Economic Growth Mechanism of County-to-District Conversion and Its Dialectical Relationship with City Shrinkage: Case Study of County-to-District Conversion in Hangzhou, China

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Abstract: In China, county-to-district conversion (CTDC) is a major form of administrative division adjustment (ADA) and an important element of national regime policy. In this study, the authors used the synthetic control method to analyze the economic growth effect and mechanism of the CTDC that occurred in Xiaoshan and Yuhang in 2001, and to explore the dialectical relationship between CTDC and city shrinkage. The research results are as follows. First, the economic growth following CTDC in Xiaoshan and Yuhang exhibited different patterns of variation. Economic growth in Xiaoshan increased progressively from 2002 to 2012, and the difference in annual growth of per capita GDP between the actual Xiaoshan and synthetic Xiaoshan reached 5.77%. However, the economic effect of CTDC had a time lag in Yuhang, with the growth curves of actual Yuhang and synthetic Yuhang largely coinciding in 2002–2006. Since 2007, the difference of annual growth rate was 2.2%. Second, the reduced shielding effect of administrative boundaries is the key to greater economic growth after CTDC. Thus, CTDC stimulates economic growth indirectly via urban integration planning, amplification of consumption and urban investment, and retention of financial and administrative power. Third, for Hangzhou, a city with strong development, CTDC will not cause economic recession. However, it is not suitable to add municipal districts to shrinking cities by CTDC, because it has the risk of aggravating the unbalanced urban development. Fourth, the study provides evidence for evaluating policy effects of CTDC and explains China's city shrinkage and urbanization from the perspective of ADA. **DOI: 10.1061/(ASCE)UP.1943-5444.0000634**. © *2020 American Society of Civil Engineers*.

Introduction

Most countries and regions around the world are divided into administrative regions (ARs), which are managed at multiple levels. ARs are based on the division and distribution of administrative power at different regional scales, and can be regarded as the spatial projection of a political structure (Xie 2009). The mode of administrative division is constrained by the national political system. Thus, in countries characterized by centralized power, such as China, Japan, and Korea, administrative division levels are vertical, with a strict superior–subordinate relationship between levels, and each category of ARs has a distinct hierarchy and authority (Jacobs 2004; Bakarić 2012). In federal countries such as the United States, Canada, and Germany, the state's subordinate units are federal states, which are generally autonomous, and their local administrative units (e.g., city, town) have greater autonomy and maintain relative independence (Wang 2010; Tatiana 2013; Natalia and Galina 2015). States are further subdivided into areas such as electoral districts and school districts (Arenas and Alonso 2015; Marian et al. 2017).

China's Constitution divides China's administrative areas into province, county, and township levels. Following political reforms, the administration division evolved into four levels, namely "province–city–county–township" (Fan et al. 2012), and county-level ARs include counties, county-level cities, and municipal districts. Municipal districts are affiliated to prefecture-level cities, and their financial, land, and planning power are controlled by the city government. Multiple municipal districts form the central area of a prefecture-level city, which is known as the main urban area (MUA), while counties or county-level cities are often located in the peripheral part of a city. Compared with municipal districts, counties have greater administrative autonomy, as they are under the direct jurisdiction of the provincial government, and thus have some power independent of the city government.

Owing to the rapid development of industrialization and urbanization, China has carried out administrative division adjustments (ADAs) with the goal of expanding MUAs. The primary method used has been county-to-district conversion (CTDC). CTDC is a type of ADAs, in which counties or county-level cities become newly established districts (NEDs) affiliated to prefecture-level cities or municipalities directly under the central government. During 2010–2018, a total of 84 prefecture-level cities in China implemented CTDC 172 times (Chen and Wang 2018). CTDC has consequently become a hot research topic in the field of administrative division studies in China.

A number of descriptive and conceptual studies suggest that CTDC, as a means for regional management to integrate ARs, can

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benefit regional economic growth (Han et al. 2014; Shao et al. 2018). However, the following questions remained unanswered: do all counties or county-level cities exhibit the same economic growth trends after CTDC? What is the mechanism of the CTDC affecting regional economic growth? How can the positive effects of CTDC be maximized to deal with possible city shrinkage? To address these questions, the synthetic control method (SCM) is used to test the economic effects of CTDC in Xiaoshan and Yuhang in 2001. We then discussed the economic growth mechanism of CTDC and the relationship between CTDC and city shrinkage, to expand and deepen theoretical research on ADA.

Literature Review

There are many factors affecting economic growth, including land, labor force, capital, market, and policy (Meeusen and van Den Broeck 1977; Au and Henderson 2006). ADA formally links with economic growth through these factors, and acts on economic growth through specific paths and mechanisms (Gao and Sun 2015; Tang and Wang 2015). Research in Western academia noted that an AR's economic interests have a significant relationship with the area and quantity of administrative jurisdictions, and minimal adjustments may lead to major changes in economic development (Alesina and Spolaore 1997; Spolaore et al. 2000; Wagenaar 2004). Political borders determine the scale of markets, and restrictions due to political borders lead to restrictions on market access, and thus have a significant effect on economic development (Hopkins 2001; Lucy and Phillips 2000). ADAs involve the adjustment of administrative boundary, which will weaken the effects of political borders, promote the increase of the total amount of labor and capital investment, give play to the advantages of agglomeration economy, and thus accelerate the development of local economy (Hawkins et al. 1991; Feiock 1994; Redding and Sturm 2008).

As far as China's national conditions are concerned, Chinese scholars have a strong interest in the study of ADA. The essence of Chinese administrative division is the spatial allocation of governance and administrative power (Liu 2006). In addition to market forces, the local government conducts macro-control over social and economic development through administrative means and policy guidance in China (Li et al. 2012). Liu and Shu (1996) promoted a concept of "administrative region economy," which is a special regional economic phenomenon due to the rigid constraints of administrative division on regional economy. Under the strict control of the local government, the flow of production factors across ARs is restricted and blocked, and the economic development is relatively closed (Liu 2006). Affected by the administrative region economy, each AR is an independent unit of regional economic development in China. Other scholars have proposed a theory of "administrative region potential" (ARP) to explain the impact of ADAs on regional development. The ARP theory stated that the scale of population, resources, and industry under the control of the AR, and the administrative level and authority of the AR, determine whether the AR is in a favorable position in regional development from the horizontal and vertical aspects (Chen et al. 2018; Wang et al. 2019). The value of ARP represents the influence, development potential, and comprehensive competitiveness of the AR in the whole country or region. The scientific and reasonable ADA is conductive to the promotion of regional ARP. Some exploratory empirical studies on the ARP theory have pointed out that the ADA will affect the economic development of the AR through changing the value of ARP, such as Chongqing city (Chen et al. 2018; Wang et al. 2019). It is indicated that the ADA is a means to optimize the structure of "administrative region economy" and improve space governance.

