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How Digitalization and Its Context Affect the Urban–Rural Income Gap: A Configurational Analysis Based on 274 Prefecture-Level Administrative Regions in China

Yulong Jie [1], Shuigen Hu [1], Siling Zhu [1] and Lieen Weng [2,*]

[1] School of Public Affairs, Zhejiang University, Hangzhou 310058, China; jieylvia@gmail.com (Y.J.); 22322508@zju.edu.cn (S.Z.)
[2] School of Public Administration, Zhejiang University of Technology, Hangzhou 310014, China
* Correspondence: wenglieen2022@zjut.edu.cn; Tel.: +86-185-3835-3276

Abstract: Digitalization offers an opportunity to narrow the economic gap between urban and rural areas; however, there are fragmented and competing explanations regarding its impact mechanisms. Responding to calls for research on the complex effects of digitalization, this paper, based on a contextual perspective and configurational theory, analyzes the impact of digitalization conditions embedded in contexts on the urban–rural income gap. The study, based on a sample of 274 prefecture-level administrative regions in China from 2014 to 2021, employs a Panel Fuzzy-Set Qualitative Comparative Analysis (Panel fsQCA) and Necessary Condition Analysis (NCA). The combined application of necessity analysis and sufficiency analysis reveals that certain digitalization conditions—such as digital infrastructure, digital industry, and digital finance—have a universal influence on the urban–rural income gap. Importantly, the sufficiency analysis demonstrates that the impact mechanisms of digitalization conditions exhibit configurational effects, varying with changes in contextual and conditional combinations. The models that significantly narrow the urban–rural income gap include (1) the "infrastructure–finance–governance" model, (2) the comprehensive digital transformation model, (3) the "technology–infrastructure–industry" model, and (4) the digital infrastructure transformation model. Among these, the comprehensive digital transformation model is the most universally effective. These configurations reflect the logic of completeness and substitutability and exhibit specific dynamic evolutionary trends and spatial distribution characteristics. These findings provide contextual and adaptable empirical insights for economies, including China, to implement targeted digital transformation strategies that effectively narrow the urban–rural income gap. For instance, economies can focus on developing comprehensive digital transformation in prosperous and open regions to reduce income gap.

Keywords: urban–rural income gap; digitalization; panel fsQCA; NCA

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1. Introduction

The urban–rural income gap is one of the major issues affecting sustainable economic growth in many countries, including China [1]. The United Nations regards promoting balanced urban–rural development as a key goal for achieving sustainable development [2]. Urban–rural inequality accounts for 40% of national inequality [3] and poses a significant challenge to poverty alleviation [4]. Since the beginning of this century, China has increasingly emphasized urban–rural issues, and the urban–rural gap has been effectively alleviated. However, because urban-biased economic development policies are long-term, the urban–rural income gap remains significant. Narrowing this gap and promoting common prosperity between urban and rural areas remain challenging tasks for China's development [5].

In recent years, digital transformation has become a trend. Digitalization refers to the transformation of all sectors of the economy, government, and society based on the large-

scale adoption of existing and emerging digital technologies [6]. Academic research on the impact of digitalization on the urban–rural income gap is increasingly rich, examining the roles of digital technology, digital economy, and digital governance [5,7,8], as well as mechanism heterogeneity in different regional environments [9–11]. These studies provide references for further systematic and integrative analyses. This paper aims to investigate how digitalization affects the urban–rural income gap and under what conditions it can effectively contribute to narrowing the gap.

However, the impact mechanisms of digitalization on the urban–rural income gap remain a topic of debate, reflecting ongoing uncertainties in the literature. Some empirical studies suggest that digitalization can promote the narrowing of the urban–rural gap [5,12], while others find that it accelerates the widening of the gap [13,14]. Additionally, some studies indicate an uncertain relationship between digital transformation and the urban–rural gap [15–17]. Many studies neglect the fact that digitalization is an interactive process occurring within multiple complex contexts, which affects the robustness of their conclusions. An increasing number of scholars recognize that the impact of digitalization on the urban–rural gap is mixed and nonlinear, influenced by complex interactions among digital factors and their contexts [16,18]. Therefore, maximizing digital dividends to eliminate inequality requires a comprehensive consideration of the synergistic effects of multiple digital factors and their contexts [1,19].

Overall, existing studies often focus on individual aspects of digitalization or specific regional contexts, leaving a gap in understanding the combined effects of multiple digitalization factors within varying contextual environments. Addressing this gap is challenging due to the complex and interconnected nature of digitalization and regional disparities. To address research gaps, this paper, based on a contextual perspective and configurational theory, analyzes the configurational causal effects of multiple digitalization factors embedded in key contexts on the urban–rural gap. Using Necessary Condition Analysis (NCA) and Panel Fuzzy-Set Qualitative Comparative Analysis (Panel fsQCA) methods, and a sample of 274 prefecture-level administrative regions in China from 2014 to 2021, the study contributes by, first, integrating the fragmented impact mechanisms of digitalization on the urban–rural income gap, especially clarifying the multiple characteristics and boundaries of its contextual impact mechanisms. Second, we utilize configurational methods to explore how different combinations of digitalization factors affect the urban–rural income gap, revealing the underlying logic of how these factors complement or substitute each other. This approach deepens our understanding of the mechanisms through which digitalization influences income disparities. Third, while these findings are specific to China's unique context, they may offer valuable insights for other regions with similar characteristics.

The remainder of this paper is organized as follows. Section 2 provides a comprehensive literature review and develops the theoretical framework for our study. Section 3 describes the research design, including sample selection, variable measurement, and analysis methods. Section 4 presents the results of the necessity and sufficiency analyses. Finally, Section 5 discusses the findings, draws conclusions, and offers implications for policy and future research.

2. Literature Review and Analytical Framework

2.1. Key Paths of Digitalization Affecting the Urban–Rural Income Gap

This paper introduces configurational theory into the discussion of digitalization and the urban–rural income gap, extracting antecedent conditions and analytical frameworks from the existing literature. Based on the research and application processes of digitalization, three paths can be summarized, digital technology, digital economy, and digital governance, encompassing five influencing factors on the urban–rural income gap. Examining them individually provides meaningful references. A brief summary is shown in Table 1.

First, digital technology. Neo-Schumpeterianism and the techno-economic paradigm theory emphasize that price structure changes and shifts in economic agents' behavior

triggered by new technologies lay new rules and frameworks for economic activities [20]. Currently, digital technology mainly includes physical components such as digital hardware, technical development parts like network connections, and the application of digital technology [21]. Academics generally examine technological innovation itself and the widespread application of technological achievements through the popularization of digital infrastructure.

In terms of digital technological innovation, new generations of digital technology promote information flow, deeply empower various fields and links in agriculture and rural areas, provide more opportunities and markets [15,19], and improve agricultural production methods and farmers' lifestyles [22], promoting urban–rural income balance [13,23]. At the same time, technological progress is viewed by some scholars as a main cause of widening income gaps [24]. Technological innovation has a positive impact on regional economic growth rates, is closely related to wages and income, and exacerbates regional gaps, including urban–rural disparities [25].

Regarding digital infrastructure, new infrastructure can enable data elements to fully flow between regions, providing more development opportunities for relatively disadvantaged rural populations [26], having a greater income effect on rural residents than urban residents, and narrowing the urban–rural income gap [15]. For example, the "Broadband China" strategy has improved the current situation of the urban–rural income gap in China [13]. Opposing views argue that the potential of the internet to reduce the importance of distance is exaggerated [27]. Over time, the increasing rate of computer penetration in rural areas tends to raise the incomes of rural residents, but the average effect remains limited [28]. The widespread deployment of digital infrastructure leads to economic differentiation between urban and rural areas [23,29].

Second, digital economy. Setting aside the generalized concept that includes technology and infrastructure [15,30], in a narrow sense, digital industry and digital finance are core elements of the digital economy—the former being the main form of digital economic activities (digital industrialization) and the latter being an important digital service around economic activities (industrial digitization). They directly affect the urban–rural income gap. From the perspective of neoclassical economics, under conditions of a perfectly competitive market, resource allocation will optimize utilization on its own, which may reduce income gaps due to "trickle-down effects," but market failures may exacerbate this gap [31].

Regarding the digital industry, some scholars believe that due to the spillover effects of the digital industry [32], leading to industrial migration and rural production upgrades, it helps significantly improve the urban–rural income gap [33–35]. For example, e-commerce has been proven to increase farmers' income [36]. Opposing views argue that the development of the digital industry accelerates the flow and aggregation of production factors to urban areas and excludes low-skilled rural labor, widening the economic development gap between urban and rural areas [32,37,38]. Some scholars have empirically found that the impact of the digital industry on the urban–rural income distribution gap shows an inverted U-shaped curve relationship [15,39,40].

In terms of digital finance, it is believed to alleviate information asymmetry between long-tail financing groups and financial institutions, reduce financing costs, open up social capital circulation channels, break geographical restrictions, and narrow the income gap between urban and rural areas [41]. Studies have found that the development of digital finance can compensate for the consequences of reduced bank branches in rural areas, providing equal opportunities for rural communities to access financial services through its inclusiveness [7]. However, due to the lag in developmental investment and application in impoverished regions, the digital divide may also widen the development gap between urban and rural areas [14,32].

Third, digital governance. The public sector plays a "meta-governance" role in economic and social systems [42]. New structural economics advocates that economic transformation relies on the complementarity of government and market [43]. The techno-economic paradigm theory emphasizes that emerging techno-economic relationships require corre-

sponding institutional arrangements and social structures to support [20]. In this context, digital government governance is considered an important factor in adjusting social relations and solidly promoting common prosperity [44]. Empirical studies show that digital government construction helps narrow income and public service gaps between urban and rural areas [8,45,46]. However, research also indicates that practices such as e-government can widen gaps [47]. The realization of digital governance empowerment requires strict contextual conditions [11,48].

Table 1. Positive and negative impacts of digitalization dimensions on the urban–rural income gap.

Dimension	Impact Type	Main Arguments	References
Digital Technology Innovation	Positive	Promotes comprehensive agricultural development through information flow empowerment, improved production methods, and market opportunities, leading to urban–rural income balance	[13,15,22,23]
	Negative	Exacerbates regional and urban–rural disparities through technological innovation's uneven impact on economic growth	[24,25]
Digital Infrastructure	Positive	Enhances rural development through data flow and infrastructure accessibility, particularly benefiting rural residents' income as evidenced by the "Broadband China" strategy	[13,15,26]
	Negative	Shows limited effectiveness in reducing regional disparities due to exaggerated impact claims and insufficient rural penetration	[23,27–29]
Digital Industry	Positive	Facilitates rural development through industrial spillovers and e-commerce, significantly improving urban–rural income distribution	[32–34,36]
	Negative	Creates urban–rural divide through urban-centric resource flow and exclusion of low-skilled rural labor, showing nonlinear impact pattern	[32,37–39]
Digital Finance	Positive	Improves rural financial accessibility by reducing information asymmetry and geographical barriers while compensating for traditional banking limitations	[7,41]
	Negative	Potentially widens urban–rural gap due to developmental lag and digital divide in impoverished regions	[14,32]
Digital Governance	Positive	Promotes social equity through improved public services and income distribution mechanisms	[8,44–46]
	Negative	May increase disparities without proper implementation conditions and contextual support	[11,47,48]

2.2. Contextual Mechanisms of Digitalization Affecting the Urban–Rural Income Gap

Digital ecology theory argues that contextual complexity influences the application of technology by subjects [49,50]. The competitive views and findings on the mechanisms of digitalization affecting the urban–rural gap have prompted scholars to focus on the impact of contextual heterogeneity. However, although some studies have subdivided the mechanisms of digitalization in different regions—for example, dividing China into eastern, central, and western regions [51]—they lack examination of the synergistic effects among contextual factors and between contextual factors and different digitalization elements. They also fail to clarify the inherent differences in regional heterogeneity and their systematic impact mechanisms on digitalization. Therefore, this paper reviews and extracts the following key contexts for targeted empirical analysis.

First, economic level. The economic level itself can explain the urban–rural and regional gaps [52] and plays a complex and important role in digitalization affecting the urban–rural gap. On the one hand, when local economic levels are higher, digital infrastructure [51,53], digital economy [34,54], and digital inclusive finance [55] have a greater effect on reducing regional income gaps. On the other hand, competitive research finds that in economically less developed regions, digital technological innovation [35,56], digital industry [57], and digital inclusive finance [14] can promote balanced urban–rural development.

Second, the degree of government intervention. Government behavior relates to the formulation and effective implementation of regional coordinated development policies [58]. Its intervention activities can both promote the optimal allocation of resources among regions and lead to resource waste due to low efficiency of expenditures, profoundly affecting income gaps [21,41]. Studies have empirically shown that government intervention affects the process of digitalization [59,60]. Government intervention has a negative impact on the urban–rural income gap [30]. However, opposing findings exist; for example, government intervention has a narrowing effect on the income gap [61,62]. Compared with regions with high fiscal self-sufficiency rates, the digital economy is more conducive to narrowing the income gap within regions with low fiscal self-sufficiency rates [63].

Third, the degree of openness. The relationship between the degree of openness and regional economic development has always attracted attention [64,65] and shows complex findings in digitalization research [58]. Digitalization paths such as digital technology and digital industry have characteristics of diffusion effects, backwash effects, and learning effects [52,66]. Empirical studies have found that the scale of foreign direct investment strengthens the effect of digitalization in economically developed regions on reducing gaps, while exacerbating gaps induced by digitalization in economically backward regions [67].

Overall, the academic community has formed mainstream explanations about digitalization's influencing factors on gaps and related contextual factors, providing a solid foundation for more in-depth theoretical construction and empirical analysis. However, the logical explanations of single paths are one-sided, leading to fragmented and conflicting mechanism findings and contextual adaptation. This requires more systematic and comprehensive theories and perspectives to integrate, deepen, and supplement existing research findings.

2.3. Contextual Perspective and Configurational Theory: An Analytical Framework

If digital phenomena are increasingly complex and multifaceted, relying solely on a single theoretical perspective and relatively simplistic "more is better" linear model may be perilous [68]. The complexity and dynamic nature of digital transformation necessitate adopting integrative approaches to capture the multifaceted interactions and contextual dependencies influencing regional disparities. The combination of a contextual perspective and configurational theory provides a good analytical framework for integrating fragmented findings and supplementing new knowledge to answer questions.

The contextual perspective emphasizes the complexity of contextual impacts on digital transformation [49,50], believing that the forms of contextual effects are diverse, including

the impact of context on digitalization mechanisms and the synergistic effects within contexts and between contexts and digitalization. Moreover, the process of contextual effects is contingent and interactive [69]. This requires that only by contextualizing the discussion of digitalization mechanisms or treating contextualization as a key rather than a supplementary analysis can the full picture be understood.

Configurational theory provides an epistemological and methodological foundation for understanding the synergy mechanisms of factors. It emphasizes that each configuration has one or more central "logics" that coordinate the interactions of various attributes [70,71]. The same factors may lead to different outcomes depending on their coordination or arrangement with other factors [71]. In such a fused and chaotic digital world, there may often be multiple logics to configure information technology and resources to achieve set goals [68]. This means that the effects of different digitalization factors on the urban–rural income gap depend on their matching degree with other factors and contexts; there is no single best primary plan or its combination with contexts.

In this study, "configurational effects" refer to the causal mechanisms formed by the interactions within digitalization conditions and contextual conditions and their influence on specific states of regional income disparities. In the complex system of digital transformation, contextual and specific digital conditions often have substantial impacts on regional income disparities in configurational rather than single forms (or their additive forms).

Building upon the literature review, we identify that the impact of digitalization on the urban–rural income gap is not uniform but varies depending on specific conditions and contexts. Digital innovation, infrastructure, industry, finance, and governance can either mitigate or exacerbate income disparities based on how they interact with contextual factors like economic level, government intervention, and openness. These insights inform our analytical framework, which aims to capture the configurational effects of multiple digitalization factors within different contexts.

As shown in Figure 1, the framework consists of the context of digitalization, digitalization paths, configurational effects, and the urban–rural income gap. First, the process of digital transformation and impact occurs in specific and complex contexts (the "contextual conditions" and their dashed outer circle in Figure 1). The contextual dimension includes economic level, degree of government intervention, and degree of openness. Second, different digitalization conditions interact to form diversified combinations, which function as a whole (the "digital conditions" and their dashed inner circle in Figure 1). Digitalization paths include digital technology, digital economy, and digital governance. Digital technology focuses on digital technological innovation and technological application through digital infrastructure construction. The digital economy focuses on the development of digital industry and digital finance as tools to stimulate economic growth. Digital governance focuses on the synchronous transformation and empowerment of regulatory forces that adjust technology and economic development. Third, combinations of contextual conditions and digitalization conditions further form several configurations (arrows in the middle section of Figure 1), promoting the narrowing or widening of regional income disparities (the "outcomes" on the right side of Figure 1).

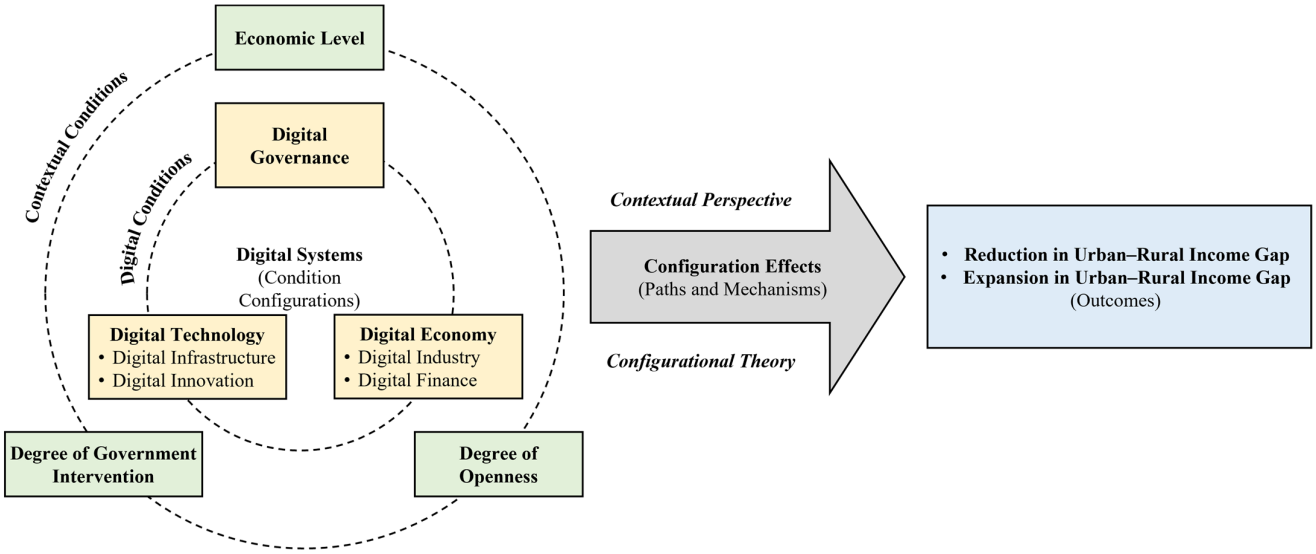


Figure 1. Analytical framework of digitalization affecting the urban–rural income gap.

