THE IMPACT OF DIGITAL ECONOMY DEVELOPMENT AND THE MEDIATING EFFECT OF INDUSTRIAL STRUCTURE ON THE URBAN-RURAL INCOME GAP IN MAINLAND CHINA

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SULTAN IDRIS EDUCATION UNIVERSITY

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ABSTRACT

The objectives of this study are to generate an improved digital economy development index (DEDI), to examine the impact of digital economy development on the urban-rural income gap (URIG) from both aggregate and disaggregate perspectives, and to test the mediating effect of industrial structure in this relationship. Data from 30 provincial-level regions in Mainland China are collected from 2013 to 2022. The study employs the entropy method for index construction, system-GMM for dynamic panel estimation, heterogeneity testing to identify regional differences, and the mediating effect test. The findings show, the improved index (DEDI) effectively measures digital economy development across China. The system-GMM results documented a positive and significant first-order coefficient for DEDI, with a negative and significant second-order coefficient. The results of Heterogeneity test indicate significant regional variation in the relationship between DEDI and URIG, and the findings of the third analysis provides indication that industrial structure upgrading significantly mediates the relationship between digital economy development and the income gap, while industrial structure optimization does not. Additionally, the impact of DEDI on URIG follows an inverted U-shape at the aggregate level, with significant regional heterogeneity at the disaggregate level. Based on the findings obtained, we may conclude there is a complex, regionally differentiated relationship between digital economy development and income distribution in China. However, in term of policy implications, it is highly recommended the policy makers to focused on the roles of different secondary indicators within DEDI, for the purpose of improving DEDI's acceleration in reducing of the urban-rural income gap. Other than that, policymakers should also implement region-specific digital economy strategies, particularly in regions where its impact is most pronounced, prioritize industrial structure upgrading, and reconsider the role of industrial structure optimization in policies aimed at improving income equality.

KESAN PEMBANGUNAN EKONOMI DIGITAL SERTA KESAN PERANTARAAN STRUKTUR INDUSTRI TERHADAP JURANG PENDAPATAN BANDAR-DESA DI TANAH BESAR CHINA

ABSTRAK

Objektif kajian ini adalah untuk membangunkan indeks pembangunan ekonomi digital yang ditambahbaik (DEDI), mengkaji kesan pembangunan ekonomi digital ke atas jurang pendapatan bandar-luar bandar (URIG) dari perspektif agregat dan disagregat, dan menguji kesan pengantaraan struktur perindustrian dalam hubungan ini. Data daripada 30 wilayah di Tanah Besar China dikumpul dari 2013 hingga 2022. Kajian ini menggunakan kaedah entropi untuk pembinaan indeks, sistem-GMM untuk anggaran panel dinamik, ujian heterogeniti untuk mengenal pasti perbezaan wilayah dan ujian kesan pengantaraan. Penemuan menunjukkan, indeks yang ditambahbaik (DEDI) mengukur pembangunan ekonomi digital di seluruh China dengan lebih berkesan. Keputusan Sistem-GMM merekodkan koefisien tertib pertama yang positif dan signifikan untuk DEDI, dengan nilai koefisien tertib kedua yang negatif dan signifikan. Keputusan ujian Heterogeniti menunjukkan keputusan yang pelbagai dalam hubungan antara DEDI dan URIG, dan penemuan analisis ketiga memberikan petunjuk bahawa hanya faktor peningkatan struktur perindustrian merekodkan keptuusan signifikan manakala faktor pengoptimuman struktur adalah tidak signifikan. Selain itu, kesan DEDI ke atas URIG mengikut bentuk U terbalik bagi analisis agregat, dengan keputusan signifikan yang pelbagai bagi analisis yang sama dalam analisis disagregat. Berdasarkan penemuan yang diperoleh, kami membuat kesimpulan terdapat hubungan yang kompleks dan dibezakan secara serantau antara pembangunan ekonomi digital dan pengagihan pendapatan di China. Walau bagaimanapun, dari segi implikasi dasar, penggubal dasar amat disyorkan untuk memberi tumpuan kepada peranan penunjuk sekunder yang berbeza dalam DEDI, bagi tujuan menambah baik pecutan DEDI dalam mengurangkan jurang pendapatan bandar-luar bandar. Selain itu, penggubal dasar juga harus melaksanakan strategi ekonomi digital khusus wilayah, terutamanya di wilayah yang kesannya paling ketara, mengutamakan peningkatan struktur perindustrian, dan mempertimbangkan semula peranan pengoptimuman struktur industri dalam dasar yang bertujuan untuk meningkatkan kesaksamaan pendapatan.

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LIST OF ABBREVIATIONS

BIC	Bayesian Information Criterion
BP Test	Breusch-Pagan Lagrange Multiplier test
DEDI	Digital Economy Development Index
DED	Digital Economy Development Index
EA	Educational Attainment
ED	Economic Development
EO	Economic Openness
F Test	Fisher Test
FE	Fiscal Expenditures
FE Model	Fixed Effect Model
GDP	Gross Domestic Product
GMM	Generalized Methods of Moments
HT	Harris–Tzavalis
IPS	Im, Pesaran and Shin Impulse
LNGDP	Level of Economic Development
OIS	Optimization of Industrial Structure
RE Model	Random Effect Model
UIS	Upgrading of Industrial Structure
UR	Urbanization Rate
URIG	Urban-rural Income Gap Index

CHAPTER 1

INTRODUCTION

1.0 Introduction

Many developing countries around the world face challenges such as underdeveloped rural economies and an imbalance between urban and rural development. Moreover, an increasingly important criterion for distinguishing between developing and developed countries is the size of the urban-rural income gap (Zhong et al., 2022). At the same time, the digital economy has emerged as a key driver of economic development with the rapid development of digital technology. It also has profound implications for reshaping urban-rural relations, promoting equitable regional development and changing income distribution patterns. Hence, the impact of the digital economy development on urban-rural income gap (URIG) should be taken seriously, as the decision-making process could affect the future urban-rural income gap or even the economic performance either positively or negatively. For a further detailed discussion, this chapter provides the background research in section 1.1. Section 1.2, 1.3 and 1.4 provides the discussions on problem statements, research questions and research objectives, respectively. Then, followed by the research

hypothesis in section 1.5. Section 1.6 and 1.7 discuss significance of the study and limitations of the study, respectively. The theoretical framework of the study is in section 1.8 and the operational definition is in section 1.9. At last, section 1.10 provides a summary of this chapter.

1.1 Background research

Economic development and income distribution are eternal themes in economy research (Kuznets, 2019; Nijman & Wei, 2020). On one hand, although the income inequality in the developing world is lower than 30 years ago, the decline in inequality between developing countries has been the main contributor, and the average inequality within developing countries has been slowly increasing (Ravallion, 2014). One of the most obvious indicators of economic inequality in China is the significant urban-rural income gap (Jiang et al., 2022; Jiang & Jin,2024). Additionally, one of the key factors separating the developing and developed countries is the gap in income between urban and rural areas (Jiang et al., 2022; Peng & Zheng, 2022). On the other hand, the digital economy recently years, has emerged as a novel economic paradigm characterized by creativity, revolution, and scalability. It can shorten the gap between time and location, boost regional trade, and increase production effectiveness（Jurayevich & Bulturbayevich, 2020). It is, therefore, essential to explore whether the rapid development of the digital economy can alleviate income inequality and, more specifically, its impact on the urban-rural income gap. This forms the primary focus of this research.

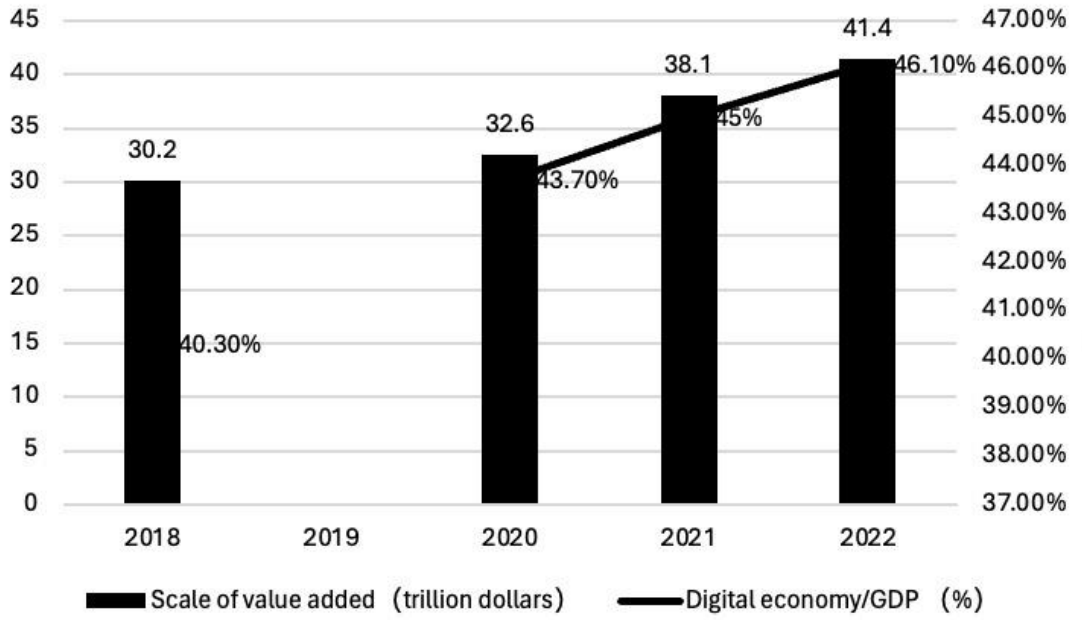
Along with the development of digital technology in recent year, the digital economy is growing rapidly worldwide. The digital economy is a broad concept, referring to the collective term for economic activities based on digital technologies. The digital economy encompasses all economic activities conducted through digital technologies and internet platforms, including electronic commerce, digital finance, digital advertising, and a wide range of services and products related to information technology. According to the International Monetary Fund (2021), the digital economy includes both traditional internet industries and the digital transformation of traditional sectors. The Organisation for Economic Co-operation and Development (2021) further describes it as utilizing digital technologies to facilitate economic activities, creating new business models and altering traditional economic operations. Additionally, the World Bank (2016) highlights its impact on economic growth, innovation, and job creation, emphasizing its broad scope and influence. Understanding these definitions is critical for framing the role of the digital economy in influencing income distribution and the mechanisms driving the urban-rural income gap.