As the main mode of China's ADAs, CTDC results in an increase in the number of municipal districts and the expansion of the land and jurisdiction of the MUA. Most importantly, CTDC makes the AR change from an independent economic unit to a cooperative unit by removing the administrative boundary, which directly strengthens local economic management and effective allocation of resources, thus enhancing the ARP (Wang and Chen 2011). Chinese scholars have carried out controlled experiments on national or provincial panel data by using spatial-metering methods such as difference-in-difference (DID), propensity score matching (PSM), or geographically weighted regression (GWR) to show that CTDC promotes the economic growth of prefecture-level cities (Gao 2011; Han et al. 2014; Shao et al. 2018). The empirical studies have suggested that as a means for regional management to integrate ARs and regional economic policies, CTDC modifies administrative and institutional boundary effects and promotes the economic growth of cities (Cui and Chen 2012; Zhang 2012). CTDC also solves the problem of regionalism in economic policy, balances the spatial distribution of resource production between municipal districts and counties, and delays city shrinkage (Zhang et al. 2016). However, the effect of CTDC on regional economic growth is not always positive, but related to the ARP of prefecture-level cities and counties (Gao and Sun 2015). If the scale of the canceled counties is too small, or the economic gap between the cities and counties is too large, it is difficult to play the agglomeration economic effect after the merge, but it is easy to appear as a partial hollowing problem due to the unbalanced development (Fan et al. 2012; Xie et al. 2004; Tang and Wang 2015).

Although previous studies analyzed the economic growth effect of CTDC from some attributes such as geographical and institutional space, there is still a lack of theoretical and systematic explanation for the effect mechanism of CTDC on regional economic growth. CTDC is not the only driving factor of regional economic growth, but existing studies cannot separate CTDC from other main drivers of economic growth. It is necessary to build a suitable quantitative measurement model to single out the net effect of CTDC on economic performance.

Method and Data

Synthetic Control Method

The DID compares the gap in economic growth between the control group and experimental group at pre- and post-ADA stages according to set economic control variables. This method can be used when a similar control group that has not implemented ADA can be identified, and adjustment randomly occurs for any AR. However, it is difficult to guarantee such premises in empirical research. Based on the logic articulated by Abadie and Gardeazabal (2003), Abadie et al. (2010) proposed the SCM. Chinese academics applied SCM to study the effect of ADAs on regional economic growth, and argued that administrative resource integration can accelerate regional economic growth (Wang and Xie 2012; Chen and Li 2017; Wang and Zhang 2017). Compared to DID, SCM assigns different weights to control subjects to obtain a control group identical to the target group. This method precisely reflects the extent to which each control subject contributes to simulated synthetic subjects, reducing deviation due to subjective choice. In addition, the individual differences between the control group and experimental group are overcome, and endogeneity problems are avoided.

Xiaoshan and Yuhang were converted from county-level cities to municipal districts in 2001, and this implementation of CTDC can be regarded as a synthetic control experiment. We cannot

directly observe the economic growth of Xiaoshan or Yuhang under the assumption that CTDC does not occur, so it needs to be simulated and predicted by the control group. Suppose that $J+1$ regions are observed, and without loss of generality, suppose also that only the first region (Xiaoshan or Yuhang) is affected by CTDC, so that the J remaining regions can be combined into a potential control group, which is the counterfactual substitute of the experiment. The economic development trend of the control group and experimental group should be largely consistent before CTDC, and the only difference between the two groups should be whether CTDC occurred. The economic growth effect of CTDC is thus revealed by comparing the difference of the real and predicted value after 2001.

Let y_{it}^I be the observed result variable (e.g., per capita GDP) for region i at time t if region i has undergone CTDC, for units $i = 1, 2, \ldots, J+1$, and time periods $t = 1, 2, \ldots T_0 \ldots, T$. Let T_0 be the year of CTDC, with $1 \le T_0 < T$. Let y_{it}^N be the nonobserved result variable for region i without the occurrence of CTDC.

Let $\alpha_{it} = y_{it}^I - y_{it}^N$ be the effect of economic growth brought about by CTDC. We assume that CTDC has no effect on the result variable before the adjustment, that is, $y_{it}^N = y_{it}^I$. Hence, for the target region 1 (Xiaoshan or Yuhang in our case)

$$\alpha_{1t} = \begin{cases} 0 & (t = 1, \ \ldots, T_0) \\ y_{1t}^I - y_{1t}^N & (t = T_0 + 1, \ \ldots, T) \end{cases} \tag{1}$$

Owing to y_{1t}^I being observed, to estimate α_{1t} we only need to estimate y_{1t}^N. Suppose that y_{1t}^N was given by a factor model

$$y_{it}^N = \delta_t + \theta_t' x_i + \lambda_t' u_i + \varepsilon_{it} \tag{2}$$

where δ_t = an unknown common factor with constant factor loadings across units; x_i = a vector of observable explanatory variables (unaffected by adjustment); θ_t' = a vector of unknown parameters; λ_t' = an unknown common factor that depends on time; u_i = an unobservable regional fixed effect with varying factor loadings; and the error term ε_{it} = unobserved transitory shocks at the regional level with zero mean for all i.

To design a control group without the occurrence of CTDC, we construct a $(J * 1)$ vector of weights $W = (\omega_2, \omega_3, \ldots, \omega_{J+1})'$, such that $\omega_i \ge 0$ and $\omega_2 + \omega_3 + \cdots + \omega_{J+1} = 1$. Thus, each particular value of the vector W represents the nonnegative weight of a region included in the synthetic control. The assignment of different W values creates different synthetic control groups. The more similar the economic characteristics between the synthetic control group and experimental group in the period $t \le T_0$, the more appropriate is the W value. The process of determining the value of W can be considered as the optimal solution process of minimizing the Mahalanobis distance between the control group and experimental group (Jiang and Zhong 2018). The value of the outcome variable for each synthetic control indexed by W is given by

$$\sum_{i=2}^{J+1} \omega_i y_{it} = \delta_t + \theta_t' \sum_{i=2}^{J+1} \omega_i x_i + \lambda_t' \sum_{i=2}^{J+1} \omega_i u_i + \sum_{i=2}^{J+1} \omega_i \varepsilon_i \tag{3}$$

Suppose that we can choose an optimal W^* that can accurately replicate pretreatment observations in Xiaoshan or Yuhang, such that

$$\sum_{i=2}^{J+1} \omega_i^* y_{it} = y_{1t} \ (t \le T_0); \quad \sum_{i=2}^{J+1} \omega_i^* x_j = x_1 \tag{4}$$

Then, it is easy to see that if $\sum_{t=1}^{T_0} \lambda_t / T_0 \ne 0$, then

$$y_{1t}^N - \sum_{i=2}^{J+1} \omega_i^* y_{it} = \frac{\lambda_t}{\sum_{t=1}^{T_0} \lambda_t / T_0} \sum_{i=2}^{J+1} \omega_i^* \frac{1}{T_0} \sum_{t=1}^{T_0} (\varepsilon_{it} - \varepsilon_{1t}) - \sum_{i=2}^{J+1} \omega_i^* (\varepsilon_{it} - \varepsilon_{1t}) \tag{5}$$

