. Her expertise and insightful advice have been invaluable to the completion of this dissertation. I am equally grateful to my co-supervisor, Profesor Madya Dr. Norimah Binti Rambeli, for her constructive feedback and encouragement, which have greatly contributed to the refinement of this research.

I would also like to extend my heartfelt appreciation to the Faculty of Human Sciences at Universiti Pendidikan Sultan Idris for providing a conducive environment and necessary resources to facilitate my academic endeavors. Special thanks are due to my colleagues and friends in the geography program, whose discussions and camaraderie have made this journey both enriching and enjoyable.

This research would not have been possible without the financial support of the Philosophy and Social Science Foundation of China under the project titled “Research on the Dynamic Mechanism and Realization Paths of High-Quality Development of Cultural Tourism Integration in Relatively Poor Areas of China” [Grant number: 21BGL150]. I sincerely acknowledge their contribution, which has significantly supported the progress of my study.

Finally, I am deeply indebted to my family, whose love, encouragement, and sacrifices have been my greatest source of strength. Their unwavering belief in my abilities has inspired me to persevere through challenges and strive for excellence in my academic pursuit.

To all those who have contributed to this dissertation, directly or indirectly, I extend my heartfelt thanks and appreciation.





ABSTRACT

The consumer services industry plays a crucial role in supporting regional economies and improving the quality of urban life. In Shandong Province, however, its development has shown clear disparities between coastal and inland cities, reflecting uneven resource allocation and infrastructure conditions. Although these differences are widely recognized, there has been a lack of systematic spatial modeling to explain the mechanisms shaping such heterogeneity. This study applies a spatial modeling approach to examine the regional consumer services industry in Shandong Province. The analysis extends the Cobb–Douglas production function by incorporating energy input and embeds a spatial distance matrix to capture spatial dependence. Methodologically, the research combines the Modified Delphi–Hierarchical Grey–Fuzzy (MDHGF) algorithm with econometric estimators, including Ordinary Least Squares (OLS), the Spatial Lag Model (SLM), the Spatial Error Model (SEM), and Geographically Weighted Regression (GWR). The empirical investigation uses panel data derived from the Shandong Statistical Yearbooks and the yearbooks of 16 prefecture-level cities, with the final-demand rate employed to identify major industry subsectors. The results reveal significant spatial heterogeneity in industry output. GWR estimates show that capital investment is the most decisive factor, followed by labor input, while the effect of energy consumption varies considerably across locations of 16 prefecture-level cities. Coastal cities such as Qingdao and Yantai record stronger performance due to geographic advantages, robust infrastructure, and diversified economic bases. In contrast, inland cities including Heze and Liaocheng lag behind because of limited infrastructure and weaker development foundations. Moran's I confirms moderate positive spatial autocorrelation, highlighting clustering of high-output and low-output areas. The findings carry important policy implications. Inland regions should focus on strengthening infrastructure and attracting resources to reduce disparities, while coastal areas need to emphasize innovation and technological upgrading. Overall, the study demonstrates the value of spatial modeling in revealing local differences and provides empirical evidence to inform regional strategies aimed at balanced and sustainable development in Shandong Province and comparable contexts.



PEMODELAN SPATIAL INDUSTRI PERKHIDMATAN PENGGUNA SERANTAU DI WILAYAH SHANDONG

ABSTRAK

Industri perkhidmatan pengguna memainkan peranan yang amat penting dalam menyokong pertumbuhan ekonomi serantau serta meningkatkan kualiti kehidupan bandar. Namun demikian, di Wilayah Shandong, pembangunan industri ini menunjukkan jurang yang ketara antara bandar pesisir dan bandar pedalaman, mencerminkan ketidakseimbangan dalam pengagihan sumber dan tahap kemudahan infrastruktur. Walaupun perbezaan ini telah dikenal pasti secara meluas, kajian sistematik yang menerapkan pemodelan ruang bagi menjelaskan mekanisme yang membentuk heterogeniti tersebut masih terhad. Kajian ini menggunakan pendekatan pemodelan ruang bagi meneliti industri perkhidmatan pengguna di Wilayah Shandong. Analisis ini memperluas fungsi pengeluaran Cobb–Douglas dengan memasukkan pemboleh ubah input tenaga serta matriks jarak ruang sebagai parameter berwajaran bagi menangkap kebergantungan ruang. Dari segi metodologi, kajian ini menggabungkan algoritma Modified Delphi–Hierarchical Grey–Fuzzy (MDHGF) dengan penganggar ekonometrik seperti Ordinary Least Squares (OLS), Spatial Lag Model (SLM), Spatial Error Model (SEM), dan Geographically Weighted Regression (GWR). Analisis empirikal menggunakan data panel yang diperoleh daripada Shandong Statistical Yearbooks dan yearbook bagi 16 bandar peringkat prefektur, manakala kadar permintaan akhir digunakan untuk mengenal pasti subsektor utama dalam industri perkhidmatan pengguna. Dapatan kajian menunjukkan wujudnya heterogeniti ruang yang ketara dalam output industri. Anggaran GWR membuktikan bahawa pelaburan modal merupakan faktor paling dominan, diikuti oleh input buruh, manakala kesan penggunaan tenaga berbeza dengan ketara antara bandar-bandar yang dikaji. Bandar pesisir seperti Qingdao dan Yantai menunjukkan prestasi yang lebih kukuh hasil daripada kelebihan geografi, infrastruktur yang mantap, dan asas ekonomi yang pelbagai. Sebaliknya, bandar pedalaman seperti Heze dan Liaocheng ketinggalan akibat kekangan infrastruktur dan asas pembangunan yang lemah. Indeks Moran's I mengesahkan kewujudan autokorelasi ruang positif sederhana yang menunjukkan pengelompokan kawasan beroutput tinggi dan rendah. Penemuan kajian ini membawa implikasi dasar yang penting. Kawasan pedalaman disarankan untuk menumpukan kepada peningkatan infrastruktur dan penarikan sumber bagi mengurangkan ketidakseimbangan pembangunan, manakala kawasan pesisir perlu memberi tumpuan kepada inovasi, peningkatan teknologi dan kecekapan pengeluaran. Secara keseluruhannya, kajian ini membuktikan nilai pendekatan pemodelan ruang dalam menjelaskan perbezaan tempatan serta menyediakan bukti empirikal yang berguna untuk merangka strategi pembangunan serantau yang lebih seimbang dan mampan di Wilayah Shandong serta wilayah lain yang mempunyai ciri geografi dan ekonomi yang setara..



CONTENTS

	Page
ACKNOWLEDGEMENT	iv
ABSTRACT	v
ABSTRAK	vi
CONTENTS	vii
LIST OF TABLES	xx
LIST OF FIGURES	xxi
LIST OF ABBREVIATIONS	xxii
CHAPTER 1 INTRODUCTION	
1.1 Introduction	1
1.2 Background of the Study	10
1.3 Problem Statement	14
1.4 Research Questions	16
1.5 Research Objectives	18
1.6 Research Hypothesis	20
1.7 Theoretical and Conceptual Framework of Research	21
1.8 Consumer Services Industry	26
1.9 Capital	27
1.10 Labor Force	29
1.11 Energy	31
1.12 Cobb-Douglas Production Function	33
1.13 Spatial Correlation	34
1.14 Spatial Heterogeneity	36



1.15	Operation Definitions	38
1.15.1	Operation Definition of Spatial Heterogeneity	40
1.15.2	Operation Definition of Regional Consumer Services Industry	41
1.15.3	Operation Definition of Output of Consumer Services Industry	41
1.15.4	Operation Definition of Capital	42
1.15.5	Operation Definition of Labor Force	42
1.15.6	Operation Definition of Energy	43
1.16	Scope & Limitations of the Study	44
1.16.1	Scope of the Study	44
1.16.2	Limitations of the Study	44
	1.16.2.1 Data Availability and Accuracy	45
	1.16.2.2 Model Limitations	45
	1.16.2.3 Geographic Scope	45
	1.16.2.4 Temporal Scope	46
	1.16.2.5 External Factors	46
	1.16.2.6 Subjectivity in Data Interpretation	46
1.17	Significance of the Study	47
1.17.1	Significance of the Study to Theory	47
	1.17.1.1 Conceptual Understanding	47
	1.17.1.2 Methodological Advancements	48
	1.17.1.3 Empirical Evidence	48
	1.17.1.4 Policy Implications	49
	1.17.1.5 Comparative Analysis	49
1.17.2	Significance of the Study to practice	50
	1.17.2.1 Policy Formulation	50
	1.17.2.2 Regional Planning	51
	1.17.2.3 Investment and Resource Allocation	51



1.17.2.4 Economic Development Strategies	51
1.17.2.5 Comparative Analysis	52
1.18 Thesis Organization	52
CHAPTER 2 LITERATURE REVIEW OF SPATIAL MODELING OF INDUSTRY OUTPUTS	
2.1 Introduction	55
2.2 The Main Basic Theories	56
2.2.1 Basic Theories of Geography	57
2.2.2 Economic Growth Theory	60
2.2.3 Growth Pole Theory	63
2.2.4 Center Periphery Theory	64
2.2.5 Unbalanced Growth Theory	66
2.2.6 A Brief Review of the Main Basic Theories	68
2.3 Spatial Heterogeneity Affect Industrial Outputs	70
2.3.1 Literature Retrieval and Research Ideas	73
2.3.2 The Logical Basis of Spatial Heterogeneity Affecting Industrial Outputs	76
2.3.2.1 Spatial Dimensions that Cannot be Ignored	76
2.3.2.2 Heterogeneity of Individual Enterprises	78
2.3.3 Industrial Outputs Analysis Needs to be Carried Out Based on the Relationship between Spatial Heterogeneity and Spatial Dependence	80
2.3.4 A Brief Review of Research on Spatial Heterogeneity Affecting Industrial Outputs	82
2.4 Geographically Weighted Regression Model	84
2.4.1 Research Methods and Data Sources	89
2.4.1.1 Research Methods	89
2.4.1.2 Data Sources	93
2.4.2 Academia Community of GWR Model Research	95



2.4.2.1	Disciplinary Classification and Co-Occurrence Analysis	95
2.4.2.2	Authors and Cooperation Networks	97
2.4.2.3	Network of cooperation between the countries and research institutions	99
2.4.2.4	Journals Co-citation Analysis	102
2.4.3	Research Directions and Hotspots of GWR Model	104
2.4.3.1	Analysis of Highly Cited Literatures	104
2.4.3.2	Highly Cited Authors Analysis	107
2.4.3.3	Research Hotspots Analysis	108
2.4.3.4	Research Hotspots Clusters Analysis	112
2.4.4	Research Trends of GWR Model	115
2.4.4.1	Theoretical Construction of GWR Model	115
2.4.4.2	GWR Model Based on Flexible Distance Measurement Selection	116
2.4.4.3	Spatial Scale Effect of GWR Model	117
2.4.4.4	GWR Model Independent Variable Factor Selection is more Diversified	119
2.4.4.5	Strengthen the Matching Degree between GWR Model and Big Data	120
2.4.4.6	Promote the establishment of Interdisciplinary and Closely Cooperative Academic Research Networks	121
2.4.4.7	A Brief Review of Research on GWR Model	122
2.5	Research Progress on the Consumer Services Industry	125
2.5.1	Spatial Patterns of the Consumer Services Industry	126
2.5.2	Influencing Factors	127
2.5.3	Policy and Institutional Impacts	128
2.5.4	Research Methods and Techniques	129
2.5.5	Research Focus and Controversies	130
2.5.6	Research Prospects	131