With the rapid development and widespread adoption of digital technologies, the digital economy has become a significant driver of global economic growth. Data from CAICT(CAICT, 2023; CAICT, 2022) shows that the value added by the digital economy in 47 countries around the world grew by around 37 per cent between 2018 and 2022, indicating the global digital economy is expanding. The digital economy's contribution to the global economy increased by 5.8 percentage points over this four-year period, highlighting its growing importance to GDP. This demonstrates a

steady growth trend both in absolute size and as a share of GDP, reflecting significant progress in digital transformation across countries. With advancements in technology and the increasing accessibility of the Internet, the digital economy's contribution to global economic growth is rising. The trend is expected to continue in the coming years, further boosting global economies.

Figure 1.1

Size of the Digital Economy (47 Countries) and Share of GDP



Note: Data are from the *White Paper on Global Digital Economy Development* (2019, 2021, 2022, 2023) by the China Academy of Information and Communication Research (CAICR). The 2020 report was not published. Figures for 2019 are based on digital economy statistics from 47 countries. By 2022, the number of countries increased to 51 with the inclusion of Laos, South Africa, the Philippines, and Israel

In 2022, the estimated value added by the digital economy across 51 countries reached 41.4 trillion USD, marking a nominal increase of 7.4% year-on-year and accounting for 46.1% of global GDP (CAICT, 2024). In terms of scale, the United States ranks first, with a digital economy valued at 17.2 trillion USD, while China

ranks second at 7.5 trillion USD. In terms of proportion, the digital economy accounts for more than 65% of GDP in the UK, Germany, and the United States. Saudi Arabia, Norway, and Russia, with growth rates exceeding 20%, rank among the top three countries in terms of digital economy growth.

The rapid development of the digital economy has garnered global attention for its critical role and wide-reaching impact. As a result, many countries have made it a strategic priority (Sorescu & Schreier, 2021; Heng et al., 2020; Hui & Lin, 2019). By 2022, nearly all United Nations member states had formulated digital economy strategies at various stages of development (Xu & Li, 2022). Japan, for instance, began its digital economy efforts early. In 1997, Japan's Ministry of International Trade and Industry coined the term digital economy and introduced a series of policies to bolster the digital information industry (Abbos et al., 2021; Peng, 2021). Similarly, in 1998, the U.S. Department of Commerce published its inaugural report, The Emerging Digital Economy, which underscored the pivotal role of digital resources in both macro and microeconomics (Peng, 2021). In 2009, the UK launched its Digital Britain initiative, aiming to accelerate the digital economy with the aid of information technology. Germany followed with its Industry 4.0 and Digital Germany 2015 plans, designed to foster digital transformation in businesses and boost economic growth. Russia also introduced a Digital Economy Development Plan, highlighting its commitment to unlocking the potential of the digital economy. The G20 further spotlighted this shift, adopting the G20 Digital Economy Development

and Cooperation Initiative at the 2016 Hangzhou Summit, providing fresh momentum for global innovation and growth. In 2021, the United States Agency for International Development (USAID) released its 2020-2024 Digital Strategy, outlining 30 objectives to be achieved within the specified period.

The digital economy is widely acknowledged as a key driver of contemporary economic growth (Hu et al., 2021; Li et al., 2020; Myovella et al., 2020). The integration of digital technologies across various industries has led to profound transformations in operational frameworks and business models, reshaping traditional sectors. In finance, the adoption of big data analytics and blockchain technology is revolutionizing service delivery, fostering financial innovation, and promoting the development of inclusive finance. In manufacturing, the industrial internet and smart manufacturing technologies are driving the digitalization and automation of production processes, improving both efficiency and product quality. Similarly, in the service sector, technologies like artificial intelligence and big data analytics are enhancing service delivery and operational efficiency. Furthermore, in agriculture, digital innovations are catalyzing the modernization of the sector, boosting productivity and ensuring higher-quality agricultural outputs. These advancements across industries underscore the transformative impact of the digital economy on global economic structures.

In addition to its widespread application in the economic sphere, the digital economy has also exerted profound impacts on social development. The emergence of digital technologies represented by computers, the internet, intelligent manufacturing, 5G, and blockchain is the most significant change in human society since the industrial revolution, changing the traditional relationship between individuals, companies, and society (Fu et al., 2022; Voronkova et al., 2020). It provides entrepreneurs and innovators with more opportunities and platforms, fostering innovation and entrepreneurship activities. The development of the digital economy has also created a large number of job opportunities, particularly in high-tech fields and emerging industries, providing new impetus for the development of the labor market. However, the digital economy development also presents challenges, such as the widening digital divide between developed and developing regions, which can exacerbate economic inequalities. Moreover, issues related to data privacy and cybersecurity are increasingly prominent as more economic activities move online. Besides, the digital economy also has significant implications for urban-rural development inequality, industrial restructuring, talent cultivation, and other aspects, requiring governments and enterprises to formulate corresponding policies and strategies to address them. Therefore, gaining a deep understanding of the background and definition of the digital economy, as well as its impact on economic and social development, is of great significance for formulating future development strategies and policies.

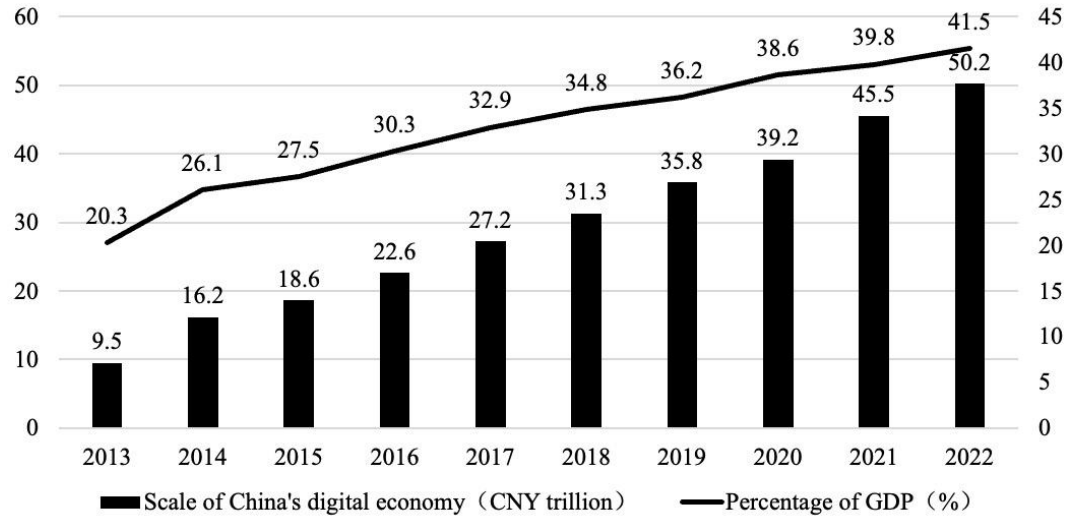
While the digital economy is growing globally, China's unique trajectory offers valuable insights into its role in addressing income disparities, particularly between urban and rural areas. The Chinese government has played a crucial role in shaping the digital economy by formulating and implementing a range of policies aimed at facilitating its growth. Since the 18th National Congress of the Communist Party of China, the government has placed great importance on the development of the digital economy, recognizing it as a strategic priority for the country's long-term growth. In line with this, a series of supportive measures, including the National Big Data Strategy, have been introduced and consistently implemented since 2015 (Belozyorov et al., 2022) . The emphasis on the deep integration of the internet, big data, artificial intelligence, and the real economy has been a key policy recommendation from the Communist Party of China's 19th National Congress. Furthermore, the government has prioritized investments in digital infrastructure, talent cultivation, and innovation, all of which have helped strengthen the foundation for the growth of the digital economy in China.

China's digital economy is one of the most dynamic and rapidly evolving sectors globally, garnering widespread attention both domestically and internationally. Since being officially included in China's government work report in 2017, the digital economy has been recognized as a primary driver of innovation and a crucial component for sustaining economic growth. This recognition has been accompanied by consistent and remarkable growth in the scale of China's digital economy (Hu et

al., 2021; Li et al., 2020; Myovella et al., 2020). According to the *China Digital Economy Development Report* (2023), the digital economy in China reached a remarkable size of CNY 50.2 trillion in 2023, marking a growth rate of 10.3% compared to the previous year. This growth outpaced China's GDP expansion for over a decade, positioning China as the second-largest digital economy in the world. Its contribution to the GDP stands at 41.5%, highlighting the importance of this sector, on par with the traditional secondary industries in the national economy. The rapid penetration of digital technologies into various sectors continues to propel China's economic progress, revealing the vast potential of the digital economy.

