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# Do natural disasters influence long-term saving?: Assessing the impact of the 2008 Sichuan earthquake on household saving rates using synthetic control[**]

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**Abstract**: In this study, employing the synthetic control method (Abadie et al., 2003), we examine the short- and long-term effects of the 2008 Sichuan earthquake on saving behaviors. The results indicate that, in the short-run, the earthquake has caused drastic declines in household saving rates—from 24% to 7% and from 23% to 21% for rural and urban populations, respectively. However, household saving rates recovered to the baseline shortly after the shock, and they exactly match their counterfactual counterparts in the period ahead. The estimates imply that, at the aggregate level, the earthquake has no discernible long-run impact on the saving propensity of the affected population.

*Keywords:* Natural disaster, Sichuan earthquake, Saving, Synthetic control method, long-term impact

*JEL classification:* Q54, D81, E21

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# 1. Introduction

The economic impact of natural disasters has been attracting considerable attention in the past few decades. The ongoing debate mainly centers on how and whether natural catastrophes affect economic growth, with a large body of literature providing divergent insights. Economic models have predicted that the growth effects of natural events can be in distinct directions (positive, negative, or neutral) and magnitudes, both in the short- and long-run[1]. On the other hand, existing empirical literature has highlighted diverse findings as well. Incipient literature, such as Albala-Bertrand (1993), Tol and Leek (1999), and Skidmore and Toya (2002), reveals that economic growth tends to be positively correlated with the frequency and magnitude of moderate disasters, whereas more recent studies (Vigdor, 2008; Noy, 2009; Coffman and Noy, 2012; Strobl, 2012) discover that natural catastrophes lead to negative economic consequences, particularly for less-developed countries in the short term. Moreover, there is emerging evidence implying that natural disasters have a mixed impact on the aggregate growth. The overall effect depends on the features of disasters (type, intensity, and spatial extent, etc.), geographical conditions, and national characteristics (Toya and Skidmore, 2007; Loayza et al., 2009; Noy and Vu, 2010; Cavallo et al., 2013).

Literature on disaster impact has long been preoccupied with the growth effect, whereas the characterization of aggregate growth barely provides complete answers, thus the conundrum is ultimately an empirical one. Instead of investigating the economy as a whole and focusing merely

[1] For instance, according to traditional neoclassical models, provided that natural disasters only cause capital losses, technological progress should remain intact; thus, the shock spurts short-term growth but has a neutral effect in the long-run (in the steady state). On the other hand, endogenous growth models generally contend that destruction will lead to a permanent slowdown in growth, resulting in deviation from the equilibrium growth path, which can translate into a sluggish growth or even a poverty trap. Further, the "creative destruction" and "build back better" theories suggest that destruction can boost replacement, construction, and the use of new technologies, which might foster greater growth and probably a better economic potential in the event aftermath (Aghion and Howitt, 1990; Caballero and Hammour, 1991).

on economic growth, it seems desirable to take a further look into the mechanisms and channels through which the growth effect is formed. In this study, we make explicit attempts to identify the disaster impact on household saving—a critical and decisive determinant of economic growth. This perspective applies very well to China's case, as its economic development is largely driven by the capital-extensive investment pattern fueled by its extraordinarily high household saving rate.

Saving behavior is a central topic in economics. The common belief on the subject is that people tend to be conservative and save more in the wake of natural disasters, or they might simply become self-indulgent and consume more instead of saving. In this study, we employ the synthetic control method developed by Abadie et al. (2003, 2010, 2015) to estimate the short- and long-term effects of the 2008 Sichuan earthquake on household saving, to extend the empirical knowledge of saving behaviors. According to the results, the earthquake has caused substantial declines in Sichuan household saving rates—from 24% to 7% for the rural population, and from 23% to 21% for the urban population—as a manifestation of the direct economic losses from the disaster. However, we notice that both the rural and urban saving rates have rebounded to the "counterfactual" levels shortly after their cliff-fall drops. Accordingly, the earthquake has resulted in a short-term negative effect, while having no perceivable long-term effect on the saving propensity. This finding is confirmed by a "placebo test," and the main conclusion is robust across a series of checks employing alternative predictors.

The structure of the paper is as follows: In the next section, we discuss the existing literature relevant to the disaster impact on saving behaviors, and we concisely summarize the mechanisms of the effects. In Section 3, we give a brief overview of the 2008 Sichuan earthquake; what follows covers the empirical strategy (the synthetic control method), the data source, and the definition of variables. Section 4 presents the estimates, placebo test, and robustness checks. Section 5 closes the paper with brief concluding remarks.