2.6	Conclusions	133
2.6.1	Theoretical Foundations	133
2.6.2	Impact of Spatial Heterogeneity on Industrial Outputs	133
2.6.3	Geographically Weighted Regression (GWR) Model	134
2.6.4	Academic Community and Research Trends	134
2.6.5	Methodological Advances and Future Directions	135
2.6.6	Policy Implications and Practical Applications	135
CHAPTER 3 METHODOLOGY		
3.1	Introduction	136
3.2	Research Design	137
3.2.1	Descriptive Statistics on the Output of Consumer Services Industry and its Influencing Factors in Shandong Province	140
3.2.1.1	Final Demand Rate	141
3.2.1.2	Concentration Trend	142
3.2.1.3	Discrete Trend	143
3.2.1.4	Distribution Pattern	144
3.2.2	Evaluation Method of Development Level of Consumer Service Industry in Shandong Province	145
3.2.2.1	Constructing an Evaluation Index System	145
3.2.2.2	Determining Weights	146
3.2.2.3	Constructing the Evaluation Matrix Based on Expert Scores	148
3.2.2.4	Defining Evaluation Levels and Forming Grey Classes in MDHGF Algorithm	149
3.2.2.5	Deriving Evaluation Results from the Fuzzy Judgment Matrix	150
3.2.3	Spatial Autocorrelation Test of The Output of Consumer Services Industry in Shandong Province	151
3.2.3.1	Spatial Gini Coefficient	151
3.2.3.2	Location Quotient	153





3.2.3.3	Moran's Index	154
3.2.4	Model Specification	155
3.2.4.1	Ordinary Least Squares	155
3.2.4.2	Spatial Lag Model (SLM)	156
3.2.4.3	Spatial Error Model (SEM)	157
3.2.4.4	Spatial Autocorrelation Test and Selection of SLM and SEM	158
3.2.4.5	Geographically Weighted Regression Model (GWR)	158
3.2.5	Deduction of the Promotion Paths of The Output of Consumer Services Industry in Shandong Province	160
3.3	Data Resource	161
3.4	Data Sample	165
3.4.1	The Typical Characteristics of The Consumer Services Industry in Shandong Province	166
3.4.1.1	Diversified Service Sectors	166
3.4.1.2	High urbanization level	168
3.4.1.3	Emphasis on Service Quality	169
3.4.1.4	Combination of Tradition and Modernity	171
3.4.1.5	Focus on Health and Wellness	173
3.4.1.6	Thriving Tourism Industry	175
3.4.2	The Typical Characteristics of Consumer Services Industry in Different Cities of Shandong Province	179
3.5	Validity of the Time Series Data	183
3.5.1	Nature of the Research	184
3.5.2	Scope and Sample Size	184
3.5.3	Secondary Data are Reliable and Objective	184
3.5.4	Practical Constraints	185
3.6	Techniques of Analyzing Data (software)	185
3.6.1	Excel Software	185





3.6.2	Geoda Software	186
3.6.3	GWR4 Software	190
3.7	Conclusions	192
3.7.1	Research Design	192
3.7.2	Descriptive Statistics	193
3.7.3	Modified Delphi-Hierarchical Grey-Fuzzy (MDHGF) Algorithm	193
3.7.4	Spatial Autocorrelation Test	193
3.7.5	Spatial Constant Parameter Estimation Modeling	194
3.7.6	Geographically Weighted Regression (GWR) Model	194
3.7.7	Data Collection and Validity	194
3.7.8	Analytical Tools	195
CHAPTER 4 RESEARCH FINDINGS		
4.1	Introduction	196
4.2	Background of the Respondents	197
4.2.1	Definition of Categories in the Consumer Services Industry	198
4.2.2	Basic status of Consumer Service Industry in Shandong Province	203
4.2.1.1	New Consumption as a Robust Pillar in Shandong's Consumer Recovery, Yet with Insufficient Momentum	203
4.2.1.2	New Consumption and New Investment in Shandong's Consumer Services Industry: Synergy and Mutual Promotion	205
4.2.1.3	Enhancing Investment and Consumer Confidence Remains a Critical Focus	207
4.2.3	The Role of Consumer Services in Promoting Economic Development in Shandong Province	210
4.2.3.1	Driving the Development of Related Industries and Promoting Socio-Economic Growth	211
4.2.3.2	Absorbing Labor Force and Effectively Enhancing Employment Quality	212
4.2.3.3	Facilitating the Transformation of Outdated Business	213





Practices to Enhance Industrial Competitiveness

4.2.3.4	Fostering the Development of the Tertiary Sector and Cultivating a Virtuous Cycle	214
4.2.3.5	Enhancing the Quality of Life	215
4.2.3.6	Promoting Urban-Rural Integration	216
4.2.4	Shortcomings in the Operation of the Consumer Service Industry in Shandong Province	217
4.2.4.1	Inadequate Implementation of Laws and Regulations, Regulatory Oversight Lacking	218
4.2.4.2	Inadequate Consumer Purchasing Power	218
4.2.4.3	Low Level of Branding	220
4.2.4.4	Low Service Quality	220
4.2.4.5	Insufficient Technological Level and Innovation Capacity	221
4.2.4.6	Need for Overall Improvement in Management Level	222
4.2.4.7	Intense Market Competition with Limited Profit Margins	222
4.2.4.8	Uneven Industry Development with Significant Regional Disparities	223
4.3	Evaluation of Development Disparities in Shandong's Consumer Services Industry Based on the MDHGF Algorithm	224
4.3.1	Calculation Process	224
4.3.1.1	Basic Concept of the MDHGF Algorithm	224
4.3.1.2	Steps in the MDHGF Algorithm Application	225
4.3.1.3	Indicator System and Methodology	227
4.3.2	General Characteristics of the Development Differences in Shandong Province's Consumer Service Industry	233
4.3.2.1	Significant Disparities in the Comprehensive Development Levels of Shandong Province's Consumer Service Industry	235
4.3.2.2	Distinct Hierarchical Levels in the Consumer Service Industry of Shandong Province	237





4.3.2.3	The Spatial Distribution of Consumer Service Industry Development Levels in Shandong Province Shows a Gradual Decrease from East to West	239
4.3.2.4	An Overview of the Development Level Evaluation of Consumer Service Industry in Shandong Province Based on MDHGF Algorithm	243
4.4	Comprehensive Measurement of Spatial Agglomeration in Shandong's Consumer Services Industry	244
4.4.1	Main Measurement Methods for Spatial Agglomeration in the Consumer Service Industry	245
4.4.2	Comprehensive Measurement and Analysis of Spatial Agglomeration in Shandong's Consumer Service Industry	247
4.4.2.1	Calculation of the Spatial Gini Coefficient for Shandong's Consumer Service Industry	247
4.4.2.2	Calculation of Location Quotients for Shandong's Consumer Service Industry	253
4.4.2.3	Driving Factors of Spatial Agglomeration in Shandong's Consumer Service Industry	258
4.4.3	Overview of Spatial Agglomeration of Consumer Service Industry in Shandong Province	269
4.5	Descriptive Statistical Analysis of Spatial Measurement of Output of Consumer Service Industry in Shandong Province	270
4.6	Spatial Correlation Test of the Output of the Consumer Service Industry in Shandong Province	277
4.7	Constant Parameter Estimation of CD Production Function of Consumer Service Industry in Shandong Province	284
4.8	Local Variable Parameter Estimation of the Consumer Service Industry Output in Shandong Province Using GWR	290
4.8.1	Confirmation of GWR Local Variable Parameter Estimation of the Output of Consumer Service Industry in Shandong Province	290
4.8.2	GWR Quantile Estimation Results of Consumer Service Industry Output in Shandong Province	297
4.8.3	Specific Estimation and Testing Results of Spatial Heterogeneity of the Consumer Service Industry in Shandong Province Based on the Local Geographically Weighted Regression Model	301
4.8.4	Overview of GWR Local Parameter Estimation Results for the	304





Consumer Services Industry Output in Shandong Province

4.9	Major Measures for the Development of the Consumer Service Industry in Shandong Province	305
4.9.1	Establishing a Comprehensive Supervision and Management System	306
4.9.1.1	Government Support and Guidance	306
4.9.1.2	Active Participation of the Public and Organizations	307
4.9.1.3	Strengthening Internal Supervision within Enterprises	308
4.9.2	Expanding Consumer Demand	309
4.9.2.1	Increasing Public Income Levels	310
4.9.2.2	Reducing the Urban-Rural Gap	310
4.9.2.3	Improving the Social Security System	311
4.9.3	Strengthening Service Brand Building	312
4.9.3.1	Enterprises Must Establish Brand Competitiveness Awareness and Introduce Advanced Quality Management Concepts and Systems	312
4.9.3.2	Enterprises Must Continuously Innovate Service Technologies and Standards and Vigorously Develop Independent Brands	313
4.9.3.3	Innovating Promotion Methods with Government Support and Guidance	314
4.9.4	Efforts to Improve Service Quality	316
4.9.4.1	Establishing Scientifically Reasonable Quality and Pricing Standards	316
4.9.4.2	Innovating Service Concepts	317
4.9.4.3	Enhancing Consumer Satisfaction	318
4.9.5	Enhancing the Quality-of-Service Personnel	319
4.9.5.1	Strengthening Talent Development and Improving Talent Information Systems	320
4.9.5.2	Attracting High-Quality Professionals Through Active Measures	321
4.9.5.3	Intensifying Training Efforts to Develop Grassroots	321





Talent

4.9.6	Summary of Development Measures of Consumer Services Industry in Shandong Province	323
4.10	Conclusions	325
4.10.1	Industry Categorization	325
4.10.2	Economic Contributions	326
4.10.3	Operational Challenges	326
4.10.4	Evaluation of Development Disparities	327
4.10.5	Spatial Distribution Dynamics	327
4.10.6	Spatial correlation Test	327
4.10.7	Constant Parameter Estimation	328
4.10.8	Local Variable Parameter Estimation by GWR	329
4.10.9	Policy Recommendations	329

CHAPTER 5 DISCUSSIONS AND CONCLUSIONS

5.1	Introduction	331
5.2	Discussions	332
5.2.1	Fulfillment of Research Objectives	333
5.2.1.1	Identify and Categorize the Components of the Consumer Services Industry	333
5.2.1.2	Evaluate the Spatial Distribution and Development Disparities of the Industry Using the MDHGF Algorithm	335
5.2.1.3	Analyze the Spatial Agglomeration and its Driving Factors	338
5.2.1.4	Assess the Mutual Influences of Regional Outputs in the Consumer Services Industry Through Spatial Econometric Analysis	342
5.2.1.5	Provide Policy Recommendations to Enhance the Development of the Consumer Services Industry	345
5.2.2	Theoretical Contributions and Alignment with Previous Studies	351
5.2.2.1	This Study Examines the Previous Relevant Research	352





Views

5.2.2.2	The Corrections, Additions, Developments or Refutations of this Research is Relative to the Previous Research Results	355
5.3	Research Implications	361
5.3.1	Practical Implications	362
5.3.1.1	Policy Recommendations	362
5.3.1.2	Industry Practices	364
5.3.2	Theoretical Implications	366
5.3.2.1	Methodological Advancements	366
5.3.2.2	Extension of Spatial Theories	368
5.4	Future Research	370
5.4.1	Longitudinal Studies	370
5.4.2	Comparative Analysis	371
5.4.3	Qualitative Insights	373
5.4.4	Technological Impact	375
5.5	Conclusions	378
5.5.1	The Main Results of the Study	378
5.5.1.1	Fulfillment of Research Objectives	378
5.5.1.2	Theoretical Contributions and Alignment with Previous Studies	380
5.5.2	Research Implications	381
5.5.2.1	Practical Implications	381
5.5.2.2	Theoretical Implications	381
5.5.3	Future Research Summary	382
5.5.3.1	Longitudinal Studies	382
5.5.3.2	Comparative Analysis	382
5.5.3.3	Qualitative Insights	383