3. Research Design

3.1. Research Methods

In social science research, it is necessary to distinguish among three types of relationships between variables: average effect relationships, necessary relationships, and sufficient relationships, and to employ methods that match these relationships [72]. Average effect relationships focus on analyzing the average impact effect of changes in independent variable X on changes in dependent variable Y. Necessary relationships focus on analyzing whether a certain level of X is a necessary condition for a certain level of Y. Sufficient relationships focus on analyzing whether the occurrence of X will sufficiently lead to the occurrence of Y. Traditional regression methods primarily analyze average effect relationships between independent and dependent variables, based on the assumption of overall separability, suitable for analyzing phenomena with weak interdependencies among antecedent variables. Necessary and sufficient relationships are mainly used to analyze complex causal relationships [70]. To address these complexities and reconcile inconsistencies in prior research, this study adopts a complex system's perspective and employs two analytical methods: Panel Fuzzy-Set Qualitative Comparative Analysis (Panel fsQCA) and Necessary Condition Analysis (NCA).

Among them, QCA views research subjects as configurations of conditions, helping to analyze causal complexities such as multiple concurrent causes, causal asymmetry, and equifinality, making it suitable for this study's examination of the complex necessary and sufficient relationships between context, digitalization paths, and the urban–rural income gap. Panel fsQCA is an emerging research method [73], which can fully reflect the continuous changes in configurations at different time points. Compared with traditional QCA, Panel fsQCA further provides means to effectively utilize panel data, helping to construct theories that can empirically verify, refute, and explain configuration results at different periods. In the empirical analysis, we will analyze configurations that lead to the narrowing (or widening) of the urban–rural income gap, as well as their between consistency (changes in explanatory power over time) and within consistency (urban–rural distribution of explanatory power), and conduct supplementary configurational analyses based on contextual grouping.

This study also employs Necessary Condition Analysis (NCA) to supplement and extend the analysis of necessary conditions. NCA can identify necessary (but not sufficient) conditions for outcomes and quantify the degree of necessity [72]. Unlike a traditional Necessary Condition Analysis in QCA, which only determines whether a condition is necessary, NCA provides a more detailed understanding by calculating the effect size

of necessary conditions. This complements the results of QCA, helping to provide a more comprehensive understanding of the role of digitalization in the urban–rural income gap. Appendix A contains detailed instructions on the application steps of Panel fsQCA and NCA.

3.2. Sample Selection

Sample selection is critical in ensuring that our analysis accurately reflects the diverse regional characteristics influencing the urban–rural income gap in China. Panel fsQCA requires a balanced panel dataset to ensure consistency and comparability across cases and over time. We initially constructed a sample frame covering all prefecture-level and above administrative regions in China from 2014 to 2021. To ensure data quality and reliability, we excluded samples with a large amount of missing data. For variables with only a few missing values, we applied logarithmic linear interpolation and mean imputation within the same income or regional category to fill in the gaps. We finally used 274 prefecture-level administrative regions as samples[1]. This extensive dataset enabled us to conduct a robust configurational analysis that could reveal nuanced insights into how digitalization affects income disparities. By the end of 2020, China's internet penetration rate reached 70.4%, 1.4 times that of 2014. Various new industries and new models are flourishing. In addition, in 2019, China proposed the urban–rural integrated development strategy based on fully implementing the rural revitalization strategy. China's urban–rural integrated development has made great progress, but the income gap remains prominent. The selected time span and sample balance data diversity and accessibility.

To clarify, in China, prefecture-level administrative regions are appropriate units for analyzing the urban–rural income gap. Each prefecture-level region encompasses both urban and rural areas, allowing us to capture income disparities within the same administrative context. This approach aligns with previous studies examining regional inequalities and urban–rural disparities in China (e.g., [74]). By using data at this level, we can effectively assess the impact of digitalization on the urban–rural income gap within each region.

3.3. Definition and Operation of Variables

3.3.1. Outcome Variable

This paper measures income using the per capita disposable income of urban and rural residents. At the gap measurement level, indices such as the Theil index, Gini coefficient, and coefficient of variation are widely used to measure social gaps [13,75]. Considering that differences in regional population distribution cannot be ignored and referring to existing research [64], we calculated the population-weighted Theil index, Gini coefficient, and coefficient of variation in urban–rural per capita income. These inequality measures satisfy the relative income principle (mean independence), population principle, and Pigou–Dalton principle. Among them, the Theil index is more sensitive to data extremes. Considering that the Theil index is more sensitive to changes at both ends of the income distribution, the subsequent analysis mainly uses the population-weighted Theil index for empirical analysis and conducts robustness checks using the population-weighted Gini coefficient and population-weighted coefficient of variation (see 4.5. Robustness Tests for details). Data are from provincial and prefecture-level statistical yearbooks.

3.3.2. Explanatory Variables

Digital Innovation. Following existing practices [76] (Dai et al., 2022), focusing on the four core industries of the digital economy—digital product manufacturing, digital product service, digital technology application, and digital element driving—we used three indicators: patent grants, trademark registrations, and software copyright registrations to measure the degree of regional digital technological innovation. These indicators represent technological innovation, product innovation and quality, and software innovation activities of the digital industry, reflecting digital technological innovation output. After

standardization, they are weighted at a ratio of 2:1:1. Data are from the China Digital Economy Innovation Index and the National Intellectual Property Administration.

Digital Infrastructure. Digital infrastructure generally refers to public facilities that provide digital services to people using digital technology, comprehensively applying a new generation of information technology. Combining existing research [11,21], we used the entropy weighting method to score six indicators—the number of mobile phone users per 10,000 people at year-end, the number of internet users per 10,000 people, the length of long-distance optical cable lines per 10,000 people, the number of web pages per 10,000 people, the number of domain names per 10,000 people, and the number of enterprises with websites per 10,000 people—to measure digital infrastructure. Data are from provincial and prefecture-level statistical yearbooks.

Entropy Weight Method: The entropy weight method uses the concept of entropy in information theory to measure the amount of information provided by each indicator and assigns weights accordingly, helping alleviate the difficulty and irrationality of subjective judgments, improving the rationality and reliability of the decision-making process in multi-attribute evaluation problems. The method mainly includes the following steps (the calculation process for other variables using the entropy weight method is similar):

Step 1: Normalize the Data

$$f_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \tag{1}$$

Step 2: Calculate Entropy for Each Indicator

$$H_j = -k\sum_{i=1}^{m} f_{ij} \ln f_{ij} \tag{2}$$

Step 3: Determine Weights for Each Indicator

$$w_j = \frac{1 - H_j}{\sum_{j=1}^{n} (1 - H_j)} \tag{3}$$

Step 4: Compute Comprehensive Score for Each Evaluation Object

$$S_i = \sum_{j=1}^{n} w_j r_{ij} \tag{4}$$

where i represents the evaluation object. j represents the indicator. m represents the number of evaluation objects. n represents the number of indicators. r_{ij} represents the standardized value of the i-th evaluation object under the j-th indicator. f_{ij} represents the proportion of the i-th evaluation object under the j-th indicator. H_j represents the entropy of the j-th indicator, measuring the uncertainty or dispersion degree of the information provided by the j-th indicator. $k = \frac{1}{\ln m}$ is a constant to ensure $0 \leq H_j \leq 1$. w_j represents the weight of the j-th indicator. S_i represents the comprehensive score of the i-th evaluation object.

Digital Industry. Referring to existing practices [62], this study assesses the digital industry from incremental and stock perspectives. The incremental part is based on the number of new enterprises, foreign investment attraction capacity, and venture capital attraction in China's core digital economy industries, weighted at a ratio of 4:3:5, depicting the development prospects of the digital industry [76]. The stock analysis calculates the entropy weighting method scores of per capita data in information, telecommunications, e-commerce, IT services, software industry, and postal industry, comprehensively reflecting industry strength. The mean of the standardized values of the two reveals the comprehensive state of the digital industry. Data are from provincial and prefecture-level statistical yearbooks.

Digital Finance. In a narrow sense, digital finance mainly focuses on the financial innovation services of internet enterprises [77]. Following existing research [14], we used the "Peking University Digital Financial Inclusion Index of China" (DFI) for measurement.

Digital Governance. Regarding digital governance, there are third-party evaluations such as government website performance evaluations and digital government development

indices. The second is specific proxy variables, using the reply rate of messages on the *People's Daily Online* message board, the word frequency of government work reports, etc. These measurements have respective deficiencies in evaluation levels, time spans, data openness, comparability, and scientificity. Considering comprehensively, this paper selects the performance evaluation data of Chinese government websites as the output indicator of digital governance, which revolves around dimensions such as government information disclosure, public participation, online services, user experience, or innovative development. The indicators have strong scientificity, continuity, and comparability. On the other hand, we chose the keyword word frequency of local government work reports as the input indicator of digital governance [78]. The keywords, combining various third-party evaluation methodologies and GPT-4 suggestions, include 235 keywords in multiple dimensions such as digital government services and digital economic governance. Considering the hierarchical relevance of digital governance [79], the word frequency score of prefecture-level cities is the average of the provincial score and the municipal score; the provincial level is the average of the provincial score and the average of all cities. The digital governance variable takes the entropy weighting method score of government website performance and the keyword ratio in government work reports.

Economic Level. Per capita GDP is an indicator measuring the wealth created by a region within a specific time, reflecting the overall economic situation. This paper uses it to represent the level of economic development. Data are from provincial and prefecture-level statistical yearbooks.

Degree of Government Intervention. Government intervention refers to the regulation of economic activities by the government through fiscal, financial, and legislative means to achieve specific economic goals. Referring to general practices [21,61], we used the ratio of local fiscal general budget expenditure to GDP to measure the degree of government intervention. This indicator reflects the intensity of government activities in providing public services and implementing macro-control and is closely related to its efforts to adjust economic disparities. Data are from provincial and prefecture-level statistical yearbooks.

Degree of Openness. While trade volume is commonly used to measure openness, consistent and reliable trade data at the prefecture level in China are often unavailable due to reporting limitations. Therefore, we used the actual utilized foreign direct investment (FDI) as a proxy for the degree of openness. Foreign direct investment can provide funds and technology for regional economic growth and is a symbol of opening up. Referring to existing research [21,65], this paper measures the level of foreign capital utilization by the ratio of foreign direct investment to regional GDP. Foreign direct investment (FDI) across Chinese regions refers to investments made by foreign investors within their jurisdictions through various means, including establishing foreign-invested enterprises, partnerships, engaging in cooperative exploration and development of oil resources with local investors, and setting up branches of foreign companies. The assessment of FDI is primarily based on the actual amount of foreign capital utilized. The data are collected by local statistical departments and typically denominated in US dollars, which we convert to RMB using the exchange rates of the respective years. Data are from provincial and prefecture-level statistical yearbooks.

3.4. Data Preprocessing and Analysis Procedure

In constructing panel data, first, we excluded samples with a large amount of missing data and used logarithmic linear interpolation and mean imputation within the same income or regional category for samples with only a few missing values to improve the dataset. Second, to consider the lag effect of digitalization and potential reverse causality issues, this study, following the methods of the literature [8,63], lagged the condition variables by one period.

In the QCA process, the data were uniformly calibrated based on existing theories and prior research to analyze internal, between, and overall consistency and coverage. According to general practices when significant distribution characteristics were lacking,

the direct calibration method was used, setting the 95th percentile, 50th percentile, and 5th percentile as the anchors for full membership, crossover point, and full non-membership, respectively. For subsequent analysis, the urban–rural gap was reverse-calibrated. A consistency level of 0.9 was used as the threshold for necessity analysis. Subsequently, using the truth table algorithm for sufficiency analysis, the consistency threshold was set at 0.9, and the PRI score was 0.75. The case frequency threshold was set at 2, meaning that each configuration needed to be observed in at least two cases to be considered relevant for analysis.

See Table 2 for detailed descriptive statistics of the variables used in the analysis.

Table 2. Variable operation and calibration results.

Variable	Operation	Data Source	Full Non-Membership	Crossover Membership	Full Membership
Urban–Rural Income Gap	Population-weighted Theil index of urban and rural per capita income	Local Statistical Yearbook	0.133973	0.058956	0.020876
Digital Innovation	Weighted scores of patents, trademarks, and software copyrights	China Digital Economy Core Industry Innovation and Entrepreneurship Index	12.84714	24.5397	38.22102
Digital Infrastructure	Entropy weight method scores of access and use in various fields	Local Statistical Yearbook	0.03979	0.075069	0.172136
Digital Industry	Weighted scores of digital industry increments and stocks	China Digital Economy Core Industry Innovation and Entrepreneurship Index; Local Statistical Yearbook	−1.04067	−0.09693	1.482382
Digital Finance	Digital Inclusive Finance Index	Peking University Digital Inclusive Finance Index of China	120.7745	207.3655	275.5115
Digital Governance	Entropy weight method scores of government website performance and digital governance keyword frequency statistics	China Government Website Performance Evaluation; Government Work Reports	0.136526	0.34035	0.548956
Economic Level	Per capita GDP	Local Statistical Yearbook	22,102.36	47,217.5	123,874.4
Degree of Government Intervention	Local fiscal general budget expenditure/GDP	Local Statistical Yearbook	1008.815	1809.198	3902.766
Degree of Openness	Foreign direct investment amount/GDP	Local Statistical Yearbook	0.000492	0.011431	0.051172

4. Results Analysis

Before presenting the analysis results, it is important to acknowledge the main challenges faced in this study. The multifaceted nature of digitalization and its impact on the urban–rural income gap present significant analytical complexities. The interactions among various digitalization conditions and contextual factors create a high degree of configurational diversity across regions. Additionally, data heterogeneity and the potential for causal asymmetry pose challenges in deriving clear conclusions. To address these issues, we employ a combination of Qualitative Comparative Analysis (QCA) and Necessary Condition Analysis (NCA) to unravel the complex causal relationships and provide robust insights.

4.1. Necessity Analysis of QCA and Necessary Condition Analysis

This section uses Panel Fuzzy-Set Qualitative Comparative Analysis (Panel fsQCA) and Necessary Condition Analysis (NCA) to examine the necessity of digitalization factors on the urban–rural income gap. In the necessity analysis of Panel fsQCA, when the pooled consistency of a condition variable is above 0.9, the pooled coverage is above 0.5, and both the between consistency deviation and within consistency deviation are below 0.1, the condition can be considered a necessary condition for the outcome [70].

Table 3 shows the necessity analysis results of digitalization factors on the narrowing and widening of the urban–rural income gap. The pooled consistency of all digitalization conditions did not reach the threshold of 0.9. The pooled consistency of digital infrastructure on the narrowing of the urban–rural income gap was 0.762, still below the necessity standard. This indicates that single digitalization factors are not necessary conditions for the narrowing or widening of the urban–rural income gap nationwide. Additionally, the consistency adjustment distances of most digitalization conditions were above or close to 0.2, indicating that their necessity fluctuates greatly over time or space. The between consistency deviations of economic level, degree of government intervention, and degree of openness were all below 0.2 in the context of narrowing the urban–rural income gap, indicating that the roles of contextual factors are relatively stable at different time points. These results overall make it difficult to argue the necessity of these variables.

Therefore, we used NCA to supplement and extend the necessity analysis of Panel fsQCA. NCA identifies necessary conditions by analyzing the necessity effect size of antecedent conditions and their significance and by analyzing bottleneck levels to assess the necessary levels of antecedent conditions for achieving certain outcome levels. It helped supplement insights such as "if a region wants to achieve a specific level of urban–rural gap, what minimum level should the antecedent factors reach?" The closer the effect size is to 1, the larger the effect [72]. Ceiling Regression (CR) was used for handling continuous variables. Table 2 reports the NCA necessity analysis results of single conditions. When the effect size (d) of a single condition is greater than 0.1 and the *p*-value is significant, the condition is considered a necessary condition for the outcome [72]. The bottleneck table allows this paper to make necessity statements in degrees. "NN" indicates that X is not necessary for a specific value of Y.

Table 4 shows the average necessity of each variable. Digital finance and degree of government intervention had effect sizes greater than 0.1 and *p*-values less than 0.05 in the narrowing of the urban–rural income gap, showing significant positive effects. This is consistent with the findings of Ding and Kang (2024), emphasizing the key roles of digital finance and degree of government intervention in promoting urban–rural balanced development [41]. Digital infrastructure and digital industry had *p*-values less than 0.1, but effect sizes were also less than 0.1, indicating limited necessity. Appendix B shows the bottleneck tables (CR method) of several important conditions for analyzing necessary relationships (in degrees). For digital infrastructure, digital industry, and economic level, moderate bottleneck levels (60%, 60%, 50%) can serve as necessary conditions to promote the narrowing of the urban–rural income gap.

Table 3. Necessity analysis of Panel fsQCA.

Variable	Reduction in Urban–Rural Income Gap				Expansion of Urban–Rural Income Gap			
	Overall Solution Consistency	Overall Solution Coverage	Between Consistency Adjusted Distance	Within Consistency Adjusted Distance	Overall Solution Consistency	Overall Solution Coverage	Between Consistency Adjusted Distance	Within Consistency Adjusted Distance
Digital Innovation	0.730	0.763	0.188	0.333	0.561	0.544	0.369	0.433
~Digital Innovation	0.563	0.580	0.272	0.483	0.755	0.722	0.195	0.316
Digital Infrastructure	0.762	0.837	0.144	0.250	0.533	0.544	0.392	0.433
~Digital Infrastructure	0.585	0.574	0.168	0.449	0.841	0.767	0.114	0.233
Digital Industry	0.739	0.807	0.275	0.266	0.552	0.559	0.433	0.383
~Digital Industry	0.596	0.589	0.299	0.399	0.809	0.742	0.181	0.216
Digital Finance	0.709	0.752	0.533	0.200	0.565	0.557	0.621	0.266
~Digital Finance	0.582	0.590	0.563	0.300	0.748	0.705	0.426	0.166
Digital Governance	0.732	0.759	0.265	0.266	0.592	0.570	0.460	0.350
~Digital Governance	0.585	0.607	0.409	0.333	0.749	0.722	0.366	0.216
Economic Level	0.734	0.833	0.060	0.366	0.517	0.545	0.198	0.516
~Economic Level	0.599	0.572	0.114	0.449	0.841	0.746	0.030	0.266
Degree of Government Intervention	0.547	0.609	0.101	0.516	0.723	0.747	0.158	0.366
~Degree of Government Intervention	0.772	0.750	0.097	0.316	0.621	0.560	0.057	0.416
Degree of Openness	0.627	0.741	0.174	0.433	0.542	0.595	0.047	0.499
~Degree of Openness	0.657	0.607	0.084	0.399	0.764	0.655	0.067	0.316

Table 4. Average results of Necessary Condition Analysis.

	Reduction in Urban–Rural Income Gap		Expansion in Urban–Rural Income Gap	
	Effect Size	*p*-Value	Effect Size	*p*-Value
Digital Innovation	0.002	0.406	0	0.984
Digital Infrastructure	0.083	0.039	0.001	0.974
Digital Industry	0.077	0.054	0	1
Digital Finance	0.105	0.015	0	1
Digital Governance	0.047	0.208	0.002	0.976
Economic Level	0.032	0.307	0	0.996
Degree of Government Intervention	0.131	0.004	0.041	0.169
Degree of Openness	0	0.983	0	0.96

Since panel data were used and the necessity analysis of Panel fsQCA showed time effects, we conducted NCA on each year's cross-section (Appendix C). The results show that digital infrastructure, digital industry, digital finance, and economic level had necessity in most cases in the early and middle years, with P-values less than 0.1 and effect sizes greater than 0.1. This shows a declining trend in the necessity of the above variables. In addition to the degree of government intervention, other conditions had limited necessity in the widening of the urban–rural income gap, reflecting that the main role of digitalization development lies in narrowing rather than widening the urban–rural income gap.