# 2. Natural disasters and saving behaviors

Disaster impact on saving behaviors has seldom been explicitly examined so far. As a notable exception, Japan—as a disaster-prone country—has offered numerous valuable studies and fairly rich data sources on the topic of household decisions against natural events. In a literature survey, Horioka (1990) mentions that the high frequency and enormous damages of natural events occurring in Japan have contributed to its high saving persistence in the postwar periods. To the best of our knowledge, Skidmore (2001) is the first empirical attempt in English academic circles to look into the correlation between disasters and saving accumulation. Employing a cross-country estimation based on a sample of 14 developed nations, the analyst finds that disaster loss is positively correlated with household saving rate, in support of the precautionary saving hypothesis. In a subsequent study (Skidmore and Toya, 2002), the authors reveal a growth impact of climatic disasters on national capital accumulation. In a similar vein, Leiter et al. (2009) estimate that firms that were flood victims in Europe tend to pursue a higher growth in asset accumulation.

On the other hand, more recent empirical literature has presented different insights. Dercon (2004) discovers that rainfall shocks have significantly stimulated the consumption of rural residents in Ethiopia. Sawada and Shimizutani (2008) investigate how local residents insured themselves against the 1995 Kobe earthquake. Their analysis indicates that homeowners have dis-saved and borrowed extensively after the shock, implying that the formal and informal insurance systems were essentially ineffective and that the complete risk-sharing hypothesis can be rejected. Gignoux and Menéndez (2016) find that individuals who have experienced short-term economic losses from the Indonesian earthquakes, recovered in the medium-run, and even exhibited welfare gains (consumption growth) in the long term. Berlemann et al. (2015) study the effect of the 2002 European flood on saving behaviors. They conclude that mostly owning to the generous government compensation, the flood turns out to have depressed the victims' motive to save. Their finding lends

support to the much-debated hypotheses referred as "Samaritan's Dilemma" and "Charity hazard". In a study similar to the present one, Filipski et al. (2015) investigate the impact of the 2008 Sichuan earthquake on consumer behaviors. They find that households who lived closer to the epicenter, tend to save less, spend more on alcohol and cigarettes, and pursue more leisure activities after the shock.

The existing literature has provided diverse evidence with respect to the disaster impact on saving behaviors, yet the sign and magnitude of the overall effect remain ambiguous. To be clear, the disaster impact is a multi-dimensional issue that is rather complicated to quantify, since the destructive nature of disasters not only generates economic costs, but also triggers changes in consumer behaviors and influences people's attitude towards the future[2]. Matters are aggravated when it comes to empirical assessments because the statistical inference will be disturbed to a certain extent by the existing transfer mechanisms (e.g., disaster relief and donations). Here we briefly summarize the mechanisms and channels through which saving behavior is potentially driven.

First, natural disasters cause direct physical destruction. Households exposed to natural events confront the increases in expenditures (e.g., home, contents, and medical services). That is, those severely affected might have required available resources to cope with the adverse consequences, and they might encounter a higher risk of unemployment and negative income shocks (Vigdor, 2007; Deryugina et al., 2014). In this sense, individuals usually earn less and expend more

[2] Saving propensity generally increases with risk aversion (attitude towards risk) and decreases with time preference (the strategy to "discount" future outcomes). In behavioral economics, there is ample evidence suggesting that individuals respond to natural disasters by becoming more risk averse towards uncertainty (e.g., Van Den Berg et al., 2009; Cameron and Shah, 2015; Cassar et al., 2017). However, some support the contrary, that disaster victims tend to be risk tolerant and reckless, gamble more, and spend more on consumer goods (e.g., Eckel et al., 2009; Li et al., 2011; Page et al., 2014; Hanaoka et al., 2015; Filipski et al., 2015). In the context of time preference, Callen (2015) argues that consumers become less impatient after catastrophic events, whereas Cassar et al. (2017) advocate the opposite. Beyond economics, the impact known as post-traumatic stress disorder (PTSD) has been exclusively studied in medical fields with a consensus that extreme shocks usually depress saving motives.

after the event. In the short-run, the "volume effect" of natural disasters (e.g., destruction, income loss, losses of domestic and foreign investments) can lead to higher consumption and lower saving both in household and aggregate levels.