Figure 1.2

China's Digital Economy Scale from 2013 to 2022 Sources: China's Digital Economy Development Report from 2014-2023

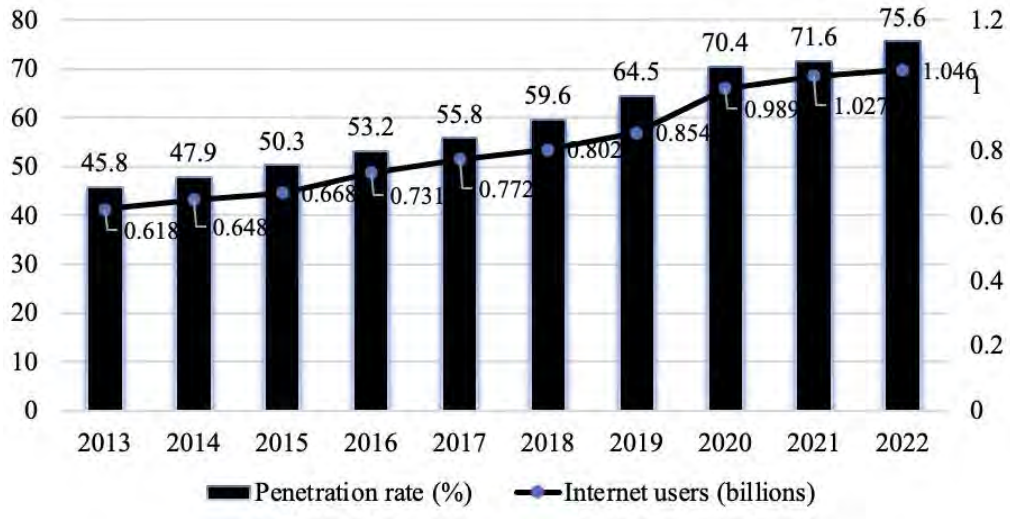


As the world's largest digital market, China has demonstrated both strong momentum and immense potential in the digital economy. Several factors have

contributed to the rapid growth of the sector. Firstly, the internet penetration is really high. With China having the largest internet user base globally, internet penetration reached 75.6% by December 2022, with 1.067 billion internet users (CNNIC, 2023). This widespread adoption of the internet, coupled with the growing ubiquity of smartphones and mobile internet, has transformed the way people consume goods and services, produce content, and socialize. Digital platforms are becoming increasingly central to everyday life, and their impact continues to expand, further driving the development of the digital economy. The digital economy now encompasses an ever-growing range of industries, from e-commerce to digital entertainment and beyond.

Figure 1.3

The Number of China's Netizens from 2013 to 2022



Sources: Statistical Report on the Development Status of China's Internet from 2014-2023

Secondly, e-commerce has provided substantial support for the growth of the digital economy. According to the China E-Commerce Report (2022), the country's

national e-commerce turnover reached CNY 43.83 trillion in 2022. Of this, rural online retail sales amounted to CNY 2.17 trillion, reflecting the expanding reach of e-commerce into rural areas. The rapid development of e-commerce has not only boosted economic activity but also created significant employment opportunities, with the number of e-commerce-related employees reaching 69.37 million in 2022. Therefore, the digital economy has opened new entrepreneurial opportunities for farmers, helping bridge the employment gap between urban and rural regions.

Furthermore, the rapid development of China's digital economy is driving a profound transformation in the nation's industrial structure. In 2022, China's digital industrialization reached CNY 9.2 trillion, with the scale of industrial digitalization totaling CNY 41 trillion, representing 18.3% and 81.7% of the digital economy, respectively. These figures highlight the significant and growing digital penetration across the primary, secondary, and tertiary sectors. The advancement of digital technologies, including cloud computing, big data, artificial intelligence, and 5G, is accelerating the integration of these technologies into industries, thereby reshaping production processes, business models, and industry organization (Bahrini & Qaffas, 2019; Luo et al., 2023). As a result, the digital economy not only facilitates the transformation of traditional industries but also introduces new business models, creating opportunities for industrial upgrading.

In particular, the digital economy has played a key role in optimizing industrial structures by improving economic efficiency and promoting technological innovation (Murthy et al., 2021; Ping & Yi, 2022). It encourages companies to adopt data-driven business strategies and promotes internal corporate reforms, which leads to better resource utilization and more efficient production processes (Guo & Miao, 2023; Reuschke & Mason, 2022). Furthermore, the rapid technological advancements within the digital economy have reshaped industrial competition, as firms leverage these innovations to create new products, services, and business models, thus accelerating industrial restructuring (Zang, 2019; Xiao & Zhou, 2021). This dynamic interplay of technology and industry is contributing to the overall optimization and upgrading of China's industrial structure, fostering the continued growth of the digital economy while enhancing industrial integration and competitiveness. These transformations in industrial structure directly impact employment and income distribution, making it crucial to analyze their role in narrowing or widening the urban-rural income gap.

While the digital economy has significantly reshaped China's economic landscape, its influence on income distribution, particularly on the urban-rural income gap, remains under explored.

Amidst the transformative forces of digitalization, the persistent urban-rural income gap remains a critical challenge for China's socioeconomic development. The

significant urban-rural income gap has long been a crucial issue in China's social development (Lagakos, 2020; Sicular et al., 2008). The high-quality development of an economic society is not only reflected in the continuous growth of the economy, but also in the sharing of the fruits of development by the majority of residents (Rodrik, 2000). In China, the economy has grown rapidly after the reform and opening up. The GDP has grown from USD 149.5 billion in 1978 to USD 18 trillion in 2022, and the GDP per capita has grown from USD 156 in 1978 to USD 12,741 in 2022, which has significantly raised the income level of residents. However, from 2003 to 2020, the Gini coefficient of per capita disposable income of Chinese residents has always been above 0.46, which is at a relatively high level, and there is no obvious shrinking trend in recent years (Li, et al., 2021b; Sicular et al., 2008; Wen & Ying, 2021). And in 2020, the income ratio between urban and rural residents in China was 2.56, significantly higher than the levels observed in OECD countries (Guo et al., 2022). Compared to major developed economies, China's urban-rural income gap is the result of the intertwined effects of multiple imbalances in economic development, with significant differences between regions (Huang & Mao,2023).

In recent years, the rapid development of the digital economy has reshaped economic structures globally, creating both opportunities and challenges for income distribution. While urban and rural areas alike have benefited from technological advancements, significant income disparities between these regions persist, particularly in China. Before examining the impact of digital economy development

on the urban-rural income gap, it is crucial to highlight the key role that this disparity plays in shaping China's economic and social landscape.

Many scholars agree that the widening income disparity between urban and rural areas is a major contributor to the rising inequality in China (Molero-Simarro, 2017). Chen et al. (2015), for instance, estimated that the urban-rural income gap accounted for about 58% of the total income inequality in China from 2005 to 2012, using the Gini coefficient. On average, urban residents in China earned more than three times the income of those in rural areas, making the urban-rural income ratio one of the highest in the world (Sicular et al., 2008), with the trend expected to continue. This gap is even more pronounced when considering differences in welfare between urban and rural populations. Li (2021) emphasized that the excessive urban-rural income gap has become a defining feature of China’s economy and society, posing significant challenges to sustainable economic development. This widening disparity not only exacerbates social inequality but also hampers the country’s efforts towards high-quality economic development (Manduca, 2019; Nijman & Wei, 2020). As a result, numerous studies have focused on identifying the causes behind the urban-rural income gap and exploring potential solutions (Bowen & Morris, 2019; Couture et al., 2016; Li, Sun, et al., 2021b; Li , 2018; Tang & Sun, 2022; Yuan et al., 2020).

Building on this, it is also important to explore the drivers of the urban-rural income gap, which can be grouped into two broad categories. The first includes factors that contribute to the expansion of the gap. The shift in industrial structures has been a key driver of the urban-rural income divide (Dong et al., 2020; Huang & Mao,2023). Initially, industrialization, marked by the growth of capital-intensive sectors, resulted in a reduction of agriculture's contribution to national income, thereby widening the gap between urban and rural areas. However, with the development of the service sector and the transition to a post-industrial economy, this disparity began to narrow. This progression aligns with the general "inverted U-shaped" pattern observed in income inequality during economic development. Institutional factors, notably the urban-rural dual structure, have also contributed to income disparities (Kuang, 2018; Zhang, 2020; Huang & Mao, 2023). The urban-centered resource allocation policies of the planned economy era left rural areas disadvantaged in terms of industrial policies, infrastructure, and public services. Although recent policies, such as the rural revitalization strategy, aim to address these imbalances, the legacy of past institutional arrangements continues to sustain urban-rural income differences. Regional disparities further compound the urban-rural income gap (Huang & Mao, 2023). In the eastern regions, where economic development is more advanced, the income ratio between urban and rural areas is relatively low, approaching 2. However, in the central and western regions, where economic growth has been slower, this ratio remains above 2.5. These regional

differences reflect variations in economic growth rates, industrial development, and resource allocation, further exacerbating the overall income inequality in the country.

