THE UNIVERSITY OF CHICAGO

Implicitly Transferring Development Rights: Land Coupon Policy's Effects on Spatial Income Inequality

By

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Abstract

The misallocation of land resources in China harms the development of both rural and urban areas. Rural areas suffer from the surplus supply of construction land quota when its shortage emerges in urban areas. To address this allocative inefficiency and make villages enjoy the benefit of urban development in China, the Land Coupon policy, similar to the U.S.'s Transferable Land Development Rights programs, was implemented in Chongqing province in 2008. This paper estimates the effects of the Land Coupon approach on spatial income inequalities, particularly the urban-rural income ratio, applying the newly developed MASC estimator combining the matching and synthetic control estimators through model averaging. The evidence shows that the policy has indeed accelerated the decrease of the province-level urban-rural income gap. This paper discusses different implementations of the MASC method with the variations of pre-treatment covariates, different weights in the matching criterion, and how the cross-validation is done.

Keywords: Spatial Income Inequality, Land Coupon, Transferable Development Rights, Urban-Rural Income Gap, MASC, Synthetic Control

1 Introduction

The allocation of land resources is often regarded as one of the main differences between socialist and capitalist systems. In China, all urban lands are state-owned and rural lands are mostly collectively owned by communities since the enactment of the Agrarian Reform Law of 1950 (Zhang and Donaldson, 2013). Since the regulation of the law of the land Administration in 1998, non-agricultural development using arable land with permission must be accompanied by farmland reclamation of the same amount of land as taken (Han and Lin, 2019). However, at the same time, this regulation also brought inefficient land-resource allocation and dissatisfaction of rural residents.

Most governments worldwide, including the U.S. and U.K., face similar issues of inefficiency with land-zoning regulations and regional development goals. To guide new urban development and protect natural resources, several states in America have launched more than 100 Transferable Development Rights (TDR) programs since the end of the 1970s (Kaplowitz et al., 2008)(Barrese, 1983)(Field and Conrad, 1975). In the common law system, the land development right is the right to convert land use, which could be separated from the bundle of property rights and transferred to others (Jin and Shen, 2010). In contrast, the Land Coupon policy is highly similar to the TDR programs but in the civil law system. For the similar purpose of improving land resource allocation efficiency and making villages enjoy the benefit of urbanization, starting in 2008, the government of Chongqing province in China stipulated that the newly added commercial urban construction land must be used with a permit which is called "Land Coupon." The government develops the land coupons through the voluntary reclamation of communal rural lands that meet the standards set by the Ministry of Land and Resources (Wen et al., 2017).

The urban-rural distribution of land resources plays a decisive role in regional development and income inequality. In China, the most important explanatory force of income inequality is the gap between urban and rural areas (Yao, 1999). The government wishes that the Land Coupon policy could narrow this gap by transforming rural "fixed assets" to tradable "virtual property" to increase property incomes for rural residents. Until now, the policy has realized a large-scale and long-distance land replacement within the province, enhanced the value of rural homestead in the exurb areas and counties, and provided a benefit property-income compensation mechanism for farmers in the process of urbanization.

This paper aims to provide quasi-experimental estimates of the causal effect of land market reforms, particularly the Land Coupon policy, on the regional urban-rural disposable income gap. Researchers have widely understood neither the event nor its income-related consequences. There were few provinces other than Chongqing implemented Land Coupon policy around 2008, but all of them were suspended or terminated after one or two years (Mi and Dai, 2020). Chongqing is the only provincial region where continuously keeps operating an active land coupon market.

The theoretical effect of the Land Coupon policy on the urban-rural income gap is complex and unclear. On the positive side, the Land Coupon policy opened up a new channel to develop agriculture, rural areas, and

farmers. After deducting the necessary costs, farmers have gained nearly 6.5 billion dollars from the coupon transactions over the past ten years. Collective economic organizations have also gained about 2.4 billion dollars, eliminating a large number of "empty shell villages" of collective assets (Huang, 2020). Thus, we would expect the Land Coupon to increase the incomes of rural residents, so that shrink the urban-rural gap. However, some research suggests that a smaller urban-rural income gap would not be necessarily achieved if the urban economic structure was optimized due to a better land resource allocation brought by the Land Coupon (Mi and Dai, 2020). As a result, the increasing rate of urban-residential incomes might be higher than that of rural-residential incomes (Xia, 2013). At the same time, the benefits from reclamation and land coupon trading are not necessarily more significant than other options.

This paper first applies the classic synthetic control method and the newly-developed MASC method. It shows that the Land Coupon policy had accelerated the narrowing of the province-level urban-rural income gap in Chongqing. Then I discuss different MASC methods' implementations with the variations of pre-treatment covariates, different weights in the matching criterion, and how the cross-validation is done.

This is the first article to estimate the mechanism of the causal effect of the land coupon policy on spatial income inequality by applying the latest econometric tool, the model averaging estimator that combines the standard synthetic control and matching estimators (Kellogg et al., 2020), in studying land market reforms. Yu (2013) found that the land coupon policy improved the relative income level of rural residents by promoting the free flow of resources, which drove the urban-rural income gap to shrink; Wen et al. (2017) investigated in depth the efficacy of the Land Coupon program to activate rural assets in 2017; Guo and Wu (2020) argued that the land coupon policy significantly improved the property income of rural residents.

This study contributes to the economics of income and resources inequality literature by extending the analysis to land market reforms, particularly the Land Coupon policy in Chongqing, China. The debates about the relationship among growth, resource distribution, and inequality primarily begins with the classic paper by Kuznets in 1950s (Kuznets, 1955); Carter (2004) discusses the role of agrarian structure in explaining contemporary trend of increasing income inequality, finding significant evidence of the 'self-dampening level' and 'legacy effects' of agrarian structure on income inequality. Particularly for China, Benjamin et al. (2005) challenge the popular perception that inequality in rural China is primarily a geographic phenomenon and find that most inequality is local. Recently Zhao (2020) suggests that the elimination of land reallocations in China increased off-farm labor and household per capita net income while coming with a reduction in total agricultural output and a signicant jump in intra-village income inequality. More and more studies investigate the relative merits of land market policies impacting income inequality (Ashley and Maxwell, 2001)(Deininger et al., 2000)(Adams, 2002)(Ceddia, 2019)(Chakravorty et al., 2019).

Economists, law experts, sociologists, and political researchers all around China have significant interests in the Land Coupon policy as it reallocates large amounts of land resources under much controversy. For example, this reallocation has been considered significant in Chongqing province, and its impact on income

distribution might be reproducible. Furthermore, this study would influence change in policies related to the expansion or correction of the land coupon policy in other areas since spatial income inequality is still a priority for the current administration. Recently similar systems of transferring development rights have been implemented in multiple cities in Fujian, Zhejiang, and Guangdong provinces. The idea of allowing land coupon transactions across provinces is on the State Council's table now.

This paper is structured as follows: Section 2 introduces the Land Coupon policy in detail and covers its relationship with the TDR programs; Section 3 discusses the spatial income inequality under the land coupon policy; Section 4 describes how the MASC analysis is conducted; Section 5 presents the results; Section 6 concludes.

2 Land Coupon Policy and Transferable Development Rights Programs

The Land Coupon policy is an institutional innovation of property rights economics under the existing zoning regulations in Chongqing province of China, based on the experience of "transferable land development rights" in Britain and the United States.

Since 1998, non-agricultural development using arable land with permission must be accompanied by farmland reclamation of the same amount of land as taken to secure China's national food supply. In 2004, a new policy, Bundling up Addition of Urban Land with Reduction of Rural Construction Land (BAR), requires that the amount of arable land reclaimed from rural construction land set up the limit for urban land expansion.

Chongqing, a metropolitan area, built on mountains, has its unique geographical characters which need a customized land allocation strategy to boost its development potential. Hence Chongqing was selected as the pilot region of land market reforms in several major policy adjustments in the past 100 years, including the Land Coupon scheme.

In 2008, with the State Council's approval, Chongqing established a Rural Land Exchange to carry out Land Coupon trading. Land coupon refers to the voucher of the amount of land used for rural collective construction, including land for rural homestead and its affiliated facilities, land for township enterprises, land for rural public facilities, and rural public welfare undertakings, which has been reclaimed and checked and accepted strictly by land administrative departments. The coupons purchased by developers could be incorporated into the plan for new land for construction, and the same amount of land for urban construction shall be added. In other words, a Land Coupon is a market-operated and legally recognized land credit with economic value.

The Land Coupon policy aims to solve a common problem encountered in China's economic development. According to the experience of urbanization in other countries, the general situation is that while urban area is expanding, rural construction land is constantly decreasing. However, there has been a phenomenon of "double increasing" in urban and rural construction lands in China. A significant amount of

the rural population entered the city. However, the rural construction land increased because rural residents simultaneously hold homesteads in their hometown and seek new destinations in the city.

The Land Coupon policy is highly similar to the Transferable Development Rights (TDR) programs in Britain and the United States. It is another version of TDR programs in a country with public ownership of land. Both the Land Coupon policy and TDR programs are voluntary, incentive-based programs that allow landowners to sell development rights from their land to a developer or other interested party who then can use these rights to increase the density of development at another designated location. However, the TDR programs have been widely explored in current literature, while the Land Coupon has not got enough attention.

TDR programs permanently protect blocks of productive farmlands. Developers give farmers cash for their development rights. Farmers can use the money in any way they please (e.g., pay down debt, start a retirement account, pay operational expenses). The farmer still owns the land and retains the right to farm it.

In Contrast, the Land Coupon policy is a way to temporarily secure the future of blocks of rural lands to be farmlands. Developers give rural residents cash for their development rights and encourage them to go back to reclaim their lands. Nevertheless, the lands are still owned by the village collectives, and this development right could be retrieved in 50 or 70 years.

The Chongqing Land Coupon transaction consists of three parts; the first is the land reclamation of rural residential (constructive) lands. The government oversees a process whereby rural collective construction land is registered for voluntary reclamation. Rural residents and collective agents voluntarily register their land and apply for reclamation. When reclamation has been approved by the government, through the assessment conrming that the new farmland meets the Ministry of Land and Resources regulation, the reclaimed land will be returned to farmland. Land coupons, equal to the amount of reclaimed land, are then issued by the government (Wen et al., 2017).