Second, through rational expectation, natural events influence the preference and behavioral responses of victims, which in turn induce a reallocation of time resources (Eckel et al., 2009; Cameron and Shah, 2015; Cassar et al., 2017). To simplify, there are roughly two kinds of uncertainties that exogenous shocks might bring about. One concerns uncertainty on future earnings, the other one concerns uncertainty on life expectancy. *(1)* After the 2008 earthquake, there was widespread awareness that Sichuan is located in the vicinity of dense faults, making it particularly vulnerable and susceptible to seismic activity. Saving is regarded as a tool to smooth the life-time consumption. To fend off the potential property damage, unemployment, and income loss, individuals living in disaster-prone regions react to the corresponding uncertainty by saving and other methods of self-insurance. *(2)* On the other hand, in the context of extreme natural catastrophes that can cause large number of casualties and human toll, rational agents might anticipate an increase in mortality and thus a decrease in their life expectancy. They will update their evaluation of the future by adjusting their time preferences, all of which in turn shape the patterns of consumption and saving[3]. In this case, extreme events are likely to cause a concentration on consumption other than on saving accumulation in the long-run. In summary, effects of risk perception offset each other. One promotes savings in preparation for latent economic losses, and the other one reduces savings in response to the perceived lower life expectancy. It is unclear how these effects would balance out on net.

[3] As a typical example, Kinugasa and Mason (2007) theoretically and empirically study the effect of changing mortality on national saving rates.

Third, the follow-on saving behaviors rely crucially on the objective factors. For instance, disaster consequences are often less severe in nations with higher insurance penetration, better institutions, greater openness, and better economic status (Kunreuther, 1996; Toya and Skidmore, 2007). In fact, private insurance usually does a poor job in the face of severe natural events, even in advanced economies with high take-up rates of insurance[4]. On the other side, in the wake of natural disasters, external elements—such as government compensation, disaster relief, adaptation policies, external aid, private donations, and transfers—have proven profound influences on consumer behaviors (Raschky and Weck-Hannemann, 2007; Cavallo et al., 2013; Berlemann et al., 2015; Gignoux and Menéndez, 2016). These factors have no doubt helped to relieve the direct disaster consequences, but will more or less blunt the statistical inference derived from empirical assessments.

Theoretical models and previous empirical evidence will only take us so far. To sum up, the overall impact of natural disasters on saving behaviors is ex-ante ambiguous. It seems a formidable enterprise to conceptually and practically reach a clear-cut conclusion on the subject, thus it is almost impossible to distinguish between various mechanisms of what might have driven the ups and downs in economic indicators. With respect to that, we would like to stress that the current study is *not* aimed at testing any of the hypotheses on saving behaviors. Instead, we pay careful attention to the validity of the statistics, the economic meaning, and the feasibility of empirical approaches to arrive at more accurate estimates of the disaster impact. All in all, there is an urgent need to move beyond the "short-term effect" and "statistical correlation" to extend the empirical knowledge on saving behaviors.

[4] See Skidmore and Toya (2001) for a comprehensive survey of the insufficiency of private insurance against extreme catastrophic events. See Sawada and Shimizutani (2008) and Horwich (2000) for the performance of Japanese self-insurance mechanisms in coping with the 1995 Kobe earthquake.

# 3. Background, empirical strategy, and data

### 3.1 2008 Sichuan earthquake

On May 12, 2008, an earthquake measuring 8.0 on the Richter scale hit the Sichuan province of China. The earthquake is recorded as one of the strongest natural disasters in human history, resulting in 69,268 deaths, 17,923 persons listed as missing, 374,643 injured, 5 million homeless, and 46 million people affected[5]. The direct economic loss is estimated at over US$ 120 billion, of which 27.4% was for housing destructions, 20.4% for non-residential destructions, and 21.9% for infrastructure damages. Sichuan province constituted 99% of the overall human toll and 91.3% of the total economic losses from the catastrophe (Gansu province represented 5.8%, and the Shaanxi province 2.8%)[6]. The earthquake was felt even by people living 2,000 km away from the epicenter. Between May 12 and June 23, the main shock was followed by hundreds of aftershocks, five of which reached the magnitude of MS 6.0. In April 2013, another severe earthquake of 7.0 on the Richter scale—also believed one of the aftershocks of the 2008 main shock—took place in Ya'an city, western Sichuan.