In general conditions, the right part of Eq. (4) tends to be close to 0, that is, $y_{1t}^N = \sum_{i=2}^{J+1} \omega_i^* y_{it}$. Therefore, the estimated value of policy effects is

$$\hat{\alpha_{1t}} = y_{1t}^I - y_{1t}^N = y_{1t} - \sum_{i=2}^{J+1} \omega_i^* y_{it} \quad (t = T_0 + 1, \ \ldots, T) \tag{6}$$

Variables and Data Sources

We need to first determine the result variable Y and the observable explanatory variables x_i: let Y be per capita gross domestic product (GDP); let x_1 to x_3 be variables that reflect industrial structure and combined forms of production, that is, the proportion of the contribution of primary industry to GDP (x_1), proportion of the contribution of secondary industry to GDP (x_2), and proportion of the contribution of tertiary industry to GDP (x_3); let x_4 be the proportion of fixed assets investments to GDP, which reflects the internal driving force for economic growth; let x_5 be the proportion of government revenue to GDP, which reflects the strength of the local government's control of the market economy; let x_6 be the proportion of total retail sales of consumer goods to GDP, which reflects the growth of the regional economy. With reference to Abadie et al. (2010), we took per capita GDP in 1994 and 1998 as two additional variables (x_7, x_8).

We used annual county-level panel data for the period 1992–2012. CTDC occurred in Xiaoshan and Yuhang in 2001, giving us 10 years of pre- and post-adjustment data, and permitting us to obtain a suitable fitting result. The economic indicators in Table 1 involve the data of economic aggregate, industrial structure, government finance, and capital investment of each county, which have been collected from *Hangzhou Statistical Yearbook (1993–2013)*, *Zhejiang Statistical Yearbook (1993–2013)*, and *Zhejiang 60-Year Statistical Files Compilation (1949–2009)*.

Table 1. Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
Per capita GDP (Y)	358	29,431	25,742	1,596	139,686
Proportion of the contribution of primary industry to GDP (X_1)	358	0.126	0.071	0.04	0.50
Proportion of the contribution of secondary industry to GDP (X_2)	358	0.574	0.064	0.25	0.70
Proportion of the contribution of tertiary industry to GDP (X_3)	358	0.300	0.051	0.16	0.45
Proportion of fixed assets investments to GDP (X_4)	358	0.379	0.129	0.140	0.877
Proportion of government revenue to GDP (X_5)	358	0.054	0.027	0.000	0.151
Proportion of total retail sales of consumer goods to GDP (X_6)	358	0.295	0.077	0.139	0.496

We also used the regional administrative division data, such as boundary and name, and enterprise distribution data, such as name, scale, and address, to analyze the spatial distribution of economic growth hotspots after CTDC. Administrative division data is extracted from the official website of National Catalogue Service for Geographic Information (http://www.webmap.cn), and the enterprise distribution data is obtained through web-crawler technology in Baidu Map API ports and further processed in ArcGIS10.3 developed by the Esri company.

Study Area and Control Region

Hangzhou is located in the north of Zhejiang province, the lower reaches of Qiangtang River. It is one of the central cities in the Yangtze River Delta urban agglomeration, with prominent regional advantages. In 2018, the total population of Hangzhou reached 7.9 million, with a GDP of 1,430.7 billion. The structure of the primary, secondary, and tertiary industries was adjusted to 2.1:32.8:65.1, which means that the industrial structure has been continuously upgraded. Since 2000, Hangzhou has experienced three times of CTDC, and the spatial framework of the MUA has been constantly enlarged. In 2001, Xiaoshan and Yuhang changed from county to district. As seen from Fig. 1, we take all the municipal districts in 2001 as the study area, including nine districts, with a total area of 3,068 km^2, a total population of 5.1 million, and a GDP of 1,120.2 billion.

As the experimental subjects in this research were Xiaoshan and Yuhang, the AR selection of the control group was required to follow three conditions. First, the ARs must not be affected by CTDC or other events during the experimental period. Second, the financial, land, and administrative policies in different provinces are different, so each AR must be a county or county-level city in Zhejiang Province. Third, the location conditions of each AR must be as similar as possible to the experimental subject. Thus, the ARs of the control group should ideally be located north of Hangzhou Bay or affiliated to the Hang-Shao metropolitan area, and have similar terrain, traffic, market, and other environmental conditions (Fig. 2). According to these requirements, 15 counties or county-level cities were selected for the control group: Lin'an, Fuyang, Jiande, Tonglu, Chun'an, Yuyao, Cixi, Fenghua, Keqiao, Shangyu, Zhuji, Pinghu, Haining, Tongxiang, and Haiyan.

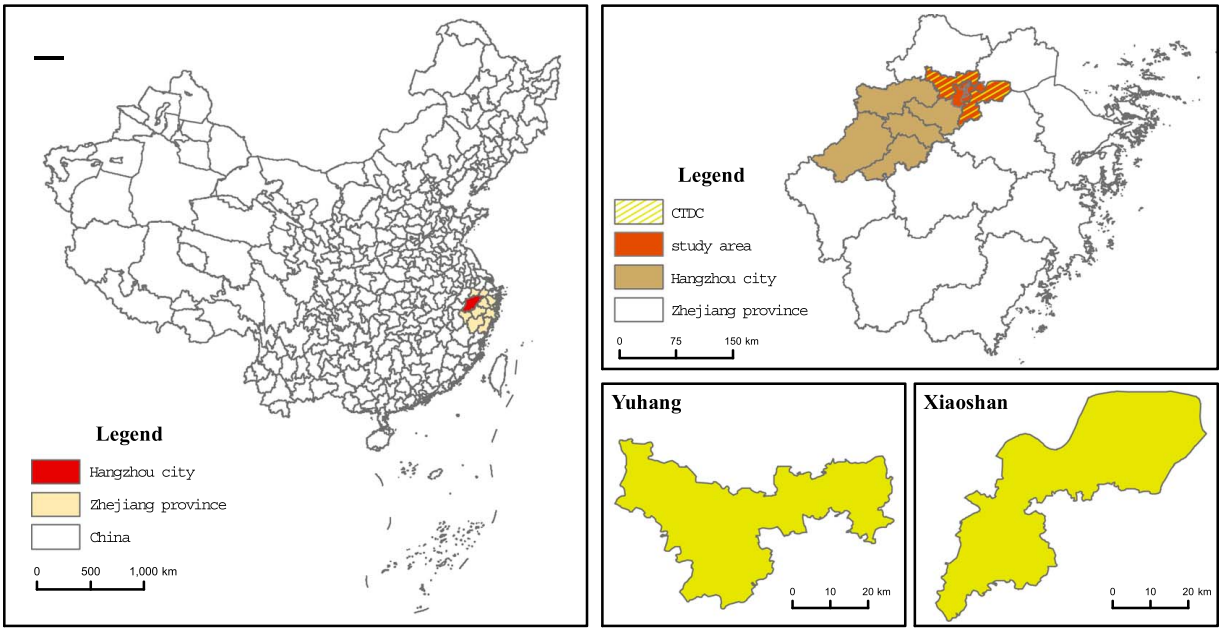

Fig. 1. Study area.