4.2. Sufficiency Analysis: What Are the Combinations of Digitalization Paths and Contexts?

The previous section overall supports our hypothesis that digital transformation in different domains often cannot individually serve as necessary conditions for changes in regional income disparities, which justifies the rationality of QCA's sufficiency analysis. We identified configurations by constructing a truth table and logical minimization. After constructing the truth table, considering the particularity of dynamic QCA, we conducted an enhanced standard analysis [73]. In the counterfactual analysis part, we first excluded contradictory simplifying assumptions. Then, because China is vast and regional endowments differ significantly, and there are many competitive findings in existing empirical studies, it is difficult to uniformly judge the effect of antecedent conditions on the outcome, so we did not set directional expectations, choosing "present or absent" for all. Finally, we obtained enhanced simple solutions, intermediate solutions, and complex solutions.

This paper mainly focuses on the intermediate solutions, supplemented by the parsimonious solutions, to identify core conditions and peripheral conditions. As shown in

Table 5, the consistency values of each configuration are all above 0.9, and the PRI values are also high, indicating that these configurations had strong explanatory power as sufficient conditions. Most configurations had raw coverage between 0.3 and 0.5, and the overall coverage shows that more than half of the cases were explained. The overall consistency and overall PRI of the solution were high, indicating good explanatory power. Details of the case membership for each configuration are provided in Appendix D.

Table 5. Configurations of digitalization affecting the urban–rural income gap[2].

Variable		Reduction in Urban–Rural Income Gap					Expansion in Urban–Rural Income Gap		
		H1a	H1b	H2	H3	H4	NH1	NH2	NH3
Digital Paths	Digital Innovation	□		●	□		⊗		⊗
	Digital Infrastructure	●	●	●	□	□	⊗	⊠	⊗
	Digital Industry	□	□	□	□	⊗	⊗	⊠	⊗
	Digital Finance	●	●	□		⊠	⊗	⊠	
	Digital Governance	●	●	●		●	⊠	⊠	●
Context	Economic Level	●	●	●	□	●	⊗	⊠	⊠
	Degree of Government Intervention		⊠	⊗	⊠	⊠		□	□
	Degree of Openness	●	●		□	□		□	
Consistency		0.962	0.973	0.955	0.963	0.976	0.872	0.907	0.916
PRI		0.901	0.924	0.891	0.904	0.806	0.74	0.684	0.726
Raw Coverage		0.365	0.353	0.447	0.388	0.219	0.542	0.3	0.355
Unique Coverage		0.023	0.004	0.104	0.035	0.011	0.182	0.014	0.062
Overall Solution Consistency				0.942				0.869	
Overall PRI				0.87				0.737	
Overall Solution Coverage				0.536				0.619	

4.2.1. Affirmative Analysis: Configurations Leading to the Narrowing of the Urban–Rural Income Gap

Based on the combinations of digitalization factors and considering contextual factors as background, we extracted the following four types of configurations that narrow the urban–rural income gap.

First, the "infrastructure–finance–governance" digital transformation model based on prosperity and openness (H1a and H1b). This model reflects that in regions with high economic levels and degrees of openness, the coordinated development of digital infrastructure, digital finance, and digital governance promotes the narrowing of the urban–rural income gap. In this configuration, digital infrastructure (●), digital finance (●), and digital governance (●) co-exist as core conditions; economic level (●) and degree of openness (●) are also core presences, while degree of government intervention is either absent (⊠) or not significant. The consistency of this configuration reached 0.962 (H1a) and 0.973 (H1b), with PRI values of 0.901 and 0.924 and raw coverage of 0.365 and 0.353, indicating strong explanatory power for narrowing the urban–rural income gap. Typical cases include economically developed regions such as Beijing, Shanghai, Guangzhou, Shenzhen, and Hangzhou. High economic levels provide a solid material foundation for digitalization development, increased openness promotes the flow of technology and resources, and the improvement of digital infrastructure and the popularization of digital finance create conditions for urban and rural residents to obtain digital dividends. Meanwhile, the advancement of digital governance enhances government service efficiency, reducing information asymmetry between urban and rural areas. The absence or insignificance of government intervention may reflect that market mechanisms play a larger role in these regions [43].

Second, the comprehensive digital transformation model based on economic prosperity (H2). This model reflects that in economically developed regions (●), comprehensively promoting the application of digital technology (●), optimizing infrastructure (●), expanding digital industry (□), improving inclusive finance (□), and enhancing digital governance

capability (●) effectively address structural differences between urban and rural areas, promote urban–rural coordinated development, and narrow the income gap. The consistency of this configuration was 0.955, with a PRI value of 0.891 and raw coverage of 0.447, indicating strong explanatory power for narrowing the urban–rural income gap. Typical cases include non-coastal developed regions such as Nanjing, Chengdu, and Nanchang. This model emphasizes the importance of comprehensive digitalization integrated with high economic levels, showing the synergistic effects of digital measures in economically developed regions [49,68]. Compared with other configurations, it shows the logic of completeness rather than substitutability in digitalization. The improvement of economic level provides a good environment for digital innovation, and the strengthening of digital governance enhances the efficiency and fairness of public services. The improvement of digital infrastructure lays the foundation for the application and promotion of digital innovation. The peripheral roles of digital industry and digital finance indicate that they are not decisive factors in this model. This may be because these regions already have a high level of development, and the impact of digital innovation and governance is more prominent.

Third, the "innovation–infrastructure–industry" digital transformation model based on prosperity and openness (H3). The characteristics of this model are that economic level (□) and degree of openness (□) are background conditions, degree of government intervention is absent (⊠), digital industry (□) and digital infrastructure (□) exist as peripheral conditions, digital innovation (□) is also a peripheral condition, and digital finance and digital governance have no significant impact on the outcome. The consistency of this configuration was 0.963, with raw coverage of 0.388, indicating strong explanatory power for narrowing the urban–rural income gap. Typical cases include coastal cities such as Qingdao, Xiamen, and Fuzhou. Although these regions are at a medium economic level in digital development compared with first-tier cities, increased openness promotes the inflow of resources and technology, assisting digital transformation. This finding aligns with some studies. Li and Li (2022) pointed out that the impact of digitalization varies in regions with different economic levels [16]. By continuously promoting digital innovation and infrastructure construction, the urban–rural gap can be gradually narrowed [17]. The development of the digital industry drives the improvement of employment and income levels. However, the roles of digital finance and digital governance have not yet been fully manifested, possibly constrained by policy support and market demand.

Fourth, the digital infrastructure transformation model with economy as the main factor and openness as a supplement (H4). Under this model, the contextual conditions are high economic level (●) with a certain degree of openness (□). In terms of digitalization, digital governance exists as a core condition (●), digital infrastructure exists as a peripheral condition (□), digital industry is absent as a core condition (⊗), digital finance and degree of government intervention are absent as peripheral conditions (⊠), and digital innovation has no significant impact on the outcome. The consistency of this configuration was 0.976, with a PRI value of 0.806 and raw coverage of 0.219, indicating a certain explanatory power for narrowing the urban–rural income gap. Typical cases include regions with developed economies but needing industrial structure adjustment, such as Nantong, Xuzhou, and Taizhou. Digital governance enhances government service levels, optimizes resource allocation, and promotes the equalization of urban–rural public services. A developed and relatively open background provides a foundation for focused digitalization. The strengthening of digital governance improves the efficiency and fairness of public services, enhancing the quality of life for urban and rural residents. The construction of digital infrastructure provides technical support for the implementation of digital governance. The absence of digital industry may indicate that the economic development of these regions is mainly based on traditional industries, and the improvement of digital governance compensates for the shortcomings of the industrial structure.

4.2.2. Negative Analysis: Configurations Leading to the Widening of the Urban–Rural Income Gap

One characteristic of QCA is causal asymmetry, which helps capture additional causal laws. Therefore, this paper analyzes the digitalization paths and contexts that lead to the widening of the urban–rural income gap. Overall, the coverage of negative analysis configurations was higher than that of affirmative analysis, and the consistency was lower than that of affirmative analysis. This indicates that these configurations can participate in explaining more cases but with weaker explanatory strength. We briefly introduce them:

First, the model of comprehensive lack of digitalization under low economic level (NH1). The comprehensive lack of digitalization elements, coupled with a low economic level, makes it difficult for these regions to enjoy the dividends brought by digitalization, leading to the further widening of the urban–rural income gap. This finding is consistent with some of the literature. The World Bank Group (2016) pointed out that the digital divide is more evident in economically underdeveloped regions, and the lack of digitalization can exacerbate income inequality [1].

Second, the model of digitalization lag under economically backward and government intervention and openness background (NH2). The lack of digital industry limits employment and income growth, and the lack of digital infrastructure hinders the application of digital technology. The insufficiency of digital governance and digital finance further aggravates this situation. The backwardness of the economy limits digitalization development, and untimely government intervention and openness may exacerbate the negative impact of digitalization lack, leading to the widening of the urban–rural income gap.

Third, the model of digital governance failure under economic backwardness and government intervention background (NH3). Due to the lack of digitalization synergy support, although the government is promoting digital governance, the effect is limited. At the same time, the low economic level limits digitalization investment, and the peripheral presence of degree of government intervention and degree of openness is insufficient to drive digitalization development, further promoting digital governance to become an "isolated" existence, widening the urban–rural income gap.

4.2.3. Logic of Completeness and Substitutability

These configurations reflect the logic of completeness and substitutability. While some of the literature emphasizes the synergistic effects of digitalization factors on the urban–rural income gap [15,16,68], there are few answers regarding whether a complete digital ecosystem is necessary or which elements are essential at a minimum. This paper finds that, as shown in Figure 2, on the one hand, there is a logic of completeness in digitalization effects, meaning that only when all elements of digitalization are fully developed can the urban–rural income gap be narrowed, such as configurations H1a and H2. Due to the inclusion of contextual factors, this paper also demonstrates macro background information compatible with this logic. On the other hand, there is also a logic of substitutability (equivalence), especially in the same or similar contexts where different digital transformation paths exist, such as configurations H1b, H2, and H4. These configurations indicate that in the context of high economic levels and degrees of openness, different combinations of digitalization elements can substitute for each other to achieve similar effects. This provides the possibility for different regions to choose suitable digitalization development paths based on their actual situations.

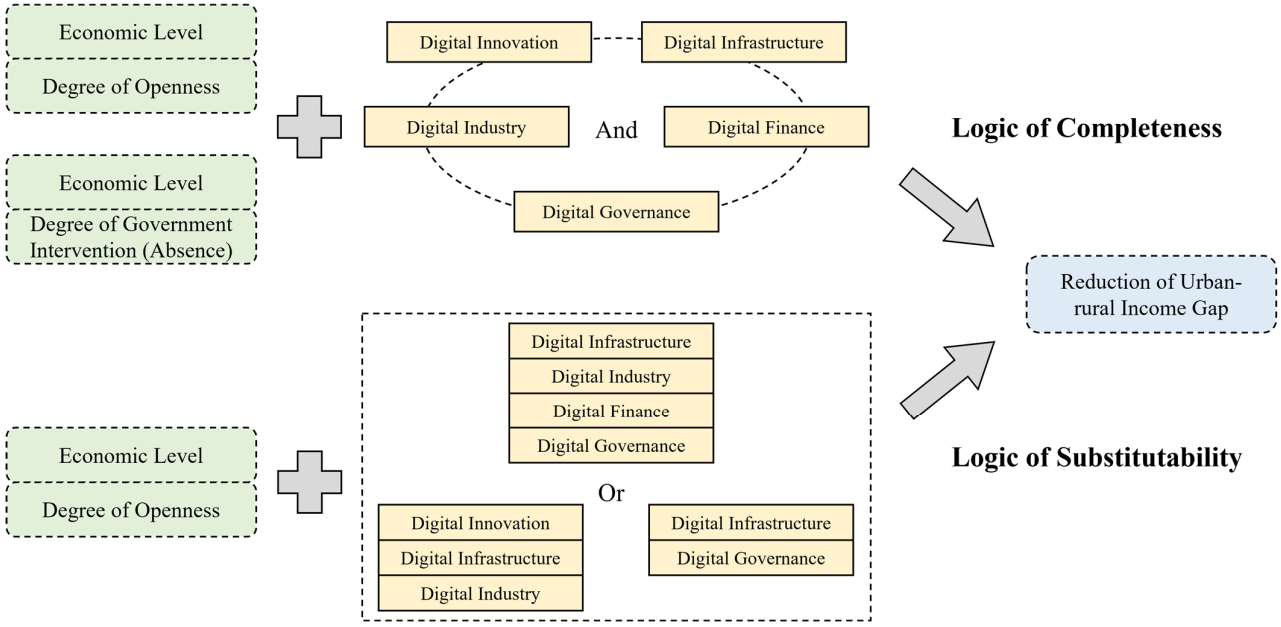


Figure 2. Logic of completeness and substitutability in configurations.

4.3. Between Consistency Analysis: Phasic Changes in Configurational Explanatory Power

Between consistency reflects the dynamic characteristics of each configuration's explanatory power at different stages [80]. Figure 3 and Appendix E show that the consistency values of affirmative configurations (H1a, H1b, H2, H3, H4) generally remained at a high level between 2014 and 2021, all above 0.94, indicating strong explanatory power of these configurations for narrowing the urban–rural income gap in each year. However, observing changes in between consistency still revealed additional findings. Specifically, the consistency of all configurations showed a slow downward trend before 2019. This period coincided with China's economic slowdown, and the gradual weakening of digital dividends may have led to a decline in the explanatory power of configurations. In 2020 and 2021, consistency values rebounded. This may have benefitted from increased investment in new digital infrastructure [22] and the widespread acceleration of digital transformation during COVID-19 pandemic prevention and control. After 2019, with the advancement of "new infrastructure" and the vigorous development of the digital economy, the role of digitalization elements in narrowing the urban–rural income gap had been strengthened. At the same time, the outbreak of the COVID-19 pandemic accelerated digital transformation, increasing the penetration rate of digital technology between urban and rural areas, promoting the narrowing of the urban–rural income gap.

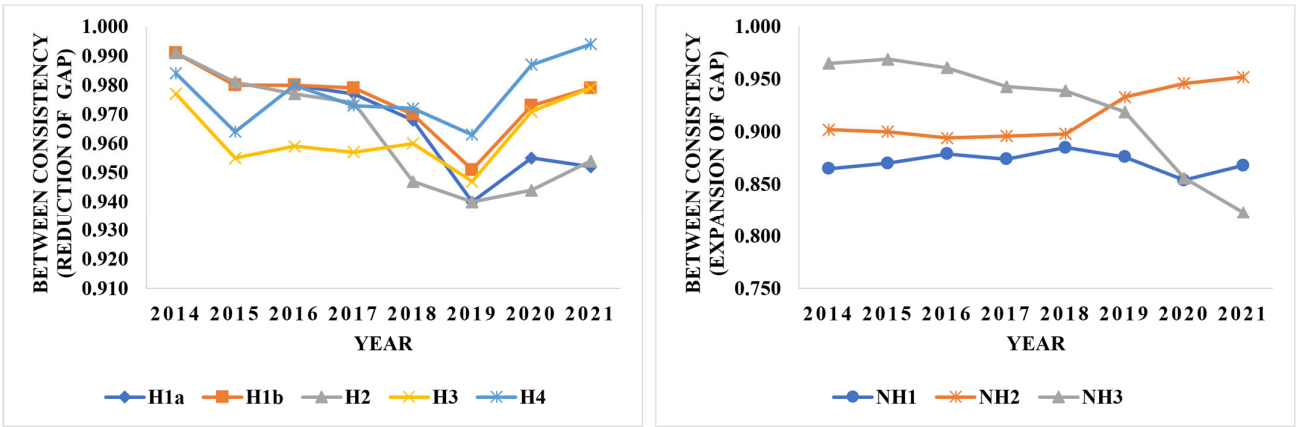


Figure 3. Between consistency analysis.

In contrast, the consistency values of negative configurations (NH1, NH2, NH3) were relatively low. The consistency of NH3 decreased from 0.965 in 2014 to 0.823 in 2021. This may indicate that under the joint action of policies and markets, the impact of the lack of digitalization elements (and digital governance) on the widening of the urban–rural income gap weakened.

4.4. Within Consistency Analysis: Regional Distribution of Configurational Explanatory Power

Within consistency analysis aims to explore the distribution of the explanatory power of each configuration in different regions and cities. Figure 4 and Appendix F show that in affirmative configurations (H1a, H1b, H2, H3, H4), within consistency was generally high in eastern regions, with most cities' values close to or equal to 1, showing strong explanatory power of these configurations for narrowing the urban–rural income gap in eastern regions. This is closely related to the economic development, high level of digitalization, and improved digital infrastructure in eastern regions. Within consistency in central regions showed significant differences. Provincial capital cities like Changsha and Hefei had within consistency values close to 1 in affirmative configurations, while economically underdeveloped cities like Shiyan and Xinzhou had lower values, even below 0.4. The situation in the western regions was more complex. Some central cities like Chengdu and Xi'an had higher consistency. However, more western cities had lower consistency. This may be related to the low economic level and insufficient digitalization investment in western regions. The northeastern regions showed significant differences in within consistency. Some cities like Harbin and Changchun had higher consistency, but more cities like Jixi and Hegang had extremely low consistency, even below 0.1. This is closely related to issues such as economic growth slowdown, population loss, and single industrial structures.

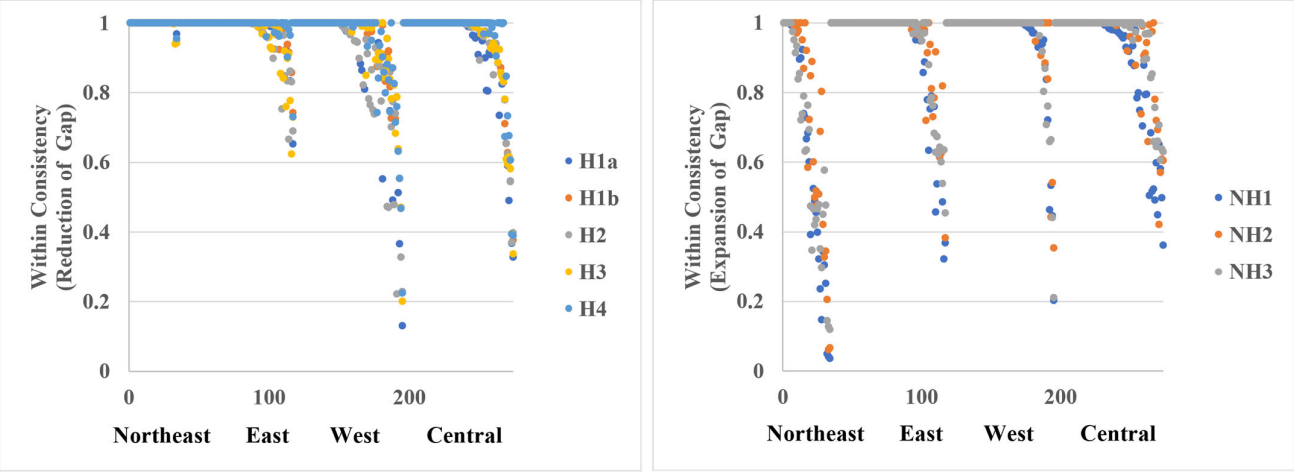


Figure 4. Within consistency analysis[3]. Note: The vertical axis represents within consistency, and the horizontal axis represents the samples.