The second phase is the transaction itself, where the newly developed Land Coupons are sold. All market activities take place at the Chongqing Country Land Exchange (CCLE). Individuals, enterprises, and government agencies applied for purchasing can participate in the market, and the CCLE sets minimum prices. When a Land Coupon is sold, a small percentage (less than 0.1%) of the sale price is held by the Land Exchange to cover the program's operating costs. Thus, 85% of the remaining total goes directly to the farmer who had previously managed the rural construction land, while 15% to the collective agents or organizations owned by rural residents.

The final phase of the Land Coupon transaction occurs when the Land Coupon is used. When a purchaser buys a Land Coupon, he or she holds the right to purchase and develop urban farmland equal to the area corresponding to the Land Coupon. Without the Land Coupon, one cannot buy and develop farmland even if the farmland is in an area planned for construction. In addition, the value of a Land Coupon can be deducted from other government taxes that are usually assessed by land exchanges.

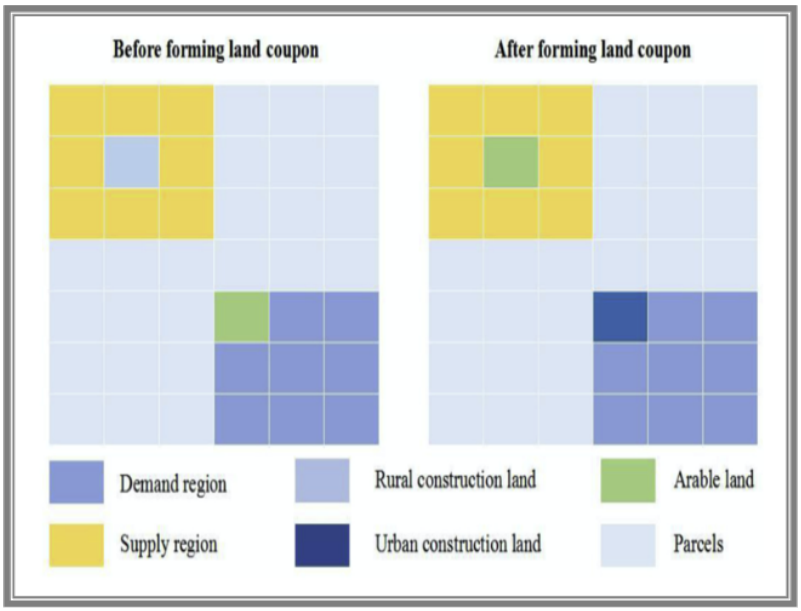


Figure 1: An Example of Land Coupon Transaction (Wen et al., 2017)

For example, a group of rural collective Landowners A would like to get an additional economic return from their idle constructive rural lands. In exchange for temporary restrictions on their lands in farming, they sell the development rights that are part of their property. This temporary prevention of development helps the region reach its farmland preservation goals. On the other hand, land developer B in the city would like to develop the arable lands in the urban receiving area. Land developer B nds that she would earn an enormous profit by purchasing Land Coupon credits from A, thereby allowing her to convert the arable land to construction one in the city to build housing units or operate her industry.

Wolfram (1981) proposed that allowing the sale of development rights on such land can achieve Lindahl equilibrium to protect open space as a public good. In 1999, Paul Thorsnes concluded that through the transfer of development rights, impersonal efforts to increase the land value are eliminated, while the limited development of the landowners is compensated. Thus, the gains resulting from impersonal efforts under zoning control are fairly distributed among different landowners (Thorsnes and Simons, 1999). Jin and Shen (2010) explain the details of the evolution of transferable development rights and their application in history. They claim that for China, which is in the stage of rapid urbanization and is severely constrained by land resources, the policy tool of land development right transfer undoubtedly has great reference and application value.

3 Spatial Income Inequality under Land Coupon Scheme

3.1 Spatial Income Inequality

Spatial income inequality includes urban-rural income gap and regional gap. The geographical distribution of economic activities has a spatial agglomeration effect, so does income distribution. Some places have natural advantages, such as fertile agricultural soil and the city's perfect high-density buildings. According to the 2017 China Development Report[1], in 2016, more than 50% of China's income inequality can be explained by spatial gaps.

The income gap between urban and rural areas is an important reason to explain the change in income inequality in China and other developing countries. Young (2013) and Wu and Jiao (2019) Using the decomposition of the Theil index, China's urban-rural income gap in 1995 could account for 34.2% of China's overall income gap. Using mixed data on household income and consumer spending, Tsokhas estimated that the contribution of the urban-rural income gap to China's overall income gap increased from 38 percent in 1990 to 43 percent in 2009 (Tsokhas, 2011).

According to Figure 2, during the 21st century, China's urban-rural disposable income gap has been in an inverted V-shaped trajectory of "rising first and then falling". With the fading of the dividend of rural land reform in the last century and the advancement of market economic reform and other factors, the urban-rural income gap expanded rapidly, reaching the highest point of 3.33 in 2009. Since then, the urban-rural income ratio has decreased year by year, reaching 2.64 in 2019. However, the current urban-rural income gap is still high, and the rate of decline is slowing down.

Many factors can explain the decline in the urban-rural income gap: The lower surplus of the rural labor force due to large-scale urban-rural migration; The improvement of agricultural Labour productivity; Rapid urbanization; In recent years, the government's policy actions to improve social security and poverty alleviation programs have contributed to the increase in farmers' incomes and the narrowing of the urban-rural income gap.

3.2 Theoretical Analysis

Land market reforms play critical roles in the history of China's spatial income inequality history. The land is a spatial carrier of economic activities and an essential factor of production. Therefore, its use from agricultural production to non-agricultural production is bound to have a meaningful impact on income

[1]2017 China Development Report was written by the China Development Research Foundation (CDRF), which is a public foundation initiated by the Development Research Center of the State Council (DRC). Its mission is to advance good governance and public policy to promote economic development and social progress. Donations from Chinese and international patrons provide financial support for the Foundation. Funding is used to support policy research, publications, leadership training, development forums, and academic exchanges.

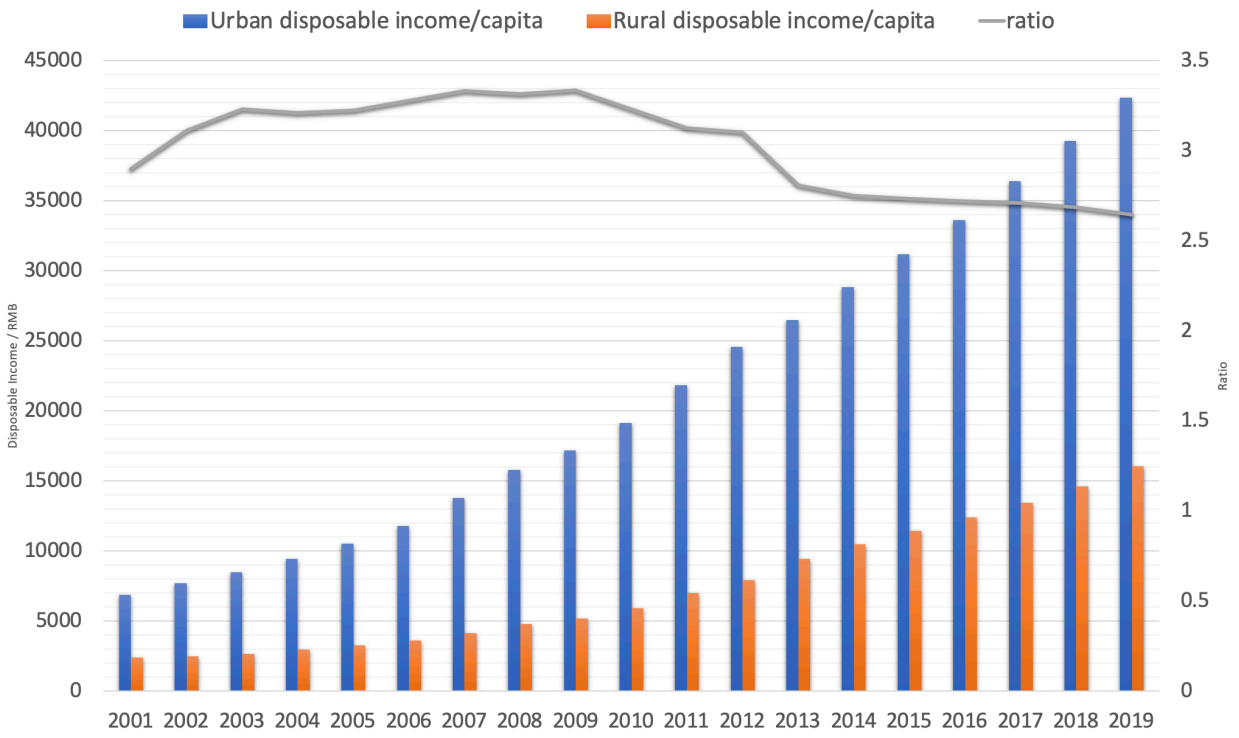


Figure 2: China Urban-Rural Disposable Income/Capita Comparison

distribution. From 1949, land resources successfully played the role of a booster for China's industrialization and urbanization. It is an essential local government fiscal revenue source and an essential tool for leveraging bank funds, urban infrastructure, and real estate investment and financing. Thus, in China, changes in the use of land may have a more significant impact on the distribution of income than in other countries (Gao et al., 2019).

The Land Coupon scheme impacts spatial income inequality by influencing residents' income components. According to their sources, the income of urban and rural residents in the statistics of the Chinese government can be divided into wage, operating income, property income, and transfer. Operating income refers to the net income of households or household members engaged in production and business activities. Property income refers to the income generated by capital participation in social production and living activities. According to the Chinese Statistical Yearbook data shown in Figure 3, after implementing the Land Coupon Policy in 2008, rural household operating income in the Chongqing area still accounts for about 40% of their total disposable income. In parallel, though the contribution of property income to their total disposable income is insignificant, as small as 2%, its share increased by 1.5 percentage points after 2008.