5.5.3.4 Technological Impact

383

REFERENCES

384

APPENDIX

405



LIST OF TABLES

No. Table		Page
1. 1	Conceptual variables and Operational variables	38
2. 1	Top ten co-cited journals in GWR Model researchTable 2.1	103
2. 2	Statistics of highly cited literatures in GWR Model	105
2. 3	Statistics of highly cited authors in GWR Model	108
2. 4	Key word frequency results of co-occurrence analysis of GWR Model research	111
3. 1	Reasons for research units Selection	180
4. 1	The main categories of the consumer services industry	199
4. 2	Priority weights for detailed index on evaluation of index system in Difference of Consumer Services' Development	228
4. 3	The stage divides of development of consumer services	232
4. 4	Spatial Gini Coefficient for Major Industry Categories in Shandong's Consumers Service Industry	248
4.5	Location quotient of wholesale and retail, accommodation and catering industry in Shandong Province	254
4. 6	Distribution of prefecture-level cities with wholesale, retail, accommodation and catering industries in Shandong Province in 2022	254
4.7	Descriptive statistical results of urban consumer industry output and its influencing factors	276
4. 8	OLS Estimation Results	285
4. 9	SLM and SEM Estimation Results	288
4. 10	Estimated results of production function of consumer service industry in Shandong Province	291
4. 11	GWR quantile estimation results of the urban consumer industry production function	297
4. 12	Local GWR estimates, t and R2 tests of the urban consumer industry production function in Shandong Province	302



LIST OF FIGURES

No. Figures		Page
1. 1	Conceptual and Theoretical Framework of Research	25
2. 1	The main basic theories	57
2. 2	Annual trends of the impact of spatial heterogeneity on industrial outputs literature amount from 2002 to 2022	74
2. 3	The number of articles of GWR Model research	94
2. 4	Co-occurrence knowledge map of WoS Categories of GWR Model	96
2. 5	Knowledge map of authors of GWR Model posts	98
2. 6	National Knowledge Map of GWR Model	100
2. 7	Knowledge Map of Research Institutions of GWR Model	101
2. 8	Co-cited knowledge map of GWR Model research journals	102
2. 9	Knowledge map of research hotspot in GWR Model research	109
2. 10	Clusters view of GWR Model research hotspots	113
3. 1	Research Methodolo	139
4. 1	The result of evaluation in Difference of Consumer Services' Development of Shandong Province (2022)	236
4. 2	The Spatial Distribution in Difference of Consumer Services' Development of Shandong Province	240
4. 3	Change trend of spatial Gini coefficients of major categories of consumer service industry in Shandong Province (2013-2022)	249
4. 4	Moran's I scatter plots of the urban consumer industry production	281



LIST OF ABBREVIATIONS

AAEP	Average Annual Employment
AHP	Analytic Hierarchy Process
AIC	Akaike information criterion
AR	Augmented reality
BIC/MDL	Bayesian Information Criterion / Minimum Description Length
CD	Production function – Cobb-Douglas production function
CR	Consistency Ratio
EC	Electricity Consumption
GDP	Gross Domestic Product
GIOV	Output Variable is Gross Industrial Output Value
GWR	Model Geographically weighted regression model
LED	Light Emitting Diode
LM	Lagrange Multipliers
log L	log likelihood
LQ	Location Quotient
LR	Likelihood Ratio
MDHGF	Modified Delphi-Hierarchical Grey-Fuzzy
Moran's I	Moran's Index
OLS	Ordinary least squares
PIIFA	Fixed Asset Investment Price Index
PPI	Producer Price Index
R&D	Research and Development
R ²	R-Square





SC	Schwartz criterion
SEM	Spatial Error Model
SLM	Spatial lag model
TA	Total Assets
UNESCO	United Nations Educational, Scientific and Cultural Organization
VR	virtual reality





CHAPTER 1

INTRODUCTION

1.1 Introduction

China's economy has been experiencing the "new normal" since 2014 (Yu et al., 2019; Tang et al., 2023). This phase is characterized by a transition from high-speed growth to high-quality development, marking a significant shift in the national economic strategy. Corresponding to this transformation, the concept of the consumer services industry was first introduced and emphasized in China's 11th Five-Year Plan in 2016 (Li et al., 2016). China is currently undergoing socio-economic transformation and upgrading, during which the consumer services industry has gained significant prominence within the national economy.

In the context of China, the service industry is classified into productive services industry and consumer services industry based on their functions (National Bureau of Statistics of China, 2023). The definitions and scopes of these concepts have not yet reached a unified understanding internationally (Wei et al., 2016). Generally, productive



services industry is understood as intermediary service sectors that primarily support the production activities of various market entities (Liu et al., 2023). In contrast, consumer services industry, also known as living services industry (Bai et al., 2021), provides services mainly for residents' final consumption needs (National Bureau of Statistics of China, 2023). Consumer services industry encompasses a wide range of areas that are integral to people's daily lives and are closely related to their quality of life. Consumer services industry is defined as services aimed primarily at consumers, meeting residents' consumption or basic living needs (Chen et al., 2022).

Accelerating the development of consumer services industry, increasing the effective supply of services, expanding service consumption demand, and improving service quality can further strengthen the foundational role of consumption in economic development. This, in turn, enhances people's sense of gain and happiness, promoting a shift in consumer lifestyles from survival-based, traditional, and material-oriented to developmental, modern, and service-oriented.

Therefore, a comprehensive understanding of the development characteristics and dynamics of the consumer services industry holds significant strategic importance. For example, the real estate industry occupies a significant position in China's economy, especially against the backdrop of accelerated urbanization and rising household incomes, leading to continuous expansion of the real estate market. In recent years, the government has implemented a series of policies to regulate housing prices, maintain market stability, and prevent the formation of real estate bubbles. By analyzing the distribution, types, and influencing factors of the real estate industry in different regions, it is possible to better identify development opportunities and potential risks, thereby formulating targeted

measures to promote the sustainable development of the real estate industry and related sectors. This is crucial for achieving industrial upgrading and enhancing the overall level of the national economy.

Transitioning to regional economic dynamics, the economic performance of Shandong Province provides a practical illustration of these strategic imperatives. In 2022 Shandong Province achieved a notable regional GDP of 8,743.51 billion yuan, reflecting a 3.9% increase compared to the previous year when adjusted for constant prices (Wu, 2023). The province's economic structure was characterized by substantial contributions across sectors: the primary industry saw an added value of 629.86 billion yuan, marking a 4.3% increase; the secondary industry contributed 3,501.42 billion yuan, growing by 4.2%; and the tertiary industry, including the service sector, added 4,612.23 billion yuan, with a growth rate of 3.6% (Shandong Provincial Bureau of Statistics, 2024). The service industry notably contributed 50.6% to the province's economic growth (Wang, et al., 2024); underscoring its pivotal role in driving regional economic expansion. Moreover, revenues from enterprises above the designated size within the service sector increased by 6.6% compared to the previous year (Shandong Provincial Bureau of Statistics, 2024), highlighting the sector's resilience and contribution to overall economic performance.

Key industries showed significant support, with revenue from information transmission, software, and information technology services, leasing and business services, and scientific research and technical services increasing by 12.5%, 12.1%, and 9.2%, respectively (Shandong Provincial Bureau of Statistics, 2024). However, the consumer market experienced a slowdown. The total retail sales of consumer goods amounted to 3,323.62 billion yuan, a decline of 1.4% from the previous year. Specifically, catering



revenue was 362.77 billion yuan, down 5.2%, while retail sales of goods were 2,960.85 billion yuan, down 0.9% (Shandong Provincial Bureau of Statistics, 2024). Urban retail sales of consumer goods decreased by 1.5% to 2,795.75 billion yuan, and rural retail sales dropped by 1.0% to 527.87 billion yuan (Shandong Provincial Bureau of Statistics, 2024). Quality-oriented consumption maintained a positive growth trend, with retail sales of books, newspapers, and magazines, cosmetics, and gold, silver, and jewelry from units above the designated size increasing by 4.1%, 19.4%, and 4.1%, respectively (Shandong Provincial Bureau of Statistics, 2024). Demand for green upgrade consumption continued to be released, with retail sales of new energy vehicles and household appliances with energy efficiency levels of 1 and 2 from units above the designated size growing by 125.3% and 24.8%, respectively. Online retail sales reached 669.87 billion yuan, a 7.5% increase over the previous year (Shandong Provincial Bureau of Statistics, 2024). Online retail sales of physical goods were 595.71 billion yuan, an increase of 9.6%, accounting for 17.9% of the total retail sales of consumer goods, up 3.8 percentage points from the previous year (Shandong Provincial Bureau of Statistics, 2024). These economic indicators not only validate the strategic emphasis on developing the consumer services industry but also underscore its critical role in bolstering regional economic resilience and advancing national economic objectives. The alignment of provincial economic growth with the goals set forth in national economic strategies emphasizes the interconnectedness of sectoral development with broader economic agendas, illustrating the imperative of nurturing robust and adaptable service sectors in achieving sustainable economic development across China.

Shandong Province, endowed with abundant resources and a robust industrial foundation, has significantly contributed to China's national economy. Its economic





development has had a profound impact on the country's overall economic performance (Wang et al., 2022). However, Shandong's economic growth has been hampered by challenges related to economic transformation, including a narrow industrial structure, severe structural and institutional issues, and substantial resource depletion. Consequently, there is an urgent need to develop the consumer services industry to diversify and sustain economic growth (Vîrjan, 2023).

Despite the potential, the development pace of the consumer services industry varies considerably across different cities within Shandong Province, leading to significant intra-provincial disparities (Xun et al., 2019). This study aims to analyze and understand the output of the consumer services industry in Shandong Province, using an advanced spatial econometric approach. Specifically, this study incorporated energy input into Cobb-Douglas production function and embedded spatial distance matrix as a weighted parameter to explain the spatial heterogeneity of consumer service industry. Moreover, it emphasizes the importance of economic cooperation and coordination to promote high-quality growth and balanced development in the consumer services industry of Shandong Province (Liu et al., 2022).

So, this study selects Shandong Province as a case study area for analyzing the consumer services industry, primarily based on its significant economic status and development potential as one of China's major economic provinces. With a population of over one hundred million in both registered and permanent residents (Liu et al., 2022), Shandong boasts a substantial economic aggregate and expansive consumer market, capable of showcasing the diversity and development trends within the consumer services sector (Gu et al., 2024). Furthermore, Shandong Province has accumulated rich experience





through economic system reforms and market liberalization, rendering its development trajectories and dynamics within the consumer services industry representative and exemplary (Li et al., 2023). Considering Shandong Province's comprehensive statistical data and research resources, choosing this province as a research subject facilitates a thorough understanding of local economic development characteristics and influencing factors, thereby providing critical insights for formulating differentiated policies and sharing experiences.

However, there is a clear disparity in the output of the consumer services industry among prefecture-level cities in Shandong Province. Coastal cities such as Qingdao, Yantai, and Weihai exhibit higher levels of output due to their geographic advantages and advanced economic development, bolstered by well-developed tourism and commercial service infrastructure. In contrast, inland cities like Jinan and Tai'an maintain relatively stable output in the consumer services sector, largely due to their roles as provincial capitals and regional centers. Other prefecture-level cities tend to have lower outputs, facing challenges such as inadequate infrastructure and limited market size. These disparities impact not only the overall economic development of each city but also significantly affect consumer service levels and employment opportunities. Such spatial unevenness is often referred to as spatial heterogeneity (Dziauddin et al., 2015). The first law of geography states that everything is related to everything else, but near things are more related than distant things (Tobler, 1970). This principle underscores the inherent spatial relationships between geographical entities or attributes. Specifically, geographical features or attributes exhibit stronger correlations with one another when they are in close proximity. However, as geographical distance increases, these correlations diminish. Understanding these disparities is crucial because regional imbalances in the development of the consumer





services industry significantly impact overall regional economic growth (Calero et al., 2020). Addressing these imbalances requires measuring the spatial heterogeneity of the consumer services industry within Shandong Province, which holds both theoretical and practical significance. By identifying the factors contributing to these regional disparities, targeted strategies can be developed to promote balanced and sustainable growth across different regions.