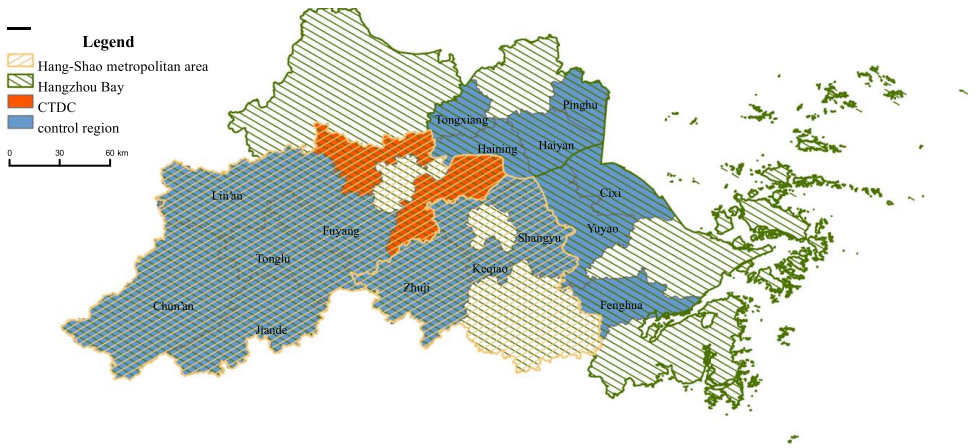

Fig. 2. Spatial distribution of control regions.

Using Eqs. (3)–(5), the weights of 15 counties of the synthetic control group can be calculated. The weights of most counties in synthetic Xiaoshan are 0; Keqiao (0.692) and Chun'an (0.308) take the first two positions and provide the maximum synthetic contribution. The weights of five counties in synthetic Yuhang are positive, namely Tonglu (0.367), Yuyao (0.271), Keqiao (0.227), Tongxiang (0.126), and Cixi (0.009).

Based on these weights, as listed in Table 2, the explanatory variables of synthetic Xiaoshan are close to those of actual Xiaoshan from 1992 to 2001, which means that synthetic Xiaoshan approximately reproduced the real economic characteristics of actual Xiaoshan, with a particularly strong similarity being exhibited in industry structure. Synthetic Xiaoshan can therefore be used as a synthetic control group for Xiaoshan. Similarly, synthetic Yuhang simulates the actual Yuhang reasonably well, and the difference between explanatory variables of the two groups is within 0.01.

Synthetic Control Method-Based Assessment of Economic Growth Generated by County-to-District Conversion

Economic Growth Effects of CTDC

In this study, we used the Stata15.0 program developed by StataCorp company to calculate the weight and results of SCM. The value of per capita GDP for synthetic Xiaoshan can be calculated via Eq. (2). As shown in Fig. 3(a), before 2001, the growth trend of actual Xiaoshan and synthetic Xiaoshan coincides, which shows that synthetic Xiaoshan is a reasonable counterfactual substitute of actual Xiaoshan before CTDC. After 2001, per capita GDP of actual Xiaoshan gradually increases beyond that of synthetic Xiaoshan, and thus the gap between their respective growth curves increases.

Using Eq. (6), the gap between the per capita GDP of actual Xiaoshan and synthetic Xiaoshan during 1992 to 2012 can be calculated, and the result is shown in Fig. 3(b). As can be seen, it immediately increases in 2002 to RMB 6,700. In addition, the adaptation process of CTDC results in the difference in per capita GDP fluctuating up and down by RMB 1,000 in the initial stage (2002–2004). After 2005, the curve rapidly steepens, showing that the gap in per capita GDP continues to widen. The average annual growth rate of per capita GDP of actual Xiaoshan in 2001–2012 is 40.27%, whereas that of synthetic Xiaoshan is 34.51%: a large difference of 5.76%. The results thus show that CTDC increases the economic growth of actual Xiaoshan for a decade after 2001, and the beneficial effect of CTDC has become increasingly significant over time.

Similarly, the growth path of per capita GDP and gap between actual Yuhang and synthetic Yuhang is shown in Fig. 4. As can be seen, and contrary to the results of Xiaoshan, the two growth curves of Yuhang coincide from 1992 to 2005, showing no obvious difference in 2001. In 2001–2005, the per capita GDP of actual Yuhang remains lower than that of synthetic Yuhang but becomes greater than that of the latter in 2006. The average annual per capita GDP growth rate of actual Yuhang exceeds that of synthetic Yuhang by 2.2% in 2007, showing that obvious superior economic growth begins to occur at this time in actual Yuhang.

Overall, these results show that the economic growth effects of CTDC vary between different municipal districts. Owing to other factors, such as differences in function, planning strategy, and development foundation, Yuhang is not immediately integrated into the construction of the MUA in Hangzhou. There is a time lag in the effects of CTDC on economic growth in Yuhang, meaning

Table 2. Predictor balance before county-to-district conversion

Explanatory variables	Actual Xiaoshan	Synthetic Xiaoshan	Actual Yuhang	Synthetic Yuhang
Proportion of the contribution of primary industry to GDP (X_1)	0.122	0.185	0.149	0.154
Proportion of the contribution of secondary industry to GDP (X_2)	0.596	0.545	0.569	0.572
Proportion of the contribution of tertiary industry to GDP (X_3)	0.284	0.269	0.281	0.273
Proportion of fixed assets investments to GDP (X_4)	0.371	0.358	0.334	0.269
Proportion of government revenue to GDP (X_5)	0.037	0.056	0.042	0.047
Proportion of total retail sales of consumer goods to GDP (X_6)	0.303	0.213	0.304	0.304
Per capita GDP (1994) (X_7)	7,511	7,572	7,571	7,570
Per capita GDP (1998) (X_8)	15,261	15,157	13,911	14,012

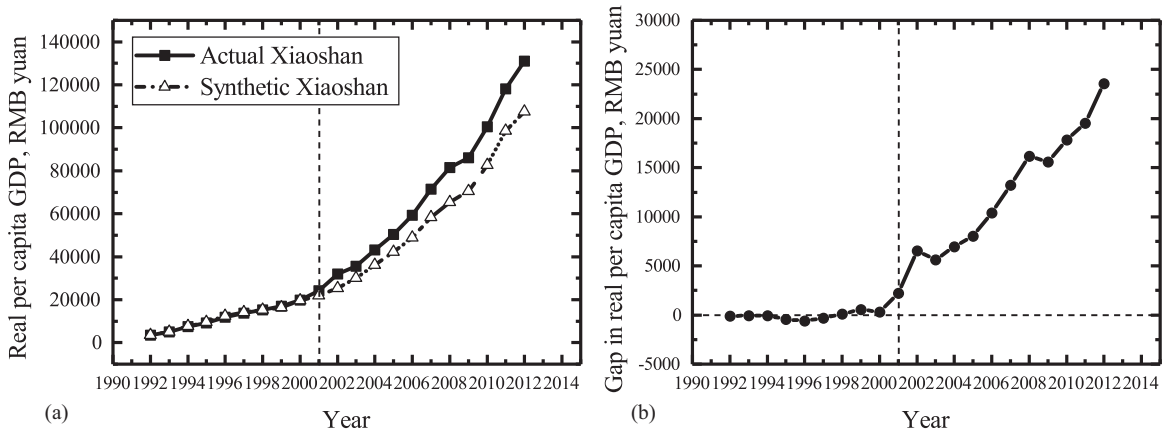

Fig. 3. (a) Economic growth path: actual Xiaoshan versus synthetic Xiaoshan; and (b) gap between per capita GDP of actual Xiaoshan and synthetic Xiaoshan.