The Land Coupon scheme directly influences the property income of rural residents through the change of land use and the associated transfer. Arable land is a crucial factor of production to generate operating income for farmers. However, the return on capital per unit of land in agriculture is significantly lower than

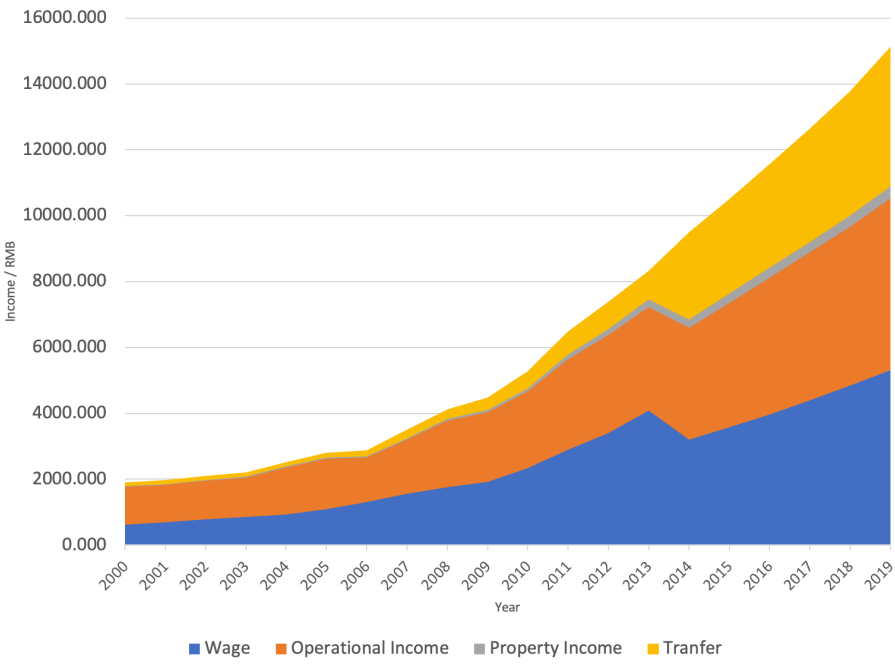


Figure 3: Disposable Income of Rural Residents in Chongqing

that in construction or service sectors. However, under the current land regulations, rural arable land could not convert to construction land without permission. As a result, the return from construction land in urban is often higher than in the countryside. Hence some rural residents would like to barter the development rights of their arable lands for enjoying higher capital return from the development of designated urban receiving areas. Specifically, the Land Coupon policy has expanded farmers' choices, allowing farmers to transfer the land development and management rights in the form of lease, exchange, transfer and share cooperation. Therefore, the reform of farmland right confirmation and trade mechanism has laid a foundation for farmers to obtain property income. Moreover, the property income that they get from Land Coupons would encourage farmers to invest in other assets, such as shops, housing, and financial products, to increase their property income further. Thus, introducing the market mechanism like Land Coupon into the area of land-use converting indeed increased farmers' property income (Guo and Wu, 2020). As a result, farmers have gained nearly 6.5 billion dollars from the coupon transactions over the past ten years, and collective economic organizations have also gained about 2.4 billion dollars (Huang, 2020).

While the Land Coupon system may narrow the urban-rural income gap by increasing farmers' property income, it may also do the opposite. First, farmers can choose to vacate, reclaimed, sell, transfer or rent their construction land that can be reclaimed. Depending on the factor endowment of a specific area, the benefits of any other use of construction land may exceed the benefits obtained through Land Coupon transactions after reclamation. Second, suppose the Land Coupon scheme improves the efficiency of allocating land resources between towns and villages. In that case, the development speed of cities relative to rural areas is

likely to accelerate. The corresponding income gap may widen.

The Land Coupon policy also affects the income inequality within the rural areas. A majority of the property incomes from coupons majorly might land in the hands of the rural residents who own a large number of idle homesteads or locate in the communities with timely decisive governments (Han and Lin, 2019) (Benjamin et al., 2005). In both situations, there exists the Matthew effect in the transaction process. In contrast, the residents from poorer counties might participate in the transactions of Land Coupons more frequently, and 15% of the income of every Land Coupon transaction is required to go to collective economic organizations whose dividends are usually distributed equally to all community members (Wen et al., 2017). Therefore, we would expect the intra-village inequality to decrease because the amount of cash from the coupon transaction could alleviate poverty significantly and reduce the gap across counties.

3.3 Current Empirical Studies

The Land Coupon scheme, as selected in one of the 40 cases of local reform and innovation in 40 years of reform and opening up by the China Economic Reform Journal[2], is a representative policy of land market reforms. However, its impacts on spatial income inequality are not widely examined in the existing literature.

Few empirical studies on the relationship between income inequality and the Land Coupon policy mostly use provincial macro data to analyze and never directly use the regional transaction data from Chongqing Country Land Exchange. Second, some of them adopted the difference-in-difference method and synthetic control method. Third, the selection of control variables was based on the selection of previous domestic literature without a detailed explanation of the mechanism.

Yu in 2013 used the synthetic control method to analyze the impact of the urban-rural coordination reform, including the Land Coupon scheme, on the urban-rural disposable income ratio from the perspective of resource mismatch (Yu, 2013). He concluded that the urban-rural coordination policy improved the income level of rural residents by promoting the free flow of resources and then narrowed the income gap between urban and rural residents. However, Xia used the difference-in-difference method to quantitatively evaluate the impact of coordinated urban-rural policies on the urban-rural income ratio based on provincial panel data (Xia, 2013). He concluded that coordinated urban-rural policies had no noticeable inhibitory effect on the urban-rural income gap, contrary to Yu's research. Fu and other scholars in 2017 established a panel-data model with county-level data (the Counties in Chongqing as treatments when the Counties in Zhejiang as controls). They found that under the control of factors such as financial development and urbanization rate of the industrial structure of transportation infrastructure construction, the implementation

[2]China Economic Reform Journal was founded in 1986. Supervised by the National Development and Reform Commission and sponsored by the China Society for Economic Reform, it is the only national-level publication that undertakes the task of publicizing reform. Famous economists Gao Shangquan and Wu Jinglian respectively serve as the director of the magazine's expert steering committee and honorary editor-in-chief. Yuan Xucheng, deputy secretary-general of China Society for Economic System Reform, serves as the president and editor-in-chief.

of the coordinated urban and rural policy promoted the industrialization process and urbanization level of Chongqing and significantly narrowed the income gap between urban and rural areas (Fu et al., 2017).

This paper differs from the current empirical studies mainly in two ways: it is the first article applying the newly developed MASC estimating method in the economics of land and development; second, in this paper, the effects of the Land Coupon system on spatial income inequality under different variations of critical parameters are examined.

4 MASC Analysis

Measuring the causal effect of provincial policies is challenging as it demands the construction of a proper counterfactual. In this study, I use the newly developed matching and synthetic control estimator(MASC) to compare the evolution of the urban-rural income gap over time between Chongqing as a treated unit under the Land Coupon policy and other provinces in mainland China.

MASC is an estimator combining the matching and synthetic control estimators through model averaging that developed by Maxwell Kellogg and others in 2020, as illustrated below (Kellogg et al., 2020):

$$\hat{\mu}_t^{\text{masc}}(\phi, m) \equiv \phi \hat{\mu}_t^{ma}(m) + (1-\phi)\hat{\mu}_t^{sc} \tag{1}$$

where $\phi \in [0, 1]$ is a tuning parameter, m is the number of untreated units included in the matching estimator, $\hat{\mu}_t^{ma}$ and $\hat{\mu}_t^{sc}$ are matching and synthetic control estimators respectively, and $\hat{\boldsymbol{w}}^{\text{masc}} \equiv \phi \hat{\boldsymbol{w}}^{\text{ma}}(m) + (1-\phi)\hat{\boldsymbol{w}}^{\text{sc}}$. In the traditional difference-in-difference comparative study, there is always some degree of ambiguity about how comparison units are chosen (Abadie et al., 2010). Considering Chongqing's unique geographical conditions, political status, and economic structure, I concluded that no single one could be a proper control unit with fitted pre-treatment characteristics. Therefore, a 1-to-m matching[3] or synthetic control(SC) estimator might be a good counterfactual (Abadie and Gardeazabal, 2003)(Abadie et al., 2010)(Abadie, 2021).

However, while the SC limits extrapolation bias by combining untreated units using traditional tools like linear regression, its interpolation bias is hard to control as it is a convex weighted average of the untreated units to create a synthetic untreated unit with pre-treatment characteristics similar to those of the treated unit. In contrast, classical matching estimators have the opposite behavior as they limit interpolation bias in exchange of extrapolation ones. Therefore, Kellogg uses a rolling-origin cross-validation procedure to train the MASC to resolve trade-offs between interpolation and extrapolation bias (Kellogg et al., 2020). Following the notation used in their work, let's dene the folds, $f = 1, ..., F$, as consisting of data running between two dates $\underline{t}_f$ and $\bar{t}_f$ in the pre-treatment period. Let $\hat{\gamma}_f$ denote a generic estimator of the outcome

[3]The matching estimator is defined by choosing a positive integer and equally weighting the m untreated units with pre-period characteristics closest to those of the treated unit as applied in the Kellogg's paper. Similar to the SC estimator, the matching estimator is a sparse and convex weighted average of the post-period outcomes of the untreated units.

in period $\hat{t}_f + 1$ based on data in fold f, where ϕ is a vector of tuning parameters. Apply simple least squares algebra, the tuning parameter for any fixed m could be computed as follow:

$$\hat{\phi}(m) \equiv \frac{\sum_{f=1}^{F} \left(\hat{\gamma}_f^{\text{ma}}(m) - \hat{\gamma}_f^{\text{sc}}\right)\left(y_{1,\bar{t}_f+1} - \hat{\gamma}_f^{\text{sc}}\right)}{\sum_{f=1}^{F} \left(\hat{\gamma}_f^{\text{ma}}(m) - \hat{\gamma}_f^{\text{sc}}\right)^2} \tag{2}$$

to minimize the average one-step ahead forecast error, $Q(\phi, m) = \frac{1}{|\mathcal{F}|} \sum_{f \in \mathcal{F}} \left(y_{1,f+1} - \hat{\mu}_{f+1}^{masc}(\phi, m)\right)^2$. Then I compute the Q for a set of potential matches (in this study: m ranges from 1 to 8). For each m in the set,

$$\hat{\phi}^{\star}(m) \equiv \begin{cases} 0, & \text{if } \hat{\phi}(m) \leq 0 \\ 1, & \text{if } \hat{\phi}(m) \geq 1 \\ \hat{\phi}(m) & \text{otherwise} \end{cases}$$

Then the optimal value of m^* is achieved by minimizing Q. Therefore, I get the cross-validated MASC estimator based on m^* and $\hat{\phi}^{\star}$.