The second category of studies addresses factors that help to reduce the income gap between urban and rural regions. The narrowing of the urban-rural income gap in China is driven by a combination of government policies, industrial transformation, regional development, human capital improvements, and the advancement of the digital economy. Government initiatives, such as rural revitalization and targeted poverty alleviation efforts, have been crucial in boosting rural incomes. Yin and Wang (2020) suggest that expanding financial services has the potential to narrow the income gap in the short term. The restructuring and upgrading of China's industrial structure and urban-rural integration have played a pivotal role in reducing the urban-rural income gap. Industrialization and urbanization have historically been drivers of income inequality, but the shift toward modernizing rural industries and improving agricultural productivity has gradually mitigated the gap. Wu et al. (2023) concluded that the integrated development of rural industries significantly decreased the urban-rural income gap, possibly by boosting rural economic growth or accelerating urbanization. In a study of small and medium-sized towns across China, Tang (2023) found that rising urbanization levels contributed to a reduction in the income disparity between urban and rural areas.

Additionally, several studies (Li, 2019; Liu, 2020; Wang et al., 2021) have highlighted the non-linear relationships between various factors and the urban-rural income gap. For example, Li (2019) identified a U-shaped effect in the relationship between market potential, industrial structure upgrading, and the urban-rural income gap. Wang et al. (2021) argued that in the early stages of the digital economy, the benefits were widely distributed across the population, thus narrowing the urban-rural income gap. However, as the digital economy matured, the barriers to access increased, potentially exacerbating the gap. Liu (2020) through a dynamic spatial panel model, found that industrial intelligence led to a widening gap overall, with variations observed across different regions of China. In the eastern region, it narrowed the gap, while in the western region, it had the opposite effect, and no significant impact was found in the central region. Song (2017) also suggested that improving financial inclusion could play a role in reducing the urban-rural income gap, providing digital dividends in the context of the growing digital economy

Moreover, disparities in public services such as education, healthcare, and social security contribute significantly to the urban-rural income gap. Due to limited public service access in rural areas, rural residents often face lower levels of human capital investment and weaker social security coverage compared to their urban counterparts. Institutional factors, including the household registration system (hukou) and the land tenure system, also contribute to shaping the income disparity between urban and rural areas.

To address these challenges, the Chinese government has implemented various policies aimed at reducing the urban-rural income gap. These include poverty alleviation initiatives, increased investment in rural infrastructure, and efforts to promote rural economic development. In addition, the government has focused on enhancing public services such as education and healthcare in rural areas, fostering human capital development among rural populations. Moreover, promoting integrated urban-rural development and facilitating the mobility of labor and other resources between the two areas are seen as essential steps in narrowing the income gap.

Despite some successes, challenges remain in addressing the urban-rural income gap. For instance, public services in rural areas are still underdeveloped, and there is significant room for improvement in human capital investment among rural populations. Economic structural differences between urban and rural regions also persist, with rural economies lagging behind. To overcome these challenges, it is essential for the government to continue enhancing policy support for rural areas and promote more balanced, coordinated development between urban and rural regions in the future.

The rapid growth of the digital economy offers transformative opportunities to address the structural, institutional, and regional factors driving the urban-rural income gap. Digital platforms have the potential to optimize resource distribution, enhance public service delivery, and create new economic opportunities. By improving access to employment, healthcare, and education in rural areas, digital

technologies can help bridge the urban-rural divide. Moreover, the integration of digital tools into traditional industries has the potential to reshape industrial structures, creating more equitable opportunities for economic development.

Increasing focus has been placed on how the growth of the digital economy influences both economic expansion and income inequality. (Jurayevich & Bulturbayevich, 2020; Olamide et al., 2022; Yalmaev et al., 2020). Some scholars have argued that developing and emerging countries are not benefiting from investments in ICT to the same extent as developed economies; however, significant regional heterogeneities exist within the same country (Appiah-Otoo & Song, 2021; Bahrini & Qaffas, 2019; Zhang, & Chen, 2021). Others believe that ICT generally increases economic growth in both countries, but poor countries tend to gain more from the ICT revolution (Appiah-Otoo & Song, 2021). Some studies have also shown that the impact of the digital economy development on income inequality exists widely and differs between countries, urban and rural areas, and individuals (Barata, 2019; Ning & Leming, 2022).

Research exploring the relationship between the digital economy and income inequality largely originates from discussions surrounding the dual implications of digital technology development, specifically the concepts of the digital divide and the digital dividend. On one hand, the extensive implementation and advancement of digital infrastructure and related industries under the digital economy framework have

enabled digital empowerment at the micro, meso, and macro levels, fostering both economic progress and social development (Peng & Zheng, 2022). The connectivity facilitated by internet capital and the narrowing of access disparities have significantly expanded opportunities for individuals to benefit from internet-based platforms (Qiu et al., 2016). For example, the rapid expansion of the Internet economy has enhanced access to employment information and job prospects. According to data from the China Academy of Information and Communications Technology, the digital economy generated 191 million jobs in 2018, representing 24.6% of total national employment for that year. Digital tools such as communication technologies, the Internet, and other information systems play a vital role in improving access to essential resources and uncovering opportunities. Through various channels, including job portals, recruitment applications, and public accounts, farmers can quickly gather information on employment opportunities. This enhanced accessibility allows them to monitor industry trends, adapt to market fluctuations, increase their income, and ultimately enhance their quality of life (Deng et al., 2023).

On the other hand, while the digital economy has presented significant opportunities for growth, it has also led to economic and social differentiation. This issue is particularly concerning as the progression of the digital divide has evolved from disparities in access opportunities to disparities in internet usage, ultimately resulting in significant digital inequalities（Furuholt & Kristiansen, 2007). Users with higher levels of education, higher income, and higher scores on cognitive tests are

more inclined to utilize the internet to accumulate capital and obtain economic benefits. The differences in information and communication technology across regions, industries, ownership types, and company sizes have caused or widened the income level and inequality between different groups. Büchi et al. (2016) refer that the digital divide exists not only between prefecture-level cities, but also between urban and rural areas. The digital divide exists not only between prefectures but also between urban and rural areas. According to the 50th Statistical Report on the Development Status of the Internet in China published by the China Internet Network Information Center (CNNIC), there were 1.032 billion Internet users in China as of the end of December 2021, representing a 73.0% Internet penetration rate, while there were 284 million Internet users in rural areas, representing a 57.6% Internet penetration rate (China Internet Network Information Center, 2020). Although China's rural digital infrastructure has accelerated and network conditions have improved, the primary digital divide is remains significant. In addition, at this stage, the overall education level of China's rural residents is low, they face limited opportunities to systematically learn about computers, smartphones, and other digital tools, and a large number of groups have barriers in applying digital devices, which exacerbates the secondary digital divide between urban and rural areas.

However, many scholars agree that the combined effects of digital dividends and the digital divide determine the structure of income inequality (Mora-Rivera & García-Mora, 2021). The digital economy could bring digital dividends through

economies of scale, technology spillover effects, optimal labor allocation, easing financial constraints and lowering barriers to financial services (Du, 2022). It can also promote the revitalization of rural industries by expanding the production possibility boundary of rural industries, alleviating information asymmetry, saving production and transaction costs, stabilizing production expectations and smoothing sales channels (Guo & Miao, 2023). While, the divides could come from the access divide, application divide and income divide (Philip & Williams, 2019).

In this context, it is crucial to recognize that the impact of DEDI on the URIG can be observed directly through employment opportunities and income levels. Moreover, it can also manifest indirectly through factors such as changes in human capital investment among urban and rural residents, as well as improvements in the efficiency and transparency of the labor market. For instance, the development of the digital economy has facilitated the emergence of new business models such as rural e-commerce, online education, and remote work, thereby enhancing the income levels of rural residents. Moreover, the widespread application of digital technology can also improve access to education and healthcare services. However, existing studies rarely explore the mediating role of industrial structure in this relationship, which this research aims to address.

The impact of industrial structure on the urban-rural income gap is a significant research topic in the field of economics. Early studies are primarily based

on human capital theory and income inequality theory, suggesting that differences in industrial structure would affect the income levels of urban and rural residents (Chen & Ma, 2022). With the progress of urbanization and industrialization, researchers have increasingly focused on the mechanisms through which industrial restructuring affects the URIG. Current research indicates that changes in industrial structure not only directly influence the employment opportunities and income levels of urban and rural residents but also indirectly affect the formation and evolution of the URIG through their impact on the labor market, education, and skills training (Hong & Zhang, 2020).

China's urban rural industrial structure has been continuously upgrading and optimizing over time. With the advancement of urbanization and industrial upgrading, the share of the secondary and tertiary sectors in urban areas has increased significantly (Wan et al., 2024). In contrast, rural areas remain primarily reliant on the primary sector, though its proportion has gradually declined (Long et al., 2016). At the same time, the secondary and tertiary sectors in rural regions have also experienced some development; however, their overall scale and growth rate remain considerably lower than those in urban areas (Long et al., 2016).. This trend has led to the differentiation of urban rural industrial structures and further widened the URIG. Additionally, in recent years, the Chinese government has intensified efforts to adjust the industrial structure. Through the implementation of various policy measures, it has promoted the development of advanced manufacturing, high-tech industries, and the

service sector, among other emerging industries. However, to some extent, these policies have also exacerbated the differentiation of urban rural industrial structures.