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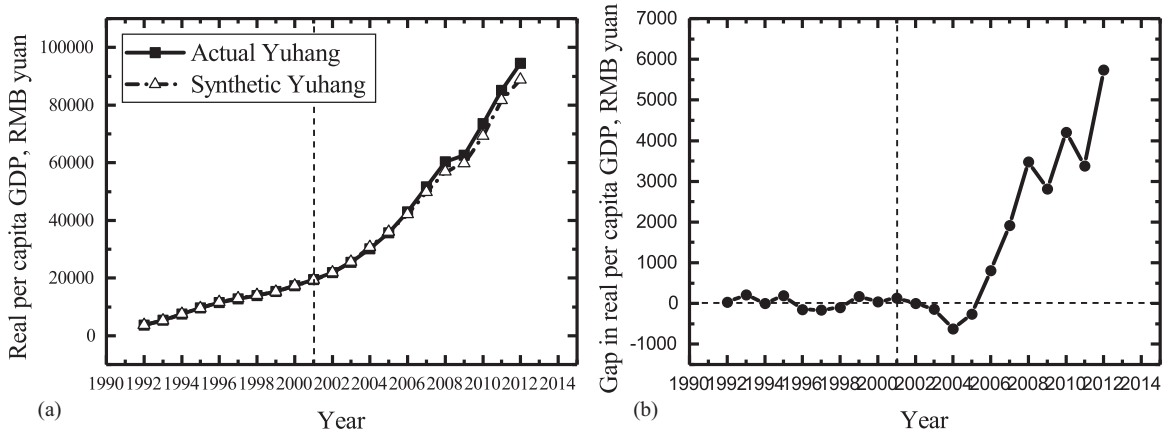


Fig. 4. (a) Economic growth path: actual Yuhang versus synthetic Yuhang; and (b) gap between per capita GDP of actual Yuhang and synthetic Yuhang.

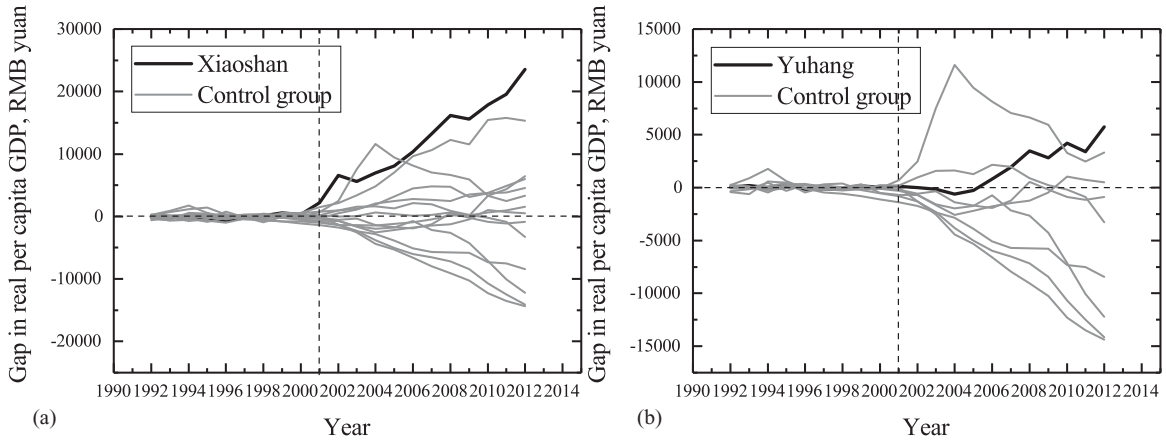


Fig. 5. (a) Per capital GDP gaps of Xiaoshan and other placebo regions; and (b) per capital GDP gaps of Yuhang and other placebo regions.

that these effects are more prominent in the later stages of CTDC implementation.

Placebo Test

To test the robustness of the previously estimated results, a "placebo test" was used, following the proposal of Abadie et al. (2010). This is similar to the "permutation test" in statistics, which aims to exclude the possibility that economic growth is completely driven by other accidental factors. For the test, a county was randomly selected from the control group as a hypothetical target region, and it was supposed that CTDC occurred in this county, and the original experimental region (Xiaoshan or Yuhang) was included in the new control group. The SCM experiment was repeated several times for each county, and the distribution characteristics of all effect curves were compared. To optimize the synthetic result and reduce fluctuation effects, the mean squared prediction error (MSPE) of each county prior to 2001 was calculated before the placebo test, and counties with MSPEs that were more than twice as large as that of the experimental region were excluded.

As shown in Fig. 5(a), 13 counties are included in the placebo test for Xiaoshan, and the results show that the economic growth of most counties either tends to be stable or declining since 2001, while economic growth of Xiaoshan increases rapidly after CDTC. If we suppose that CTDC had no effect on economic growth, the probability of Xiaoshan becoming the region with the fastest economic growth among the 14 counties was only 0.071 (1/14), which is statistically significant above the 10% level.

As shown in Fig. 5(b), before 2001, the economic growth curve of Yuhang is similar to that of the other nine counties. In 2001–2010, the curve does not show a rapid increase in economic growth, and is indistinguishable from those of other counties. This means that the first placebo test method cannot directly prove the robustness of the experimental results in Yuhang, so another method must be used to test robustness in Yuhang.

Accordingly, we calculated the MSPE ratio of each county in the pre- and post-CTDC periods. The MSPE of Yuhang after CTDC is approximately 14 times greater than that before CTDC, and the ratio is much greater than that of the other nine counties. If we suppose that CTDC had no effect on economic growth, the probability of the MSPE ratio of Yuhang being the largest among all 10 counties as a result of other factors was 10%, which is a normal significance level.

Economic Growth-Effect Mechanism of CTDC

China has a strict system of administrative and financial decentralization, which leads to a shielding effect between different ARs (Chen and Li 2017). The existence of an administrative boundary

will directly hinder the cross-administrative governance of administrative powers and fragment the administrative governance unit, thus affecting the cross-border economic and social behavior (Liu 2006). However, by removing the administrative boundary between the MUA and the surrounding counties, CTDC not only involves a change in the AR types, but also reconstruction of the power relationship of local governments (Wang and Xie 2012). Some of the involved counties' administrative powers become centralized in the city government, and the city government's jurisdiction over policy implementation is expanded. CTDC makes it possible to provide institutional support for the allocation of regional resources and economic reorganization, reduce administrative barriers through reform, and realize integrated spatial governance.