So, this study employs a comprehensive spatial econometric analysis of the output of the consumer services industry in Shandong Province, providing insights into optimizing industry output and identifying potential growth drivers. The findings offer solutions for improving the output of the consumer services industry and serve as a decision-making reference for leveraging economic growth under the new normal. The analytical framework used encompasses correlation identification, econometric regression, result interpretation, and improvement path formulation, scientifically revealing the spatial heterogeneity of the consumer services industry's output. This approach aims to enhance spatial econometric research in economic geography, providing new perspectives and methodologies for improving industry output. Additionally, this research seeks to expand the application fields of spatial econometrics by offering targeted policy recommendations.

This study focuses on Shandong Province, China, to investigate the influencing factors of the output of the consumer services industry. It comprehensively considers the impacts of capital, labor, and energy inputs on the output of this sector. Capital input refers to the financial resources invested in the consumer services industry. This includes investments in infrastructure, technology, and business operations. Higher capital input can lead to better service quality, enhanced operational efficiency, and the ability to attract more





consumers, thereby increasing industry output. Cities with higher capital investments tend to have more developed consumer service sectors, with better facilities and services that can cater to a larger consumer base. Labor input refers to the human resources employed in the consumer services industry. This encompasses the number of workers, their skills, and productivity. A larger and more skilled labor force can provide better and more efficient services, which can attract more consumers and boost industry output. Cities with a larger, skilled labor force will likely have a more vibrant consumer services industry, capable of offering diverse and high-quality services. Energy input refers to the amount and type of energy consumed by the consumer services industry. This includes electricity, gas, and other energy sources used in operating businesses. Efficient energy use and access to reliable energy sources can enhance business operations, reduce costs, and improve service delivery. Cities with better access to energy resources and more efficient energy use are likely to have higher consumer services industry output due to reduced operational costs and improved service reliability. To analyze the spatial variation in the impact of capital, labor, and energy inputs on the output of the consumer services industry across different cities in Shandong Province. The GWR model extends the traditional regression model by allowing the coefficients to vary spatially. This means that the impact of each influencing factor (capital, labor, energy) on the consumer services industry output can differ from one city to another.

Analyze the spatial variation in the coefficients to understand how the impact of each factor differs across cities. Identify cities where each factor has a significant positive or negative impact on the consumer services industry output. Provide policy recommendations based on the findings to help optimize resource allocation and enhance industry output. By following this framework, the study aims to provide a detailed





understanding of the spatial heterogeneity in the consumer services industry output in Shandong Province and offer insights for targeted policy interventions.

So, this study selects relevant economic development data from 16 cities in Shandong Province for the year 2022. The rationale for using 2022 data to evaluate the spatial heterogeneity of the consumer services industry output in Shandong Province is as follows: First, the 2022 data represent the most recent annual statistical information, providing a more accurate reflection of the current development status and trends of the consumer services industry in Shandong Province. Second, the 2022 data has been published by the Shandong Provincial Bureau of Statistics, ensuring high data completeness and availability, which guarantees the reliability and accuracy of the analysis. Third, 2022 marks an important year for China's economy entering the phase of the "new normal," where the effects of economic restructuring and industrial upgrading policies began to emerge. Using 2022 data can better capture the impact of these changes on the consumer services industry. Fourth, in recent years, Shandong Province has introduced a series of policy measures aimed at economic development, industrial upgrading, and consumption promotion. Analyzing the 2022 data allows for the evaluation of these policy implementations and their actual impact on the output of the consumer services industry. Fifth, 2022 represents a critical juncture for the global economic impact of the pandemic. Using data from this year enables the analysis of the pandemic's impact and recovery on Shandong Province's consumer services industry, providing valuable insights for future industrial development and policy formulation. Therefore, using 2022 data to evaluate the spatial heterogeneity of the consumer services industry output in Shandong Province not only provides the most up-to-date and accurate information but also offers robust support for policy evaluation and future planning.



1.2 Background of the Study

Geographical attributes or phenomena are not evenly distributed across space, resulting in spatial imbalances and increasing complexity in their distribution patterns (He et al., 2023). This variability in spatial relationships and distribution is generally referred to as spatial heterogeneity, which highlights the non-uniform nature of geographical phenomena and their tendency to vary across different locations (Yu et al., 2023). Understanding spatial heterogeneity and spatial autocorrelation is crucial for regional economic analysis. It allows researchers to capture the complex and varied nature of economic phenomena across different geographical areas. This understanding informs more effective and targeted policy interventions aimed at addressing regional disparities and promoting balanced economic growth.

In any given region, economic phenomena are likely correlated with similar phenomena in adjacent regions (Batrancea et al., 2023). This interdependence manifests as spatial autocorrelation, where economic activities or outcomes in one area are influenced by those in neighboring areas. Consequently, spatial imbalance arises from the uneven distribution of economic activities, resources, and development levels across different regions, leading to disparities in economic performance and development. Therefore, these spatial imbalances underscore the need to analyze and understand the spatial heterogeneity of economic phenomena to address regional disparities effectively.

Anselin (1988) emphasized the importance of spatial analysis in understanding these dynamics. He highlighted that spatial autocorrelation and spatial imbalance are fundamental aspects of economic geography that need to be considered when analyzing



regional economic phenomena. By accounting for these spatial aspects, researchers and policymakers can better understand the underlying factors driving economic outcomes and develop strategies that are more attuned to the unique spatial characteristics of each region.

Therefore, Michael Goodchild (2004) proposed the second law of geography, known as the Law of Spatial Heterogeneity. This law posits that spatial isolation leads to differences among geographical entities, resulting in heterogeneity (Lavrikova et al., 2023). Spatial heterogeneity is further divided into two types: spatial local heterogeneity and spatial stratified heterogeneity (Wang et al., 2024). Spatial local heterogeneity refers to the variation that occurs within a localized area (Zhang et al., 2024). This type of heterogeneity is evident when distinct differences exist within a small geographical space, influenced by localized factors such as micro-climates, localized resources, or specific land uses. Spatial stratified heterogeneity, on the other hand, encompasses variations that occur across larger, more defined strata or regions (Hu et al., 2024). This form of heterogeneity is observed when there are distinct differences across broader geographical scales, influenced by factors such as regional policies, broader economic conditions, or larger-scale environmental factors. In the context of an increasingly specialized and fine-grained social division of industries, spatial heterogeneity exerts a profound impact on industrial outputs. The intricate variations in geographical factors and localized conditions mean that industrial outputs are significantly influenced by the spatial context in which they operate (Zheng et al., 2023). The study of spatial heterogeneity's impact on industrial outputs has become a crucial research focus within the field of economic geography (Qin et al., 2023). Researchers are increasingly interested in understanding how spatial variations and the unique characteristics of different regions affect industrial productivity, efficiency, and growth. This interest is driven by the need to develop more precise and effective economic





policies that account for the spatial dimensions of economic activity. The recognition of spatial heterogeneity allows for a more nuanced analysis of industrial outputs, acknowledging that industries do not operate in a vacuum but are deeply embedded within their geographical contexts. By examining spatial local heterogeneity and spatial stratified heterogeneity, researchers can uncover the specific spatial factors that contribute to industrial performance, leading to more tailored and region-specific economic strategies. The Law of Spatial Heterogeneity underscores the importance of considering spatial variations in economic analyses. As industries become more specialized and the division of labor becomes finer, understanding the spatial dimensions of industrial outputs becomes increasingly essential for fostering regional economic development and addressing disparities across different geographical areas.



However, when the research perspective focuses on the spatial difference of the output of consumer service industry in Shandong Province, the performance is particularly outstanding, which arouses scholars' strong research interest. The current discussions regarding the spatial heterogeneity of the consumer services industry in Shandong Province encompass several key themes, reflecting ongoing debates among scholars and policymakers. These debates focus on regional disparities (Guo et al., 2020), spatial agglomeration (Yan et al., 2023), the impact of external factors (Li et al., 2022), innovation and transformation (Wang et al., 2022), and the implications for policy formulation (Wang et al., 2023). There is considerable discourse on the causes of regional disparities within Shandong Province. Scholars examine factors such as historical development paths (Liu et al., 2023), local resource endowments (Fan et al., 2023), infrastructure disparities (Cong et al., 2022), and policy interventions (Weng et al., 2022). to understand why certain regions within the province exhibit varying levels of consumer services industry development.





There is debate about whether spatial concentration (agglomeration) or dispersion of economic activities is more desirable for fostering economic growth and development. Some argue that concentration promotes economies of scale, knowledge spillovers, and innovation (Li et al., 2022), while others advocate for dispersed development to mitigate congestion, reduce inequalities, and promote regional balance (Zheng et al., 2022). These debates aim to deepen understanding of the complex dynamics of spatial heterogeneity within Shandong Province's consumer services industry. By informing evidence-based policies, stakeholders' endeavor to promote inclusive and sustainable development that addresses regional disparities, enhances competitiveness, and contributes to the province's overall economic resilience and prosperity.

Although the consumer services industry in Shandong Province has achieved notable progress, it remains a pivotal area requiring substantial development to elevate its scale and sophistication. Currently, the contribution of the service industry's added value to the province's GDP lags behind the national average. Moreover, there exists a significant disparity when compared to economically advanced provinces and cities like Guangdong, Jiangsu, and Zhejiang. The evaluation of spatial heterogeneity in the output of the consumer services industry across different regions of Shandong Province holds substantial significance from a geographical perspective. Understanding this spatial variation is crucial for several reasons. Firstly, analyzing spatial heterogeneity allows for a nuanced understanding of the uneven distribution of economic activities and resources within Shandong Province. This includes identifying regions that exhibit higher or lower levels of consumer services industry development, which can inform targeted interventions to bolster weaker areas and leverage strengths in more developed ones. Secondly, by examining spatial heterogeneity, policymakers and researchers can uncover underlying



factors contributing to disparities in industry performance across regions. This may include differences in infrastructure, human capital, market access, and local economic policies, among others. Thirdly, the geographical perspective provides insights into the spatial dynamics of economic activities and their implications for regional development strategies. It helps in assessing the impact of spatial factors such as geographic location, transportation networks, urban-rural divides, and regional connectivity on the consumer services industry's output and growth potential. Moreover, addressing spatial heterogeneity effectively can contribute to broader economic goals such as promoting balanced regional development, reducing disparities between urban and rural areas, and enhancing overall economic resilience. Therefore, conducting a comprehensive evaluation of spatial heterogeneity in the output of the consumer services industry in Shandong Province not only sheds light on existing challenges but also offers opportunities for targeted policies and strategic interventions. This approach is essential for advancing the province's economic development agenda, improving competitiveness, and achieving sustainable growth in the consumer services sector.

1.3 Problem Statement

The consumer services industry encompasses a wide range of activities that directly engage with customers. However, researchers often have divergent views on the specific categories within this sector due to varying research objectives and frameworks. This divergence underscores the need for a clear and consistent categorization of the consumer services industry. Clarifying these categories is essential not only for academic rigor but also for practical applications in policy-making and economic planning. By building on previous



studies, this research seeks to establish a well-defined framework for understanding the industry categories that constitute the consumer services sector in Shandong Province.