Notably, in negative configurations (NH1, NH2, NH3), some cities in central and western regions had higher consistency. For example, Xinzhou, Shiyan, and Lvliang had within consistency close to or equal to 1 in negative configurations, indicating that the lack of digitalization elements had a significant impact on the widening of the urban–rural income gap in these regions. This is related to weak digital infrastructure and lack of digital skills in these regions.

Overall, within consistency analysis revealed differences in digitalization development levels among regions in China, and the impact on the urban–rural income gap also showed significant regional differences. Digitalization elements play a significant role in narrowing the urban–rural income gap in economically developed regions with high levels of digitalization, while in economically underdeveloped regions with insufficient digitalization

investment, the role is limited or may even widen the urban–rural income gap. This is consistent with existing research, which states that while digitalization promotes economic development, it may also exacerbate inequality between regions and between urban and rural areas.

4.5. Robustness Tests

This paper conducts additional tests to assess the robustness of the main results (affirmative analysis of sufficiency analysis). First, besides using the Theil index, we used the population-weighted Gini coefficient and population-weighted coefficient of variation to construct proxy variables for the urban–rural gap (see Appendix G for details). Second, we tightened and relaxed key thresholds in the QCA, changing the case frequency threshold for sufficiency analysis to 4 and 8 cases, respectively (see Appendix H), and adjusting the consistency threshold to 0.8 and 0.9, respectively (see Appendix I). Third, to ensure that our findings were not sensitive to the calibration thresholds, we changed the full non-membership point, crossover point, and full membership point to the 10th percentile, 50th percentile, and 90th percentile, respectively (see Appendix J). Comparisons show that the results are generally consistent with the main conclusions of the above analysis, confirming the robustness of the research results.

5. Discussion and Conclusions

The digitalization process in China presents a complex picture, characterized by significant regional disparities in digital progress and uneven contexts of regional development. While digitalization offers immense potential to narrow the urban–rural income gap, these disparities pose substantial challenges. Regions with advanced digital infrastructure and economic prosperity have benefited more from digital transformation, whereas less developed areas lag behind, exacerbating existing inequalities. This uneven development highlights the limitations of applying uniform digitalization strategies across diverse contexts.

Therefore, it is crucial for academia and practitioners to move beyond common average effect mechanisms and explore context-specific configurational mechanisms of digitalization. By understanding the unique combinations of digitalization factors that work effectively in different settings, particularly in regions with limitations, more flexible and pragmatic strategies can be devised. This paper, based on a contextual perspective and configurational theory, analyzes the impact mechanisms of digitalization factors embedded in contexts on the urban–rural income gap. Using a sample of 274 prefecture-level administrative regions in China from 2014 to 2021, and employing Necessary Condition Analysis (NCA) and Panel Fuzzy-Set Qualitative Comparative Analysis (Panel fsQCA), the study yields the following conclusions:

5.1. Main Conclusions

First, some digital factors and contextual factors play key roles in narrowing the urban–rural income gap. Most digitalization factors can significantly affect the urban–rural income gap. Among them, digital infrastructure, digital industry, digital finance, and economic level play certain necessary roles in narrowing the urban–rural income gap, which aligns with affirmative findings around these variables [7,15,80]. The impact mechanisms of digital innovation, digital governance, and other contexts are more complex and variable, requiring specific discussions combining factor combinations and contextual adaptation.

Second, the impact of digitalization on the urban–rural income gap exhibits configurational effects. Previous studies mainly focus on the linear effects of single factors [7,81]. We found that the narrowing of the urban–rural income gap was jointly promoted by different digitalization factors under specific contexts. Specifically, the four configurational models that narrow the urban–rural income gap include (1) the "infrastructure–finance–governance" digital transformation model based on prosperity and openness (H1a and H1b); (2) the comprehensive digital transformation model based on economic prosperity

(H2); (3) the "technology–infrastructure–industry" digital transformation model based on prosperity and openness (H3); and (4) the digital infrastructure model with economy as the main factor and openness as a supplement (H4). Additionally, we have identified several configurations that lead to the widening of the urban–rural income gap. This reflects the logic of completeness and substitutability in the impact of digitalization on the urban–rural income gap, meaning that both comprehensive development of digitalization elements and effective combinations of different digitalization elements can achieve the goal of narrowing the urban–rural income gap. Overall, the existence of these typical configurations and important logic partially integrates the fragmented and competitive conclusions in existing research.

Third, contextual factors have multiple impacts on digitalization mechanisms. Economic level and degree of openness as background conditions affect the play of digitalization factors. In regions with high economic levels and degrees of openness, digitalization elements are more likely to play a role in promoting the narrowing of the urban–rural income gap. In economically backward regions, the lack of digitalization elements may lead to the widening of the urban–rural income gap. This reflects the "Matthew effect" of digitalization development. In other words, the systemic challenges faced by backward regions in narrowing the urban–rural income gap through digitalization are more severe than expected. Additionally, the degree of government intervention often shows an enhancement in widening the urban–rural income gap, reflecting potential drawbacks of the government's high involvement in the national economy.

Fourth, the explanatory power of conditions and configurations shows time trends and spatial characteristics. Over time, the explanatory power of single factors and configurations on the urban–rural income gap has declined overall, with dramatic changes occurring in 2019, possibly related to changes in the macroeconomic environment, adjustments in digital economy policies, and the COVID-19 pandemic. Spatially, the role of digitalization in narrowing the urban–rural income gap is more significant in eastern regions, while in central, western, and northeastern regions, the effect is limited and may even widen the urban–rural income gap, reflecting regional imbalances in digitalization development.

5.2. Practical Implications

These findings provide empirical insights for digital transformation practices aimed at narrowing the urban–rural income gap.

First, the government should embrace digitalization and comprehensively promote digital transformation. The government should increase investment in digital infrastructure in rural areas of underdeveloped regions, promoting the popularization and upgrading of broadband networks, mobile communications, and the Internet of Things. This will provide material guarantees for rural residents to access digital services and participate in digital economic activities. Financial institutions should be encouraged to expand the coverage of digital financial services in rural areas, using technologies such as big data and blockchain to innovate financial products, reduce the cost of rural financial services, and improve farmers' access to credit and financial services. They should also support the development of the digital industry, encourage the application of digital technology in traditional industries, promote industrial digitization and digital industrialization, create more employment opportunities, and increase residents' income, as well as accelerate the construction of digital government, enhance digital governance capabilities, and achieve equalization of urban–rural public services through online government service platforms.

Second, the government should implement differentiated digital development strategies based on contexts. The government should formulate digital development plans tailored to local conditions based on regional economic levels and degrees of openness. The configurational analysis above provides several specific contextualized paths. Meanwhile, the government can explore more feasible solutions based on the "contextual" perspective and "configurational" methods. For example, in regions with high economic levels, the government can fully play the role of market mechanisms to support digital innovation and

industrial upgrading; in regions with low economic levels, it can increase governmental support to compensate for market mechanism deficiencies and promote the accumulation of digitalization elements.

Third, the government should not only go with the flow but also create contextual conditions. Most importantly, the government should focus on economic construction to provide a good economic foundation for urban–rural coordinated development, expand high-level opening-up and let the market play a decisive role in resource allocation, creating a world-class business environment. Additionally, the government can encourage developed regions to carry out digital cooperation with underdeveloped regions, supporting cross-regional flow of technology, capital, and talent. Through jointly building digital industrial parks and cooperating on digital projects, it can drive the digitalization development of underdeveloped regions and achieve coordination and sharing between regions.

5.3. Research Limitations

This paper has certain limitations that await improvement and deepening in the future. First, due to data availability limitations, the selected digitalization indicators may not fully reflect the full picture of digitalization development. Future research can further expand the indicator system to improve the comprehensiveness of the research. Second, the QCA method has limitations on the number of condition variables; there may be trade-offs in variable selection in this study. Future research can try to introduce more variables or supplement verification by combining other methods. Third, this study is mainly based on empirical data from China; the international applicability of the research conclusions needs to be tested. Future research can expand the research scope to other countries and regions to explore the universality and particularity of the impact of digitalization on the urban–rural income gap. Fourth, we acknowledge that using lagged variables may not fully address the issue of reverse causality. Our choice of Qualitative Comparative Analysis (QCA) focuses on identifying configurational patterns rather than establishing strict causal relationships. Nonetheless, we have taken steps to mitigate potential reverse causality by ensuring that all explanatory conditions precede the outcome variable in time. Future research could explore additional methods, such as instrumental variables or longitudinal designs, to further address this concern. Additionally, this paper did not find a digital empowerment path for urban–rural coordinated development that is well suited to underdeveloped regions, which limits the application value of the conclusions.

Last but not least, while certain digitalization paths, such as the comprehensive digital transformation model and the infrastructure–finance–governance model, have been effective in narrowing the urban–rural income gap, others show limited impacts due to regional imbalances and contextual constraints. Regions with advanced economies and higher openness levels tend to benefit more from digitalization efforts, whereas less developed areas may not experience the same advantages. Policymakers and practitioners should focus on enhancing digital infrastructure and capabilities in less developed regions, tailoring digitalization initiatives to local contexts. By doing so, they can amplify the positive effects of digitalization and mitigate its limitations. We encourage academia and practitioners to further explore and refine context-specific digitalization strategies, leveraging strengths and addressing weaknesses to promote more equitable and inclusive development.

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Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Major Procedures of Panel fsQCA and NCA

In this study, we employ Panel Fuzzy-Set Qualitative Comparative Analysis (Panel fsQCA) (Garcia-Castro and Ariño, 2016) and Necessary Condition Analysis (NCA) (Dul et al., 2020) to investigate the impact of digitalization on the urban–rural income gap. Our analytical approach encompasses four types of analysis designed to assess the influence of individual and combined digitalization conditions, as well as their explanatory power across different time periods and regions.

Firstly, we conducted a necessity analysis using Panel fsQCA to determine whether any single digitalization condition was essential for the observed changes in the urban–rural income gap. This involved calibrating the data into fuzzy sets, calculating consistency scores for each condition to assess their necessity, and evaluating the coverage to understand the extent of their influence. A condition was deemed necessary if it consistently appeared in cases where the outcome was present, indicating that the outcome could not occur without this condition.

Secondly, we performed Necessary Condition Analysis (NCA) to complement the Panel fsQCA necessity analysis. NCA quantifies both the type and degree of necessary relationships, addressing questions such as "What minimum level should condition variables reach to achieve a specific level of the urban–rural income gap?" In our study, we conducted an overall effect size and p-value analysis for the condition variables to assess their necessity across the entire dataset. Additionally, we performed a year-by-year interface effect size and p-value analysis to examine how the necessity of conditions evolved over time. Furthermore, we implemented the NCA Method Bottleneck Level (%) Analysis to identify critical threshold levels that conditions must meet to constrain the outcome effectively. This quantitative assessment enhanced our understanding of the necessary conditions identified through Panel fsQCA, providing a more nuanced view of their impact.

Thirdly, we undertook a sufficiency analysis in Panel fsQCA to identify configurations of conditions that were sufficient to produce changes in the urban–rural income gap. This process involved constructing truth tables, setting frequency and consistency thresholds, performing logical minimization, and interpreting the resulting configurations to uncover the combinations of digitalization factors that lead to the desired outcomes. Sufficiency analysis allowed us to explore how different combinations of digitalization conditions interacted to influence income disparities, highlighting the pathways through which digitalization can either narrow or widen the urban–rural income gap.

Lastly, we engaged in temporal and spatial consistency analysis to assess the stability and distribution of the identified configurations. Between consistency analysis examines the changes in the explanatory power of configurations on a yearly basis, highlighting temporal dynamics in how digitalization affects income disparities. Within consistency analysis explores the geographic distribution of the explanatory power of these configurations across different regions, revealing spatial patterns and regional variations in the impact of digitalization. This dual analysis provides insights into how the influence of digitalization evolves over time and varies across different regional contexts.

By integrating Panel fsQCA and NCA, our methodology provides a comprehensive framework for understanding both the necessary and sufficient conditions that influence the urban–rural income gap. This combined approach allows us to capture the complex, nonlinear interactions among digitalization factors and contextual elements, offering robust insights into the mechanisms through which digitalization can either narrow or widen income disparities between urban and rural areas.

Appendix B. NCA Method Bottleneck Level (%) Analysis Results (Gap Narrowing)

	Reduction in Urban–Rural Income Gap								Expansion in Urban–Rural Income Gap							
	Digital Innovation	Digital Infrastructure	Digital Industry	Digital Finance	Digital Governance	Economic Level	Degree of Government Intervention	Degree of Openness	Digital Innovation	Digital Infrastructure	Digital Industry	Digital Finance	Digital Governance	Economic Level	Degree of Government Intervention	Degree of Openness
0	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
10	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
20	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
30	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
40	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
50	NN	NN	NN	NN	NN	0.3	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
60	NN	0.2	1.6	NN	NN	2.7	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
70	NN	10.5	10.4	8	NN	5.1	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
80	NN	20.8	19.2	25.6	1.5	7.5	26.9	NN	NN	NN	NN	NN	0.3	NN	NN	NN
90	NN	31.1	27.9	43.3	23.6	9.9	60	NN	NN	0.3	NN	NN	1	NN	3.8	NN
100	40	41.4	36.7	60.9	45.7	12.3	93.1	0.5	0.8	2.7	1.9	NN	1.6	4.5	77.4	1

Appendix C. Necessary Condition Analysis Results for Each Year's Cross-Section

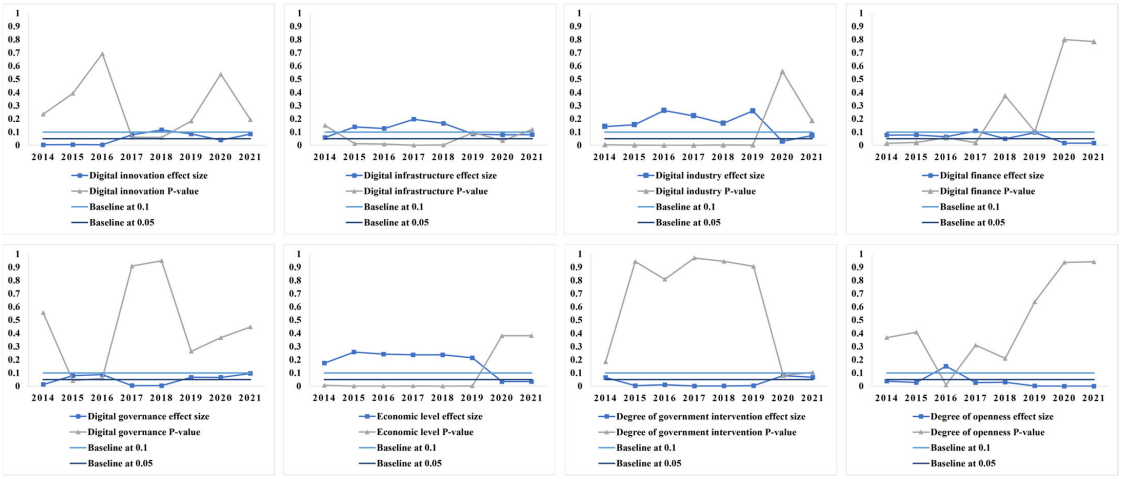


Figure A1. Necessary Condition Analysis results for narrowing the urban–rural income gap.

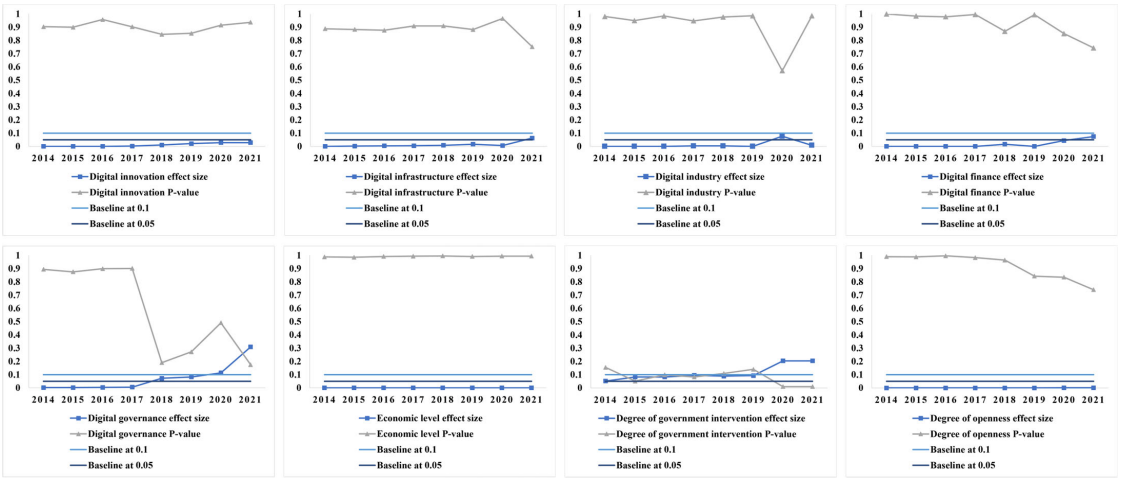


Figure A2. Necessary Condition Analysis results for widening the urban–rural income gap.