Since MASC can adapt to cases where either SC or matching would do better, it allows me to examine the causal effect of the Land Coupon policy on the urban-rural income gap, using different sets of control variables to compare the results from several potential counterfactual units.

4.1 Data and Variables

I use a province-level sample that integrates data from the China Statistical Yearbook (CSY) between 2000 and 2019. This annual statistical publication comprehensively reflects the macroeconomic and social development of mainland China. It includes statistics from 31 provinces in mainland China. Since annual data from CSY is collected at the end of each year, as a convention, in the MASC regional analysis, I use Chongqing data collected at the end of 2007 as the treatment period since the Land Coupon policy started before the collecting date of the 2008 data. The observations from CSY include all 30 administrative provinces of mainland China, except for Sichuan province since another pilot-city for the Land Coupon policy, Chengdu, is included. Therefore, Chongqing province is the only treated unit.

Our primary dependent variable is the income gap between urban and rural residents, adapted in previous literature. The ratio of disposable income of urban residents to the net income of rural residents is used as the proxy variable of the income gap between urban and rural residents.

4.2 Two Cases of predictor-variable choosing

The province-level covariates are extracted from the CSY (2000–2019), including demographics and economic factors. These variables serve as control variables in the regression analysis. Selecting these control variables is the most controversial and critical step in applying the synthetic control method. For example, when constructing the synthetic control group, Mi and Dai (2020) adopted the relevant predictive variables of information technology, urbanization level, labor productivity and price, human resources,

external dependence, and population density, respectively (Mi and Dai, 2020). In contrast, Yu Jingwen in 2013 took economic openness, financial development indicators, government investment in education, the proportion of the secondary industry, the proportion of the tertiary industry, and the income gap between urban and rural residents in five critical years as fitting predictive variables (Yu, 2013).

Considering the objectivity and the research methods using the synthetic control method in previous works of literature about Chongqing, this paper covers two sets of pre-treatment fitting variables to compare different conditions in the applications of the MASC method.

5 Results

This section shows the results from two cases of control-fitting-variable choosing. Under each case, the estimation from the traditional synthetic control (SC) method emerges first, and the part of the MASC estimator follows (Abadie and Gardeazabal, 2003).

When presenting the Land Coupon policy's estimated effect on Chongqing's urban-rural income gap from either the SC or the MASC method, placebo tests and variation of critical parameters are included to test our validity results further.

5.1 First case: with auxiliary covariates

In the first case, I follow the real-world logic and previous income-inequality analysis (Kuznets, 1955) so that the control set covers the following variables:

1. Income Level: measured by total disposable income per capita and property income per capita of both urban and rural residents,
2. Rural-resident living condition: measured by value and area of living space per capita of rural residents,
3. Economic Structure: measured by the GDP contribution of primary and secondary sectors,
4. Economic Development: measured by GDP per capita
5. Relative Development of Finance: represented by the GDP contribution of the financial sector.

In addition, a particular predictor of the outcome variable in 2001 is included since, in 2001, China officially joined the World Trade Organization.

5.1.1 Synthetic Control results

Firstly, the results from the traditional synthetic control method are presented. Then, a counterfactual synthesis control province of the pilot province of land coupon trading, Chongqing, is constructed using the predictive variables from 2000 to 2007. Finally, the provinces which make up synthetic Chongqing are reported in Table 1 and the predictor comparison is presented in Table 3 in the Appendix, comparing the pre-treatment characteristics of the real Chongqing with these of the synthetic Chongqing.

In Figure4, the red-dashed vertical line indicates the treatment year of the Land Coupon policy, 2008. The blue and black lines show the synthetic Chongqing trajectory before and after implementing the Land Coupon policy compared to the actual outcome. Although there are some fluctuations between the two curves for the pre-treatment period, they are generally consistent. Therefore, the synthetic Chongqing gives us a good approximation of the urban-rural income gap that Chongqing would have if the Land Coupon transactions never happened. From the Figure4 we can see that the real-Chongqing urban-rural income gap is always smaller than its synthetic value after the implementation of the Land Coupon system. After 2008, the gap between the real and the synthetic Chongqing increases year by year, indicating that the Land Coupon system significantly promotes the reduction of urban-rural income inequality in Chongqing. Specifically, the synthetic control model suggests that the Land Coupon scheme resulted in a 0.32 smaller urban-rural income ratio from 2008 to 2019, which is about an 11% decrease.

Table 1: Estimated Chongqing Weights

Synthetic Control		Optimal Matching	
Province Name	**Estimated Weight**	**Province Name**	**Estimated Weight**
The First Case: with auxiliary covariates			
Shanghai	0.043	Anhui	0.167
Hubei	0.002	Jiangxi	0.167
Hunan	0.343	Hubei	0.167
Guangdong	0.084	Hunan	0.167
Guizhou	0.527	Sichuan	0.167
		Shannxi	0.167
The Second Case: exclusively with lagged outcomes			
Beijing	0.269	Shannxi	0.167
Heilongjlang	0.052	Guangxi	0.167
Guizhou	0.575	Qinghai	0.167
Yunnan	0.062	Ningxia	0.167
Xinjiang	0.042	Gansu	0.167
		Xinjiang	0.167

Next, I examine the statistical significance of the experimental effects of the Land Coupon policy to verify the robustness of the estimates further. According to Abadie and Gardeazabal (2003) and Abadie et al. (2010), the non-parameter estimation results obtained by the synthesis control method could not be tested for significance using statistical inference techniques with large samples. However, the significance of the assessed effects could be analyzed by means of a placebo test and a permutation test.

The basic idea of the placebo test is: for all the provinces in the control group, we assumed that they had implemented the same Land Coupon policy in the same year as the Chongqing province. Then the

synthetic control method is used to make the same fitting. Suppose the gap of urban-rural income ratio of all the provinces in the control group is estimated to be larger than the gap value of Chongqing. In that case, the results show that the land coupon trading is effective in narrowing the spatial income inequality of Chongqing. Otherwise, it indicates that the analysis result is invalid.

Based on the idea above, I apply the synthetic control model to all 29 additional province units for the placebo analysis. The top panel of Figure8a gives the placebo distribution using all units as donor pool. Chongqing is in the tails of the distribution of treatment effects. In this analysis, 20 times the pre-treatment MSPE of placebo should be higher than that of the treated unit to be considered extreme and discarded. After excluding the units with extreme pre-treatment MSPE, Chongqing enjoys the second-largest downward impact and fluctuation, which indicates that there is only $\frac{2}{26}$, i.e. 7.69%, that there is such a big difference between the urban-rural income gaps in real Chongqing and the synthetic one, which could be used as the significance level of traditional statistical inference. In other words, we can reject the null hypothesis that the reform has no significant impact on the urban-rural income gap in Chongqing at the significance level of 7.69%.

The basic idea of the permutation test is to calculate the ratio of root mean square prediction error (RMSPE) of each province in the control group and the treatment group before and after implementing the Land Coupon policy the results obtained from the synthetic control method. The smaller the root mean square error (Pro-RMSPE) before implementing the Land Coupon policy, the better the fitting effect of the synthetic control method. The closer the synthetic urban-rural income ratio is to the actual value. The greater the root mean square error (Pro-RMSPE) after implementing the Land Coupon policy strategy, the greater the effect of the land bill system on the reduction of urban and rural income. Therefore, the larger the mean square prediction error ratio before and after the implementation, the greater the placebo effect and the more significant the impact of the Land Coupon policy.

The top panel of Figure 9a in the Appendix shows the distribution of RMSPE ratios. Chongqing has the 10th highest ratio of post–RMSPE to pre-RMSPE relative to any other province unit, implying a p-value of 0.333. Therefore, the null hypothesis cannot be rejected at the significance levels of 5% and 10%. Hence the effect of the implementation of the Land Coupon system on the urban-rural income gap at the provincial level in Chongqing is not very statistically significant with the permutation test.

5.1.2 MASC results

To implement MASC analysis, after we constructing a proper synthetic control estimator, a set of associated matching estimators with the same set of pre-period fitting variables needs to be calculated. Then, the optimal one with the lowest average one-step-ahead forecast error, Q, would be chosen.

The matching estimator here is defined by choosing a positive integer and equally weighting the m untreated units with pre-period characteristics closest to those of the treated unit as applied in Kellogg's