The impact mechanism of industrial structure on the URIG can be analyzed from two primary aspects. Firstly, changes in the industrial structure directly influence the employment opportunities and income levels of both urban and rural residents. As the proportion of secondary and tertiary industries increases, urban areas tend to experience a rise in job opportunities, whereas rural areas face challenges such as increased employment pressure and lower income levels (Chen & Ma,2022). Secondly, adjustments in the industrial structure also affect the provision and quality of public services, including education and skills training, which in turn impacts the investment in human capital and the employability of urban and rural residents. Studies, such as those by Diao et al (2019) highlight that the essence of industrial structural adjustment lies in changing the allocation across different industries. In the context of China, a developing country, significant inequality exists in the economic structure between rural and urban areas (Lagakos, 2020).The primary industry, primarily focused on agricultural production, is largely concentrated in rural areas, while secondary and tertiary industries, which emphasize non-agricultural production, are predominantly found in urban centers (Yu & Lu, 2021). The modernization and transformation of industries during economic development inevitably alter the flow of production elements (Liang et al., 2021). Consequently, this leads to changes in the distribution of resources between urban and rural areas, which affects residents' income and contributes to the URIG (Manduca, 2019).

In sum, despite the progress made since the beginning of the reform and opening up, the URIG in China remains significant, highlighting persistent constraints and challenges (Che, 2022). The barriers of the urban rural dual system have yet to be fully broken, and the process of urban rural integration faces numerous obstacles (Lu, 2013). The journey towards common prosperity is still arduous. However, the development of the digital economy has brought new opportunities and ways of developing. It can drive rural economic growth and provide new opportunities to narrow the URIG by employment effect, financing effect, market participation effect in China. While many types of studies have previously explored the scope of the impact of the DEDI and the factors influencing the urban rural income divide, there are fewer comprehensive empirical studies on the impact of the DEDI on the urban rural income divide (Hossain, 2020) and a lack of studies that explore how the DEDI affects the urban rural income divide. Therefore, this study aims to systematically examine the impact of the DEDI on the URIG and how the DEDI affects the URIG.

In China, how to take advantage of the DEDI in narrowing the URIG and accelerating economic growth has raised widespread government concern. At present, the rural revitalization strategy is being comprehensively promoted in China. In order to support the rapid growth of the digital economy in rural areas, policies such as network speed reduction, fee reduction, and full coverage of urban rural broadband have been consistently deepened and implemented (Ji, 2023). The Fourteenth Five-Year Plan for National Economic and Social Development and Outline of

Long-term Goals for 2035 also further pointed out that digital transformation should be used to drive the transformation of production methods, lifestyles and governance methods as a whole, so as to further consolidate the common prosperity of the people. In this context, it is of great practical significance to deeply explore the impact of the DEDI on the URIG (Li et al., 2021; Peng, 2021).

1.2 Problem statement

The income gap has long been a focal point in economic research (Ma et al., 2018), particularly in developing countries, with China serving as a notable example due to its pronounced urban-rural divide (Molero-Simarro, 2017; Jiang , Li, & Si, 2022; Ma et al., 2022). Although the ratio of the urban-rural income gap in Mainland China narrowed from 2.80 in 2013 to 2.45 in 2022, it remains considerably higher than the international average level, which typically falls below 1.6 (Sicular 2010; Yuan et al., 2020; Wang et al., 2024). Moreover, the absolute income difference between urban and rural residents widened, underscoring a growing disparity (Li, 2018). This widening gap poses significant risks to both social stability and economic development, as an excessive income inequality can lead to social polarization, reduced consumption, and hindered economic growth (Sicular et al., 2007; Stewart et al. , 2020; Wang et al., 2024).

In recent years, the accelerated advancement of information technology and its widespread integration into economic systems have established the digital economy as a new engine of economic growth (Heng et al., 2020). Since 2003, China's digital economy has undergone rapid expansion, promoting the deep integration of digital technologies with the traditional real economy (Ping & Yi, 2022; Wu & Yang, 2022). The digital economy development plays a critical role in reducing the urban-rural income gap, significantly transforming urban-rural dynamics and fostering more balanced development (Ji, 2023; Xiong et al., 2022). This transformation has also affected income inequality between urban and rural regions, contributing to a more equitable distribution of wealth (Leng, 2022; Zhang,2022). Nevertheless, disparities in the development of digital infrastructure, coupled with differing levels of digital literacy among various demographic groups, have resulted in a pronounced digital divide, further intensifying social inequality (Hong et al., 2024; Liao et al., 2022; Robinson et al., 2020).

The role of industrial structure is also critical in this context. Changes in industrial structure, such as shifts in the economy's sectoral composition, can significantly affect wage distribution and job opportunities (Wang & Li, 2024). Yu and Wang (2021) argue that the digital economy's impact on the urban-rural income gap is not direct but mediated through these structural changes. The transition from traditional to more technology-driven industries could lead to improved productivity (Zheng et al., 2023; Chang et al., 2024) and income levels (Ghosh et al., 2023),

particularly in rural areas, thus narrowing the income gap. However, this process is complex and may also result in new forms of inequality if the benefits of industrial upgrading are not evenly distributed across regions.

Given the emerging significance of digital economy development, scholars have started to explore its impact on the urban-rural income gap, focusing on aspects such as ICT (Appiah-Otoo & Song, 2021; Niebel, 2018), Internet development (Cheng & Zhang, 2019; Mora-Rivera & García-Mora, 2021), and digital financial inclusion (Li, 2022). However, existing studies present conflicting results regarding whether the digital economy effectively narrows this income gap (Chen et al. 2021; Wen & Ying, 2021). Additionally, limited empirical research has examined the mediating role of industrial structure in this relationship (Guo, 2022; Wang et al., 2022).

Another challenge lies in the measurement of digital economy development (Bánhidi & Dobos, 2023; Wang et al., 2021). Current methods include calculating the added value of the digital economy, constructing indicator systems, and developing digital economy satellite accounts (Barefoot et al., 2018; Duc et al., 2024). Compared to the added value calculation, digital economy indices and indicator systems offer a more comprehensive capture of information across various aspects of digital economy development. Furthermore, in comparison to digital economy satellite accounts, digital economy indices provide more concise and intuitive measurement results

(Mirolyubova et al., 2020； Zhang, & Xu, 2024). However, up to now, significant differences exist among the results of various digital economy-related indices due to the different perspectives of scholars and institutions regarding the digital economy (Duc, 2024; Leng & Zhong, 2024； Wang., 2024). Studies using the index method often focus on only some aspects of the digital economy but do not reflect the digital economy as a whole (Duc, 2024). Moreover, these indicators only allow evaluation of some features of the digital economy but do not help determine its monetary contribution to total economic product output, and authoritative digital economy indices have not yet been compiled by the Chinese government (Leng & Zhong 2024; Tao et al., 2024). These weaknesses in existing digital economy indices make it crucial to improve them to provide a more precise and comprehensive understanding of the digital economy development's role in addressing the urban-rural income gap.

Given these complexities, it is essential to conduct in-depth research on the impact of digital economy development on the urban-rural income gap in Mainland China. This study aims to provide empirical evidence by analyzing data from 30 provinces in Mainland China from 2013 to 2022. First, it generate an improved and comprehensive Digital Economy Development Index (DEDI) that captures the multidimensional characteristics of digital economy development across Chinese provinces. Second, using the improved index, the study examines the relationship between digital economy development and the urban-rural income gap, both at the aggregate level, reflecting national trends, and at the disaggregate level, focusing on

province-level heterogeneity. Special emphasis is placed on testing the existence of an inverted U-shaped relationship. Third, the study tests the mediating role of industrial structure, with a focus on how the optimization and upgrading of industrial structure influence the transmission mechanism between digitalization and income inequality.

Methodologically, the research employs dynamic panel data model, with the System GMM approach used to address potential issues of endogeneity, unobserved heterogeneity, and temporal dynamics. The theoretical foundation of this study integrates Kuznets' inverted U-shaped hypothesis, which explains the inverted U shape relationship between development and inequality; inclusive growth theory, which highlights the importance of equitable access to digital opportunities; and digital divide theory, which emphasizes structural barriers in digital accessibility and participation. Additionally, the industrial convergence theory provides a theoretical basis for understanding the mediating role of industrial structure. It posits that the integration of digital technologies into traditional industries can reshape economic structures, improve productivity, and facilitate income redistribution. The findings from this research could offer valuable insights for policymakers, public and private sector organizations, and scholars, aiding in the formulation of effective strategies to leverage digital economy development for reducing the urban-rural income gap in Mainland China.

1.3 Research questions

Building upon the identified statement of the problem, this study aims to address three specific research questions as outlined below:

i. How to generate a comprehensive digital economy development index that captures the nuanced impacts on the urban-rural income gap?

ii. What is the impact of digital economy development on the urban-rural income gap from aggregate and disaggregate perspectives?

iii. Do the optimization and upgrading of industrial structure play a mediating effect on the relationship between digital economy development and urban-rural income gap?

1.4 Research objectives

Based on the research questions and problem statement, the three research objectives are addressed as follows:

i. To generate an improved and comprehensive digital economy development index identified as DEDI.

ii. To examine the impact of DEDI on the urban-rural income gap from aggregate and disaggregate perspectives.

iii. To test the mediating effect of industrial structure optimization and upgrading in the relationship between the digital economy development and the urban-rural income gap.