Appendix D. Case Membership for Each Configuration

	Case Membership
H1a	Sanmenxia 2021, Dongguan 2017, Dongguan 2018, Zhongshan 2020, Zhongshan 2021, Foshan 2018, Nanjing 2016, Nanjing 2017, Nanjing 2018, Nanjing 2019, Nanjing 2020, Nanjing 2021, Nanchang 2019, Nanchang 2020, Nanchang 2021, Nantong 2019, Nantong 2020, Nantong 2021, Xiamen 2020, Xiamen 2021, Hefei 2018, Hefei 2019, Hefei 2020, Hefei 2021, Jiaxing 2017, Jiaxing 2018, Jiaxing 2019, Jiaxing 2020, Jiaxing 2021, Tianjin 2018, Tianjin 2019, Weihai 2017, Weihai 2018, Weihai 2019, Weihai 2020, Weihai 2021, Ningbo 2016, Ningbo 2017, Ningbo 2018, Ningbo 2019, Ningbo 2020, Ningbo 2021, Suqian 2021, Yueyang 2020, Yueyang 2021, Changzhou 2017, Changzhou 2018, Changzhou 2019, Changzhou 2020, Changzhou 2021, Changde 2020, Changde 2021, Pingdingshan 2021, Guangzhou 2016, Guangzhou 2017, Guangzhou 2018, Guangzhou 2019, Guangzhou 2020, Guangzhou 2021, Kaifeng 2020, Kaifeng 2021, Xuzhou 2020, Xuzhou 2021, Huizhou 2017, Huizhou 2018, Huizhou 2019, Huizhou 2020, Huizhou 2021, Chengdu 2018, Chengdu 2019, Chengdu 2020, Chengdu 2021, Yangzhou 2017, Yangzhou 2018, Yangzhou 2019, Yangzhou 2020, Yangzhou 2021, Xinxiang 2020, Xinxiang 2021, Xinyu 2019, Xinyu 2020, Xinyu 2021, Wuxi 2017, Wuxi 2018, Wuxi 2019, Wuxi 2020, Wuxi 2021, Rizhao 2021, Jincheng 2020, Hangzhou 2016, Hangzhou 2017, Hangzhou 2018, Hangzhou 2019, Hangzhou 2020, Hangzhou 2021, Zhuzhou 2020, Zhuzhou 2021, Wuhan 2017, Wuhan 2018, Wuhan 2019, Wuhan 2020, Wuhan 2021, Jiangmen 2018, Jiangmen 2019, Jiangmen 2020, Jiangmen 2021, Shenyang 2019, Shenyang 2020, Quanzhou 2017, Quanzhou 2018, Tai'an 2019, Tai'an 2021, Taizhou 2020, Taizhou 2021, Luoyang 2019, Luoyang 2020, Luoyang 2021, Jinan 2019, Jinan 2020, Jinan 2021, Jining 2021, Haikou 2020, Haikou 2021, Zibo 2019, Huaibei 2020, Huaibei 2021, Huai'an 2019, Huai'an 2020, Huai'an 2021, Huzhou 2017, Huzhou 2018, Huzhou 2019, Huzhou 2020, Huzhou 2021, Xiangtan 2019, Xiangtan 2020, Xiangtan 2021, Chuzhou 2020, Chuzhou 2021, Luohe 2020, Luohe 2021, Zhangzhou 2018, Zhangzhou 2019, Weifang 2018, Weifang 2019, Weifang 2021, Yantai 2018, Yantai 2019, Yantai 2020, Yantai 2021, Jiaozuo 2019, Jiaozuo 2020, Jiaozuo 2021, Yancheng 2021, Panjin 2020, Fuzhou 2016, Fuzhou 2017, Fuzhou 2018, Shaoxing 2018, Shaoxing 2019, Zhaoqing 2019, Zhaoqing 2020, Wuhu 2018, Wuhu 2019, Wuhu 2020, Wuhu 2021, Suzhou 2016, Suzhou 2017, Suzhou 2018, Suzhou 2019, Suzhou 2020, Suzhou 2021, Jingmen 2019, Jingmen 2020, Putian 2017, Putian 2018, Putian 2021, Bengbu 2019, Bengbu 2020, Bengbu 2021, Hengyang 2021, Xiangyang 2019, Xiangyang 2020, Xiangyang 2021, Xi'an 2019, Xi'an 2020, Xi'an 2021, Xuchang 2020, Xuchang 2021, Guiyang 2020, Guiyang 2021, Zhengzhou 2019, Zhengzhou 2020, Zhengzhou 2021, Tongling 2018, Tongling 2019, Tongling 2020, Zhenjiang 2017, Zhenjiang 2018, Zhenjiang 2019, Zhenjiang 2021, Changsha 2017, Changsha 2018, Changsha 2019, Changsha 2020, Changsha 2021, Qingdao 2018, Qingdao 2019, Qingdao 2020, Qingdao 2021, Ma'anshan 2019, Ma'anshan 2020, Ma'anshan 2021, Hebi 2020, Hebi 2021, Yingtan 2020, Sanya 2019, Sanya 2020, Sanya 2021, Shanghai 2016, Shanghai 2017, Shanghai 2018, Shanghai 2019, Shanghai 2020, Shanghai 2021, Lishui 2017, Lishui 2018, Jiujiang 2020, Jiujiang 2021, Beijing 2016, Beijing 2017, Beijing 2018, Beijing 2019, Beijing 2020, Beijing 2021, Shiyan 2019, Xiamen 2016, Xiamen 2017, Xiamen 2018, Xiamen 2019, Ji'an 2021, Tianjin 2017, Tianjin 2020, Tianjin 2021, Yichun 2020, Yichun 2021, Xuancheng 2019, Xuancheng 2020, Xuancheng 2021, Langfang 2021, Jincheng 2021, Jingdezhen 2020, Jingdezhen 2021, Chizhou 2020, Chizhou 2021, Zhuhai 2016, Zhuhai 2017, Zhuhai 2018, Zhuhai 2019, Zhuhai 2020, Zhuhai 2021, Yiyang 2021, Panjin 2021, Meishan 2021, Shijiazhuang 2021, Qinhuangdao 2021, Zhoushan 2018, Zhoushan 2019, Zhoushan 2020, Zhoushan 2021, Pingxiang 2020, Pingxiang 2021, Chenzhou 2020, Chenzhou 2021, Chongqing 2020, Chongqing 2021, Chongqing 2021, Tongchuan 2021, Tongling 2021, Changzhi 2021, Yingtan 2021, Huangshan 2019, Huangshan 2020, Huangshan 2021
H1b	Nantong 2017, Nantong 2018, Xuzhou 2017, Xuzhou 2018, Xuzhou 2019, Taizhou 2017, Taizhou 2018, Taizhou 2019, Huai'an 2018, Lianyungang 2018, Lianyungang 2019, Lianyungang 2020, Lianyungang 2021, Ezhou 2018, Yangjiang 2019, Sanmenxia 2021, Dongguan 2017, Dongguan 2018, Zhongshan 2020, Zhongshan 2021, Foshan 2018, Nanjing 2016, Nanjing 2017, Nanjing 2018, Nanjing 2019, Nanjing 2020, Nanjing 2021, Nanchang 2019, Nanchang 2020, Nanchang 2021, Nantong 2019, Nantong 2020, Nantong 2021, Xiamen 2020, Xiamen 2021, Hefei 2018, Hefei 2019, Hefei 2020, Hefei 2021, Jiaxing 2017, Jiaxing 2018, Jiaxing 2019, Jiaxing 2020, Jiaxing 2021, Tianjin 2018, Tianjin 2019, Weihai 2017, Weihai 2018, Weihai 2019, Weihai 2020, Weihai 2021, Ningbo 2016, Ningbo 2017, Ningbo 2018, Ningbo 2019, Ningbo 2020, Ningbo 2021, Suqian 2021, Yueyang 2020, Yueyang 2021, Changzhou 2017, Changzhou 2018, Changzhou 2019, Changzhou 2020, Changzhou 2021, Changde 2020, Changde 2021, Pingdingshan 2021, Guangzhou 2016, Guangzhou 2017, Guangzhou 2018, Guangzhou 2019, Guangzhou 2020, Guangzhou 2021, Kaifeng 2020, Kaifeng 2021, Xuzhou 2020, Xuzhou 2021, Huizhou 2017, Huizhou 2018, Huizhou 2019, Huizhou 2020, Huizhou 2021, Chengdu 2018, Chengdu 2019, Chengdu 2020, Chengdu 2021, Yangzhou 2017, Yangzhou 2018, Yangzhou 2019, Yangzhou 2020, Yangzhou 2021, Xinxiang 2020, Xinxiang 2021, Xinyu 2019, Xinyu 2020, Xinyu 2021, Wuxi 2017, Wuxi 2018, Wuxi 2019, Wuxi 2020, Wuxi 2021, Rizhao 2021, Jincheng 2020, Hangzhou 2016, Hangzhou 2017, Hangzhou 2018, Hangzhou 2019, Hangzhou 2020, Hangzhou 2021, Zhuzhou 2020, Zhuzhou 2021, Wuhan 2017, Wuhan 2018, Wuhan 2019, Wuhan 2020, Wuhan 2021, Jiangmen 2018, Jiangmen 2019, Jiangmen 2020, Jiangmen 2021, Shenyang 2019, Shenyang 2020, Quanzhou 2017, Quanzhou 2018, Tai'an 2019, Tai'an 2021, Taizhou 2020, Taizhou 2021, Luoyang 2019, Luoyang 2020, Luoyang 2021, Jinan 2019, Jinan 2020, Jinan 2021, Jining 2021, Haikou 2020, Haikou 2021, Zibo 2019, Huaibei 2020, Huaibei 2021, Huai'an 2019, Huai'an 2020, Huai'an 2021, Huzhou 2017, Huzhou 2018, Huzhou 2019, Huzhou 2020, Huzhou 2021, Xiangtan 2019, Xiangtan 2020, Xiangtan 2021, Chuzhou 2020, Chuzhou 2021, Luohe 2020, Luohe 2021, Zhangzhou 2018, Zhangzhou 2019, Weifang 2018, Weifang 2019, Weifang 2019, Weifang 2021, Yantai 2018, Yantai 2019, Yantai 2020, Yantai 2021, Jiaozuo 2019, Jiaozuo 2020, Jiaozuo 2021, Yancheng 2021, Panjin 2020, Fuzhou 2016, Fuzhou 2017, Fuzhou 2018, Shaoxing 2018, Shaoxing 2019, Zhaoqing 2019, Zhaoqing 2020, Wuhu 2018, Wuhu 2019, Wuhu 2020, Wuhu 2021, Suzhou 2016, Suzhou 2017, Suzhou 2018, Suzhou 2019, Suzhou 2020, Suzhou 2021, Jingmen 2019, Jingmen 2020, Putian 2017, Putian 2018, Putian 2021, Bengbu 2019, Bengbu 2020, Bengbu 2021, Hengyang 2021, Xiangyang 2019, Xiangyang 2020, Xiangyang 2021, Xi'an 2019, Xi'an 2020, Xi'an 2021, Xuchang 2020, Xuchang 2021, Guiyang 2020, Guiyang 2021, Zhengzhou 2019, Zhengzhou 2020, Zhengzhou 2021, Tongling 2018, Tongling 2019, Tongling 2020, Zhenjiang 2017, Zhenjiang 2018, Zhenjiang 2019, Zhenjiang 2021, Changsha 2017, Changsha 2018, Changsha 2019, Changsha 2020, Changsha 2021, Qingdao 2018, Qingdao 2019, Qingdao 2020, Qingdao 2021, Ma'anshan 2019, Ma'anshan 2020, Ma'anshan 2021, Hebi 2020, Hebi 2021, Yingtan 2020

	Case Membership
H2	Sanming 2018, Sanming 2019, Sanming 2020, Sanming 2021, Dongguan 2019, Dongguan 2020, Dongguan 2021, Dongying 2019, Dongying 2020, Dongying 2021, Zhongshan 2017, Zhongshan 2018, Zhongshan 2019, Urumqi 2021, Leshan 2020, Leshan 2021, Foshan 2017, Foshan 2019, Foshan 2020, Foshan 2021, Lanzhou 2019, Lanzhou 2020, Lanzhou 2021, Baotou 2021, Nanning 2020, Nanping 2018, Nanping 2019, Nanping 2020, Nanping 2021, Taizhou 2017, Taizhou 2018, Taizhou 2019, Taizhou 2020, Taizhou 2021, Hohhot 2021, Xianning 2019, Xianning 2020, Daqing 2021, Dalian 2020, Dalian 2021, Taiyuan 2019, Taiyuan 2020, Taiyuan 2021, Ningde 2018, Ningde 2020, Ningde 2021, Yibin 2020, Yichang 2019, Yichang 2020, Yichang 2021, Baoji 2021, Suqian 2020, Dezhou 2019, Dezhou 2021, Deyang 2018, Deyang 2019, Deyang 2020, Deyang 2021, Panzhihua 2019, Panzhihua 2020, Panzhihua 2021, Rizhao 2019, Rizhao 2020, Kunming 2020, Kunming 2021, Zaozhuang 2019, Yulin 2021, Shantou 2020, Shantou 2021, Shenyang 2021, Quanzhou 2019, Quanzhou 2020, Quanzhou 2021, Tai'an 2018, Jining 2019, Haikou 2018, Haikou 2019, Zibo 2018, Zibo 2020, Zibo 2021, Wenzhou 2016, Wenzhou 2017, Wenzhou 2018, Wenzhou 2019, Wenzhou 2020, Wenzhou 2021, Binzhou 2019, Binzhou 2020, Binzhou 2021, Zhangzhou 2020, Zhangzhou 2021, Weifang 2020, Yancheng 2020, Shizuishan 2019, Fuzhou 2019, Fuzhou 2020, Fuzhou 2021, Shaoxing 2017, Shaoxing 2020, Shaoxing 2021, Mianyang 2019, Mianyang 2020, Mianyang 2021, Liaocheng 2019, Zhaoqing 2018, Zigong 2020, Zigong 2021, Jingmen 2021, Putian 2019, Putian 2020, Ezhou 2019, Ezhou 2020, Ezhou 2021, Jinhua 2016, Jinhua 2017, Jinhua 2018, Jinhua 2019, Jinhua 2020, Jinhua 2021, Yinchuan 2021, Zhenjiang 2020, Changchun 2019, Changchun 2020, Changchun 2021, Yangjiang 2021, Yangquan 2019, Suizhou 2020, Suizhou 2021, Huangshi 2019, Huangshi 2020, Huangshi 2021, Longyan 2017, Longyan 2018, Longyan 2019, Longyan 2020, Longyan 2021, Sanmenxia 2021, Dongguan 2017, Dongguan 2018, Zhongshan 2020, Zhongshan 2021, Foshan 2018, Nanjing 2016, Nanjing 2017, Nanjing 2018, Nanjing 2019, Nanjing 2020, Nanjing 2021, Nanchang 2019, Nanchang 2020, Nanchang 2021, Nantong 2019, Nantong 2020, Nantong 2021, Xiamen 2020, Xiamen 2021, Hefei 2018, Hefei 2019, Hefei 2020, Hefei 2021, Jiaxing 2017, Jiaxing 2018, Jiaxing 2019, Jiaxing 2020, Jiaxing 2021, Tianjin 2018, Tianjin 2019, Weihai 2017, Weihai 2018, Weihai 2019, Weihai 2020, Weihai 2021, Ningbo 2016, Ningbo 2017, Ningbo 2018, Ningbo 2019, Ningbo 2020, Ningbo 2021, Suqian 2021, Yueyang 2020, Yueyang 2021, Changzhou 2017, Changzhou 2018, Changzhou 2019, Changzhou 2020, Changzhou 2021, Changde 2020, Changde 2021, Pingdingshan 2021, Guangzhou 2016, Guangzhou 2017, Guangzhou 2018, Guangzhou 2019, Guangzhou 2020, Guangzhou 2021, Kaifeng 2020, Kaifeng 2021, Xuzhou 2020, Xuzhou 2021, Huizhou 2017, Huizhou 2018, Huizhou 2019, Huizhou 2020, Huizhou 2021, Chengdu 2018, Chengdu 2019, Chengdu 2021, Yangzhou 2017, Yangzhou 2018, Yangzhou 2019, Yangzhou 2020, Yangzhou 2021, Xinxiang 2020, Xinxiang 2021, Xinyu 2019, Xinyu 2020, Xinyu 2021, Wuxi 2017, Wuxi 2018, Wuxi 2019, Wuxi 2020, Wuxi 2021, Rizhao 2021, Jincheng 2020, Hangzhou 2016, Hangzhou 2017, Hangzhou 2018, Hangzhou 2019, Hangzhou 2020, Hangzhou 2021, Zhuzhou 2020, Zhuzhou 2021, Wuhan 2017, Wuhan 2018, Wuhan 2019, Wuhan 2020, Wuhan 2021, Jiangmen 2018, Jiangmen 2019, Jiangmen 2020, Jiangmen 2021, Shenyang 2019, Shenyang 2020, Quanzhou 2017, Quanzhou 2018, Tai'an 2019, Tai'an 2021, Taizhou 2020, Taizhou 2021, Luoyang 2019, Luoyang 2020, Luoyang 2021, Jinan 2019, Jinan 2020, Jinan 2021, Jining 2021, Haikou 2020, Haikou 2021, Zibo 2019, Huaibei 2020, Huaibei 2021, Huaian 2019, Huai'an 2020, Huai'an 2021, Huzhou 2017, Huzhou 2018, Huzhou 2019, Huzhou 2020, Huzhou 2021, Xiangtan 2019, Xiangtan 2020, Xiangtan 2021, Chuzhou 2020, Chuzhou 2021, Luohe 2020, Luohe 2021, Zhangzhou 2018, Zhangzhou 2019, Weifang 2018, Weifang 2019, Weifang 2021, Yantai 2018, Yantai 2019, Yantai 2020, Yantai 2021, Jiaozuo 2019, Jiaozuo 2020, Jiaozuo 2021, Yancheng 2021, Panjin 2020, Fuzhou 2016, Fuzhou 2017, Fuzhou 2018, Shaoxing 2018, Shaoxing 2019, Zhaoqing 2019, Zhaoqing 2020, Wuhu 2018, Wuhu 2019, Wuhu 2020, Wuhu 2021, Suzhou 2016, Suzhou 2017, Suzhou 2018, Suzhou 2019, Suzhou 2020, Suzhou 2021, Jingmen 2019, Jingmen 2020, Putian 2017, Putian 2018, Putian 2021, Bengbu 2019, Bengbu 2020, Bengbu 2021, Hengyang 2021, Xiangyang 2019, Xiangyang 2020, Xiangyang 2021, Xi'an 2019, Xi'an 2020, Xi'an 2021, Xuchang 2020, Xuchang 2021, Guiyang 2020, Guiyang 2021, Zhengzhou 2019, Zhengzhou 2020, Zhengzhou 2021, Tongling 2018, Tongling 2019, Tongling 2020, Zhenjiang 2017, Zhenjiang 2018, Zhenjiang 2019, Zhenjiang 2021, Changsha 2017, Changsha 2018, Changsha 2019, Changsha 2020, Changsha 2021, Qingdao 2018, Qingdao 2019, Qingdao 2021, Ma'anshan 2019, Ma'anshan 2020, Ma'anshan 2021, Hebi 2020, Hebi 2021, Yingtan 2020
H3	Jiaxing 2014, Jiaxing 2015, Weihai 2015, Weihai 2016, Chengdu 2016, Yangzhou 2016, Rizhao 2016, Rizhao 2017, Wuhan 2015, Jinan 2014, Jinan 2015, Jinan 2016, Jining 2016, Haikou 2015, Haikou 2016, Huzhou 2014, Huzhou 2015, Weifang 2015, Weifang 2016, Weifang 2017, Yantai 2015, Yantai 2016, Fuzhou 2015, Shaoxing 2014, Suzhou 2014, Xiangyang 2017, Xi'an 2015, Xi'an 2016, Qingdao 2014, Qingdao 2015, Qingdao 2016, Dongguan 2014, Dongguan 2015, Dongguan 2016, Zhongshan 2014, Zhongshan 2015, Foshan 2014, Foshan 2015, Foshan 2016, Nanjing 2014, Nanjing 2015, Xiamen 2014, Xiamen 2015, Jiaxing 2016, Tianjin 2015, Ningbo 2014, Ningbo 2015, Changzhou 2016, Guangzhou 2014, Guangzhou 2015, Huizhou 2014, Huizhou 2015, Huizhou 2016, Wuxi 2015, Wuxi 2016, Hangzhou 2014, Hangzhou 2015, Jiangmen 2016, Jiangmen 2017, Quanzhou 2016, Huzhou 2016, Zhangzhou 2017, Zhuhai 2014, Zhuhai 2015, Fuzhou 2014, Shaoxing 2016, Zhaoqing 2016, Zhaoqing 2017, Wuhu 2017, Suzhou 2015, Putian 2016, Hefei 2017, Hohhot 2017, Tangshan 2020, Tangshan 2021, Chengdu 2017, Rizhao 2018, Wuhan 2016, Jinan 2017, Jinan 2018, Yantai 2017, Shizuishan 2018, Xi'an 2017, Xi'an 2018, Zhengzhou 2018, Ordos 2020, Ezhou 2017, Qingdao 2017, Sanmenxia 2021, Dongguan 2017, Dongguan 2018, Zhongshan 2020, Zhongshan 2021, Foshan 2018, Nanjing 2016, Nanjing 2017, Nanjing 2018, Nanjing 2019, Nanjing 2020, Nanjing 2021, Nanchang 2019, Nanchang 2020, Nanchang 2021, Nantong 2019, Nantong 2020, Nantong 2021, Xiamen 2020, Xiamen 2021, Hefei 2018, Hefei 2019, Hefei 2020, Hefei 2021, Jiaxing 2017, Jiaxing 2018, Jiaxing 2019, Jiaxing 2020, Jiaxing 2021, Tianjin 2018, Tianjin 2019, Weihai 2017, Weihai 2018, Weihai 2019, Weihai 2020, Weihai 2021, Ningbo 2016, Ningbo 2017, Ningbo 2018, Ningbo 2019, Ningbo 2020, Ningbo 2021, Suqian 2021, Yueyang 2020, Yueyang 2021, Changzhou 2017, Changzhou 2018, Changzhou 2019, Changzhou 2020, Changzhou 2021, Changde 2020, Changde 2021, Pingdingshan 2021, Guangzhou 2016, Guangzhou 2017, Guangzhou 2018, Guangzhou 2019, Guangzhou 2020, Guangzhou 2021, Kaifeng 2020, Kaifeng 2021, Xuzhou 2020, Xuzhou 2021, Huizhou 2017, Huizhou 2018, Huizhou 2019, Huizhou 2020, Huizhou 2021, Chengdu 2018, Chengdu 2019, Chengdu 2020, Chengdu 2020, Chengdu 2021, Yangzhou 2017, Yangzhou 2018, Yangzhou 2019, Yangzhou 2020, Yangzhou 2021, Xinxiang 2020, Xinxiang 2021, Xinyu 2019, Xinyu 2020, Xinyu 2021, Wuxi 2017, Wuxi 2018, Wuxi 2019, Wuxi 2020, Wuxi 2021, Rizhao 2021, Jincheng 2020, Hangzhou 2016, Hangzhou 2017, Hangzhou 2018, Hangzhou 2019, Hangzhou 2020, Hangzhou 2021, Zhuzhou 2020, Zhuzhou 2021, Wuhan 2017, Wuhan 2018, Wuhan 2019, Wuhan 2020, Wuhan 2021, Jiangmen 2018, Jiangmen 2019, Jiangmen 2020, Jiangmen 2021, Shenyang 2019, Shenyang 2020, Quanzhou 2017, Quanzhou 2018, Tai'an 2019, Tai'an 2021, Taizhou 2020, Taizhou 2021, Luoyang 2019, Luoyang 2020, Luoyang 2021, Jinan 2019, Jinan 2020, Jinan 2021, Jining 2021, Haikou 2020, Haikou 2021, Zibo 2019, Huaibei 2020, Huaibei 2021, Huai'an 2019, Huai'an 2020, Huai'an 2021, Huzhou 2017, Huzhou 2018, Huzhou 2019, Huzhou 2020, Huzhou 2021, Xiangtan 2019, Xiangtan 2020, Xiangtan 2021, Chuzhou 2020, Chuzhou 2021, Luohe 2020, Luohe 2021, Zhangzhou 2018, Zhangzhou 2019, Weifang 2018, Weifang 2019, Weifang 2021, Yantai 2018, Yantai 2019, Yantai 2020, Yantai 2021, Jiaozuo 2019, Jiaozuo 2020, Jiaozuo 2021, Yancheng 2021, Panjin 2020, Fuzhou 2016, Fuzhou 2017, Fuzhou 2018, Shaoxing 2018, Shaoxing 2019, Zhaoqing 2019, Zhaoqing 2020, Wuhu 2018, Wuhu 2019, Wuhu 2019, Wuhu 2020, Wuhu 2021, Suzhou 2016, Suzhou 2017, Suzhou 2018, Suzhou 2019, Suzhou 2020, Suzhou 2021, Jingmen 2019, Jingmen 2020, Putian 2017, Putian 2018, Putian 2021, Bengbu 2019, Bengbu 2020, Bengbu 2021, Hengyang 2021, Xiangyang 2019, Xiangyang 2020, Xiangyang 2021, Xi'an 2019, Xi'an 2020, Xi'an 2021, Xuchang 2020, Xuchang 2021, Guiyang 2020, Guiyang 2021, Zhengzhou 2019, Zhengzhou 2020, Zhengzhou 2021, Tongling 2018, Tongling 2019, Tongling 2020, Zhenjiang 2017, Zhenjiang 2018, Zhenjiang 2019, Zhenjiang 2021, Changsha 2017, Changsha 2018, Changsha 2019, Changsha 2020, Changsha 2021, Qingdao 2018, Qingdao 2019, Qingdao 2020, Qingdao 2021, Maanshan 2019, Ma'anshan 2020, Ma'anshan 2021, Hebi 2020, Hebi 2021, Yingtan 2020