First, CTDC removes planning boundaries, thus promoting the transfer of industries and functions from MUA to NEDs through integrated planning in a city, such as the Hangzhou metropolitan area.

CTDC has transformed the competitive relationship between prefecture-level cities and counties into a cooperative relationship. City government has jurisdiction over the re-adjustment and re-planning of NEDs' functional positioning and industry composition. Since CTDC, Xiaoshan and Yuhang, as NEDs, have participated in the spatial and industrial planning of Hangzhou. As shown in Fig. 6, due to Xiaoshan mainly accepting manufacturing industries transferred from the MUA of Hangzhou, the proportion of secondary industry in Xiaoshan dramatically increases after 2001. The main function of Yuhang is industrial

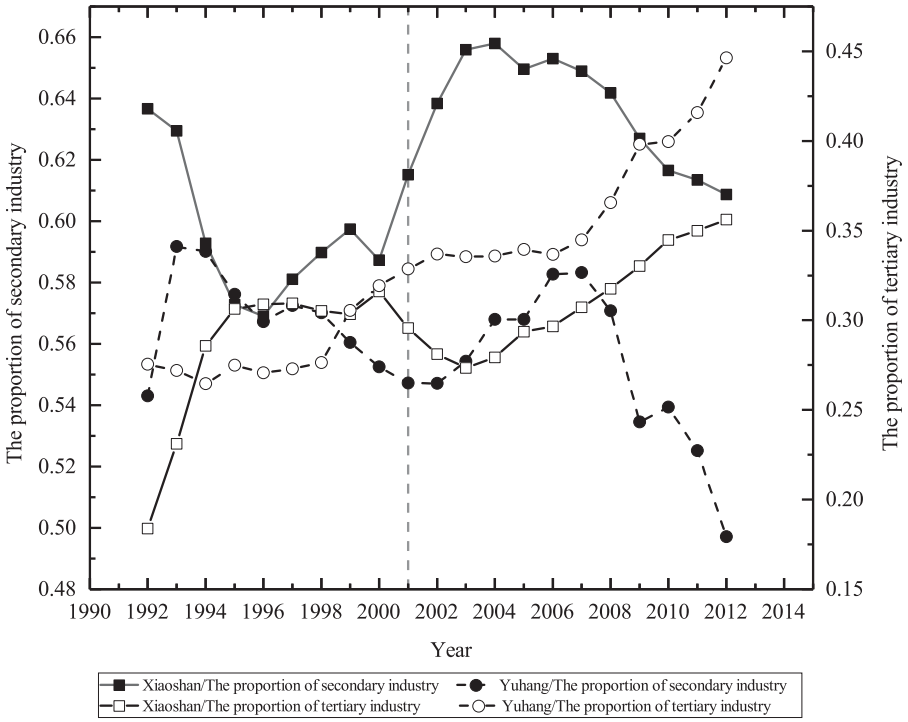
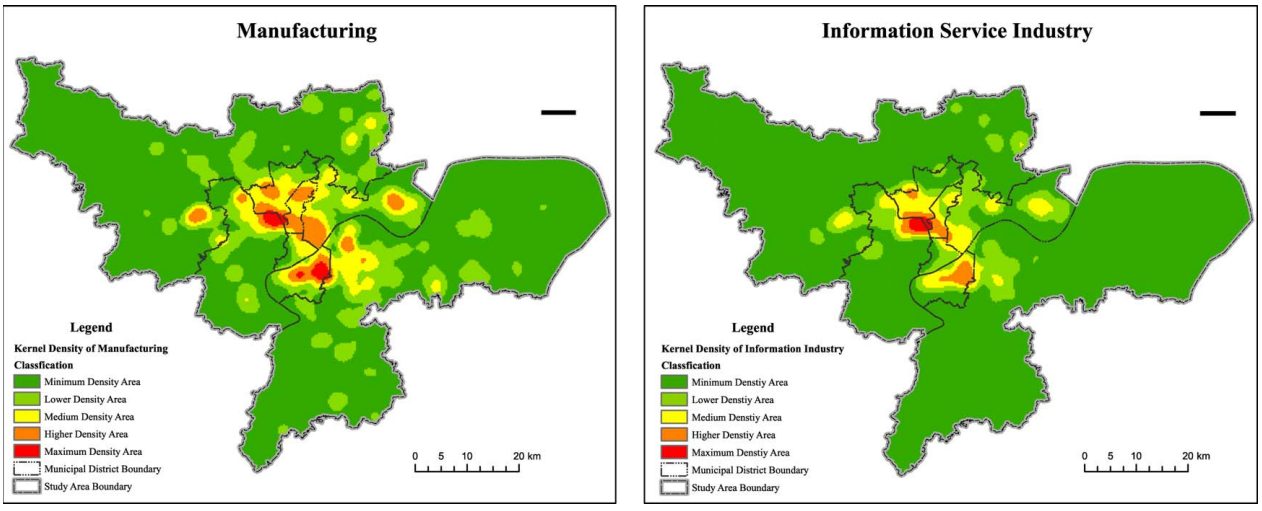


Fig. 6. Proportion of industrial output value: Xiaoshan versus Yuhang.



(a) (b)

Fig. 7. (a) Spatial distribution of manufacturing enterprises in Hangzhou; and (b) spatial distribution of information service enterprises in Hangzhou.

cooperation, especially in the service industry, which leads to a steady increase in the proportion of tertiary industries.

Enterprises are important stimulus for industrial development. We used the manufacturing and information service industries as research objects in this study to analyze the spatial distribution pattern of enterprises in Hangzhou after 2001, as shown in Fig. 7. As can be seen, the original MUA of Hangzhou remains a high-density agglomeration area of two industries. Medium-density agglomeration areas have been created in Jiangnan Town in Xiaoshan, Linping Town in Yuhang, and the Technology and Innovation Corridor in the west of Hangzhou. This distribution of enterprises largely conforms to the industrial development requirement stipulated by city planning and indirectly reflects the transfer of economic resources from the MUA to NEDs.

Second, CTDC provides policy conditions for the integration of infrastructure and service facilities between the MUA and NEDs, which helps to enhance traffic accessibility and public service, and promote consumption and investment in NEDs.

After CTDC, the "core–periphery" development network between MUA and NEDs has been reconstructed. NEDs need to solve the issue of public transport connections with MUA and achieve standardization of basic public services. As shown in Fig. 8, the infrastructure investment and consumption level in Xiaoshan and Yuhang steadily increase after CTDC, and the economic growth rate is generally stable and rational. An optimized traffic network has a significant absorption effect on labor and capital, accelerating the growth of regional investment in Xiaoshan and Yuhang. Infrastructural integration reduces travel costs between the MUA and NEDs, and trans-district consumption stimulates consumption in Xiaoshan and Yuhang.