1.5 Research hypothesis

In this section, research hypotheses are proposed regarding the relationships among the independent, dependent, and mediating variables. To achieve research objective 2, two hypotheses (H1 and H2) are formulated. Similarly, to achieve research objective 3, two additional hypotheses (H3 and H4) are proposed.

1.5.1 Impact of the digital economy development on urban-rural income gap

Based on an extensive review of prior literature, as summarized in Chapter 2, the development of the digital economy impacts the urban-rural income gap through a variety of interconnected mechanisms (Jin & Shao, 2016; Cheng & Zhang, 2019; Pazarbasioglu et al., 2020). On the one hand, numerous studies have demonstrated that the digital economy promotes rural income growth by enabling effects such as enhanced employment opportunities (Yin et al., 2019; Abdurakhmanova et al., 2020), improved financial inclusion and accessibility (Pazarbasioglu et al., 2020; Yu & Wang, 2021), increased participation in broader markets (Mekonnen, 2009; Yang, 2022), and the optimization of industrial structures (Babkin et al., 2020; Han & Li, 2022; Ge et al., 2022). These positive influences are widely considered to contribute to the

narrowing of the urban-rural income gap. On the other hand, opposing views also exist, with studies like those conducted by Wu et al. (2023) arguing that structural transformations driven by the digital economy may, under certain conditions, aggravate the income gap between urban and rural areas. Furthermore, the persistent digital divide, which includes disparities in both access to and utilization of digital technologies, has been identified by scholars such as Fuchs and Horak (2008) and Zhang et al. (2020) as a critical factor contributing to the widening income gap between rural and urban regions.

Additionally, several studies have explored the potential non-linear effects of digital economy development on the urban-rural income gap. For instance, Chen and Lin (2013) argue that the relationship between economic development and the urban-rural income gap in China demonstrates a U-shaped trend. They observe that the gap first narrows during the initial stages of economic growth but widens again as development progresses, ultimately challenging the applicability of Kuznets' inverted U-shaped curve to the Chinese context. In contrast, Jin and Shao (2016) suggest that the income gap in China exhibits a more robust inverted U-shaped pattern, driven by the dual processes of modernization and the transition from a planned to a market-oriented economy. Further, Cheng and Zhang (2019) provide both theoretical and empirical insights into the non-linear dynamics between Internet penetration, a key component of the digital economy, and the urban-rural income gap. Using provincial panel data spanning from 2003 to 2016, they reveal that the relationship

follows an inverted U-shaped trajectory. Specifically, they find that Internet penetration initially amplifies the urban-rural income gap, but once a critical inflection point, identified as occurring around 2009, is reached, this trend reverses, and the gap begins to narrow. Their findings underscore the transformative potential of Internet technologies in mitigating income disparities between urban and rural areas, particularly when digital tools and platforms become more widely accessible.

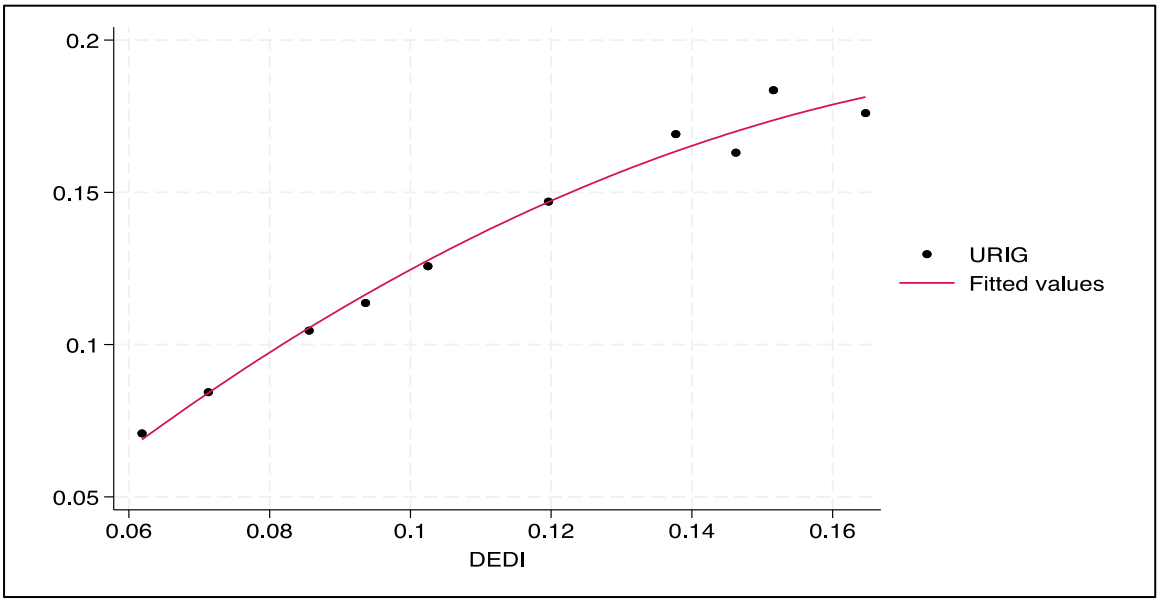
This study posits that the early stages of digital economy development in China were characterized by pronounced disparities in digital infrastructure and technological capabilities between urban and rural regions. These disparities resulted in a primary digital divide, reflected in unequal access to physical infrastructure, such as broadband and mobile networks, and a secondary digital divide, involving differences in individuals' capacities to process, interpret, and leverage digital information effectively. Together, these divides contributed to the gradual widening of the urban-rural income gap during the initial phase of digital economy development. However, as digital technologies became more widespread and affordable, rural residents began to derive significant benefits from the digital economy. For example, the proliferation of e-commerce platforms, mobile payment systems, and other digital innovations has enabled rural households to access broader markets, reduce production costs by bypassing traditional intermediaries, and allocate resources more efficiently. Moreover, these advancements have created new employment opportunities outside of agriculture and fostered entrepreneurial activities, further supporting rural income growth and narrowing the income gap.

From a theoretical perspective, the principle of diminishing marginal returns provides a useful framework for understanding the evolving relationship between digital economy development and the urban-rural income gap. This principle suggests that as the digital economy progresses, its incremental impact on reducing the income gap tends to decline. To capture this non-linear dynamic, the inclusion of a squared term for the digital economy development index ($DEDI^2$) in empirical models is essential. Such an approach allows for the identification of critical thresholds, where the marginal benefits of digital economy development begin to diminish or even reverse. This theoretical insight aligns with the findings of numerous empirical studies, which collectively suggest that while the digital economy initially exacerbates income disparities, its longer-term effects are more complex and context-dependent.

Lastly, Figure 1.4 provides empirical support for the inverted U-shape relationship between DEDI and URIG. The scatterplot, which examines the relationship between the URIG and the DEDI across China from 2013 to 2022, reveals a clear inverted U-shaped trend. Specifically, the analysis shows that in the initial stages of digital economy development, increases in the DEDI are associated with a widening income gap. However, once the DEDI surpasses a certain threshold, further increases are correlated with a narrowing of the gap, illustrating the dual impact of DEDI on URIG.

Figure 1.4

Relationship between DEDI and URIG in China (2013–2022)



Therefore, this research proposes the first research hypothesis in line with research objective two, from aggregate perspective:

H1: The impact of digital economy development on the urban-rural income gap in China follows an inverted U-shape from an aggregate perspective.

1.5.2 Regional heterogeneity

In examining the regional heterogeneity of the impact of digital economy development on the urban-rural income gap in China, this study draws upon Regional Economics Theory, which highlights spatial disparities as critical factors in economic development. This theory examines the distribution of economic activities across regions, accounting for disparities in resources, infrastructure, and policy

environments. Key concepts such as location theory and industrial clusters highlight how geographic and policy factors contribute to varied development trajectories across regions. Additionally, Regional Economics Theory underscores the role of regional innovation systems, wherein interactions among local governments, enterprises, and research institutions significantly influence the effectiveness of digital economy initiatives. By incorporating these principles, the study recognizes that the impact of digital economy development is not uniform across regions but varies according to distinct regional characteristics, supporting the hypothesis that regional heterogeneity plays a crucial role in shaping the urban-rural income gap.

China's vast territory and diverse regional characteristics have led to significant economic disparities across the country, which have been formalized into four distinct economic regions under the Eleventh Five-Year Plan for National Economic and Social Development (2006–2010): Eastern, Central, Western, and Northeastern regions[1]. These categories are based on variations in economic development, infrastructure capacity, and historical as well as geographic conditions.

China's four major economic regions, which are named the Eastern, Central, Western, and Northeastern regions, exhibit significant disparities in terms of economic development, infrastructure, and digital economy readiness, which

[1] The Eastern region encompasses Beijing, Tianjin, Hebei, Shandong, Jiangsu, Zhejiang, Shanghai, Fujian, Guangdong, and Hainan. The Central region includes Henan, Shanxi, Hubei, Hunan, Anhui, and Jiangxi. The Western region comprises Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. The Northeastern region consists of Heilongjiang, Jilin, and Liaoning.

influence the effects of digital economy development on the urban-rural income gap. The Eastern region leads with its advanced infrastructure, robust innovation ecosystem, and open institutional environment, enabling it to reap substantial benefits from digital economy advancements (Fan & Sun, 2013; He et al., 2019; Wei, 2015). In contrast, the Central and Western regions, characterized by slower economic growth, limited resources, and less openness, face greater obstacles in leveraging the digital economy to narrow the income gap (Wei, 2015). Meanwhile, the Northeastern region, though historically an industrial powerhouse, struggles with outdated industrial structures and institutional challenges, which hinder its ability to fully capitalize on digital transformation (Zhang et al., 2024). These regional differences highlight the need for tailored strategies to address the unique challenges and opportunities across China's diverse economic landscape.