	Case Membership
H4	Nantong 2014, Nantong 2015, Nantong 2016, Xuzhou 2015, Xuzhou 2016, Taizhou 2015, Taizhou 2016, Huai'an 2015, Yancheng 2016, Putian 2015, Zhenjiang 2014, Changzhou 2014, Changzhou 2015, Jiangmen 2014, Quanzhou 2015, Zhangzhou 2016, Xiangyang 2016
NH1	Leshan 2014, Leshan 2015, Neijiang 2014, Neijiang 2015, Beihai 2014, Xianyang 2014, Xianyang 2015, Xianyang 2016, Baoji 2014, Yueyang 2014, Kaifeng 2017, Deyang 2014, Deyang 2015, Guilin 2014, Guilin 2015, Wuzhou 2014, Wuzhou 2015, Cangzhou 2014, Cangzhou 2015, Cangzhou 2016, Yulin 2014, Yulin 2015, Zigong 2014, Zigong 2015, Zigong 2016, Zigong 2017, Heze 2016, Ziyang 2015, Ziyang 2016, Qinzhou 2017, Jinzhou 2016, Suizhou 2014, Suizhou 2015, Suizhou 2017, Anshan 2017, Jixi 2014, Nanyang 2014, Nanyang 2015, Nanyang 2016, Nanyang 2017, Xianning 2014, Siping 2014, Siping 2015, Loudi 2014, Loudi 2015, Xiaogan 2015, Anyang 2014, Anyang 2015, Anyang 2016, Anyang 2017, Baoji 2015, Changde 2014, Changde 2015, Changde 2016, Pingdingshan 2014, Pingdingshan 2015, Pingdingshan 2016, Pingdingshan 2017, Kaifeng 2014, Kaifeng 2015, Kaifeng 2016, Xinxiang 2014, Xinxiang 2015, Xinxiang 2016, Xinxiang 2017, Jincheng 2014, Jincheng 2015, Jincheng 2016, Luoyang 2014, Huaibei 2014, Huaibei 2015, Luohe 2014, Luohe 2015, Luohe 2016, Luohe 2017, Puyang 2014, Puyang 2015, Puyang 2016, Jiaozuo 2014, Qinhuangdao 2014, Qinhuangdao 2015, Jingmen 2014, Jingmen 2015, Hengshui 2014, Hengyang 2014, Hengyang 2015, Xuchang 2014, Xingtai 2014, Handan 2014, Handan 2015, Handan 2016, Handan 2017, Chenzhou 2014, Qinzhou 2014, Qinzhou 2015, Jinzhou 2014, Jinzhou 2015, Changzhi 2017, Yangquan 2014, Yangquan 2015, Yangquan 2016, Yangquan 2017, Jixi 2015, Jixi 2016, Hebi 2014, Hebi 2015, Huangshi 2014, Qiqihar 2014, Qitaihe 2014, Qitaihe 2015, Qitaihe 2016, Qitaihe 2017, Qitaihe 2018, Zhongwei 2014, Zhongwei 2015, Linfen 2014, Linfen 2015, Linfen 2016, Linfen 2017, Lincang 2014, Lincang 2015, Lincang 2016, Lincang 2017, Lincang 2018, Lincang 2019, Dandong 2017, Lijiang 2014, Lijiang 2015, Lijiang 2016, Lijiang 2017, Yichun 2015, Yichun 2016, Yichun 2017, Yichun 2018, Jiamusi 2017, Baoshan 2017, Baoshan 2018, Shiyan 2014, Shiyan 2015, Nanchong 2014, Nanchong 2015, Nanchong 2016, Nanchong 2017, Shuangyashan 2014, Shuangyashan 2015, Shuangyashan 2016, Shuangyashan 2017, Lvliang 2015, Lvliang 2016, Lvliang 2017, Xianning 2015, Shangqiu 2014, Shangqiu 2015, Shangluo 2014, Shangluo 2015, Shangluo 2016, Shangluo 2017, Shangluo 2018, Datong 2014, Datong 2015, Datong 2016, Anqing 2015, Anqing 2016, Ankang 2014, Ankang 2015, Ankang 2016, Ankang 2017, Ankang 2018, Dingxi 2014, Dingxi 2015, Dingxi 2016, Dingxi 2017, Dingxi 2018, Yibin 2014, Yibin 2015, Yibin 2016, Yibin 2017, Chongzuo 2014, Chongzuo 2015, Chongzuo 2016, Chongzuo 2017, Chongzuo 2018, Bazhong 2014, Bazhong 2015, Bazhong 2016, Bazhong 2017, Bayannur 2014, Pingliang 2014, Pingliang 2015, Pingliang 2016, Pingliang 2017, Pingliang 2018, Guangyuan 2014, Guangyuan 2015, Guangyuan 2016, Guangyuan 2017, Guang'an 2014, Guang'an 2015, Guang'an 2016, Guang'an 2017, Qingyang 2014, Qingyang 2015, Qingyang 2016, Qingyang 2017, Qingyang 2018, Zhangjiajie 2014, Zhangye 2014, Zhangye 2015, Zhangye 2016, Zhangye 2017, Xinzhou 2014, Xinzhou 2015, Xinzhou 2016, Xinzhou 2017, Huaihua 2015, Huaihua 2016, Huaihua 2017, Chengde 2014, Chengde 2015, Chengde 2016, Fushun 2017, Zhaotong 2014, Zhaotong 2015, Zhaotong 2016, Zhaotong 2017, Zhaotong 2018, Zhaotong 2019, Jinzhong 2014, Qujing 2014, Qujing 2015, Qujing 2016, Qujing 2017, Qujing 2018, Chaoyang 2016, Chaoyang 2017, Chaoyang 2018, Chaoyang 2019, Guest 2014, Guest 2015, Guest 2016, Guest 2017, Guest 2018, Wuzhou 2016, Wuzhou 2017, Wuwei 2014, Wuwei 2015, Wuwei 2016, Wuwei 2017, Wuwei 2018, Hanzhong 2014, Hanzhong 2015, Hanzhong 2016, Hanzhong 2017, Hechi 2014, Hechi 2015, Hechi 2016, Hechi 2017, Hechi 2018, Luzhou 2015, Luzhou 2016, Weinan 2014, Weinan 2015, Weinan 2016, Weinan 2017, Weinan 2018, Mudanjiang 2014, Yulin 2016, Yulin 2017, Yulin 2018, Baicheng 2014, Silver 2014, Silver 2015, Silver 2016, Silver 2017, Baise 2014, Bose 2015, Bose 2016, Bose 2017, Yiyang 2015, Yiyang 2016, Meishan 2016, Suihua 2014, Suihua 2020, Jingzhou 2014, Jingzhou 2015, Huludao 2016, Huludao 2017, Huludao 2018, Hengshui 2016, Hengshui 2017, Guigang 2014, Guigang 2015, Guigang 2016, Guigang 2017, Guigang 2018, Hezhou 2014, Hezhou 2016, Hezhou 2017, Hezhou 2018, Ziyang 2017, Chifeng 2014, Liaoyang 2017, Dazhou 2014, Dazhou 2015, Dazhou 2016, Dazhou 2017, Yuncheng 2014, Yuncheng 2015, Yuncheng 2016, Tonghua 2015, Suining 2014, Zunyi 2014, Zunyi 2015, Xingtai 2016, Shaoyang 2014, Shaoyang 2015, Shaoyang 2016, Shaoyang 2017, Shaoyang 2018, Tieling 2017, Tieling 2018, Tieling 2018, Tongchuan 2014, Tongchuan 2015, Tongchuan 2016, Tongchuan 2017, Jinzhou 2017, Jinzhou 2018, Fuxin 2016, Fuxin 2017, Fuxin 2019, Fuyang 2014, Fuyang 2015, Fuyang 2016, Fuyang 2017, Ya'an 2014, Ya'an 2015, Ya'an 2016, Ya'an 2017, Huanggang 2014, Huanggang 2015, Huanggang 2016, Huanggang 2017, Qiqihar 2019, Dandong 2014, Dandong 2015, Dandong 2016, Ulanqab 2014, Jiujiang 2014, Jiujiang 2015, Jiujiang 2016, Yichun 2014, Jiamusi 2014, Jiamusi 2015, Jiamusi 2016, Baoshan 2014, Baoshan 2015, Baoshan 2016, Xinyang 2014, Xinyang 2015, Xinyang 2016, Xinyang 2017, Lu'an 2014, Lu'an 2015, Liupanshui 2015, Ji'an 2014, Ji'an 2015, Ji'an 2016, Lv Liang 2014, Zhoukou 2014, Zhoukou 2015, Zhoukou 2016, Zhoukou 2017, Zhoukou 2018, Shangqiu 2016, Shangqiu 2017, Siping 2016, Siping 2017, Datong 2017, Loudi 2016, Loudi 2017, Xiaogan 2014, Xiaogan 2017, Anqing 2014, Anshun 2014, Anshun 2015, Yichun 2014, Yichun 2015, Yichun 2016, Yichun 2017, Xuancheng 2014, Xuancheng 2015, Suzhou 2014, Suzhou 2015, Suzhou 2016, Zhangjiakou 2014, Zhangjiakou 2015, Zhangjiakou 2016, Zhangjiajie 2015, Zhangjiajie 2016, Zhangjiajie 2017, Fuzhou 2014, Fuzhou 2015, Fuzhou 2016, Fuzhou 2017, Jinzhong 2015, Jinzhong 2016, Jingdezhen 2014, Jingdezhen 2015, Chaoyang 2014, Chaoyang 2015, Yongzhou 2014, Yongzhou 2015, Yongzhou 2016, Yongzhou 2017, Huainan 2015, Mudanjiang 2015, Baicheng 2015, Baicheng 2016, Baicheng 2017, Baicheng 2018, Meishan 2014, Meishan 2015, Suihua 2015, Suihua 2016, Suihua 2017, Pingxiang 2015, Huludao 2014, Huludao 2015, Hengshui 2015, Hengyang 2016, Hezhou 2015, Ganzhou 2014, Ganzhou 2015, Tonghua 2014, Tonghua 2016, Tonghua 2017, Xingtai 2015, Chenzhou 2015, Chenzhou 2016, Qinzhou 2016, Tieling 2014, Tieling 2015, Tieling 2016, Changzhi 2014, Changzhi 2015, Changzhi 2016, Fuxin 2014, Fuxin 2015, Fuxin 2018, Zhumadian 2014, Zhumadian 2015, Zhumadian 2016, Zhumadian 2017, Zhumadian 2018, Jixi 2017, Jixi 2018, Hegang 2014, Hegang 2015, Hegang 2016, Hegang 2017, Yingtan 2014, Huangshan 2014, Huangshan 2015, Heihe 2014, Heihe 2015, Heihe 2016, Heihe 2018, Qiqihar 2015, Qiqihar 2016, Qiqihar 2017, Qiqihar 2018
NH2	Dandong 2014, Dandong 2015, Dandong 2016, Ulanqab 2014, Jiujiang 2014, Jiujiang 2015, Jiujiang 2016, Yichun 2014, Jiamusi 2014, Jiamusi 2015, Jiamusi 2016, Baoshan 2014, Baoshan 2015, Baoshan 2016, Xinyang 2014, Xinyang 2015, Xinyang 2016, Xinyang 2017, Lu'an 2014, Lu'an 2015, Liupanshui 2015, Ji'an 2014, Ji'an 2015, Ji'an 2016, Lvliang 2014, Zhoukou 2014, Zhoukou 2015, Zhoukou 2016, Zhoukou 2017, Zhoukou 2018, Shangqiu 2016, Shangqiu 2017, Siping 2016, Siping 2017, Datong 2017, Loudi 2016, Loudi 2017, Xiaogan 2014, Xiaogan 2017, Anqing 2014, Anshun 2014, Anshun 2015, Yichun 2014, Yichun 2015, Yichun 2016, Yichun 2017, Xuancheng 2014, Xuancheng 2015, Suzhou 2014, Suzhou 2015, Suzhou 2016, Zhangjiakou 2014, Zhangjiakou 2015, Zhangjiakou 2016, Zhangjiajie 2015, Zhangjiajie 2016, Zhangjiajie 2017, Fuzhou 2014, Fuzhou 2015, Fuzhou 2016, Fuzhou 2017, Jinzhong 2015, Jinzhong 2016, Jingdezhen 2014, Jingdezhen 2015, Chaoyang 2014, Chaoyang 2015, Yongzhou 2014, Yongzhou 2015, Yongzhou 2016, Yongzhou 2017, Huainan 2015, Mudanjiang 2015, Baicheng 2015, Baicheng 2016, Baicheng 2017, Baicheng 2018, Meishan 2014, Meishan 2015, Suihua 2015, Suihua 2016, Suihua 2017, Pingxiang 2015, Huludao 2014, Huludao 2015, Hengshui 2015, Hengyang 2016, Hezhou 2015, Ganzhou 2014, Ganzhou 2015, Tonghua 2014, Tonghua 2016, Tonghua 2017, Xingtai 2015, Chenzhou 2015, Chenzhou 2016, Qinzhou 2016, Tieling 2014, Tieling 2015, Tieling 2016, Changzhi 2014, Changzhi 2015, Changzhi 2016, Fuxin 2014, Fuxin 2015, Fuxin 2018, Zhumadian 2014, Zhumadian 2015, Zhumadian 2016, Zhumadian 2017, Zhumadian 2018, Jixi 2017, Jixi 2018, Hegang 2014, Hegang 2015, Hegang 2016, Hegang 2017, Yingtan 2014, Huangshan 2014, Huangshan 2015, Heihe 2014, Heihe 2015, Heihe 2016, Heihe 2018, Qiqihar 2015, Qiqihar 2016, Qiqihar 2017, Qiqihar 2018, Jiujiang 2017, Ji'an 2017, Xiaogan 2016, Guilin 2016, Chizhou 2014, Chizhou 2015, Huainan 2014, Chuzhou 2014, Chuzhou 2015, Bengbu 2014, Bengbu 2016, Bengbu 2017, Xingtai 2017, Xingtai 2018, Chenzhou 2017, Huangshan 2016