Historical patterns of economic development reveal that the consumer services industry grows within specific spatial contexts, driven by the self-organization of industrial technologies. In Shandong Province, this growth process exhibits distinct spatial characteristics. Prefecture-level cities within the province demonstrate significant levels of communication and interaction in this sector. These interactions encompass cross-market collaboration, experience sharing, inter-city tourism promotion, joint marketing activities, and talent cultivation and exchange. Such interactions and cooperation create a mutually beneficial environment, enhancing the overall development of the consumer services industry and driving its prosperity in Shandong Province. The consumer services industry in Shandong Province forms an integrated entity, where the industrial technology system and the industrial space system interact through technological and spatial correlations. This integration raises critical questions: Is there spatial correlation between the outputs of the consumer services industry in Shandong Province? How does this spatial correlation manifest? Addressing these questions requires a theoretical exploration from both industrial technology and industrial space perspectives, thereby enriching our understanding of the spatial dynamics of the industry.

Economic activities and resources are not evenly distributed across regions, resulting in spatial imbalances and disparities in economic performance and development levels. In Shandong Province, there is a notable supply-demand relationship between regions in terms of labor, products, capital, information, and technology. The complementarity of factor resources between regions is based on specific economic ties, and the intensity of spatial



interaction is directly proportional to regional complementarity (Ding et al., 2022). Statistics indicate significant variation in the output of the consumer services industry across Shandong Province, with a lack of regional cohesion. The differing development levels of the consumer services industry in each city contribute to imbalances in spatial distribution, resulting in spatial heterogeneity. This spatial heterogeneity highlights the uneven nature of economic development, where some cities are more developed and others lag behind, leading to disparities in service provision and economic opportunities.

1.4 Research Questions

There are three research questions that are raised to answer the problem statements in this research.

- i. What are the main categories of the consumer services industry?

To address the first research question, this study will utilize quantitative methods to define the major categories of the consumer services industry. By considering the final demand rate as a crucial criterion, the study will systematically identify and categorize the service industries within the national economic industry classification. This process aims to establish a comprehensive and precise delineation of the consumer services industry.

- ii. How about the mutual influence degree (spatial correlation) of the output of consumer service industry among different prefecture-level cities in Shandong Province?

The research question number two aims to determine the presence and extent of the

mutual influence degree (spatial correlation) in the output of the consumer services industry across different regions of Shandong Province. To assess whether regional economic outputs are spatially correlated, Moran's Index (Moran's I), a widely recognized measure of spatial autocorrelation, will be utilized. By analyzing the values of Moran's I, the study seeks to uncover patterns of spatial dependence and interaction among the regions, providing insights into the mutual influence exerted by different cities on the consumer services industry within the province. This analysis is crucial for understanding the spatial dynamics and potential spillover effects that may exist within the region.

- iii. How is the spatial heterogeneity of the output of consumer service industry in Shandong Province?

Research question number three will explore the variability and complexity of the spatial distribution of the consumer services industry's output. Spatial heterogeneity implies that the influence of explanatory variables may vary across different locations. To address this, the study will utilize the geographically weighted regression (GWR) model, which allows for spatially varying coefficients. By applying GWR to cross-sectional data, the study aims to capture the nuanced spatial variations in the output of the consumer services industry, providing a detailed understanding of how these factors differ across Shandong Province.

Each of these research questions is designed to systematically investigate different aspects of the consumer services industry in Shandong Province, providing a comprehensive analysis of its structure, spatial relationships, and variability.

1.5 Research Objectives

This study aims to analyze and understand the output of the consumer services industry in Shandong Province, using an advanced spatial econometric approach. Specifically, this study incorporated energy input into Cobb-Douglas production function and embedded spatial distance matrix as a weighted parameter to explain the spatial heterogeneity of consumer service industry. The research aims to achieve the following specific objectives:

- i. to clarify the Categories Involved in the Consumer Services Industry.

The first objective aims to clearly define and categorize the consumer services industry in Shandong Province according to the industry classification of the National Economy of the People's Republic of China (GB/T 4754-2017). The industry classification provides a systematic categorization of industries in China's economy, reflecting the diversity and complexity of economic activities (Zhao et al., 2024). These categories illustrate the breadth of economic activities and their importance in contributing to the overall economic structure (Ma et al., 2024). This structured approach helps in recognizing the interdependencies among different sectors and supports the goal of achieving sustainable economic growth (Yue et al., 2024). By considering the specific context of Shandong's consumer services sector and drawing on both domestic and international theoretical frameworks, this research will categorize the industry into key segments, including wholesale and retail trade, accommodation and catering, real estate industry, leasing and business services, residential services, repairs and other services, health and social work, culture, sports and entertainment and other services. This categorization will facilitate a more nuanced analysis of the sector and provide a clearer understanding

of its composition.

- ii. to test the Spatial Correlation of the Output of the Consumer Services Industry in Shandong Province.

The second objective focuses on examining the spatial correlation of the consumer services industry's output across 16 cities in Shandong Province in 2022. By analyzing spatial interdependence, the study will use binary rook and queen neighborhood weight, k-nearest neighbors, and threshold distance methods to calculate Moran's Index. This will help in identifying and understanding the spatial patterns and interactions within the consumer services sector, providing insights into how different cities influence each other's economic activities.

- iii. to Calculate the Spatial Heterogeneity of the Output of the Consumer Services Industry in Shandong Province.

The third objective aims to quantify the spatial heterogeneity in the output of the consumer services industry in Shandong Province. Using cross-sectional data from 2022 and the Geographically Weighted Regression (GWR) model implemented through GWR4 software, this research will estimate the output behaviors of the consumer services industry while considering spatial heterogeneity. Additionally, the study will compare these results with those from global regression models to highlight the limitations of traditional OLS methods in capturing spatial variability.

By achieving these objectives, this research will provide a comprehensive understanding of the factors influencing the output of the consumer services industry in Shandong Province. The findings will inform policymakers and stakeholders on how to

optimize resource allocation and enhance the sector's performance through targeted interventions that consider spatial heterogeneity.

1.6 Research Hypothesis

In investigating the spatial dynamics of the consumer services industry in Shandong Province, this study formulates the following hypotheses to guide the analysis and interpretation of the spatial econometric models:

Hypothesis One: Spatial Correlation of Industry Output

H1: There is no significant spatial correlation in the output of the consumer services industry across different cities in Shandong Province.

H2: There is significant spatial correlation in the output of the consumer services industry across different cities in Shandong Province.

Rationale: This hypothesis posits that the economic outputs of consumer services in one city are influenced by those in neighboring cities, indicating a spatial interdependence. The Moran's Index (Moran's I) will be used to test this hypothesis, expecting positive spatial autocorrelation indicative of regional economic interactions and dependencies.

Hypothesis Two: Spatial Heterogeneity of Industry Output

H1: The output of the consumer services industry not exhibits spatial heterogeneity across Shandong Province, with the impact of capital, labor, and energy inputs varying by location.

H2: The output of the consumer services industry exhibits spatial heterogeneity across Shandong Province, with the impact of capital, labor, and energy inputs varying by location.

Rationale: Given the diverse economic landscapes and varying levels of development across Shandong Province, it is hypothesized that the influence of key inputs (capital, labor, energy) on industry output is not uniform. The geographically weighted regression (GWR) model will test this hypothesis by allowing coefficients to vary spatially, thus capturing the localized effects and revealing significant regional differences.

These hypotheses will be rigorously tested using spatial econometric techniques and comprehensive data analysis, providing a nuanced understanding of the spatial dynamics and contributing factors to the consumer services industry's output in Shandong Province.

1.7 Theoretical and Conceptual Framework of Research

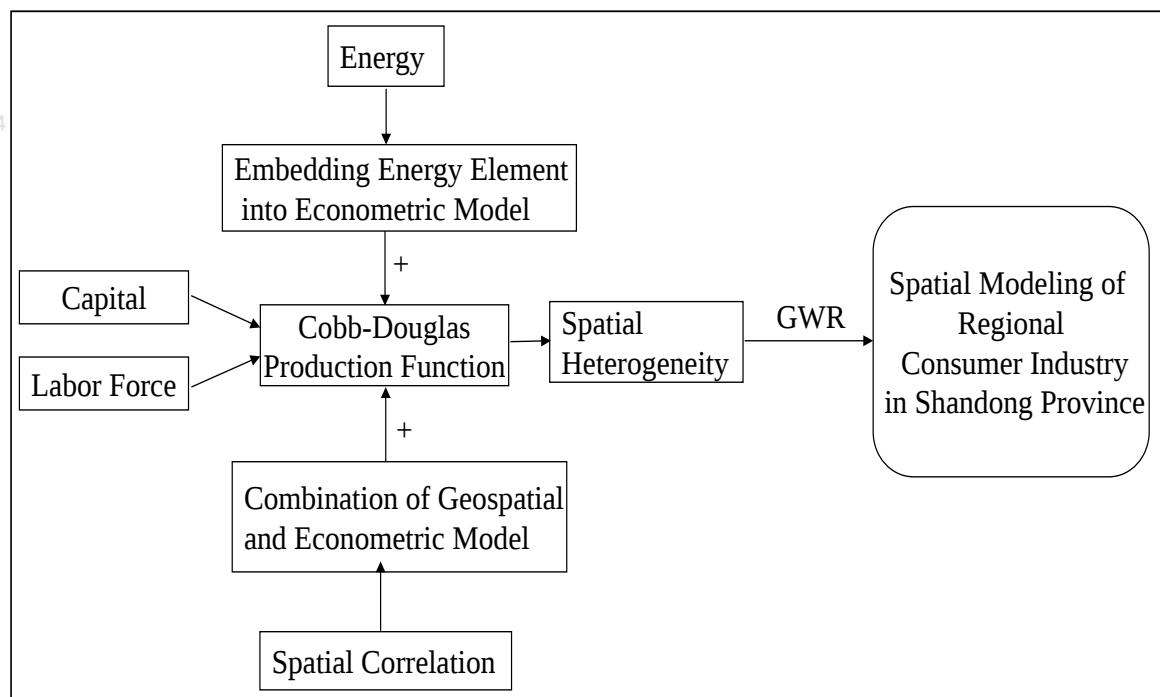
Research on the spatial modeling of regional consumer services industry in Shandong province is continuously evolving. Understanding the progress of related disciplines in this area will help clarify and further explain the basic concepts and core contents of spatial heterogeneity effects on industrial output. As a critical research perspective for geographers, spatial cognition provides a robust framework for assessing the impact of spatial heterogeneity on industrial output. The main logic of research on the impact of spatial heterogeneity on industrial output in economic geography can be summarized as the continuous deepening of the understanding of spatial heterogeneity and the ongoing

exploration of its realistic applications in industrial output. This research aims to construct a theoretical framework that progresses from causality to cognitive processes, and then to structure, rules, and behavioral decision-making (Figure1.1).

By clearly defining research questions, formulating hypotheses, establishing a theoretical framework, collecting and processing data, employing scientific analysis methods, interpreting research results, and proposing policy recommendations, this study forms a comprehensive research paradigm.

Figure 1. 1

Conceptual and Theoretical Framework of Research



The interrelated and progressively structured components ensure the systematicity and scientific rigor of the research. This paradigm not only provides new perspectives and methods for studying the consumer services industry in Shandong Province but also offers important empirical support for related policy formulation.



The theoretical framework provides the foundation and guidance for the research. The theoretical framework of this study primarily includes the Cobb-Douglas production function and the GWR model. The Cobb-Douglas production function is used to analyze the contribution of capital, labor, and energy inputs to economic output. By incorporating the energy factor, it comprehensively reflects the output state of the consumer services industry in Shandong Province. The GWR model is employed to analyze spatial heterogeneity, capturing regional nuances by allowing regression coefficients to vary with geographical location. Data collection is the foundation of the research, and ensuring the accuracy and completeness of the data is crucial. This study uses data from the consumer services industry across various cities in Shandong Province in 2022, processed and analyzed through statistical and spatial analysis tools. The analysis methods are the core component of the research. This study primarily employs the following methods: Moran's I index is used to test the spatial correlation of consumer services industry output, identifying the mutual influence of economic activities between regions. The GWR model is used to assess spatial heterogeneity, analyzing influencing factors across different geographical locations through the geographically weighted regression model.