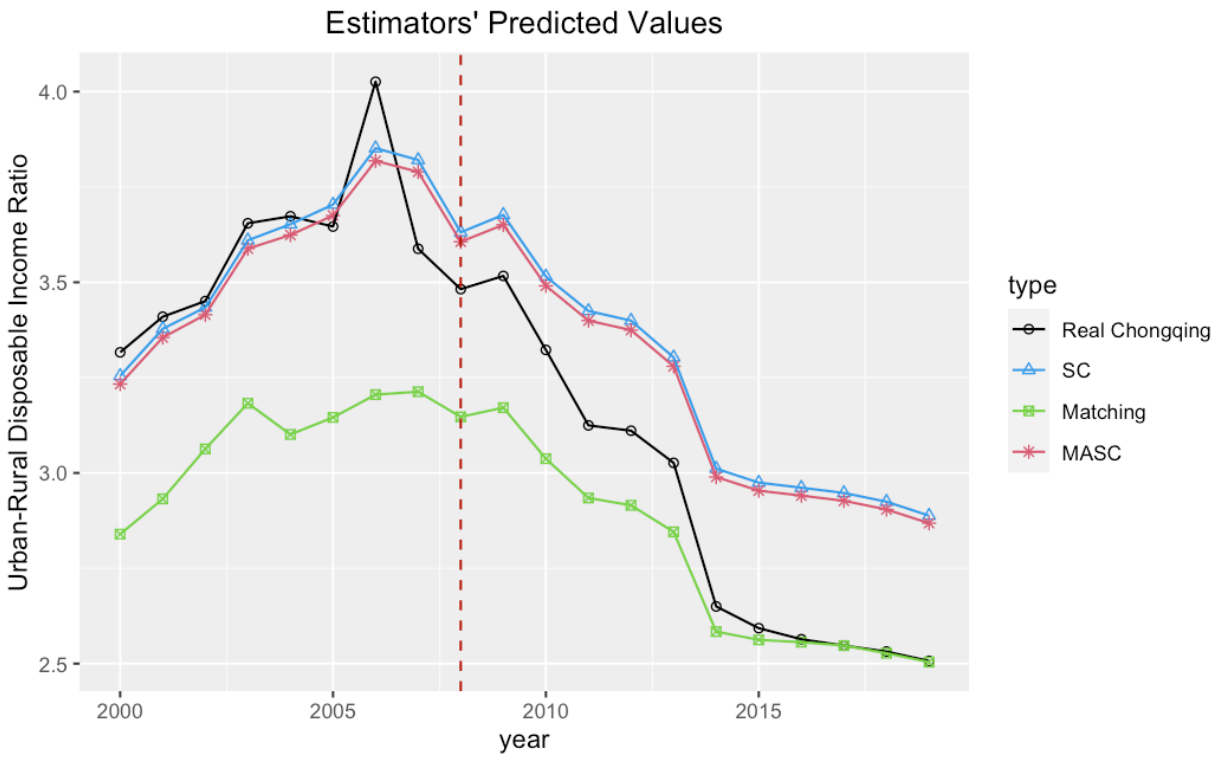


Figure 4: First Case

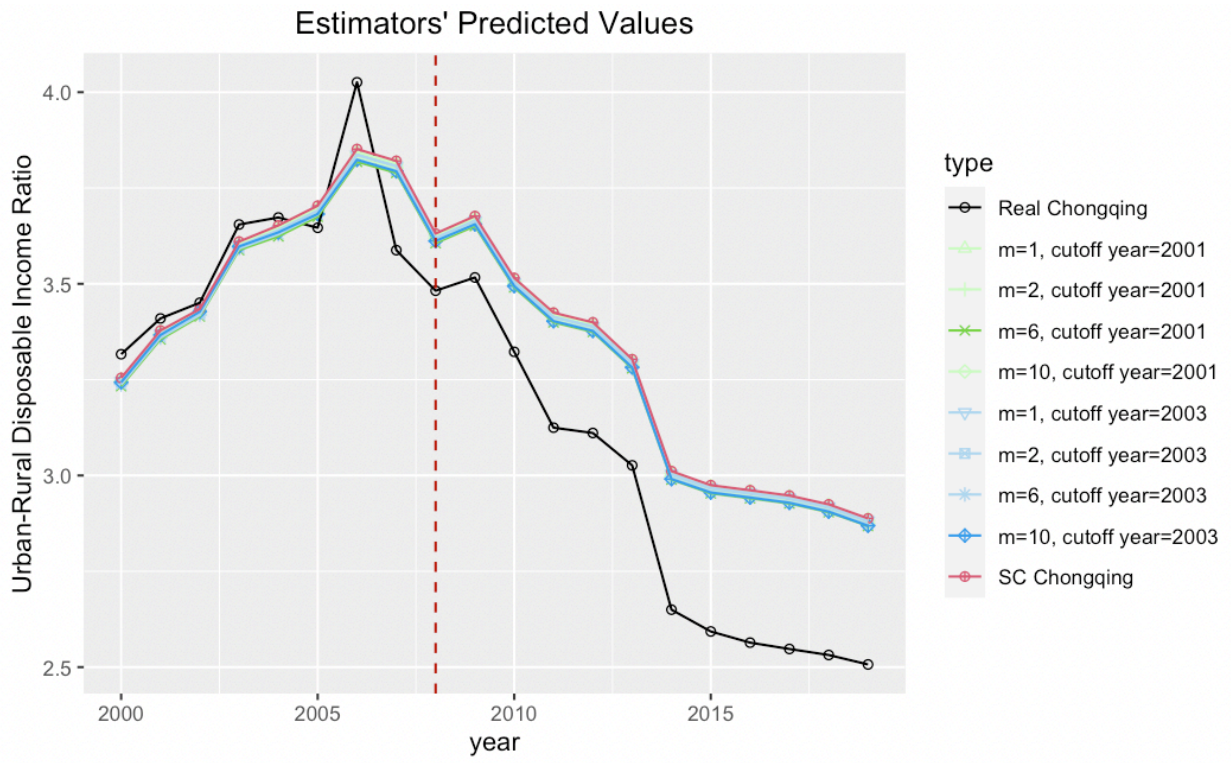
paper. In this study, we choose the set of m values as following:

$$M = \{1, 2, 6, 10\} \; and \; m \in M. \tag{3}$$

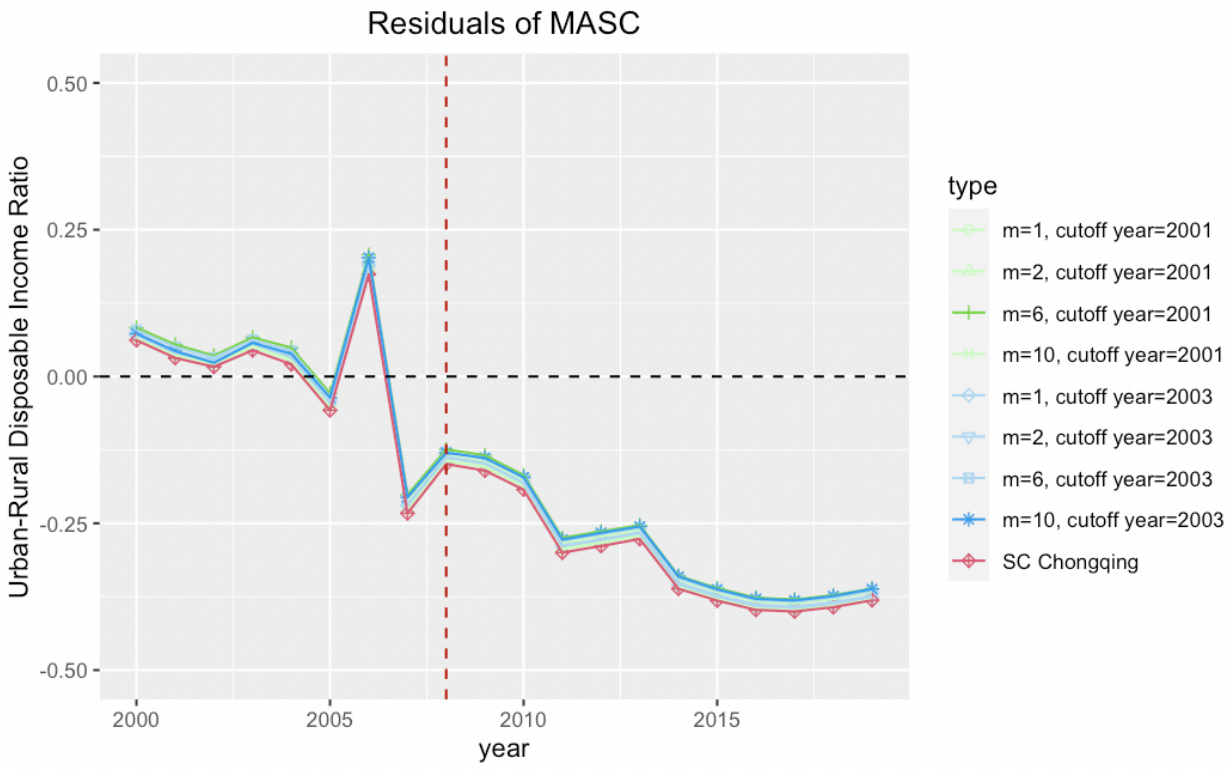
In other words, the optimal matching estimator for MASC would be selected among the 1-to-1, 1-to-2, 1-to-6, and 1-to-10 nearest neighbor's estimators.

Another influencing factor is the variation of the fold-choosing in the rolling-origin cross-validation procedure of MASC analysis. The folds are defined as consisting of data running between two dates in the pre-treatment period. According to the idea of Kellogg et al. (2020) applied in our context, the latest ending date can be the year 2006, two years before the implementation of the Land Coupon policy. Since not all folds are equally valuable in practice, folds using data closer to the actual treatment date are preferred. Thus, the ending date is kept fixed in our analysis. To further study the influence of the fold-choosing on the MASC estimator, two starting dates, 2001 and 2003, are examined, and the length of each fold is set to be one year for the convenience of comparison.

The values of ϕ and Q associated with different m values are presented in the Table 2. According to the Table, the optimal MASC emerges when the starting-year of folds is 2001 and $m = 6$ since it has the lowest $Q = 0.0337$, so a 1-to-6 nearest neighbor's estimator is used. When the starting year of folds is 2003, the best MASC consists of the SC estimator and a 1-to-10 matching estimator. Its related average one-step-ahead forecast error is 0.0469, which is larger than $Q = 0.0337$.



(a) Variation of MASC Estimated Value



(b) Variation of MASC Residuals

Figure 5: First-case MASC residual variation

Table 2: m and related Q values in MASC analysis

		The First Case: with auxiliary covariates		The Second Case: only with lagged outcomes	
f Starting Date	m	ϕ	Q	ϕ	Q
2001	1	0.0096	0.0343	0.3674	0.0514
	2	0.0107	0.0343	0.3556	0.0526
	6	**0.0513**	**0.0337**	**0.9221**	**0.0369**
	10	0.0517	0.0339	1	0.0392
2003	1	0.0197	0.0478	0.0070	0.0766
	2	0.0176	0.0477	1	0.0573
	6	0.0417	0.0474	**1**	**0.0457**
	10	**0.0706**	**0.0469**	0.8787	0.0620

The green line in Figure 4 shows the matched Chongqing trajectory around the time of the enactment of the Land Coupon policy. The provinces which make up matching Chongqing are shown in Table 1 in the Appendix. However, even though from the Figure 4 the trends of the green and black lines are analogical, we can notice that there exists a vast difference between actual Chongqing and matching one in terms of the urban-rural income gap before 2008. Therefore, the matching estimator may not be a good counterfactual.