Increasing the number of enterprises is a major form of capital investment. In 2001–2010, the average annual growth rates of industrial enterprises above scale in Xiaoshan and Yuhang are 17.9% and 33.4%. After CTDC, the industrial location entropy of Xiaoshan increases from 1.59 in 2001 to 2.04 in 2010, reflecting an increase in spatial agglomeration. Similarly, the industrial location entropy of Yuhang increases by 0.28 from 2001 to 2010, slightly less than that of Xiaoshan. This enhanced industrial agglomeration effect confirms that CTDC and urban integration effectively enhance the economic benefits of NEDs.

Third, the NEDs retained some financial and administrative autonomy after CTDC, which weakens the negative effect of local officials' self-interested behavior and guarantees the stable economic growth.

CTDC involves the adjustment of local administrative power and governmental interests, which may affect economic growth over the short term and cause economic change to follow an inverted U-shape trend, that is, it tends to first rise and then fall (Li and Xu 2015). The Hangzhou government has issued an official document after CTDC, in which it is emphasized that the financial and land management systems of Xiaoshan and Yuhang would not be adjusted. Some economic management power is also expanded, ensuring the stable economic growth of the two districts. After CTDC, the financial systems of Xiaoshan and Yuhang remain self-administered, and thus the fiscal revenue and expenditure of two districts are not greatly affected. As shown in Fig. 9, the growth rate of per capita fiscal revenue and per capita fiscal expenditure of Xiaoshan and Yuhang fluctuates from 1995 to 2010, and there is no significant increase or decrease after 2001.

Land is an important measure of local government intervention in economic activities in China. After CTDC, the provincial government still orders a quota of construction land in Xiaoshan and Yuhang, and the land-transfer fees are still collected and used directly by the NEDs government. Therefore, Xiaoshan and Yuhang do not completely lose control of their land and economic resources, showing that by maintaining control of development resources, the local government has promoted the growth of the regional economy.

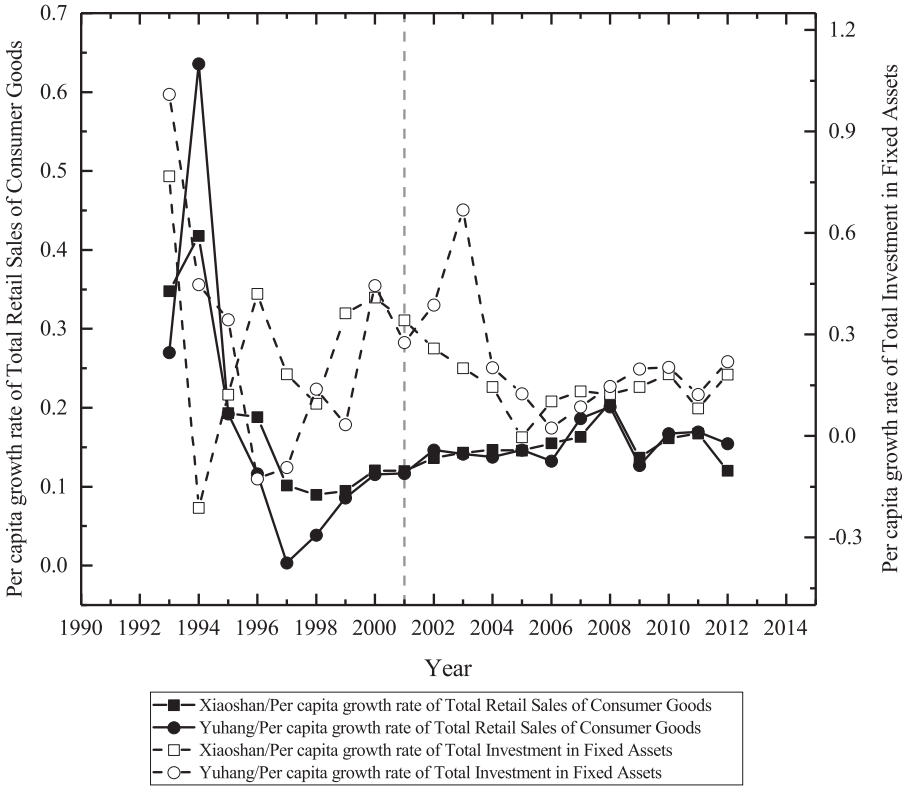


Fig. 8. Trend of investment and consumption: Xiaoshan versus Yuhang.

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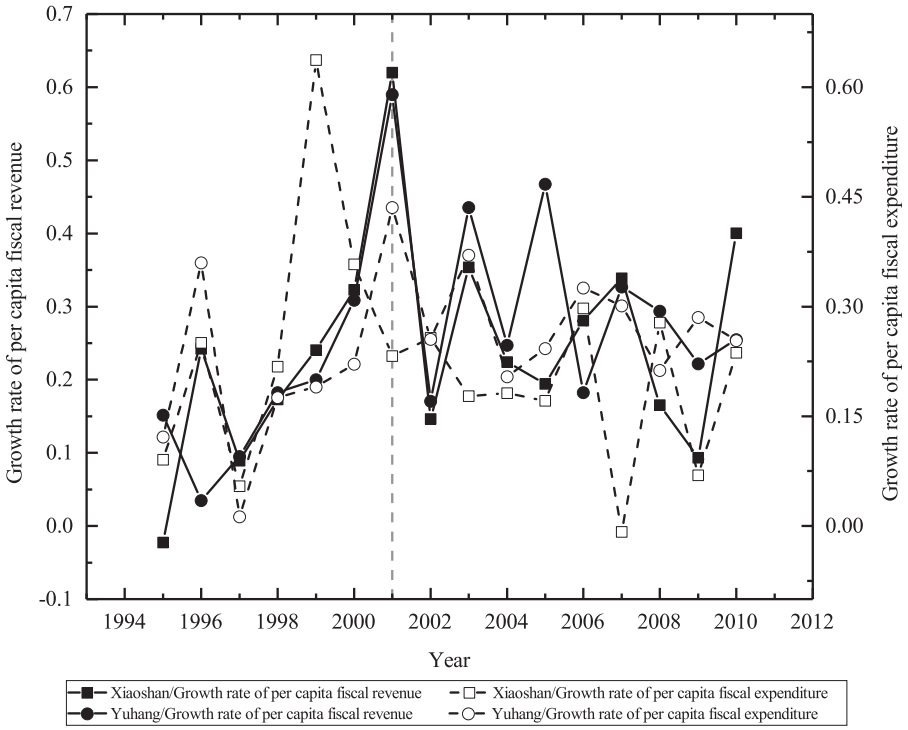

Fig. 9. Per capita fiscal revenue and expenditure: Xiaoshan versus Yuhang.