During the analysis process, the research results will reveal the main categories, spatial correlation, and spatial heterogeneity of the consumer services industry in Shandong Province. These results will provide the basis for discussion, furthering the understanding of the spatial distribution and intrinsic interaction mechanisms of the consumer services industry across various cities. Based on the research findings, targeted policy recommendations will be proposed. By optimizing resource allocation and implementing targeted policies, the balanced development of the consumer services industry in Shandong Province can be promoted, achieving coordinated regional economic progress.





The concept and connotation of spatial heterogeneity affecting industrial output are continually developing. Initially, these concepts represented the subjective cognitive image of static industrial output spatial information. Over time, they evolved to express the process of spatial perception and spatially-aware information processing on how industrial output is affected by spatial heterogeneity. This also includes the judgment of participating in their own behavioral decision-making. The influence of spatial heterogeneity on industrial output is characterized by a combination of dynamic subjective processing and static image result representation.

The influence of spatial heterogeneity on industrial output requires further attention to several key aspects. Firstly, understanding how the attributes of cognitive subjects (such as researchers or policymakers) and their cognitive processes affect their perception and interpretation of spatial heterogeneity. Secondly, investigating how the scale at which spatial heterogeneity is examined (local, regional, national) influences the perceived impact on industrial output. Thirdly, exploring how inputs to major factors of production, such as capital, labor, and energy, affect spatial cognitive outcomes and thus industrial output.

Research on the impact of spatial heterogeneity on industrial output includes not only the analysis of subjects and objects, processes, structures, and their interrelationships but also the consideration of higher dimensions and more related objects. This holistic approach reflects the complexity of subjective cognition, acknowledging that future research will need to incorporate these diverse and multifaceted elements to provide a comprehensive understanding of spatial modeling of the regional consumer services industry in Shandong Province.





In the context of spatial heterogeneity in the consumer services industry in Shandong Province, the conceptual framework may involve several components. These can include theories or models related to regional economics, economic geography, and industrial development. For example, concepts such as spatial heterogeneity, regional disparities, agglomeration, and the impact of external factors can be incorporated into the framework.

The conceptual framework also considers specific variables relevant to the consumer services industry, such as output, capital, labor force, and energy consumption. These variables are chosen based on their significance in understanding spatial heterogeneity and the impact they have on the industry's performance across different regions.

The framework may incorporate theories related to economic growth, such as growth pole theory, center-periphery theory, and unbalanced growth theory. These theories provide insights into the spatial patterns of economic development, the concentration of economic activities, and the dynamics between core and peripheral regions.

The conceptual framework of the research establishes a theoretical basis for investigating spatial heterogeneity in the consumer services industry. It helps guide the selection of variables, the formulation of research questions, and the interpretation of findings, ultimately contributing to a deeper understanding of the spatial dynamics and patterns within the industry in Shandong Province.





1.8 Consumer Services Industry

The consumer services industry primarily refers to sectors focused on providing services directly to consumers (Carlborg et al., 2014; Tajeddini et al., 2023). This industry's continuous development aligns with the evolving consumption patterns of residents, catering to the increasing demand for diverse and sophisticated service products. By expanding the supply of various service offerings, the consumer services industry plays a pivotal role in meeting the dynamic and multifaceted needs of consumers.

In this research, the consumer services industries under analysis encompass a broad range of sectors. These include wholesale and retail trade, accommodation and catering, real estate industry, leasing and business services, residential services, repairs and other services, health and social work, culture, sports and entertainment, among others. Each of these sectors contributes uniquely to the overall landscape of the consumer services industry, collectively driving economic growth and enhancing the quality of life for residents.

The gross economic value generated by the consumer services industry is a key metric used to assess its development and impact (Sturgeon et al., 2012; Agag et al., 2020). This measure reflects the industry's contribution to the economy, capturing the total output and economic activity generated by consumer-oriented service sectors. By analyzing the gross economic value, researchers and policymakers can gain insights into the health and growth trajectory of the consumer services industry, identifying areas of strength and potential for further development.





Moreover, the gross economic value serves as an indicator of the industry's ability to adapt to changing consumer preferences and economic conditions. It highlights the significance of consumer services in the broader economic context, emphasizing the need for continuous innovation and investment in these sectors to sustain growth and meet the rising expectations of consumers.

The consumer services industry, characterized by its focus on consumer-oriented services, is integral to the modern economy. Its development is crucial for responding to the upgrading consumption trends of residents and for expanding the supply of service products to meet diverse needs. The gross economic value of the consumer services industry provides a comprehensive measure of its development, underscoring its importance in driving economic progress and improving the standard of living.



1.9 Capital

Capital is a collective term for various social and economic resources utilized by humans to create both material and spiritual wealth (Lang et al., 1998; Yamaguchi et al., 2023). It encompasses the economic means and essential production factors that drive human development, shaping the distribution forms within a market economy (Bliss, 2014; Naseemullah, 2023). The nature and forms of capital have evolved alongside changes in production modes and technological advancements. Throughout history, capital has transitioned through various stages: from commodity capital and monetary capital during the agricultural era, to industrial capital, commercial capital, and bank capital in the industrial and commercial era. In the information age, capital has further transformed into



mixed capital, financial monopoly capital, and international monopoly capital groups.

In this study, the term capital specifically refers to the material elements invested in the consumer services industry. This encompasses a wide range of physical and financial resources dedicated to the growth and development of sectors within the consumer services industry. By examining these capital investments, this study can better understand the factors driving the expansion and efficiency of consumer services.

The role of capital in the consumer services industry is multifaceted. It includes investments in infrastructure, technology, human resources, and other tangible assets that facilitate the provision of services. For instance, capital investments in accommodation and catering services may involve building hotels and restaurants, purchasing advanced kitchen equipment, and training staff to enhance service quality. Similarly, in sectors like real estate and leasing services, capital investments might include the development of properties, procurement of advanced leasing technologies, and marketing efforts to attract clients.

Capital is not just a static resource; it dynamically influences the competitive landscape and innovation within the industry. The allocation and utilization of capital can significantly affect the efficiency, productivity, and overall competitiveness of the consumer services industry. Businesses that effectively leverage capital investments are often able to introduce new services, improve existing ones, and expand their market presence, thereby driving economic growth and meeting the evolving demands of consumers.

Capital is a fundamental concept encompassing the various social and economic resources used to generate wealth. Its evolution through different historical stages reflects the changing dynamics of production and technology. In the context of this study, capital

refers to the material investments made in the consumer services industry, highlighting its critical role in fostering growth, enhancing service quality, and ensuring the industry's overall development and competitiveness.

1.10 Labor Force

Labor force is the most important economic resource and production factor, playing a crucial role in the functioning and growth of any economy (Wijaya et al., 2021). In the context of a market economy, labor force refers to social groups that possess the potential to be employed, encompassing individuals who are willing and able to work (Dreze, 1976; Maqsoom et al., 2023). The value of labor is inherently tied to the value of the means of life necessary for the reproduction of labor, such as food, housing, healthcare, and education. This value is determined by the cost of sustaining the workforce and enabling its continued productivity.

Through the employment relationship in the labor commodity exchange market, the combination of labor and capital can be realized. This relationship is fundamental to the production process, where labor contributes its skills, effort, and time, while capital provides the necessary resources and infrastructure. The synergy between labor and capital is essential for producing goods and services, fostering innovation, and driving economic growth.

In this research, labor force specifically refers to the employed population within the consumer services industry. This includes individuals working in various sectors such as



wholesale and retail, accommodation and catering, real estate, leasing and commercial services, residential services, and repair and other service industries. The contribution of labor in these sectors is pivotal, as it directly impacts service delivery, customer satisfaction, and overall industry performance.

The labor force in the consumer services industry encompasses a diverse range of occupations, from frontline service providers like salespersons, waitstaff, and hotel employees, to managerial and administrative roles that oversee operations and strategic planning. Each role within this labor force is vital, contributing uniquely to the industry's functionality and efficiency. For instance, frontline workers are essential for ensuring a positive customer experience, while managers and administrators are crucial for optimizing business processes and driving growth.



The skills, training, and experience of the labor force significantly influence the quality and competitiveness of services offered. Investing in the development of the labor force through education, training programs, and professional development opportunities is essential for enhancing productivity and fostering innovation within the industry. A well-trained and motivated labor force can adapt to changing market demands, incorporate new technologies, and maintain high standards of service, thereby contributing to the industry's sustained growth and success.

The labor force is a fundamental economic resource and production factor, crucial for the functioning of the market economy. It represents the employed population's potential and value, determined by the necessary means for its reproduction. In the consumer services industry, the labor force plays a vital role, encompassing a wide range of occupations and contributing significantly to service delivery and industry performance. Understanding and





investing in the labor force is essential for fostering growth, enhancing competitiveness, and ensuring the industry's overall development.

1.11 Energy

Energy is a critical input for economic and social development, underpinning a wide range of industrial and societal activities (Stern, 2011; Batra, 2023). Energy products, such as those derived from coal mining, oil and natural gas extraction, and the production and supply of electricity and thermal power, are intricately linked with various non-energy industries (Yang et al., 2022). The vast majority of energy products are used as intermediate inputs rather than for final consumption, emphasizing their essential role in driving production processes across diverse sectors.



In the context of sustainable economic and social development, it is crucial to focus on the "production factors" of the energy industry. These factors include the availability, efficiency, and sustainability of energy resources. The energy sector's ability to provide reliable and affordable energy is fundamental to supporting industrial operations, technological advancements, and overall economic growth.

In this research, energy specifically refers to the energy inputs used within the consumer services industry. This includes the energy required for operating various facilities, such as hotels, restaurants, retail stores, real estate developments, and other service-oriented businesses. The efficient use of energy in these sectors is vital for maintaining service quality, reducing operational costs, and minimizing environmental impact.





The consumer services industry relies on a stable and efficient energy supply to power daily operations, from lighting and heating to running electronic devices and machinery. For instance, hotels and restaurants need significant amounts of energy for cooking, heating, and cooling, while retail stores require energy for lighting, refrigeration, and other utilities. Ensuring the efficient use of energy in these operations can lead to substantial cost savings and enhance the sustainability of the industry.

The adoption of energy-efficient technologies and practices is becoming increasingly important in the consumer services industry. Implementing energy-saving measures, such as LED lighting, energy-efficient appliances, and advanced heating and cooling systems, can significantly reduce energy consumption and contribute to environmental sustainability. Businesses that prioritize energy efficiency not only reduce their carbon footprint but also improve their competitive edge by lowering operational costs.

Energy is a vital input for economic and social development, essential for supporting a wide range of industrial and societal activities. The energy sector's products serve primarily as intermediate inputs, highlighting their critical role in production processes. In the context of the consumer services industry, energy inputs are necessary for maintaining operations, ensuring service quality, and promoting sustainability. Focusing on energy efficiency and sustainable practices within this industry is crucial for reducing costs, enhancing competitiveness, and supporting broader environmental goals.





1.12 Cobb-Douglas Production Function

The Cobb-Douglas production function was originally created by the American mathematician Charles W. Cobb and the economist Paul H. Douglas (Douglas, 1976; Hanan et al., 2023). This function emerged from their discussions on the relationship between input and output, leading to the development of an economic mathematical model designed to predict the production capabilities of national and regional industrial systems or large enterprises. Commonly referred to as the production function, this model is distinguished by its widespread application in economic analysis.