These regional differences suggest that the impact of digital economy development on the urban-rural income gap varies significantly across China. In more developed regions, where digital economy growth may have already reached a saturation point, its marginal effect on narrowing the urban-rural income gap could be diminishing. In contrast, in less developed regions where the digital economy is still in its early stages of development, the potential for reducing income disparities may be more significant, as these areas have greater room for growth and innovation. Therefore, the impact of digital economy development on income disparities is likely to differ depending on the level of development and the specific challenges faced by

each region. Based on the above analysis, this research proposes the second hypothesis in line with research objective two, , from disaggregate perspective:

H2: Regional heterogeneity exists in the impact of digital economy development on the urban-rural income gap across China's four major regions.

1.5.3 Mediating effect of industrial structure

The development of the digital economy has a transformative impact on various facets of economic activity, particularly in the upgrading and optimization of industrial structures (Liu & Chen, 2021; Mason et al., 2021). As digital technologies become more integrated into the economy, they drive significant changes in how industries operate, often leading to more efficient, innovative, and higher-value-added sectors (Jiang, 2017; Zhou et al., 2022). This process of industrial evolution can significantly impact income disparities between urban and rural areas. The industrial structure refers to the composition of different sectors within an economy and their relative importance (Peneder, 2003). A well-optimized and upgraded industrial structure can lead to more equitable income disparities by enhancing productivity, creating better employment opportunities, and fostering regional economic development. Conversely, a lack of such optimization might exacerbate income inequality.

The benefits of digital economy development are channeled through the process of optimizing the industrial structure (Qi & Chu, 2021; Ge et al., 2022). As digital technologies facilitate the restructuring of industries toward higher productivity and efficiency, the resultant economic benefits could lead to a more balanced income disparities between urban and rural areas. Industrial structure optimization, characterized by a shift toward more advanced and diversified industries, may help in bridging the income gap by providing better employment opportunities and enhancing regional economic integration. Digital economy development impacts the urban-rural income gap by driving the upgrading of the industrial structure. Industrial structure upgrading involves transitioning from traditional, lower-value-added industries to more advanced, higher-value-added sectors. This shift can enhance economic growth and income generation in both urban and rural areas, potentially reducing disparities. The upgrading process, facilitated by digital innovations, may lead to a more dynamic and inclusive economic environment, thereby influencing the disparities of income between urban and rural regions. Based on the analysis of previous studies as discussed in section 2.5.2, the current study proposes the following hypotheses in line with research objective three**:**

H3: Digital economy development affects urban-rural income gap through industrial structure optimization.

H4: Digital economy development affects urban-rural income gap through industrial structure upgrading.

1.6 Significance of the study

This study aims to provide in-depth insights into the pressing issue of how the development of the digital economy influences the urban-rural income gap. Its significance lies in its ability to contribute both theoretically and practically. On the theoretical front, the study seeks to establish a comprehensive framework that delineates the pathways through which digital economy development affects the urban-rural income gap, with particular emphasis on the role of industrial structure as a mediating factor. On the practical front, it endeavors to offer actionable recommendations to policymakers, aiding the formulation of targeted strategies to reduce the urban-rural income gap in China while supporting sustainable economic transformation.

1.6.1 Theoretical contributions

The accelerated expansion of China's digital economy is profoundly transforming various domains of society and the economy. While existing research has explored the urban-rural income gap, there remains a notable scarcity of studies that integrate the perspective of digital economy development into this issue. In particular, limited attention has been given to investigating the role of industrial structure as a mediating factor within this context. This study addresses these gaps by establishing a comprehensive framework to elucidate the mechanisms through which digital economy development influences the urban-rural income gap, explicitly incorporating industrial structure as a mediator.

Furthermore, the theoretical pathways underlying the relationship between digital economy development and income disparities are systematically analyzed. A regression model is constructed to empirically validate the effects of digital economy development on the urban-rural income gap in China. By bridging theoretical analysis with empirical testing, this research offers a deeper understanding of these dynamics.

The findings contribute to advancing the academic discourse on the interplay between digital economy development, industrial transformation, and income distribution. They also provide new insights into the mechanisms shaping urban-rural income disparities in the Chinese context, thereby enriching the literature on this increasingly important topic.

1.6.2 Practical contribution

This study makes substantial practical contributions by serving as a reference for the formulation and implementation of targeted policies by local governments in China. Specifically, it provides a nuanced understanding of how digital economy development impacts the urban-rural income gap, with a special emphasis on the mediating role of industrial structure. By systematically exploring these relationships, the study establishes a comprehensive analytical framework that elucidates the pathways through which industrial structure moderates and amplifies the effects of digital economy development on income disparities between urban and rural areas.

The findings are particularly valuable for policymakers seeking to design evidence-based interventions aimed at reducing income inequality. By revealing the mechanisms through which digital economy development influences the urban-rural income gap, this research offers practical recommendations to promote more inclusive and equitable economic growth. For instance, the insights gained from this study highlight the need to optimize industrial structure, foster regional innovation systems, and leverage digital technologies to create employment opportunities and enhance income levels for rural populations.

In addition, the study aligns with the strategic objectives of the Chinese government to achieve high-quality economic transformation and narrow the urban-rural development gap in the context of rapid digitalization. It sheds light on effective strategies to harness digital technology as a driving force for balanced regional development. These include promoting digital infrastructure in rural areas, encouraging digital entrepreneurship, and facilitating cross-regional collaboration to reduce resource imbalances. Moreover, this research enriches the practical understanding of digital economy dynamics by addressing the broader implications of digital transformation. It provides actionable insights into how digital tools can be utilized to improve resource allocation, increase access to education and healthcare, and reduce transaction costs, all of which are critical for alleviating urban-rural disparities.

Beyond its policy relevance, this study also contributes to methodological advancements by validating and refining measurement tools used to evaluate the impact of digital economy development. The robust methodological approach adopted in this research ensures that the findings are both reliable and applicable to other contexts, thereby offering a replicable model for future studies examining the socioeconomic impacts of digitalization.

In conclusion, this study not only deepens the understanding of the role of digital economy development in shaping the urban-rural income gap but also provides a practical foundation for addressing one of China's most pressing socioeconomic challenges. The insights derived from this research can guide policymakers in designing targeted strategies to maximize the benefits of digital economy development while minimizing its potential drawbacks, thereby contributing to the realization of more equitable and sustainable growth.

1.7 Limitations of the study

This study has identified several limitations that can be improved in further research. Firstly, this study only generates the digital economy development index from the four dimensions namely, digital economy development carrier, digital industrialization, industrial digitization, and digital economy development environment. Regarding the measurement of the regional digital economy development level, there is not yet a unified and mature index system. Due to the availability of data and the limitations of

my academic ability, the index system constructed in this study cannot fully reflect the status quo of the level of the digital economy development in different regions of China. It is hoped that there will be more in-depth research in the future.

Second, this study limits its sample size to 30 provinces of in Mainland China. Additionally, this study limits the data period and only utilizes annual-based datasets, spanning from 2013 to 2022, due to data availability constraints. Nonetheless, the findings of this study achieve the research objectives and provide appropriate results for the research questions. However, future research could consider extending the time horizon by utilizing data spanning a longer period to better observe the long-term effects of digital economy development on the urban-rural income gap. Such an extended temporal scope would provide a more comprehensive understanding of how advancements in the digital economy affect income disparities over time. Additionally, incorporating municipal-level data in future studies could enable a more detailed analysis, revealing more specific regional differences and trends. This approach would offer deeper insights into the variability of digital economy effects across smaller geographic units, thereby enhancing the robustness and nuance of the findings regarding the relationship between digital economy development and urban-rural income gap.

The third limitation concerns the selection of the variables. This study's regression analysis included only a limited number of macroeconomic variables,

which may not fully capture the complex factors that influence the urban-rural income gap in China. The indirect impact of digital economy development on this income disparity are likely mediated by a broader range of factors. By focusing on a subset of explanatory variables, this research may have overlooked other potential mediating factors. Consequently, the findings might not be comprehensive or fully representative of the multifaceted nature of the issue. Future research should aim to incorporate additional variables to explore their roles in the mechanisms at play, thereby providing a more nuanced understanding of the relationship between digital economy development and the urban-rural income gap.

1.8 Theoretical framework

The framework in Figure 1.5 shows the main relationships among the key variables of this study, and the related theory is comprehensively introduced in Chapter 2.

Figure 1.5 illustrates the theoretical framework of this study, which investigates the impact of digital economy development (DEDI) on the urban-rural income gap (URIG) in Mainland China. The framework posits both direct and indirect pathways through which the digital economy affects income disparity.

The independent variable is digital economy development (DEDI), which is hypothesized to influence the dependent variable, the urban-rural income gap (URIG).

The direct effect captures how improvements in digital infrastructure, accessibility, and usage may either widen or reduce income disparities between urban and rural regions.