	Case Membership
NH3	Liupanshui 2016, Dingxi 2019, Bazhong 2019, Huaihua 2014, Chaoyang 2020, Wuwei 2019, Hechi 2019, Luzhou 2014, Baise 2018, Yiyang 2014, Yiyang 2017, Dazhou 2018, Dazhou 2019, Suining 2015, Zunyi 2016, Zunyi 2017, Shaoyang 2019, Shangrao 2014, Shangrao 2015, Shangrao 2016, Liupanshui 2014, Liupanshui 2017, Anshun 2016, Suzhou 2018, Yongzhou 2018, Pingxiang 2014, Hengyang 2017, Ganzhou 2016, Ganzhou 2017, Lincang 2020, Lijiang 2020, Baoshan 2020, Shangqiu 2019, Dingxi 2020, Chongzuo 2020, Chongzuo 2021, Guangyuan 2019, Zhaotong 2020, Zhaotong 2021, Chaoyang 2021, Laibin 2019, Laibin 2020, Laibin 2021, Wuzhou 2019, Wuwei 2020, Hechi 2020, Hechi 2021, Yulin 2019, Yulin 2020, Yulin 2021, Silver 2019, Silver 2020, Baise 2019, Baise 2020, Bose 2021, Suihua 2021, Jingzhou 2018, Huludao 2020, Guigang 2019, Guigang 2021, Hezhou 2019, Hezhou 2020, Zunyi 2018, Tieling 2020, Tieling 2021, Fuyang 2018, Qiqihar 2020, Shangrao 2018, Xinyang 2019, Lv Liang 2019, Zhoukou 2019, Zhangjiajie 2019, Fuzhou 2018, Yongzhou 2019

Appendix E. Between Consistency Analysis Results

	H1a	H1b	H2	H3	H4	NH1	NH2	NH3
2014	0.991	0.991	0.991	0.977	0.984	0.865	0.902	0.965
2015	0.980	0.980	0.981	0.955	0.964	0.870	0.900	0.969
2016	0.980	0.980	0.977	0.959	0.98	0.879	0.894	0.961
2017	0.977	0.979	0.974	0.957	0.973	0.874	0.896	0.943
2018	0.968	0.970	0.947	0.96	0.972	0.885	0.898	0.939
2019	0.940	0.951	0.940	0.947	0.963	0.876	0.933	0.919
2020	0.955	0.973	0.944	0.971	0.987	0.854	0.946	0.856
2021	0.952	0.979	0.954	0.979	0.994	0.868	0.952	0.823

Appendix F. Within Consistency Analysis Results

Region	City	H1a	H1b	H2	H3	H4	Region	City	Nh1	Nh2	Nh3
Northeast	Anshan	1	1	1	1	1	Northeast	Matsubara	1	1	1
Northeast	White Mountain	1	1	1	1	1	Northeast	Harbin	1	1	1
Northeast	Benxi	1	1	1	1	1	Northeast	Changchun	1	1	1
Northeast	Changchun	1	1	1	1	1	Northeast	Daqing	1	1	1
Northeast	Chao Yang	1	1	1	1	1	Northeast	White City	0.998	1	1
Northeast	Dalian	1	1	1	1	1	Northeast	Huludao	0.993	1	1
Northeast	Danton	1	1	1	1	1	Northeast	Shenyang	1	1	0.975
Northeast	Daqing	1	1	1	1	1	Northeast	Tonghua	0.993	0.991	0.951
Northeast	Fushun	1	1	1	1	1	Northeast	Dalian	1	1	0.913
Northeast	Fuxin	1	1	1	1	1	Northeast	Jilin	0.982	0.971	0.934
Northeast	Hegang	1	1	1	1	1	Northeast	Yingkou	0.977	0.978	0.838
Northeast	Black River	1	1	1	1	1	Northeast	Jinzhou	0.895	1	0.854
Northeast	Huludao	1	1	1	1	1	Northeast	Liaoyang	0.899	1	0.72
Northeast	Jiamusi	1	1	1	1	1	Northeast	Liaoyuan	0.923	0.951	0.738
Northeast	Jilin	1	1	1	1	1	Northeast	Siping	0.739	0.868	0.789
Northeast	Jinzhou	1	1	1	1	1	Northeast	Anshan	0.728	1	0.631
Northeast	Chicken West	1	1	1	1	1	Northeast	Fushun	0.667	0.92	0.635
Northeast	Liaoyang	1	1	1	1	1	Northeast	Tieling	0.684	0.585	0.763
Northeast	Liaoyuan	1	1	1	1	1	Northeast	Fuxin	0.601	0.722	0.693
Northeast	Mudanjiang	1	1	1	1	1	Northeast	Chao Yang	0.392	0.847	0.473
Northeast	Panjin	1	1	1	1	1	Northeast	Benxi	0.472	0.889	0.347
Northeast	Qiqihar	1	1	1	1	1	Northeast	White Mountain	0.524	0.6	0.466

Region	City	H1a	H1b	H2	H3	H4	Region	City	Nh1	Nh2	Nh3
Northeast	Qitai River	1	1	1	1	1	Northeast	Panjin	0.489	0.499	0.419
Northeast	Shenyang	1	1	1	1	1	Northeast	Qiqihar	0.455	0.517	0.435
Northeast	Shuangyashan	1	1	1	1	1	Northeast	Danton	0.398	0.478	0.465
Northeast	Siping	1	1	1	1	1	Northeast	Suihua	0.321	0.508	0.478
Northeast	Suihua	1	1	1	1	1	Northeast	Qitai River	0.236	0.688	0.35
Northeast	Tieling	1	1	1	1	1	Northeast	Shuangyashan	0.147	0.802	0.297
Northeast	Tonghua	1	1	1	1	1	Northeast	Mudanjiang	0.343	0.421	0.45
Northeast	Yichun	1	1	1	1	1	Northeast	Black River	0.304	0.327	0.577
Northeast	Yingkou	1	1	1	1	1	Northeast	Jiamusi	0.252	0.344	0.476
Northeast	Harbin	1	1	1	0.997	1	Northeast	Yichun	0.049	0.205	0.144
Northeast	Matsubara	1	1	1	0.939	1	Northeast	Hegang	0.041	0.061	0.127
Northeast	White City	0.969	0.95	0.95	0.942	0.955	Northeast	Chicken West	0.036	0.067	0.119
Eastern	Baoding	1	1	1	1	1	Eastern	Jinan	1	1	1
Eastern	Beijing	1	1	1	1	1	Eastern	Chengde	1	1	1
Eastern	Changzhou	1	1	1	1	1	Eastern	Qinhuangdao	1	1	1
Eastern	Teochew	1	1	1	1	1	Eastern	Cangzhou	1	1	1
Eastern	Texas	1	1	1	1	1	Eastern	Yantai	1	1	1
Eastern	Dongguan	1	1	1	1	1	Eastern	Qingdao	1	1	1
Eastern	Foshan	1	1	1	1	1	Eastern	Quanzhou	1	1	1
Eastern	Guangzhou	1	1	1	1	1	Eastern	Linyi	1	1	1
Eastern	Handan	1	1	1	1	1	Eastern	Fuzhou	1	1	1
Eastern	Hangzhou	1	1	1	1	1	Eastern	Weihai	1	1	1
Eastern	Hengshui	1	1	1	1	1	Eastern	Langfang	1	1	1
Eastern	Riverhead	1	1	1	1	1	Eastern	Jining	1	1	1
Eastern	Heze	1	1	1	1	1	Eastern	Shijiazhuang	1	1	1
Eastern	Huizhou	1	1	1	1	1	Eastern	Sunshine	1	1	1
Eastern	Huzhou	1	1	1	1	1	Eastern	Zhangjiakou	1	1	1
Eastern	Jiangmen	1	1	1	1	1	Eastern	Huai'an	1	1	1
Eastern	Jiaxing	1	1	1	1	1	Eastern	Weifang	1	1	1
Eastern	Jieyang	1	1	1	1	1	Eastern	Zhangzhou	1	1	1
Eastern	Lianyungang	1	1	1	1	1	Eastern	Putian	1	1	1
Eastern	Liaocheng	1	1	1	1	1	Eastern	Binzhou	1	1	1
Eastern	Maoming	1	1	1	1	1	Eastern	Yeosu	1	1	1
Eastern	Meizhou	1	1	1	1	1	Eastern	Baoding	1	1	1
Eastern	Ningbo	1	1	1	1	1	Eastern	Beijing	1	1	1
Eastern	Qingyuan	1	1	1	1	1	Eastern	Changzhou	1	1	1
Eastern	Quzhou	1	1	1	1	1	Eastern	Dongying	1	1	1
Eastern	Shanghai	1	1	1	1	1	Eastern	Guangzhou	1	1	1
Eastern	Shantou	1	1	1	1	1	Eastern	Hangzhou	1	1	1
Eastern	Shanwei	1	1	1	1	1	Eastern	Heze	1	1	1
Eastern	Shaoguan	1	1	1	1	1	Eastern	Huzhou	1	1	1
Eastern	Suqian	1	1	1	1	1	Eastern	Jiaxing	1	1	1
Eastern	Suzhou	1	1	1	1	1	Eastern	Jinhua	1	1	1
Eastern	Tai'an	1	1	1	1	1	Eastern	Lianyungang	1	1	1
Eastern	Taizhou	1	1	1	1	1	Eastern	Liaocheng	1	1	1
Eastern	Tangshan	1	1	1	1	1	Eastern	Longyan	1	1	1
Eastern	Tianjin	1	1	1	1	1	Eastern	Nanking	1	1	1
Eastern	Wenzhou	1	1	1	1	1	Eastern	Nanping	1	1	1
Eastern	Wuxi	1	1	1	1	1	Eastern	Nantong	1	1	1
Eastern	Xiamen	1	1	1	1	1	Eastern	Ningbo	1	1	1
Eastern	Xingtai	1	1	1	1	1	Eastern	Ningde	1	1	1
Eastern	Xuzhou	1	1	1	1	1	Eastern	Qingyuan	1	1	1

Region	City	H1a	H1b	H2	H3	H4	Region	City	Nh1	Nh2	Nh3
Eastern	Yancheng	1	1	1	1	1	Eastern	Quzhou	1	1	1
Eastern	Yangjiang	1	1	1	1	1	Eastern	Sanming	1	1	1
Eastern	Yangzhou	1	1	1	1	1	Eastern	Shanghai	1	1	1
Eastern	Yunfu	1	1	1	1	1	Eastern	Shaoguan	1	1	1
Eastern	Zaozhuang	1	1	1	1	1	Eastern	Shaoxing	1	1	1
Eastern	Zhanjiang	1	1	1	1	1	Eastern	Suzhou	1	1	1
Eastern	Zhaoqing	1	1	1	1	1	Eastern	Tai'an	1	1	1
Eastern	Zhenjiang	1	1	1	1	1	Eastern	Taizhou	1	1	1
Eastern	Zhongshan	1	1	1	1	1	Eastern	Taizhou	1	1	1
Eastern	Zhoushan	1	1	1	1	1	Eastern	Tangshan	1	1	1
Eastern	Zhuhai	1	1	1	1	1	Eastern	Wenzhou	1	1	1
Eastern	Zibo	1	1	1	1	1	Eastern	Wuxi	1	1	1
Eastern	Shaoxing	1	1	0.999	1	1	Eastern	Yangzhou	1	1	1
Eastern	Nanking	1	1	0.997	1	1	Eastern	Zaozhuang	1	1	1
Eastern	Nanping	1	1	0.997	1	1	Eastern	Zhanjiang	1	1	1
Eastern	Sanming	1	1	0.997	1	1	Eastern	Zhenjiang	1	1	1
Eastern	Jinhua	1	1	0.995	1	1	Eastern	Zibo	1	1	1
Eastern	Weifang	1	1	1	0.988	1	Eastern	Jiangmen	0.998	1	1
Eastern	Yeosu	0.988	1	1	0.999	0.999	Eastern	Huizhou	1	0.98	1
Eastern	Taizhou	1	1	0.983	1	1	Eastern	Jieyang	0.992	1	0.968
Eastern	Sunshine	1	1	1	0.968	1	Eastern	Zhaoqing	0.97	0.993	0.993
Eastern	Binzhou	1	1	0.97	0.996	1	Eastern	Hengshui	0.951	1	1
Eastern	Zhangzhou	0.991	0.991	0.992	0.991	1	Eastern	Zhoushan	0.983	0.983	0.983
Eastern	Nantong	1	1	1	1	0.961	Eastern	Meizhou	0.972	0.964	0.972
Eastern	Ningde	1	1	0.958	1	1	Eastern	Yangjiang	0.948	0.984	0.962
Eastern	Jining	1	1	0.997	0.959	1	Eastern	Riverhead	0.969	0.969	0.948
Eastern	Langfang	0.989	1	1	0.93	1	Eastern	Handan	0.857	1	1
Eastern	Weihai	0.996	0.996	0.996	0.925	1	Eastern	Xuzhou	0.887	0.98	0.971
Eastern	Longyan	1	1	0.898	1	1	Eastern	Xiamen	1	0.719	1
Eastern	Putian	1	1	0.925	0.993	0.973	Eastern	Xingtai	0.779	0.913	1
Eastern	Shijiazhuang	0.967	0.966	0.966	0.966	1	Eastern	Texas	0.633	1	0.879
Eastern	Zhangjiakou	0.982	0.968	0.968	0.968	0.968	Eastern	Shantou	0.752	0.937	0.776
Eastern	Huai'an	0.981	0.923	0.977	0.981	0.962	Eastern	Shanwei	0.789	0.81	0.786
Eastern	Qingdao	0.989	0.989	0.989	0.855	1	Eastern	Zhuhai	0.761	0.73	0.761
Eastern	Dongying	1	1	0.753	1	1	Eastern	Yunfu	0.759	0.784	0.682
Eastern	Yantai	0.965	0.965	0.965	0.842	1	Eastern	Maoming	0.456	0.916	0.628
Eastern	Fuzhou	0.985	0.985	0.848	0.919	0.992	Eastern	Dongguan	0.537	0.673	0.673
Eastern	Qinhuangdao	0.923	0.989	0.989	0.759	1	Eastern	Suqian	0.625	0.625	0.623
Eastern	Quanzhou	0.938	0.938	0.834	0.898	0.902	Eastern	Tianjin	0.614	0.614	0.642
Eastern	Linyi	0.915	0.915	0.666	0.912	0.981	Eastern	Yancheng	0.626	0.626	0.601
Eastern	Cangzhou	0.834	0.861	0.861	0.777	0.965	Eastern	Teochew	0.486	0.818	0.538
Eastern	Jinan	0.858	0.858	0.831	0.624	1	Eastern	Foshan	0.321	0.635	0.635
Eastern	Chengde	0.652	0.743	0.689	0.729	0.731	Eastern	Zhongshan	0.368	0.382	0.454
Westward	Turban	1	1	1	1	1	Westward	Qingyang	1	1	1
Westward	Bayannur	1	1	1	1	1	Westward	Six Pans Of Water	1	1	1
Westward	Bazhong	1	1	1	1	1	Westward	Teluk Intan (Teluk)	1	1	1
Westward	Chengdu	1	1	1	1	1	Westward	Cool And Cool	1	1	1
Westward	Chongzuo	1	1	1	1	1	Westward	Silver	1	1	1

Region	City	H1a	H1b	H2	H3	H4	Region	City	Nh1	Nh2	Nh3
Westward	Dazhou	1	1	1	1	1	Westward	Kunming	1	1	1
Westward	Ordos	1	1	1	1	1	Westward	Xianyang	1	1	1
Westward	Fangchenggang	1	1	1	1	1	Westward	Baoshan	1	1	1
Westward	Quang An	1	1	1	1	1	Westward	Chifeng	1	1	1
Westward	Guigang	1	1	1	1	1	Westward	River Pools	1	1	1
Westward	Guilin	1	1	1	1	1	Westward	Hohhot	1	1	1
Westward	Guiyang	1	1	1	1	1	Westward	Well-Being	1	1	1
Westward	Haikou	1	1	1	1	1	Westward	Lijiang	1	1	1
Westward	Hezhou	1	1	1	1	1	Westward	Qinzhou	1	1	1
Westward	Hulunbuir	1	1	1	1	1	Westward	Sian	1	1	1
Westward	Jiuquan	1	1	1	1	1	Westward	Baoji	1	1	1
Westward	Lanzhou	1	1	1	1	1	Westward	Zunyi	1	1	1
Westward	Lincang	1	1	1	1	1	Westward	Shangluo	1	1	1
Westward	Liuzhou	1	1	1	1	1	Westward	Hanzhong	1	1	1
Westward	Meishan	1	1	1	1	1	Westward	Nanning	1	1	1
Westward	Nanchong	1	1	1	1	1	Westward	Weinan	1	1	1
Westward	Shizui Mountain	1	1	1	1	1	Westward	Yan'an	1	1	1
Westward	Suining	1	1	1	1	1	Westward	Bose	1	1	1
Westward	Tongliao	1	1	1	1	1	Westward	Chongqing	1	1	1
Westward	Wuhai	1	1	1	1	1	Westward	Guest	1	1	1
Westward	Urumchi	1	1	1	1	1	Westward	Bazhong	1	1	1
Westward	Wu Wei	1	1	1	1	1	Westward	North Sea	1	1	1
Westward	Wuzhou	1	1	1	1	1	Westward	Chongzuo	1	1	1
Westward	Xining	1	1	1	1	1	Westward	Dingxi	1	1	1
Westward	Yinchuan	1	1	1	1	1	Westward	Ordos	1	1	1
Westward	Yulin	1	1	1	1	1	Westward	Fangchenggang	1	1	1
Westward	Zhangye	1	1	1	1	1	Westward	Quang An	1	1	1
Westward	Zhaotong	1	1	1	1	1	Westward	Guangyuan	1	1	1
Westward	Ziyang	1	1	1	1	1	Westward	Guilin	1	1	1
Westward	Zigong	1	1	0.991	1	1	Westward	Haikou	1	1	1
Westward	Guest	0.997	0.997	0.998	0.997	0.997	Westward	Leshan	1	1	1
Westward	Guangyuan	1	1	0.982	1	1	Westward	Liuzhou	1	1	1
Westward	Sanya	0.976	1	1	1	1	Westward	Luzhou	1	1	1
Westward	Luzhou	1	1	0.975	1	1	Westward	Mianyang	1	1	1
Westward	Neijiang	1	1	0.972	1	1	Westward	Panzhihua	1	1	1
Westward	Yibin	1	1	0.966	1	1	Westward	Qujing	1	1	1
Westward	Nanning	1	1	0.982	0.974	1	Westward	Sanya	1	1	1
Westward	Bose	0.992	0.991	0.992	0.991	0.988	Westward	Suining	1	1	1
Westward	Deyang	1	1	0.949	1	1	Westward	Tongchuan	1	1	1
Westward	Panzhihua	1	1	0.947	1	1	Westward	Tongliao	1	1	1
Westward	North Sea	1	1	0.945	1	1	Westward	Ulanqab	1	1	1
Westward	Mianyang	1	1	0.898	1	1	Westward	Wuzhou	1	1	1
Westward	Dingxi	0.883	1	1	1	1	Westward	Xining	1	1	1
Westward	Chongqing	0.864	0.991	0.991	0.991	1	Westward	Ya'an	1	1	1
Westward	Leshan	1	1	0.822	1	1	Westward	Yinchuan	1	1	1
Westward	Central Defender	0.81	1	1	1	1	Westward	Yulin	1	1	1
Westward	Hohhot	1	1	0.952	0.849	1	Westward	Yuxi	1	1	1
Westward	Yan'an	0.998	0.969	0.911	0.986	0.933	Westward	Zhaotong	1	1	1