As the most widely used form of production function in economics, the Cobb-Douglas function has become a cornerstone in the fields of mathematical economics and econometrics. Its importance lies in its ability to represent the output of an economy or a firm as a function of input factors, typically labor and capital, while incorporating the effects of technological progress. The function is expressed in the form:

$$Y = AL^{\alpha}K^{\beta}$$

where Y represents the total output, L denotes the labor input, K signifies the capital input, A is a constant representing total factor productivity, and α and β are the output elasticities of labor and capital, respectively. These elasticities measure the responsiveness of output to changes in labor and capital inputs.

The significance of the Cobb-Douglas production function extends beyond theoretical modeling. It has practical applications in analyzing how different factors contribute to economic growth, efficiency, and productivity. By estimating the parameters α and β , economists can infer the relative contributions of labor and capital to the production process,





as well as the degree of returns to scale.

In the context of policy-making, the Cobb-Douglas function provides valuable insights into the potential impacts of investment in capital, changes in labor force participation, and technological advancements. For instance, policymakers can use the function to simulate the effects of increasing capital investment on economic output or to evaluate the potential benefits of labor market reforms.

The Cobb-Douglas production function has been instrumental in the development of growth theories, including the Solow growth model, which incorporates the function to explain long-term economic growth through capital accumulation, labor growth, and technological progress.



The Cobb-Douglas production function, created by C.W. Cobb and P.H. Douglas, is a fundamental economic model used to predict production outputs and analyze the development of industrial systems and large enterprises. Its widespread application in mathematical economics and econometrics underscores its importance in understanding the dynamics of input-output relationships and informing economic policy and growth theories.

1.13 Spatial Correlation

Spatial correlation statistics are used to measure a fundamental property of geographic data: the degree of mutual dependence between data at one location and data at other locations (Wheeler et al., 2005). This dependence, often referred to as spatial dependency, captures





the extent to which the value of a variable at a specific location is influenced by values of the same variable at surrounding locations.

Spatial correlation statistics provide critical insights into spatial patterns and relationships within geographic datasets. These statistics help identify whether similar values cluster together or if there is a systematic pattern of variation across space. Spatial dependency can manifest in various forms, such as positive spatial autocorrelation, where similar values occur near each other, or negative spatial autocorrelation, where dissimilar values are adjacent.

By quantifying spatial dependency, researchers and analysts can better understand the underlying processes that generate observed spatial patterns. This understanding is essential for a range of applications, including urban planning, environmental management, and regional economic analysis. For instance, in urban studies, spatial correlation statistics can reveal the degree of clustering in housing prices, indicating areas of high and low property values.

Recognizing spatial dependency is crucial for accurately modeling and interpreting spatial data. Traditional statistical methods often assume independence between observations, an assumption violated when spatial dependency is present. Therefore, spatial correlation statistics are foundational in developing spatial econometric models that account for these dependencies, leading to more reliable and robust inferences.

Spatial correlation statistics are essential tools for measuring the degree of mutual dependence between geographic data points. This measure, known as spatial dependency,





is pivotal in understanding spatial patterns and ensuring accurate modeling and interpretation of spatial data in various fields.

1.14 Spatial Heterogeneity

Spatial heterogeneity, or spatial difference, refers to the lack of uniformity across regions within a geographical space. This concept captures the existence of diverse economic geographical structures, such as developed and underdeveloped regions, and central (core) and peripheral (edge) areas, which lead to significant spatial disparities in economic and social development as well as innovation behaviors (Goodchild, 2001). Spatial heterogeneity manifests in the varying levels of economic activity, resources, and opportunities available in different locations.

Spatial heterogeneity reflects the inherent instability and variability in the relationships between economic behaviors (such as growth or innovation) across different spatial observation units in economic practice. This variability means that economic outcomes and processes are not evenly distributed across space but are influenced by the unique characteristics and conditions of each region. For example, a region with abundant natural resources and well-developed infrastructure may experience rapid economic growth and innovation, while a neighboring region lacking these advantages may lag behind.

In this study, spatial heterogeneity primarily refers to the imbalance in the spatial distribution of economic phenomena. This imbalance can be observed in various dimensions, such as income levels, employment rates, industrial output, and access to services. Understanding spatial heterogeneity is crucial for identifying the factors that





contribute to regional disparities and for developing targeted policies to promote balanced and inclusive economic development.

The recognition of spatial heterogeneity underscores the need for spatially explicit models and analyses that account for the unique characteristics of different regions. Traditional economic models that assume homogeneity across space may fail to capture the complexities of regional dynamics. Therefore, incorporating spatial heterogeneity into economic analysis allows for more accurate and nuanced insights into the factors driving regional development and innovation.

Addressing spatial heterogeneity is essential for achieving equitable economic growth. Policymakers need to consider the specific needs and potentials of different regions to design effective interventions. For instance, policies aimed at boosting innovation in lagging regions might focus on improving infrastructure, enhancing educational opportunities, and fostering local entrepreneurship.

Spatial heterogeneity denotes the lack of uniformity across regions in geographical space, leading to significant spatial disparities in economic and social development and innovation behaviors. This study focuses on understanding the imbalance in the spatial distribution of economic phenomena, highlighting the importance of spatially explicit analyses and targeted policies to address regional disparities and promote inclusive growth.





1.15 Operation Definitions

The conceptual framework (Table 1.1) of this research encompasses several key components that are essential for a comprehensive analysis of the spatial heterogeneity in the consumer services industry.

Table 1. 1

Conceptual variables and Operational variables

Conceptual variable	Definition from literature	Definition of this study	Operational variable
Spatial heterogeneity	Spatial heterogeneity or spatial difference refers to the lack of homogeneity of regions in the geographical space (Goodchild, 2001; Guo et.al, 2022)	The spatial heterogeneity in this study mainly refers to the imbalance in the spatial distribution of economic phenomena	Gini coefficient, Location quotient, Moran's index
Regional consumer services Industry	Consumer services industry mainly refers to consumer-oriented service industry (Carlborg et.al, 2014; Luo et.al, 2023)	The consumer services industries analyzed mainly include wholesale and retail, accommodation and catering, real estate, leasing and commercial services, residential services, repair, and other service industries	The output of consumer services industry in 16 cities in Shandong Province.
Output of consumer services industry	Gross economic value of consumer services industry (Sturgeon et.al, 2012; Mirzanov et.al, 2023)	Gross output value of consumer services industry	Gross output value of consumer services industry
Capital	Capital is a collective term for various social and economic resources used by humans to create material and spiritual wealth (Lang et.al, 1998; Abbas et.al, 2024)	Capital refers to the material elements invested in the Consumer Services industry	Total assets of consumer services industry enterprises above the limit
Energy	Energy industrial products such as coal mining and dressing products, oil and natural gas mining products, power and thermal production and supply products (Yang et.al, 2022)	Energy input in consumer Services industry	Electricity consumption





It integrates the notion of spatial heterogeneity, which emphasizes the variation in attribute values across different spatial units and the impact of spatial location on parameter estimates. This concept is crucial for understanding how geographical differences influence economic phenomena. The framework includes the regional consumer services industry, which encompasses various sectors such as wholesale and retail, accommodation and catering, real estate, leasing and commercial services, and other service industries. By referring to theoretical definitions from both domestic and international sources, the study ensures a broad and inclusive understanding of the consumer services industry. The research delves into the output, capital, labor force, and energy aspects of the consumer services industry. These variables are critical for analyzing the performance and development of the industry. Output refers to the economic value generated by the industry, while capital, labor force, and energy inputs are essential resources that drive this output.



The study focuses on Shandong Province, a coastal province in East China. Shandong's geographical location and economic significance make it an ideal case for examining the spatial heterogeneity of the consumer services industry. The province's diverse economic landscape and its role in the national economy provide valuable insights into regional disparities and development patterns.

The framework's integration of spatial heterogeneity and the consumer services industry within the context of Shandong Province allows for a detailed exploration of regional economic dynamics. By considering the variation in spatial units and the specific characteristics of the consumer services industry, the study aims to uncover the factors that contribute to spatial disparities and propose strategies for promoting balanced regional development. The inclusion of key variables such as output, capital, labor force, and energy ensure a comprehensive analysis that accounts for multiple dimensions of the industry's





performance. This multi-faceted approach helps in identifying the specific challenges and opportunities within the consumer services industry across different regions of Shandong Province. The conceptual framework of this research incorporates the notion of spatial heterogeneity, the regional consumer services industry, and key variables such as output, capital, labor force, and energy. By focusing on Shandong Province, the study aims to provide a nuanced understanding of the spatial disparities in the consumer services industry and to inform strategies for achieving balanced and sustainable regional development.

1.15.1 Operation Definition of Spatial Heterogeneity

Spatial heterogeneity is an important part of quantitative geography and spatial econometrics. Spatial heterogeneity and spatial homogeneity are both related and different. They emphasize the relationship between attribute values of spatial units and the dependency between attribute values and spatial units.

In the case of traditional regression, given a data sample, only one parameter estimate will be fitted for the two variables x and y , while the spatial heterogeneity means that after the data sample incorporates the spatial geographic location information, the parameter estimates of the two variables x and y will fluctuate with the spatial location of different data observations in the sample, and will no longer be fixed as in traditional regression.



1.15.2 Operation Definition of Regional Consumer Services Industry

This study takes a comprehensive approach to understanding the specific dynamics of the consumer services industry, drawing extensively from theoretical frameworks that define service industry categories both domestically and internationally. The consumer services industries under analysis encompass a wide spectrum, including wholesale and retail, accommodation and catering, real estate, leasing and commercial services, residential services, repair services, and other related services. This holistic approach enables the study to capture the full spectrum of activities and economic contributions within the consumer services industry. It sets the stage for a thorough analysis of spatial heterogeneity and its implications for regional economic development, aiming to provide valuable insights for policymakers, researchers, and stakeholders interested in enhancing the industry's role in sustainable economic growth.

1.15.3 Operation Definition of Output of Consumer Services Industry

The output of the consumer services industry refers to the total gross output value generated by activities within the consumer services sector (Stahel et al., 2024). This encompasses the overall monetary value of goods and services produced by enterprises and organizations engaged in providing services that directly cater to consumer needs. These services typically include hospitality, retail, entertainment, education, healthcare, and other sectors designed to meet the demands of individual consumers. The gross output value is a comprehensive measure that reflects the scale and economic significance of the consumer services industry within a given region or economy, serving as a critical indicator of its

contribution to regional economic development and the well-being of its residents.

1.15.4 Operation Definition of Capital

Capital, in the context of the consumer services industry, refers to the total assets owned by consumer service enterprises that meet or exceed a specified operational threshold (Danda,2024), often termed as "above the limit." This threshold is typically defined by regulatory or statistical standards, which classify enterprises based on criteria such as annual revenue, workforce size, or other indicators of business scale. The total assets encompass all resources owned by these enterprises, including but not limited to financial assets, fixed assets such as property and equipment, inventories, and intangible assets like patents or trademarks. This metric serves as a vital indicator of the financial strength, investment capacity, and overall economic potential of consumer service enterprises within a given region or industry sector. By analyzing the total capital of such enterprises, policymakers and researchers can assess the industry's capacity for growth, resilience, and contribution to the broader economy.

1.15.5 Operation Definition of Labor Force

The labor force in the context of the consumer services industry refers to the annual average number of all employees actively engaged in various activities within the sector over a specific period (Ozgen, 2021). This includes full-time, part-time, and contractual employees who contribute to the production and delivery of goods and services aimed at

meeting consumer demands. The annual average is calculated by aggregating the number of employees at regular intervals throughout the year and then dividing by the total number of intervals, providing a standardized measure that accounts for seasonal or temporary fluctuations in employment levels. This metric serves as a critical indicator of the industry's workforce size, reflecting its employment-generating capacity and its role in the broader labor market. By analyzing trends in the labor force, researchers and policymakers can gain insights into employment dynamics, workforce efficiency, and the socioeconomic impact of the consumer services sector.