Table 3. Average annual change rate of population and GDP

	Hangzhou		Xiaoshan		Yuhang	
Year	GDP	Population	GDP	Population	GDP	Population
1997	0.143	0.008	0.165	0.008	0.118	0.003
1998	0.095	0.006	0.117	0.005	0.088	0.001
1999	0.080	0.007	0.112	0.004	0.107	0.003
2000	0.128	0.009	0.177	0.003	0.134	0.005
2001	0.134	0.012	0.214	0.003	0.126	0.005
2002	0.136	0.012	0.22	0.003	0.133	0.002
2003	0.178	0.009	0.229	0.007	0.166	0.005
2004	0.198	0.014	0.216	0.008	0.187	0.006
2005	0.170	0.184	0.175	0.008	0.194	0.007

Effects of CTDC on City Shrinkage

Unbalanced distribution of population and economy could more easily occur after CTDC (Xie et al. 2004), as the government may struggle to manage the sudden and large increase in its administrative area. If the peripheral area is weak, its production resource is easily plundered by the MUA, which is likely to lead to regional recession. However, for a city with strong development potential and government management, such as Hangzhou, CTDC is critical for realizing regional integration. As presented in Table 3, the average annual change rate of the total population and GDP of Hangzhou, Xiaoshan and Yuhang from 1997 to 2005 are both continuously positive, indicating that CTDC does not cause the city shrinkage at the level of cities and districts.

First, the economic structure of Hangzhou diversified subsequent to CTDC, and this transformation and upgrading is successful. In 2016, the proportion of tertiary industry reaches 60.9%, and an industrial structure focuses on tertiary industry that has been established in Hangzhou. Second, as the provincial capital city of Zhejiang province, Hangzhou has a unique competitive advantage: its population and industrial agglomeration is still in a development phase. CTDC has made NED a new developing hinterland for the MUA in Hangzhou, which can provide essential materials for economic productivity, such as an increased labor force. Third, Hangzhou has a high level of urban–rural integration, due to close economic ties and strong complementarity between urban and rural areas. CTDC has brought the surrounding counties under the jurisdiction of the MUA, thereby creating complementary economic benefits linking urban and rural areas, and expanding the urban economic space. Finally, Xiaoshan and Yuhang still have independent financial, land, and other administrative powers after CTDC, which means that the municipal governments can still control the local development resources, avoiding the shrinkage of their population and economies, but also leading to the sustained and rapid development of Hangzhou.

At this point, a question needs to be addressed: if a city is in a period of shrinkage, is it still appropriate to add municipal districts to it? In general, the economic base determines the superstructure of an urban region; thus, when economic development slows down and a structural economic and population crisis occurs in a city, its development vitality is weakened, which means it is not suitable for spatial expansion via CTDC. Instead, smart growth and internal structure optimization should be used to enhance the vitality of its economic development, retain its population, and attract investment. This illustrates the fact that the effects of CTDC on urban economic development should be considered objectively. For example, not all cities need to adjust their administrative divisions: for shrinking cities, ADAs such as CTDC may only accelerate their decline.

Conclusion and Discussion

Conclusion

CTDC is a common administrative measure used to promote regional economic growth with distinct Chinese characteristics.

This study shows that CTDC has accelerated the economic growth of Xiaoshan and Yuhang, and do not cause city shrinkage in the municipal districts and prefecture-level city. In Xiaoshan, the economic growth due to CTDC is obvious, and the gap in per capita GDP growth between actual Xiaoshan and synthetic Xiaoshan gradually increases after 2001. Due to the "trans-river development" strategy, the entirety of Hangzhou develops toward to the southeast in the early 21st century. This weakens the effect of CTDC on Yuhang in terms of urban development and competitive edge, such that the economic growth curves of actual Yuhang and synthetic Yuhang largely coincide in 2001–2005. Subsequently, due to the construction of industrial zones and the subflow of service industries from the MUA to Yuhang, the economic growth rate of Yuhang exceeds that of other control regions. Thus, these two case studies show different patterns of economic growth after CTDC, which are related to their economic strength, functional localization, development planning, and the administrative management of their respective local governments.

This study has shown that a decrease in the shielding effect of administrative boundaries is the key to increasing economic growth after CTDC. In Hangzhou, CTDC results in an increase in the number of municipal districts, and the expansion of the land and jurisdiction of the MUA, which better promotes the optimization and reorganization of urban industries in the larger urban area of Hangzhou. After CTDC, NEDs such as Xiaoshan and Yuhang become part of the MUA and are able to participate in the industrial and spatial planning of the whole of Hangzhou, and form a new agglomeration and large-scale economy. A new transportation network has been constructed between the NEDs and MUA, which has a significant absorption effect on labor and production capital, directly expanding the consumption and investment market of NEDs, thus promoting their economic growth. In addition, greater financial and land management power give NEDs the ability to control resources for their development. Further, NEDs' retention of administrative autonomy enables them to maintain stable economic growth.

Discussion and Contributions

Previous researchers found that different types of ADAs had positive effects on regional economic aggregate and economic growth rate. Economic growth displayed an inverted U-shaped trend. However, the growth curve may be located at a different stage for different experiment periods (Li and Xu 2015; Ye and Gao 2017). Our research on Hangzhou proves that CTDC promotes the economic growth of NEDs, but there is no inverted U-shaped trend similar to previous analysis results based on national-panel data. In different municipal districts, there are obvious differences in effect and effective time of CTDC.

CTDC has Chinese characteristics. The study redefines some concepts related to CTDC and points out that the economic growth effect of CTDC is conditional. CTDC involves the re-integration of economic, political, and social resources in a region. There are also regional differences in economic growth resulting from CTDC, which are related to the urbanization level, the counties' stage of development, and the new governance model after adjustment. Not all cities are suitable for CTDC, especially shrinking cities. This demonstrates that CTDCs need to adapt to the economic development of ARs, and that the appropriate governance models in NEDs must be rapidly established after this adaption.

In addition, some researchers have used traditional methods such as DID and PSM to analyze adjustment effects for a whole country or province. However, this does not reflect the characteristics of individual samples and, due to the large number of samples involved, it is hard to guarantee high similarity between the control group and experimental group. However, the SCM is a new and feasible method in administrative division research. Our results verify that SCM can achieve an optimal linear combination of the control group based on the weights of different regions and calculations of indicators, avoiding subjectivity in choosing a control group and providing reliable evidence for the positive impacts of CTDC on economic growth.

CTDC in China has mainly been implemented by local governments, and a large number of issues are involved in the adjustment of administrative powers between city and district governments. After Xiaoshan and Yuhang are converted into districts, some administrative powers are not handed over to the city government during the three-year transition period. For this reason, in this study we obtain different results from previous research. Hangzhou is an important provincial capital city in eastern China. As a study case, Hangzhou is unique, and cannot fully represent other cities in China. In the future, more cities of different levels and types will be studied, and the experimental period will be extended, to further track the effect of the handover of administrative autonomy. Doing so will permit the development of a general explanatory framework for multiple regions. When using SCM, other explanatory variables affecting regional economic growth, such as resource structure, will be added to further optimize the construction of the synthetic control group.

Data Availability Statement

All data, models, or code that support the findings of this study are available from the corresponding author upon reasonable request.

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