The red curve in Figure 4 presents the pre-period fit and the post-period estimated urban-rural disposable income ratio for the MASC estimator. The associated ϕ is 0.0513, indicating that the matching estimator only contributes about 5% to our MASC estimator. Therefore, the red (MASC) and blue (SC) curves nearly overlap.

On average, MASC gives an RMSE of 0.113 in the pre-period. In contrast, the estimated average effect of the Land Coupon policy on the urban-rural income ratio in the post-period is significantly more significant, at around 0.299 from 2009 through 2019. Thus, the Land Coupon policy decreased the urban-rural income ratio by roughly 0.3. The estimated effect peaks in 2017, reaching an income gap of 0.379.

From the plot in Figure 4, the urban-rural income ratio of the synthetic Chongqing generally well fits that of the real Chongqing before the implementation of the Land Coupon policy. However, after 2008, they gradually deviated from each other. Also, the gap between them showed a widening trend, especially during the period after 2013. This behavior might be caused by a lagged effect of the Land Coupon policy. However, a more reasonable explanation is that the central government in China started a massive national "Poverty Alleviation" project which brought numerous transfers to rural residents in impoverished areas.

The curves of the MASC estimators consisting of different combinations of ms and f starting years are shown in Figure 5a. The black curve represents the real Chongqing, the green curves denote the variations of m when the f starting year is 2001, and the blue ones show the variations with the f starting year 2003. The two bold curves reveal that the optimal MASC estimators under both f starting years are incredibly

close to the original synthetic control estimator represented by the red curve.

From the bottom half of Figure 5a we can notice that the MASC estimators are slightly closer to the real Chongqing after the implementation of the Land Coupon policy. Therefore, while MASC estimators offer us a better control between the interpolation and extrapolation bias, the estimated effect of land coupon trading on the urban-rural disposable income ratio of Chongqing gets smaller than that from the synthetic control method.

5.1.3 Summary

When we consider the case where a small number of auxiliary covariates are included in pre-period fitting, even though the associated matching estimators are not ideal, both the SC and the MASC methods give us a relatively good counterfactual approximation. Both estimates show that there exist the positive effects of the Land Coupon policy on narrowing the urban-rural income gap.

Specifically, the synthetic control model suggests that the Land Coupon scheme resulted in a 0.32 smaller urban-rural income ratio from 2008 to 2019, which is about an 11% decrease. Meanwhile, the MASC analysis showed that the Land Coupon policy causes an approximately 0.30 on an average decrease in the urban-rural income gap.

The two counterfactual estimations by SC and MASC are remarkably alike because the matching estimator with the pre-period fitting covariates is not a good fit in terms of our dependent variable. So, the cross-validation process gives most MASC weights (0.9487) to the synthetic control estimator.

5.2 Second Case: exclusively with lagged outcomes

In the second case, I follow the recent convention in the synthetic control literature of taking the control set to only include all pre-treatment outcomes and no other covariates (Ferman, 2019)(Athey et al., 2021).

5.2.1 Synthetic Control results

The second-case synthetic control analysis uses the same data as above. The blue and black lines in Figure 6 below show the synthetic Chongqing trajectory before and after the implementation of the Land Coupon policy compared to the actual outcome. The synthetic control model suggests that the urban-rural disposable income ratio decreased by 0.299 or about 8.587%. Table 1 shows that the synthetic control is a weighted average of Beijing (0.269), Heilongjiang (0.052), Guizhou(0.575), Yunan(0.062), and Xinjiang(0.042). I present the actual and synthetic characteristics from the model in Table 3 in the Appendix.

The synthetic control model suggests that the Land Coupon policy resulted in about 0.4 smaller urban-rural disposable income ratio relative to the estimated counterfactual from 2008 to 2019, which is about an 11.4% decrease.

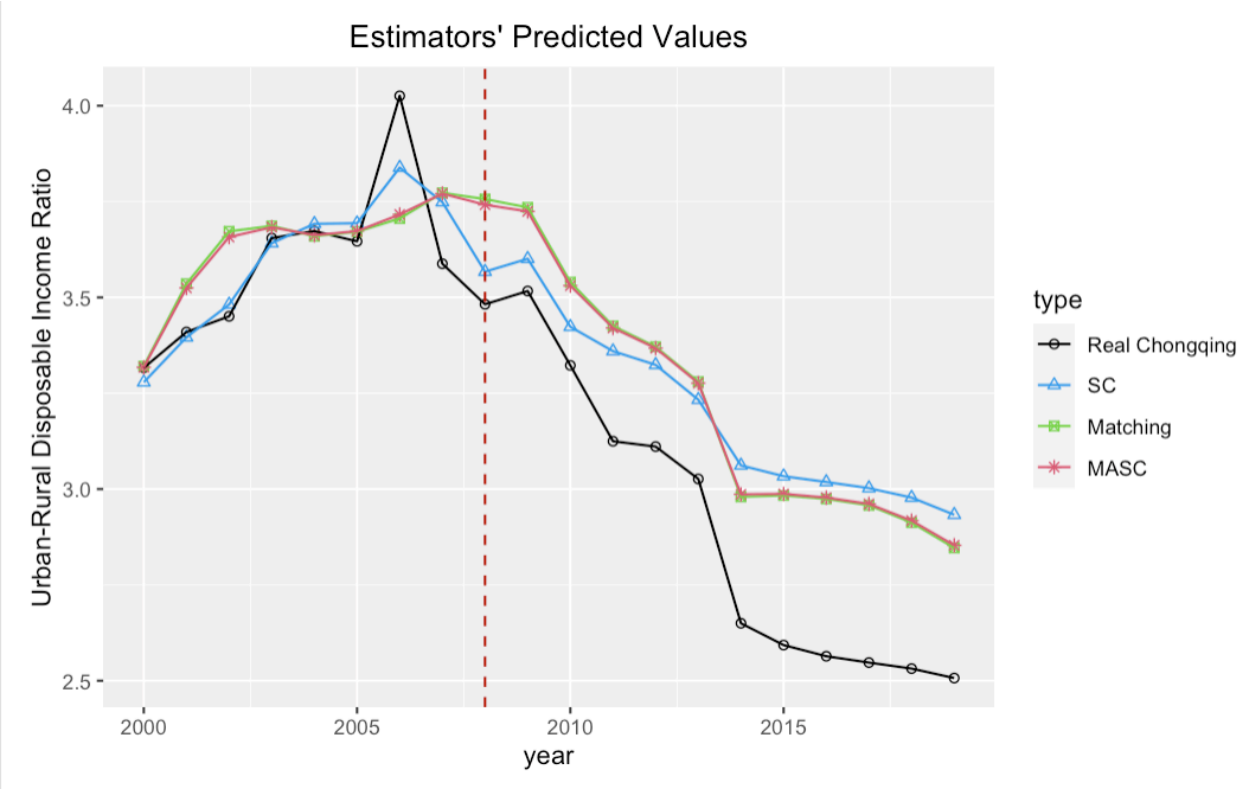


Figure 6: Second Case

The same permutation and placebo tests described in the first case are conducted. Figure 9b in the Appendix shows that Chongqing has a low (ranked 19/30) ratio of post/pre-treatment RMSPE, implying that if one were to assign the Land Coupon policy at random, the probability of obtaining a post/pre-2008 RMSPE ratio as large as Chongqing's is 0.633 (or that the p-value=0.633) which is not significant at all. However, the difference between observed unites and synthetic controls for Chongqing and controls shown in Table 8b demonstrates that Chongqing province locates in the set of units suffering the largest downward impact of the Land Coupon policy on urban-rural income inequality. Thus, the second-case results of permutation and placebo tests are highly similar to the first-case ones: the estimation by the synthetic control method is not statistically significant with the permutation test but performs well in the placebo test.

5.2.2 MASC results

As we did in the first case, the optimal matching estimator for MASC would be selected among the 1-to-1, 1-to-2, 1-to-6, and 1-to-10 nearest neighbor's estimators.

The second-case values of ϕ and Q associated with different m values are presented in the right half of Table 2. Same as the first case, the optimal MASC emerges when the starting-year of folds is 2001 and $m = 6$ since it has the lowest $Q = 0.0369$, so a 1-to-6 nearest neighbor's estimator is used. The detailed components of the matched estimator are shown in the bottom panel of Table 1. When the starting year of

folds is 2003, the best MASC estimator consists of a 1-to-10 matching estimator and the SC estimator. Its related average one-step-ahead forecast error is 0.0457, which is larger than $Q = 0.0369$.

The green line in Figure 6 shows the matched Chongqing trajectory before and after the implementation of the Land Coupon policy. The trends of the green, blue and black lines are consistent in general. Therefore, both the matching and the synthetic control estimators might be reasonable counterfactual estimations.

The red curve in Figure 6 presents the pre-period fit and the post-period estimated urban-rural disposable income ratio for the MASC estimator. Unlike the first case, the associated ϕ is 0.9221, so that the matching estimator contributes about 92.2% to our MASC estimator. Therefore, the red (MASC) and green (matching) curve nearly overlap. Moreover, similar to the first case, in Figure 6, the gap between the estimated Chongqing and the real one is widening after the year 2013.

The estimated average effect of the Land Coupon policy on the urban-rural income ratio in the post-period is significantly larger, at around 0.397 from 2009 through 2019. Thus, the Land Coupon policy decreased the urban-rural income ratio by roughly 0.4. The estimated effect also peaks in 2017, reaching an income gap of 0.42, which is slightly larger than the first case.

The curves of the MASC estimators with different combinations of ms and f starting years are presented in Figure 7a. The notations and classifications are the same as in Figure 5a. The black curve represents the real Chongqing, and the red one is the original synthetic control estimator. The green curves denote the variations of m when the f starting year is 2001, and the blue ones show the variations with the f starting year 2003. The two bold curves depict the optimal MASC estimators under either f starting years.