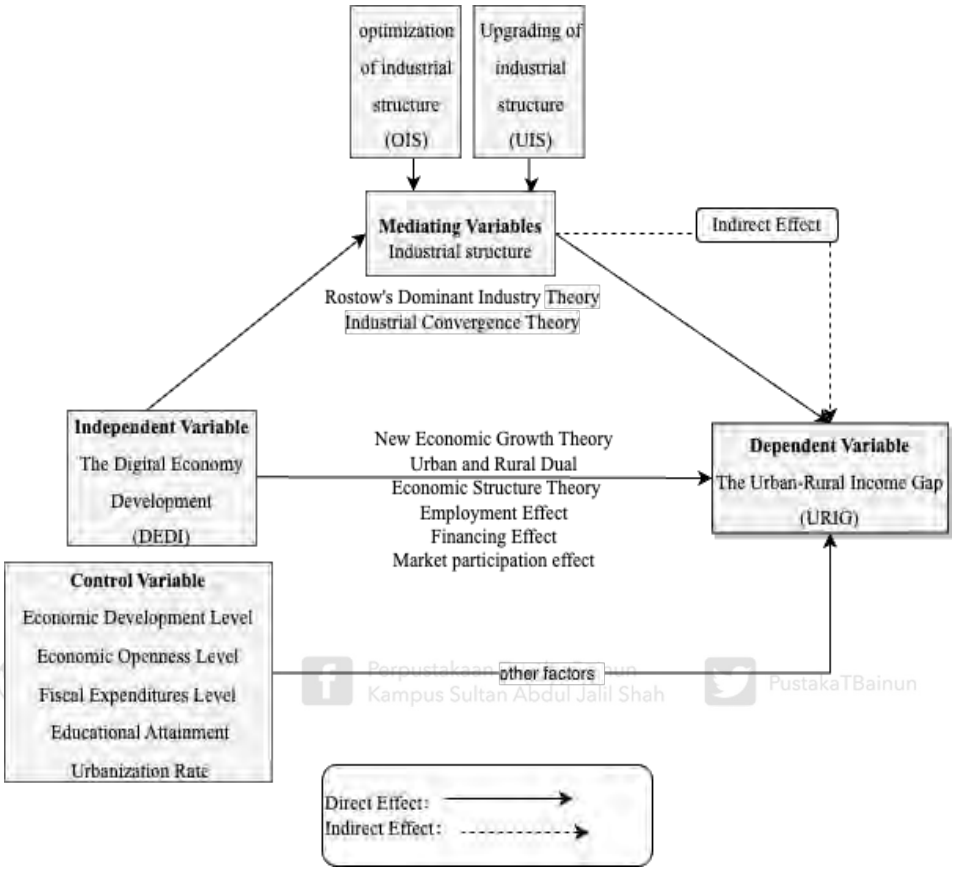
The indirect effect is modeled through mediating variables, specifically components of industrial structure transformation: the optimization of industrial structure (OIS) and the upgrading of industrial structure (UIS). These dimensions reflect the structural changes in the economy induced by digitalization, in line with industrial convergence theory, which suggests that digital technology facilitates industrial integration and evolution, particularly benefiting less developed rural areas.

The framework also includes five control variables. They are economic development level, openness, fiscal expenditure, educational attainment, and urbanization rate, which accounting for other socioeconomic factors potentially influencing the urban-rural income gap.

This theoretical framework provides the basis for empirical testing using a mediation analysis within a dynamic panel modeling approach, aimed at disentangling the pathways through which digital development impacts inequality in China.

Figure 1.5

The Theoretical Framework



1.9 Operational definition

The following terms and definitions are included in this research mainly primarily focusing on digital economy, digital economy development, urban-rural income gap, optimization and the upgrading of industrial structure, economic openness, fiscal expenditures, educational attainment and urbanization rate.

i. Digital Economy

The concept of digital economy, in the context of this study, is specifically aligned with the official definition established by Chinese authorities. The most recent version of the Classification of Digital Economy and Its Core Industries (2021), published by the National Bureau of Statistics of China, provides a framework for understanding the digital economy in China. According to this official classification, the digital economy is viewed as a comprehensive set of economic activities that depend heavily on data as a fundamental resource for production, with modern information networks acting as critical enablers. Furthermore, it highlights the importance of information and communication technology (ICT) as a driving force for improving operational efficiency and optimizing the overall economic structure. Key elements of the digital economy include the development of infrastructure, the openness and inclusiveness of the Internet economy, the focus on cyber security and privacy, consumer empowerment, and the fostering of innovation and sustainability.

In this study, the operational definition of digital economy development refers to the level or degree to which the digital economy has advanced in China. To measure this, we employ the Digital Economy Development Index (DEDI), which captures four critical dimensions: the digital economy development carrier, digital industrialization, industrial digitization, and the development environment for the digital economy.

ii. Urban-rural Income Gap

The urban-rural income gap (URIG) refers to the disparity in average income levels between urban and rural populations within a given geographical region (Kumar, 2014). This gap is typically quantified by calculating the ratio of the average income of urban households to that of rural households. A higher ratio indicates a greater disparity in income, and therefore, a wider urban-rural income gap (Sicular et al., 2007). An alternative approach to measuring this gap involves analyzing the distribution of income within each area and comparing the proportion of households with higher or lower income levels between urban and rural settings (Sicular et al., 2007). A more pronounced income gap generally suggests that a substantial segment of rural households struggles to reach a standard of living comparable to urban households. In this research, the Theil index are used to quantify the urban-rural income gap, as it offers a precise measure of income inequality and regional disparities.

iii. Optimization and Upgrading of Industrial Structure

From a dynamic economic perspective, the adjustment and development of an economic system's industrial structure can be viewed through two main processes: the optimization and upgrading of industrial structure (Gan et al., 2011). The optimization of industrial structure (OIS) refers to the extent to which industries align with one another, ensuring efficient resource allocation and improving coordination. This

involves examining the balance and interaction between input and output structures, which ultimately indicates the degree of economic aggregation within a region or nation (Zhang, Tang, & Yan, 2024). On the other hand, the upgrading of industrial structure (UIS) entails the gradual shift of a country's economic focus from the primary sector (such as agriculture) to the secondary (industry) and tertiary sectors (services). This shift often signifies the nation's level of economic development and determines the direction of future growth (Guan et al., 2022). Together, these processes are essential for understanding the evolving dynamics of a country's industrial landscape and its ability to meet new developmental challenges.

iv. Economic Development

Economic development (ED) refers to the scope, pace, and depth of a nation's economic progress. It plays a pivotal role in examining the disparities and growth trajectories of different regions within a country, particularly between urban and rural areas. In this study, per capita Gross Domestic Product (GDP) is adopted as the key indicator of economic development. Per capita GDP measures the total economic output of a region or nation divided by its population size, offering a comprehensive reflection of the average economic wellbeing and standard of living of individuals in the area (Li & Li, 2022).

v. Economic Openness

Economic openness (EO) refers to the extent to which a country or region actively engages in international economic exchanges. This concept is critical for understanding how a nation's integration into the global economy can influence domestic economic conditions, including income disparity. To measure economic openness, this study uses the ratio of total imports and exports relative to the Gross Domestic Product (GDP) of the region where the enterprise is located, which provides a clear indication of the region’s involvement in global trade (Li & Li, 2022).

vi. Fiscal Expenditures

Fiscal expenditure (FE) refers to the total amount of government spending during a specific period, covering areas such as public services, infrastructure, social welfare, education, healthcare, and more. The level of fiscal expenditure often serves as an indicator of government involvement and intervention in the economy, reflecting priorities in public spending (Qin, 2022). This variable is crucial for this study as it helps measure the government's role in mitigating the urban-rural income gap through public policies and investments. Specifically, the study used general government expenditure as a percentage of GDP, which helps control for the potential impacts of government spending on the economy and its influence on income distribution.

vii. Educational Attainment

Educational attainment (EA) refers to the highest level of education an individual has completed. This measure is typically expressed in terms of years of formal education or academic qualifications. In the context of this study, educational attainment is measured by the average number of years of education per capita, which serves as a key indicator of human capital development and the capacity for skill acquisition (Li & Li, 2022). The level of education directly influences an individual's potential for economic mobility, thus affecting income levels in both urban and rural areas.

viii. Urbanization Rate

Urbanization refers to the process by which a population shifts from rural to urban areas, leading to the expansion of urban regions and a reduction in rural populations. This process includes various facets such as demographic, regional, social, and spatial urbanization (Wang et al., 2012). The urbanization rate (UR) is typically quantified by calculating the proportion of the urban population relative to the total population (including both agricultural and non-agricultural sectors) within a region (Arif, 2013). This measure is important for understanding the scale and pace at which urbanization occurs, as well as its potential effects on income distribution and regional economic disparities.

1.10 Summary

This chapter outlines the background and problem statement of the study. In recent years, the digital economy has experienced rapid growth globally, with China emerging as the second-largest globally. Despite this advancement, China continues to face one of the widest urban-rural income gaps, a persistent issue that has drawn significant attention from the government. The government is actively seeking to leverage digital economy development to reduce this income disparity and promote the goal of achieving common prosperity. This study investigates not only the direct impact of digital economy development on the urban-rural income gap, but also the mediating role of industrial structure adjustments. Additionally, it examines the related challenges and opportunities in government policies and practical applications. The next chapter provides a theoretical and empirical review of previous literature on the key theories and variables relevant to this study.