Region	City	H1a	H1b	H2	H3	H4	Region	City	Nh1	Nh2	Nh3
Westward	Ya'an	1	1	0.782	1	1	Westward	Central Defender	1	1	1
Westward	Yuxi	1	1	0.765	1	1	Westward	Hezhou	0.999	1	1
Westward	Weinan	0.988	0.975	0.866	0.985	0.95	Westward	Nanchong	0.998	1	1
Westward	Yulin	1	1	0.751	1	1	Westward	Lanzhou	0.996	1	1
Westward	Qujing	1	1	0.739	1	1	Westward	Neijiang	0.991	1	1
Westward	Sian	0.929	0.929	0.929	0.894	1	Westward	Deyang	0.99	1	1
Westward	Ulanqab	1	0.874	1	1	0.742	Westward	Lincang	0.986	1	1
Westward	Shangluo	0.943	0.917	0.88	0.913	0.842	Westward	Dazhou	0.984	1	1
Westward	Qinzhou	0.894	0.894	0.874	0.894	0.936	Westward	Yibin	0.98	1	1
Westward	Zunyi	0.911	0.911	0.775	0.911	0.975	Westward	Zigong	0.971	1	1
Westward	Tongchuan	0.552	0.994	1	1	0.902	Westward	Ziyang	0.971	1	1
Westward	River Pools	0.842	0.859	0.859	0.844	0.859	Westward	Chengdu	1	0.946	1
Westward	Well-Being	0.875	0.832	0.861	0.863	0.799	Westward	Meishan	0.944	1	1
Westward	Hanzhong	0.955	0.912	0.473	0.955	0.881	Westward	Wu Wei	0.93	1	1
Westward	Baoji	0.919	0.919	0.47	0.897	0.836	Westward	Yulin	0.945	1	0.962
Westward	Chifeng	0.748	0.817	0.859	0.839	0.745	Westward	Guiyang	1	0.906	1
Westward	Kunming	0.727	0.727	0.701	0.782	1	Westward	Guigang	0.939	1	0.917
Westward	Lijiang	0.491	0.871	0.774	0.871	0.871	Westward	Jiuquan	0.951	1	0.803
Westward	Baoshan	0.826	0.826	0.478	0.822	0.826	Westward	Turban	0.88	0.885	0.868
Westward	Silver	0.718	0.724	0.74	0.683	0.715	Westward	Hulunbuir	0.837	1	0.708
Westward	Xianyang	0.788	0.788	0.222	0.788	0.759	Westward	Shizui Mountain	0.72	0.838	0.76
Westward	Cool And Cool	0.512	0.638	0.638	0.638	0.632	Westward	Zhangye	0.463	1	0.659
Westward	Teluk Intan (Teluk)	0.366	0.554	0.554	0.554	0.554	Westward	Urumchi	0.533	0.442	0.664
Westward	Six Pans Of Water	0.47	0.467	0.327	0.47	0.467	Westward	Bayannur	0.446	0.541	0.441
Westward	Qingyang	0.13	0.229	0.229	0.201	0.224	Westward	Wuhai	0.202	0.353	0.21
Central	Changde	1	1	1	1	1	Central	Shiyan	1	1	1
Central	Changsha	1	1	1	1	1	Central	Xinzhou	1	1	1
Central	Ezhou	1	1	1	1	1	Central	Lv Liang	1	1	1
Central	Fuyang	1	1	1	1	1	Central	Luoyang	1	1	1
Central	Fuzhou	1	1	1	1	1	Central	Ganzhou	1	1	1
Central	Hebi	1	1	1	1	1	Central	Puyang	1	1	1
Central	Hefei	1	1	1	1	1	Central	Bengbu	1	1	1
Central	Hengyang	1	1	1	1	1	Central	Chuzhou	1	1	1
Central	Huanggang	1	1	1	1	1	Central	Huaibei	1	1	1
Central	Jiaozuo	1	1	1	1	1	Central	Shangqiu	1	1	1
Central	Jingmen	1	1	1	1	1	Central	Jiujiang	1	1	1
Central	Jingzhou	1	1	1	1	1	Central	Datong	1	1	1
Central	Linfen	1	1	1	1	1	Central	Jincheng	1	1	1
Central	Lu'an	1	1	1	1	1	Central	Loudi	1	1	1
Central	Luohe	1	1	1	1	1	Central	Anqing	1	1	1
Central	Ma On Shan	1	1	1	1	1	Central	Zhangjiajie	1	1	1
Central	Nanchang	1	1	1	1	1	Central	Huaihua	1	1	1
Central	Nanyang	1	1	1	1	1	Central	Huainan	1	1	1
Central	Pingxiang	1	1	1	1	1	Central	Fuyang	1	1	1
Central	Sanmenxia	1	1	1	1	1	Central	Fuzhou	1	1	1
Central	Shaoyang	1	1	1	1	1	Central	Hefei	1	1	1
Central	Shuozhou	1	1	1	1	1	Central	Ji'an	1	1	1
Central	Suizhou	1	1	1	1	1	Central	Linfen	1	1	1
Central	Taiyuan	1	1	1	1	1	Central	Lu'an	1	1	1

Region	City	H1a	H1b	H2	H3	H4	Region	City	Nh1	Nh2	Nh3
Central	Wuhan	1	1	1	1	1	Central	Ma On Shan	1	1	1
Central	Wuhu	1	1	1	1	1	Central	Nanchang	1	1	1
Central	Xiangtan	1	1	1	1	1	Central	Sanmenxia	1	1	1
Central	Xianning	1	1	1	1	1	Central	Shangrao	1	1	1
Central	Xiaogan	1	1	1	1	1	Central	Shaoyang	1	1	1
Central	Xinxiang	1	1	1	1	1	Central	Shuozhou	1	1	1
Central	Xinyang	1	1	1	1	1	Central	Suzhou	1	1	1
Central	Xinyu	1	1	1	1	1	Central	Wuhan	1	1	1
Central	Xuchang	1	1	1	1	1	Central	Xinyu	1	1	1
Central	Yang Spring	1	1	1	1	1	Central	Yichang	1	1	1
Central	Yichang	1	1	1	1	1	Central	Yuncheng	1	1	1
Central	Eagle Pond	1	1	1	1	1	Central	Zhuzhou	1	1	1
Central	Yiyang	1	1	1	1	1	Central	Yellowstone	0.993	1	1
Central	Yongzhou	1	1	1	1	1	Central	Eagle Pond	0.993	1	1
Central	Yueyang	1	1	1	1	1	Central	Huanggang	0.991	1	1
Central	Yuncheng	1	1	1	1	1	Central	Xuancheng	0.984	1	1
Central	Zhengzhou	1	1	1	1	1	Central	Yueyang	0.983	1	1
Central	Zhoukou	1	1	1	1	1	Central	Changzhi	0.98	1	1
Central	Zhumadian	1	1	1	1	1	Central	Changde	0.982	1	0.998
Central	Zhuzhou	1	1	1	1	1	Central	Jinzhong	0.978	1	1
Central	Chizhou	0.998	1	1	1	1	Central	Yichun	0.985	0.991	1
Central	Xiangyang	1	1	0.996	1	1	Central	Zhumadian	0.975	1	1
Central	Jingdezhen	0.99	1	1	1	1	Central	Chenzhou	0.971	1	1
Central	Chenzhou	0.988	1	1	1	1	Central	Mesa	0.967	1	1
Central	Suzhou	1	1	0.987	1	1	Central	Zhoukou	0.961	1	1
Central	Yichun	0.964	1	1	1	1	Central	Nanyang	0.956	1	1
Central	Anyang	0.989	0.989	0.989	0.99	1	Central	Jingdezhen	0.962	1	0.993
Central	Shangrao	0.956	1	1	1	1	Central	Xinyang	0.929	1	1
Central	Jinzhong	0.962	0.985	0.985	0.987	1	Central	Huangshan	1	0.919	1
Central	Huangshan	0.909	1	1	1	1	Central	Anyang	0.917	1	1
Central	Yellowstone	1	1	0.893	1	1	Central	Yongzhou	0.96	0.96	0.986
Central	Kaifeng	0.966	0.972	0.969	0.969	1	Central	Xinxiang	0.885	1	1
Central	Huainan	0.949	0.974	0.974	0.976	1	Central	Yang Spring	0.934	1	0.949
Central	Huaihua	0.974	0.974	0.96	0.974	0.968	Central	Kaifeng	0.876	1	1
Central	Changzhi	0.9	0.976	0.976	0.966	1	Central	Chizhou	0.978	0.878	0.973
Central	Ji'an	0.806	1	1	1	1	Central	Luohe	0.784	1	0.998
Central	Xuancheng	0.804	1	1	1	1	Central	Xianning	0.798	0.955	1
Central	Zhangjiajie	0.916	0.97	0.942	0.969	0.97	Central	Xuchang	0.748	1	1
Central	Jincheng	0.909	0.941	0.941	0.927	1	Central	Wuhu	1	0.738	1
Central	Loudi	0.932	0.932	0.932	0.932	0.987	Central	Xiangtan	0.703	0.99	0.994
Central	Anqing	0.942	0.942	0.851	0.942	0.999	Central	Tongling	0.878	0.906	0.893
Central	Shangqiu	0.918	0.918	0.918	0.919	0.963	Central	Xiaogan	0.793	0.912	0.968
Central	Datong	0.927	0.905	0.941	0.927	0.905	Central	Changsha	0.795	0.943	0.896
Central	Mesa	0.885	0.885	0.885	0.886	1	Central	Zhengzhou	0.969	0.658	0.968
Central	Jiujiang	0.734	0.923	0.923	0.923	1	Central	Ezhou	0.504	0.994	0.968
Central	Huaibei	0.858	0.872	0.858	0.858	1	Central	Xiangyang	0.683	0.842	0.842
Central	Chuzhou	0.825	0.846	0.846	0.846	0.998	Central	Jiaozuo	0.516	0.975	0.853
Central	Bengbu	0.83	0.83	0.83	0.832	1	Central	Jingzhou	0.522	1	0.659
Central	Puyang	0.779	0.711	0.781	0.781	0.674	Central	Hebi	0.491	0.78	0.756
Central	Luoyang	0.654	0.654	0.654	0.609	0.847	Central	Yiyang	0.598	0.719	0.644

Region	City	H1a	H1b	H2	H3	H4	Region	City	Nh1	Nh2	Nh3
Central	Tongling	0.59	0.628	0.624	0.594	0.733	Central	Jingmen	0.448	0.693	0.66
Central	Ganzhou	0.49	0.616	0.616	0.616	0.677	Central	Taiyuan	0.65	0.42	0.706
Central	Lv Liang	0.545	0.606	0.544	0.581	0.606	Central	Pingxiang	0.581	0.57	0.605
Central	Xinzhou	0.367	0.395	0.37	0.395	0.393	Central	Hengyang	0.497	0.608	0.637
Central	Shiyan	0.328	0.376	0.398	0.337	0.39	Central	Suizhou	0.361	0.604	0.63

Appendix G. Robustness Tests: Adjusting Inequality Measurement of Outcome Variables

Appendix G.1. Sufficiency Analysis of Gap Narrowing Using Gini Coefficient as Outcome Variable

Variable		Reduction in Urban–Rural Income Gap				
Digital Paths	Digital Innovation	□	●	●	●	●
	Digital Infrastructure	□	●	□		●
	Digital Industry	□	□	□	□	●
	Digital Finance		□	●	●	
	Digital Governance		●	●	●	●
Context	Economic Level	□	●	●	●	●
	Degree of Government Intervention	⊠	⊗		⊠	⊗
	Degree of Openness	□		●	●	□
Consistency		0.965	0.949	0.96	0.963	0.96
PRI		0.905	0.871	0.891	0.896	0.891
Raw Coverage		0.41	0.468	0.384	0.373	0.384
Unique Coverage		0.05	0.107	0.024	0.012	0.024
Overall Solution Consistency				0.935		
Overall PRI				0.85		
Overall Solution Coverage				0.553		

Appendix G.2. Sufficiency Analysis of Gap Narrowing Using Coefficient of Variation as Outcome Variable

Variable		Reduction in Urban–Rural Income Gap					
Digital Paths	Digital Innovation	□	●	□	●	□	
	Digital Infrastructure	□	●	□	●		□
	Digital Industry	□	□	□		□	□
	Digital Finance		□	●	⊠	●	●
	Digital Governance		●	●	●	●	●
Context	Economic Level	□	●	●	●	●	●
	Degree of Government Intervention	⊠	⊗		⊗	⊠	⊠
	Degree of Openness	□		●	□	●	●
Consistency		0.965	0.953	0.962	0.978	0.964	0.972
PRI		0.905	0.881	0.896	0.878	0.899	0.921
Raw Coverage		0.402	0.461	0.378	0.244	0.366	0.365
Unique Coverage		0.028	0.106	0.023	0.005	0.012	0.011
Overall Solution Consistency				0.935			
Overall PRI				0.853			
Overall Solution Coverage				0.559			

Appendix H. Robustness Tests: Adjusting Case Frequency Threshold for Sufficiency Analysis

Appendix H.1. Change Case Frequency Threshold to 4 Cases for Sufficiency Analysis of Gap Narrowing

Variable		Reduction in Urban–Rural Income Gap				
Digital Paths	Digital Innovation	□			●	□
	Digital Infrastructure	●	●	□	●	●
	Digital Industry	●	●		□	□
	Digital Finance			⊠	●	●
	Digital Governance		□	□	●	●
Context	Economic Level	●	●	□	●	●
	Degree of Government Intervention	⊗	⊗	⊠	⊗	
	Degree of Openness	●	●	□		●
Consistency		0.963	0.973	0.977	0.955	0.962
PRI		0.904	0.928	0.888	0.891	0.901
Raw Coverage		0.388	0.377	0.25	0.447	0.365
Unique Coverage		0.024	0.004	0.01	0.104	0.023
Overall Solution Consistency				0.942		
Overall PRI				0.87		
Overall Solution Coverage				0.537		

Appendix H.2. Change Case Frequency Threshold to 8 Cases for Sufficiency Analysis of Gap Narrowing

Variable		Reduction in Urban–Rural Income Gap				
Digital Paths	Digital Innovation	□	●	□		⊠
	Digital Infrastructure	●	●	●	●	□
	Digital Industry	●	□	□	●	⊗
	Digital Finance		□	●	□	⊠
	Digital Governance		●	●	□	●
Context	Economic Level	●	●	●	●	●
	Degree of Government Intervention	⊠	⊗		⊠	⊠
	Degree of Openness	●		●	●	□
Consistency		0.963	0.955	0.962	0.973	0.976
PRI		0.904	0.891	0.901	0.924	0.767
Raw Coverage		0.388	0.447	0.365	0.353	0.195
Unique Coverage		0.039	0.104	0.023	0.004	0.01
Overall Solution Consistency				0.942		
Overall PRI				0.87		
Overall Solution Coverage				0.535		

Appendix I. Robustness Tests: Adjusting Consistency Threshold for Sufficiency Analysis

Appendix I.1. Adjust Consistency Threshold to 0.8 for Sufficiency Analysis of Gap Narrowing

Variable		Reduction in Urban–Rural Income Gap				
Digital Paths	Digital Innovation	●	□	□	●	
	Digital Infrastructure	●	●	□	●	●
	Digital Industry	●	□	□	●	□
	Digital Finance	□	●	□		●
	Digital Governance	●	●		●	●
Context	Economic Level	●	●	□	●	●
	Degree of Government Intervention	⊗		⊠	⊗	⊠
	Degree of Openness		●	□	□	●
Consistency		0.955	0.962	0.968	0.973	0.973
PRI		0.891	0.901	0.91	0.93	0.924
Raw Coverage		0.447	0.365	0.357	0.364	0.353
Unique Coverage		0.104	0.023	0.015	0.021	0.01
Overall Solution Consistency				0.945		
Overall PRI				0.876		
Overall Solution Coverage				0.516		

Appendix I.2. Adjust Consistency Threshold to 0.9 for Sufficiency Analysis of Gap Narrowing

Variable		Reduction in Urban–Rural Income Gap					
Digital Paths	Digital Innovation	●	□	□	□		
	Digital Infrastructure	●	□	□		□	□
	Digital Industry	□	□	□	□	⊗	□
	Digital Finance	●		●	●	⊠	●
	Digital Governance			●	●	●	●
Context	Economic Level	●	□	●	●	●	●
	Degree of Government Intervention	⊗	⊠		⊠	⊠	⊠
	Degree of Openness		□	●	●	□	●
Consistency		0.947	0.963	0.962	0.964	0.976	0.973
PRI		0.873	0.904	0.901	0.903	0.806	0.924
Raw Coverage		0.467	0.388	0.365	0.354	0.219	0.353
Unique Coverage		0.11	0.021	0.023	0.011	0.011	0.004
Overall Solution Consistency				0.934			
Overall PRI				0.854			
Overall Solution Coverage				0.553			

Appendix J. Robustness Tests: Adjusting the Calibration Thresholds for Sufficiency Analysis

We changed the full non-membership point, crossover point, and full membership point to the 10th percentile, 50th percentile, and 90th percentile, respectively.

Table A1. Adjusting the calibration thresholds for sufficiency analysis.

Variable		Reduction in Urban–Rural Income Gap					
Digital Paths	Digital Innovation	□	●	□	□		⊗
	Digital Infrastructure	□	●	□		□	□
	Digital Industry	□	●	□	□	□	⊗
	Digital Finance		□	●	●	●	⊠
	Digital Governance		●	●	●	●	●
Context	Economic Level	□	●	●	●	●	●
	Degree of Government Intervention	⊠	⊗		⊠	⊠	⊠
	Degree of Openness	□		●	●	●	□
Consistency		0.949	0.942	0.946	0.951	0.962	0.965
PRI		0.893	0.884	0.886	0.893	0.917	0.754
Raw Coverage		0.356	0.406	0.335	0.319	0.316	0.143
Unique Coverage		0.044	0.1	0.03	0.013	0.005	0.01
Overall Solution Consistency		0.918					
Overall PRI		0.847					
Overall Solution Coverage		0.519					

Notes

[1] It should be noted that the sample includes four municipalities (provincial-level administrative regions), namely Beijing, Shanghai, Tianjin, and Chongqing. For convenience, the sample as a whole is still referred to as prefecture-level administrative regions.

[2] The presence of conditions in configurations is indicated using specific symbols. (1) ●: presence of a core condition; (2) ⊗: absence of a core condition; (3) □: presence of a peripheral condition; (4) ⊠: absence of a peripheral condition. Core conditions are important conditions that appear in both the intermediate and parsimonious solutions. Peripheral conditions only appear in the intermediate solution and have weaker existence. Consistency refers to the degree to which all cases included in the analysis share the given condition or combination of conditions leading to the outcome. Coverage refers to the degree to which the given condition or combination of conditions explains the occurrence of the outcome. PRI stands for "Proportional Reduction in Inconsistency." The higher the PRI, the fewer contradictions and inconsistencies in the causal relationship. In the configuration numbering system, H represents configurations where positive outcomes are present, while NH represents configurations where positive outcomes are absent.

[3] The horizontal axis in the figure represents the cases, that is, the prefecture-level administrative regions.

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