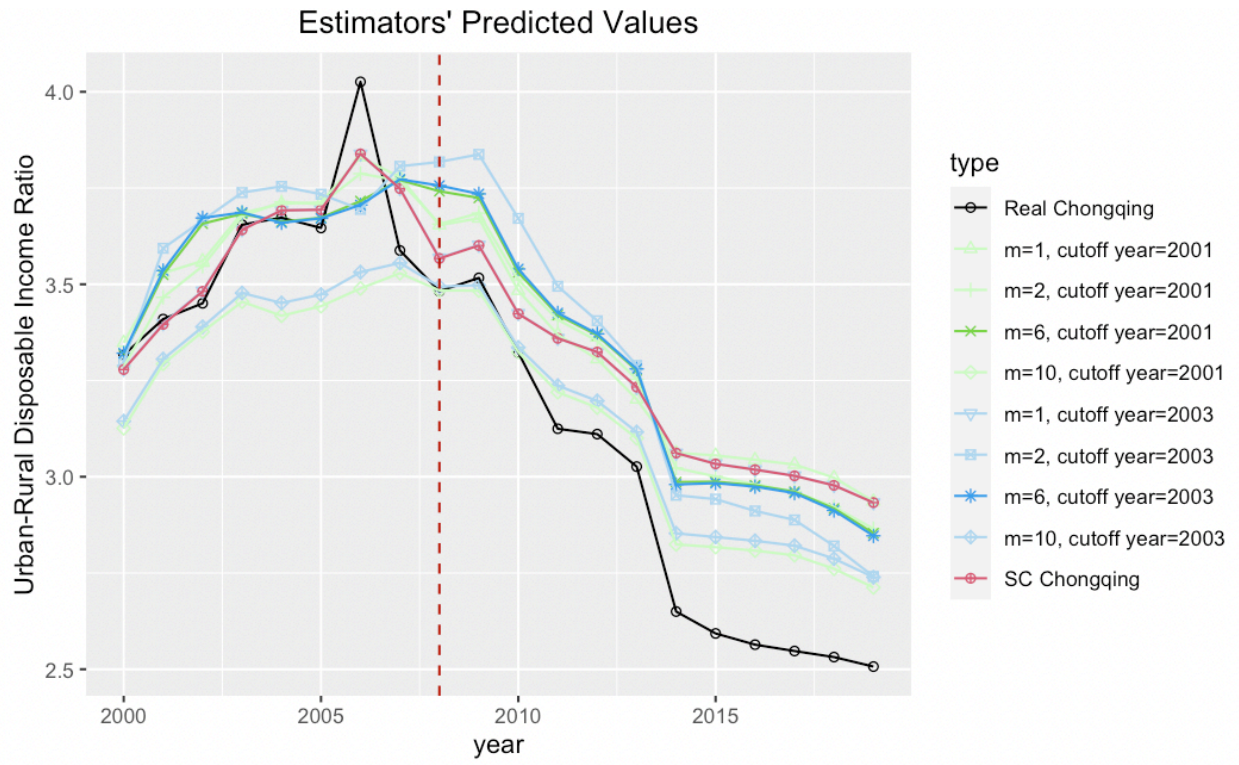
Since the second-case matching estimators predicted only by the dependent variable are better counterfactual estimations than the first-case ones with auxiliary covariates, the variation of the key parameters like m more dramatically affects the behavior of the MASC estimators. This result could be seen by comparing Figure 5b and 7b.

Even though there is much variability of the MASC estimators, most of their curves in Figure 7a have been above the real Chongqing after 2008. This graphic representation implies that no matter which m or f we choose, the effect of the Land Coupon policy on narrowing the urban-rural disposable income ratio is always positive.

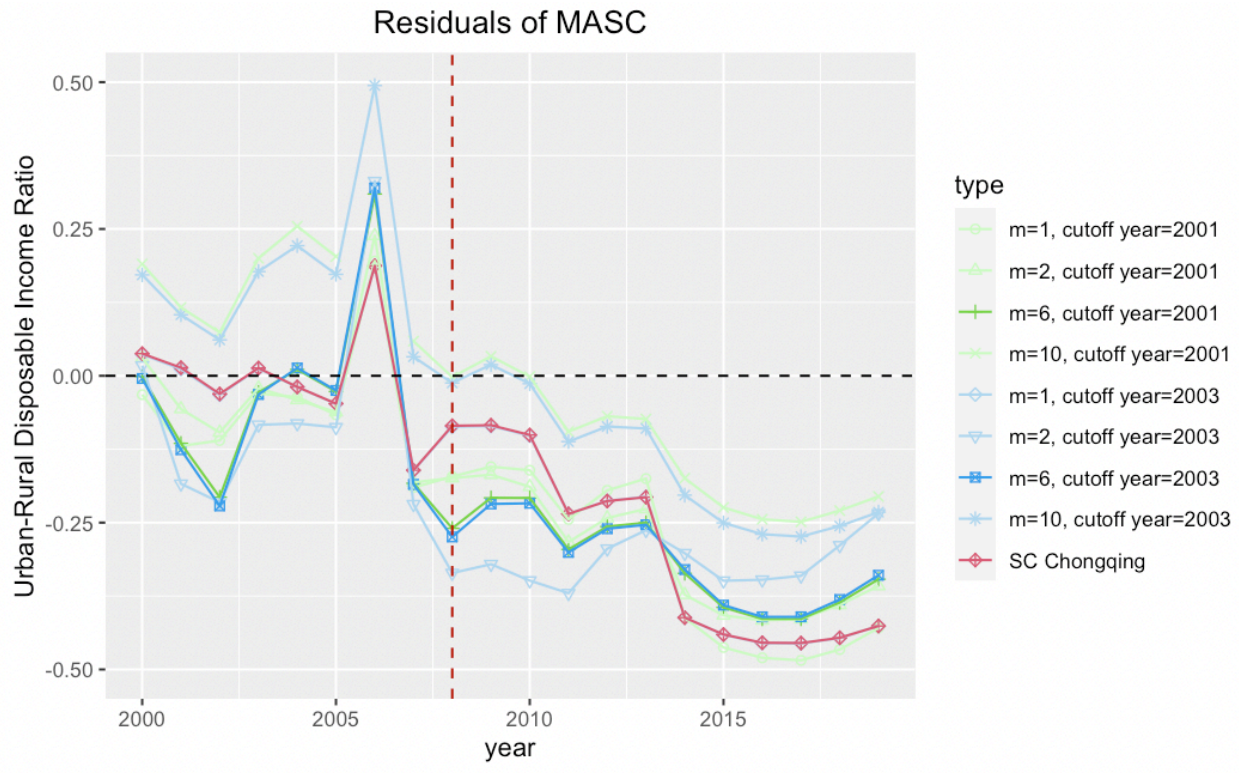
5.2.3 Summary

When we consider the case where only the dependent variable, urban-rural disposable income ratio, is included in pre-period fitting, the associated matching estimators are reasonable estimations. Also, both the SC and the MASC methods give us a relatively good counterfactual approximation. Thus, all three types of estimates show the positive effects of the Land Coupon policy on narrowing the urban-rural income gap.

Specifically, the synthetic control model suggests that the Land Coupon scheme resulted in a 0.40 smaller urban-rural income ratio from 2008 to 2019, which is about an 11.2% decrease. The optimal 1-to-6



(a) Variation of MASC Estimated Value



(b) Variation of MASC Residuals

Figure 7: Second-case MASC residual variation

matching estimator and the MASC analysis show that the Land Coupon policy causes approximately 0.397 on the average decrease in the urban-rural income gap.

Unlike the first case, the two counterfactual estimations by matching and MASC are very similar. The matching estimator with the pre-period fitting covariates is a better fit for our dependent variable. So, the cross-validation process gives the majority of MASC weights (0.9221) to the matching estimator.

6 Conclusion and Discussion

Given the divergent positions in the relationship between land market reforms and income distribution, this study provides causal estimates of the impact of the Land Coupon policy on spatial income inequality, mainly measured by urban-rural disposable income ratio. To further study the practical application of the MASC method, this paper covers two sets of pre-treatment fitting variables. The results from both cases are consistent.

The Land Coupon scheme lowers the province-level urban-rural disposable income ratio by around 11%. Though the results from our MASC analysis are not very robust that caused by the selection of the control variables, they were concordant with Yu (2013) and Fu et al. (2017). The role of the Land Coupon policy is highly similar to the Transferable Development Right programs in the US, which accelerated the process of land resource circulation and optimized the allocation of resources. Therefore, the Land Coupon scheme has successfully achieved one of its original goals: narrowing the difference between urban and rural areas in Chongqing.

While this paper specifically focuses on a land market reform in Chongqing province, China, its findings are salutary for other countries as well: variants of transferable land development right programs could significantly positively impact spatial income inequality with coordinated development among regions.

Finally, despite the findings in this article point to the positive impacts of the Land Coupon scheme, there are several limitations. First, the inner mechanisms await further study. One possibility is that the Land Coupon system lowers the level of Chongqing's income inequality by smoothing the development difference among poor and rich counties through a better land-resource allocation, instead of directly narrowing the urban-rural disposable income gap. It manifests the asset value of scattered collective construction land in remote rural areas and enables farmers to share the dividends of metropolis industrialization and urbanization. Thus, the provincial data show a significant causal effect of the policy on the urban-rural income gap in this study. Second, Chongqing's urbanization has been accelerated recently, and a large number of the rural populations take the initiative to transform into urban populations whose income data are hard to track and classify. Third, further researchers could explore the effect of the Land Coupon policy on household-level spatial income inequality when the micro-level data is tangible. Also, an important technical area awaiting future study is how we choose a proper control group when applying the newly developed MASC estimator macro settings to work better as a counterfactual.