1.15.6 Operation Definition of Energy

Energy, in the context of the consumer services industry, primarily refers to the electricity consumption associated with the operations of enterprises and establishments within this sector (Ghobakhloo et al., 2021). Electricity consumption serves as a key measure of energy usage, reflecting the amount of electrical power utilized in activities such as lighting, heating, cooling, machinery operation, and the use of electronic devices essential for service delivery. This metric provides valuable insights into the energy demand of the consumer services industry, its operational intensity, and its environmental footprint. Monitoring and analyzing electricity consumption can help identify trends in energy efficiency, highlight opportunities for adopting sustainable energy practices, and contribute to the development of policies aimed at reducing carbon emissions and promoting green growth within the sector.

1.16 Scope & Limitations of the Study

1.16.1 Scope of the Study

This study focuses on the spatial modeling of the regional consumer services industry in Shandong Province, China. The primary objective is to analyze the spatial distribution, interactions, and heterogeneity of the consumer services sector across different prefecture-level cities within the province. The study employs the Cobb-Douglas production function to evaluate the contributions of capital, labor, and energy inputs to economic output and integrates the Geographically Weighted Regression (GWR) model to assess spatial heterogeneity. The research covers data from the year 2022, which includes key economic indicators from various cities within Shandong Province. Key areas of focus include: Identifying the main categories of the consumer services industry within Shandong Province; Examining the spatial correlation of the industry's output using Moran's I index; Assessing spatial heterogeneity through the GWR model to capture regional variations in economic contributions and interactions.

1.16.2 Limitations of the Study

While this study provides significant insights into the spatial dynamics of the consumer services industry in Shandong Province, several limitations need to be acknowledged:

1.16.2.1 Data Availability and Accuracy

The analysis relies on the availability and accuracy of economic data from 2022. Any discrepancies or inaccuracies in the reported data could affect the validity of the results. The study is limited to data available for the year 2022, which may not fully capture long-term trends and variations in the consumer services industry.

1.16.2.2 Model Limitations

The Cobb-Douglas production function, while widely used, has inherent limitations in its ability to capture the complexity of economic interactions and the effects of technological changes over time.

The GWR model, although effective in analyzing spatial heterogeneity, assumes that the relationship between the variables and the output is constant within local regions, which may not always be the case.

1.16.2.3 Geographic Scope

The study is confined to Shandong Province, and the findings may not be generalizable to other regions or provinces in China. The unique economic, social, and geographical characteristics of Shandong Province may limit the applicability of the results to other contexts.



1.16.2.4 Temporal Scope

The focus on a single year of data limits the ability to assess temporal changes and trends. Longitudinal studies incorporating data from multiple years would provide a more comprehensive understanding of the spatial dynamics and growth patterns of the consumer services industry.

1.16.2.5 External Factors

The study does not account for external factors such as government policies, global economic conditions, or significant socio-political events that may influence the consumer services industry. These factors could have considerable impacts on the industry's spatial distribution and performance.



1.16.2.6 Subjectivity in Data Interpretation

Spatial and economic analyses inherently involve some level of subjectivity, especially in the interpretation of spatial heterogeneity and correlation. Different methodological approaches and interpretations can lead to varying conclusions.

Despite these limitations, the study aims to provide a robust analysis of the spatial characteristics and economic contributions of the consumer services industry in Shandong Province. It seeks to inform regional planning and policy-making by highlighting key areas for targeted interventions and resource allocation to promote balanced and sustainable economic development.



1.17 Significance of the Study

1.17.1 Significance of the Study to Theory

Based on the analysis of the influencing factors of the consumer services industry in Shandong Province, this research combs the functional relationship between the consumer services industry and variables such as labor, capital and energy, and focuses on exploring the spatial correlation and spatial heterogeneity of the output of the consumer services industry in Shandong Province in combination with relevant theories such as spatial econometrics and geography. According to the analysis process of "correlation identification - econometric regression - result interpretation - promotion path", it scientifically reveals the spatial difference of the output of the consumer services industry in Shandong Province, complements and improves the relevant research of spatial econometrics in the field of economic geography, provides a new perspective and method for improving the output of the consumer services industry, and expands and extends the application field of spatial econometrics.

The study of spatial heterogeneity in the consumer services industry in Shandong Province contributes to the body of knowledge in several ways:

1.17.1.1 Conceptual Understanding

The research contributes to the conceptual understanding of spatial heterogeneity within the consumer services industry. By examining the variations and differences in the spatial

distribution, patterns, and dynamics of consumer services industry across different regions in Shandong Province, the study deepens our understanding of how spatial factors impact industry development.

1.17.1.2 Methodological Advancements

The study utilizes advanced spatial analysis techniques and statistical modeling approaches to estimate spatial heterogeneity. By employing methodologies such as geographically weighted regression (GWR) and incorporating spatial elements into the Cobb Douglas production function theory, the research contributes to the methodological advancements in spatial econometrics and provides a framework for future studies in similar contexts.

1.17.1.3 Empirical Evidence

The study generates empirical evidence on the spatial heterogeneity of the consumer services industry in Shandong Province. By analyzing real-world data and conducting statistical analyses, the research provides concrete findings and insights into the factors influencing industry development, regional disparities, and growth patterns. This empirical evidence enhances the credibility and robustness of the study's conclusions.



1.17.1.4 Policy Implications

The research offers policy implications and recommendations for promoting balanced and sustainable development within the consumer services industry in Shandong Province. By identifying key factors affecting spatial heterogeneity and understanding their implications for regional planning and policy formulation, the study provides actionable insights for policymakers, stakeholders, and industry players to address disparities, stimulate growth, and create a favorable environment for the industry's development.

1.17.1.5 Comparative Analysis

The study contributes to comparative analysis by examining the spatial heterogeneity of the consumer services industry in Shandong Province in relation to other regions or sectors. This comparative perspective enables researchers and policymakers to identify best practices, successful strategies, and lessons learned from other contexts, facilitating knowledge transfer and potential adaptation of effective approaches to promote industry development in Shandong Province.

The study enriches the body of knowledge on spatial heterogeneity in the consumer services industry by providing a comprehensive analysis, advancing methodologies, generating empirical evidence, offering policy implications, and contributing to comparative analysis. The findings and insights generated by this research can guide future studies, inform policymaking processes, and contribute to the understanding of regional economic development and industry dynamics.



1.17.2 Significance of the Study to practice

Industrial output is not only an important economic statistical indicator to measure the industrial competitiveness of consumer services industry (Sturgeon et al., 2012), but also can help decision makers analyze the economic situation, estimate the required production factors and understand the methods to promote industrial growth. This study makes a spatial econometric analysis of the consumer services industry in Shandong Province and deduces targeted policy recommendations. It provides solutions for solving the dilemma of low output of consumer services industry in Shandong Province, and also provides decision-making reference for finding the output potential and power of consumer services industry in Shandong Province.

The research on the development of consumer services industry in Shandong Province and its factors, including spatial heterogeneity, has real-world applications that can inform policy-making and decision-making processes. Some potential applications of this research include:

1.17.2.1 Policy Formulation

The findings of this research can guide policymakers in formulating strategies and policies to promote the development of consumer services industry in Shandong Province. By understanding the factors that affect the growth of the sector, policymakers can design targeted interventions to address infrastructure gaps, enhance human capital, and create a favorable business environment.



1.17.2.2 Regional Planning

The research outcomes can contribute to regional planning efforts in Shandong Province. By considering the spatial heterogeneity and variations in economic development across different areas, regional planners can identify specific regions or cities that require focused attention and allocate resources accordingly. This can help promote balanced regional development and reduce disparities within the province.

1.17.2.3 Investment and Resource Allocation

Investors and businesses can utilize the research findings to make informed decisions about investment and resource allocation in the consumer services industry sector. Understanding the factors that influence the sector's growth, as well as the spatial variations, can help identify areas with potential market demand and growth opportunities. This information can guide investment decisions and resource allocation strategies.

1.17.2.4 Economic Development Strategies

The research can contribute to the formulation of broader economic development strategies for Shandong Province. By recognizing the significance of the consumer services industry sector and its potential for driving economic growth, policymakers can integrate the findings into comprehensive development plans. This can help diversify the province's economy, reduce reliance on traditional industries, and foster sustainable economic growth.





1.17.2.5 Comparative Analysis

The research on the development of consumer services industry in Shandong Province can be compared with similar studies conducted in other regions. This comparative analysis can provide insights into best practices, successful policies, and strategies implemented in other areas with thriving consumer services industries. Lessons learned from these comparisons can be applied to Shandong Province to further enhance its consumer services industry sector.

The research on the development of consumer services industry in Shandong Province and its applications have the potential to contribute to evidence-based decision-making, policy formulation, and strategic planning processes. By utilizing the findings and recommendations, stakeholders can work towards the sustainable growth and improvement of the consumer services industry, benefiting the province's economy and its residents.

1.18 Thesis Organization

This thesis, titled "Spatial Modeling of Regional Consumer Services Industry in Shandong Province," is organized into five comprehensive chapters, each addressing a critical component of the research on the spatial modeling of the regional consumer services industry in Shandong Province. The organization is designed to offer a detailed and systematic examination of the spatial heterogeneity in the consumer services industry across Shandong Province. The structure follows Ph.D. thesis standards of UPSI, ensuring a coherent flow from the introduction to the conclusions and recommendations.





Chapter one was introduction which provides an overview of the research, outlining the motivation, objectives, and significance of the study. It introduces the context of the consumer services industry in Shandong Province and its relevance to regional economic development. The chapter also defines the research questions and hypotheses that guide the investigation. Additionally, the structure of the dissertation is explained to give readers a roadmap of the study.

Chapter two was the literature review critically examines existing research related to the consumer services industry, spatial heterogeneity, and regional economic development. This chapter synthesizes previous studies, highlighting gaps in the literature that this dissertation aims to fill. It discusses key theories and models, such as the Cobb-Douglas production function and spatial econometric models, providing a theoretical foundation for the study. The review also covers methodological advancements in spatial analysis techniques relevant to the research.

Chapter three was the research methodology employed in the study. It explains the data collection process, including sources such as the Shandong Statistical Yearbooks and city statistical yearbooks. The chapter describes the analytical techniques used, such as descriptive statistics, regression analysis, spatial autocorrelation analysis (Moran's I), and Geographically Weighted Regression (GWR). The rationale for choosing these methods is provided, along with an explanation of how they address the research questions and hypotheses.

Chapter four was the empirical results of the study are presented and analyzed. It begins with descriptive statistics to provide an overview of industry output across different regions.



The spatial econometric analysis is then conducted, examining the spatial autocorrelation of industry output and using the GWR model to explore spatial heterogeneity. The findings are discussed in relation to the hypotheses, with particular attention to regional disparities and factors influencing the spatial distribution of the consumer services industry.

The final chapter synthesizes the findings from the empirical analysis, discussing their implications for regional economic development and policy-making. It relates the results to existing theories and models, highlighting the novel contributions of the study. The chapter provides practical policy recommendations to address regional disparities and improve the competitiveness of the consumer services industry. It also suggests avenues for future research, emphasizing the need for longitudinal studies, comparative analyses, and the integration of insights. The chapter concludes with a summary of the thesis, underscoring its contributions to the field of consumer services and regional economic development.

This structured organization ensures a comprehensive and coherent presentation of the research, facilitating a clear understanding of the spatial modeling of the regional consumer services industry in Shandong Province.