7 Acknowledgment

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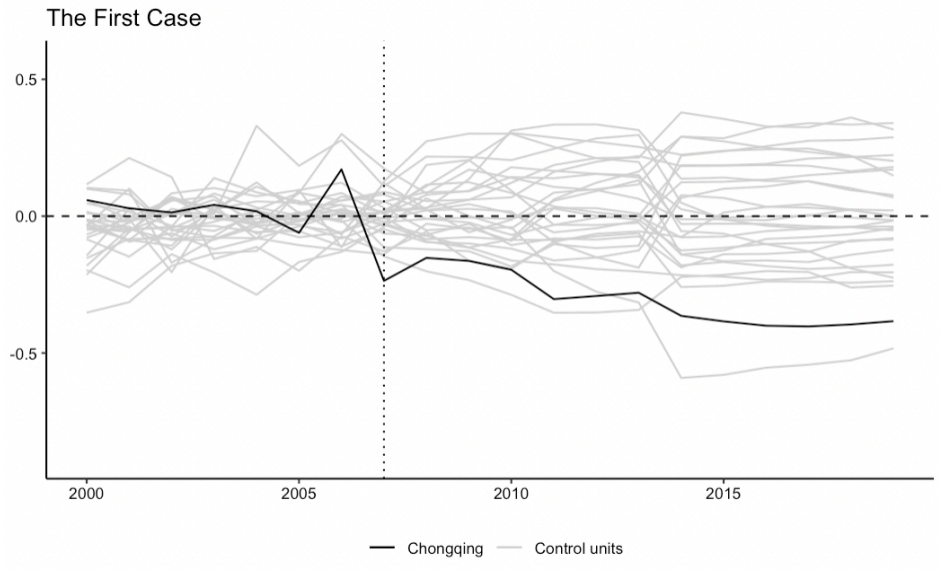
A Additional Tables

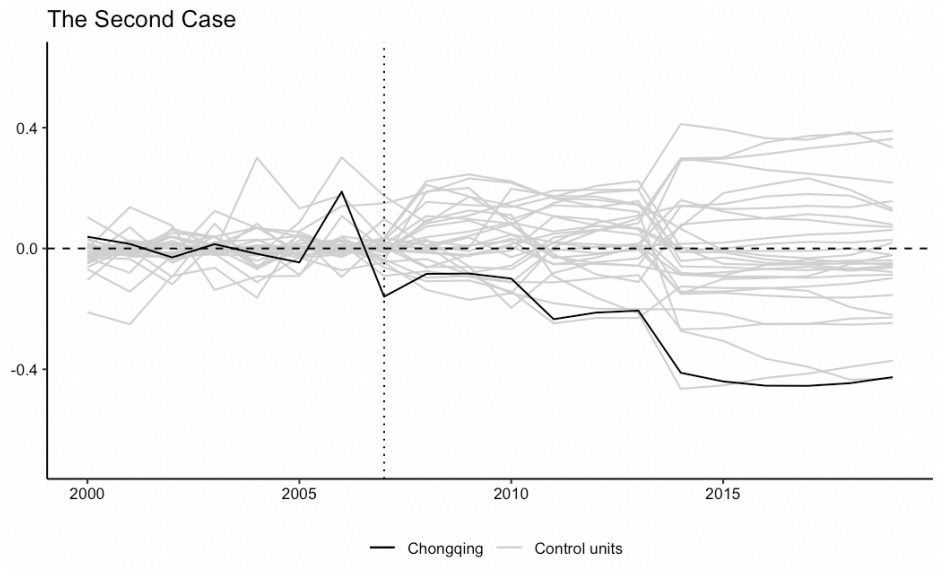
Table 3: Actual versus Estimated Chongqing Characteristics

Variable Name	**Real Chongqing**	**Synthetic Chongqing**
	The First Case: with auxiliary covariates	
Urban-resident Total disposable income per capita	8994.215	8633.35
Urban-resident property income per capita	144.181	151.560
Rural-resident Total disposable income per capita	2484.825	2576.371
Rural-resident property income per capita	26.303	56.631
Area of living space per capita of rural residents	32.163	28.646
Value of living space per capita of rural residents	155.52	185.631
GDP contribution of Primary sector	15.089	18.733
GDP contribution of Secondary sector	42.824	42.217
GDP per capita	9009.289	9196.638
GDP contribution of financial sector	0.032	0.033
	The Second Case: exclusively with lagged outcomes	
Urban-rural disposable income gap(2000)	3.316	3.277
Urban-rural disposable income gap(2001)	3.410	3.395
Urban-rural disposable income gap(2002)	3.451	3.480
Urban-rural disposable income gap(2003)	3.655	3.640
Urban-rural disposable income gap(2004)	3.673	3.691
Urban-rural disposable income gap(2005)	3.646	3.692
Urban-rural disposable income gap(2006)	4.026	3.838
Urban-rural disposable income gap(2007)	3.588	3.747

B Additional Figures

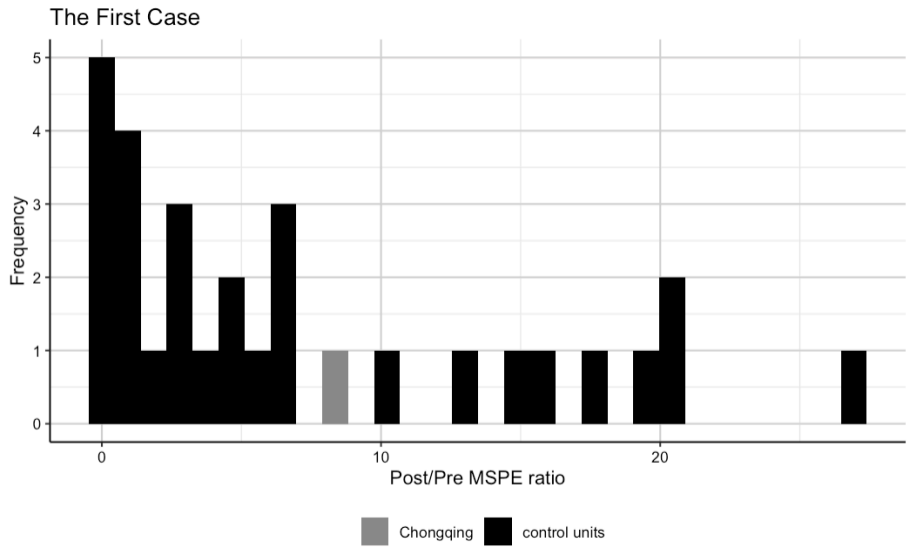


(a) First Case

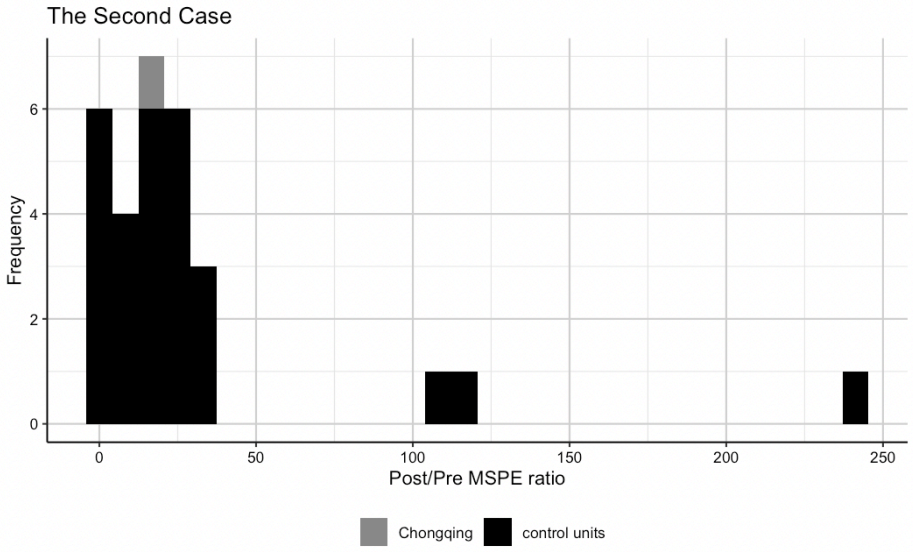


(b) Second Case

Figure 8: Placebo Test: Difference between observed units and synthetic controls for Chongqing and controls



(a) First Case



(b) Second Case

Figure 9: Ratio of post–policy and pre-policy RMSPE: Chongqing and Controls

C Datasets Sharing

C.1 #1 Province-level Dataset

This dataset integrates the data from the Chinese Statistical Yearbook (中国统计年鉴) from 2000 to 2019. It covers various macro variables, including GDP, income, rural-household info, and others.

The cleaned data is available at: clickable link

C.2 #2 County-level Dataset

This dataset integrates the data from the Chongqing Survey Yearbook (重庆调查年鉴) and Chongqing Country Land Exchange (重庆农村土地交易所) from 2009 to 2016. It covers various macro variables, including GDP, income, rural-household info, and others. Also, it combines the data of land coupon transactions from CCLE.

The cleaned data is available at: clickable link

C.3 Cleaned data of Land Coupon Transactions

This dataset is the cleaned raw data from Chongqing Country Land Exchange (重庆农村土地交易所) from 2009 to 2016.

The cleaned data is available at: clickable link

C.4 Cleaned data from 2013 CHIP

This dataset is the cleaned data from the Chinese Household Income Projects (CHIP) in 2013. It covers the cooked provincial data like calculated index of income inequality such as GINI and Theil, average education year, land demolition rate, subjective questions, and others. The associated calculation codes are also provided for future researchers.

The cleaned data is available at: the Rural data, the Urban data

The associated calculation codes (in *Rmd* format) are available at: the Rural code, the Urban code

D Chinese Abstract: Version 1.0

城乡间土地资源的低效配置是当今中国仍然面对的重要问题。在耕地“占补平衡”政策和乡村劳动力大规模外迁的大背景下，重庆市在 2008 年率先开始实施实验性质的地票制度，以求协调乡村宅基地的超额供给和城镇建设用地指标紧缺的矛盾。同时，政府希望通过地票制度带给农村居民的财产性收入让农村更直接地享受到城市化的好处。本篇论文通过运用计量领域最新的 MASC 估计法检验了地票制度实施十余年来对区域城乡可支配收入差距的影响。通过分析来自《中国统计年鉴》、《重庆调查年鉴》、以及从重庆农村土地交易所官网公告收集得到的数据，我们得出如下稳健结论：地票制度加速缩小了重庆市级数据的城乡间可支配收入差距。虽然数据显示地票交易对区县级城乡收入差距没有显著影响，但是各区县间的整体收入差距降低了。分析其中的机制，我们认为这是因为平均收入更低的区县和收入差距水平更高的区县更倾向于参与地票交易，进而有了更高效的土地资源分配机制，加快了当地经济发展，缩小了和相对发达区县的差距。