### 3.2 Empirical strategy

In the following parts, utilizing the earthquake as a natural experiment, we pursue a comparative event study to assess the disaster impact on household saving. Existing empirical literature on the subject tends to be limited in several aspects: First, most studies are oriented to assessing

[5] Borrowing the definition from EM-DAT (Emergency Events Database), "affected" denotes the people in need of immediate assistance during the post-event emergency period.

[6] The indicators in subsection 3.1 are directly taken from official figures available in the publications of the National Bureau of Statistics and the National disaster reduction and management council of China.

only the short-run effect. As the foregoing discussion underscores, direct economic costs from natural disasters usually lead to higher household expenditures, unemployment, and income fluctuations. In this sense, the effect is most likely to be identified as negative—an unfruitful inference—as the cross-section and short-panel estimations and micro-based analyses have done so far, yet the medium- and long-term impact remains vague and inconclusive. Second, conventional regression approaches pivot critically on the model-dependent extrapolation; these methods provide a weak safeguard against erroneous statistical inference, and thus might jeopardize the transparency and honesty of the estimates (Cavallo et al., 2013; Abadie et al., 2015). Third, most literature does not fully address the endogeneity concerns. On one side, it is apparent that economic indicators—such as disaster losses and fatalities, which are correlated with economic characteristics (the outcome variables), cannot serve as proper proxy for disaster occurrence. Further, there is a growing literature on disaster vulnerability considering disaster impacts as dependent variables, rather than explanatory variables. On the other side, as Kousky (2014) has suggested, incorporating disaster occurrence or frequency would not satisfy the endogeneity considerations as well, due to the inclusion criteria of databases, by which disaster occurrences in advanced economies are often under-reported. Accordingly, to utilize a natural disaster as a controlled experiment, the most harmless choice seems to be employing particular instrument variables (e.g., a time dummy variable and physical indexes). Fourth, in comparative case studies based on panel data, it is vital to control for time trends and for the heterogeneity problem[7]. Inferential techniques like the traditional DID

[7] In Abadie et al. (2010, 2015), the authors prove that when the length of pre-intervention periods is sufficient, the synthetic control method controls for the un-observed effects and mitigates the heterogeneity problem. The rationale is simple: only units that resemble in both the observed and unobserved characteristics *over sizable periods* are able to precisely produce the "counterfactual" estimates.

framework (difference-in-difference) might generate bias since the unobserved factors are generally not properly accounted for, and this is exactly the challenge in studying the dynamics of Chinese household behaviors[8].

We contribute to the literature by employing the methodological innovation formalized in Abadie et al. (2003, 2010, 2015), which is immune to the above limitations. The core concept of the methodology is to construct a comparable counterfactual scenario that demonstrates what the outcome trajectory the affected group would have experienced in the absence of the specific event of interest. The synthetic control method does not rely on statistical extrapolation; instead, it produces a reasonable "donor pool" in a data-driven manner by incorporating control groups comprised of unaffected units. The comparability of the treated group to the control group—supported by the visible similarities between the groups prior to the shock—facilitates us in displaying clearer pictures and more accurate estimates of the disaster impact. Accordingly, the causal effect can be derived from the comparison between the actual trajectory we observed and its counterfactual counterpart.

Following the enlightening works by Abadie et al. (2003, 2010, 2015), the part below briefly illustrates the theoretical underpinnings of the synthetic control method, combined with the case to be investigated in the study. Assume that there is a number of *J+1* districts (or provinces, administrative units, etc.), and the first district *(j=1)* is exposed to a specific event, whereas others are not. The first district *(j=1)* is the "treated unit," and the remaining *J* districts serve as the potential "donor pool." Let $S_{i,t}$ be the recorded value of the outcome variable, or we can simply name it as the saving rate. The earthquake occurred in 2008; thus, the pre-intervention period covers the initial year to 2007—*k* years in total.

[8] Household saving rates of China vary over time and across space. Official statistics indicate that the average saving rate of rural households by prefecture has been declining from 45% to 18%, whereas its urban counterpart has been rising from 18% to 30% in the past 20 years, demonstrated by the descriptive statistics (Table 1). To address the problem, the synthetic control method allows the unobserved effects to vary with time, rather than holding them constant in time as fixed effects.

Let $A_{1,t} = S_{1,t} - CS_{1,t}$ be the causal effect of the earthquake on the saving rate, where $S_{1,t}$ is the observed saving rate in district 1 (Sichuan province) at time *t*, $CS_{1,t}$ is the predicted counterfactual saving rate in district 1 at time *t*. As Abadie et al. (2015) put it, *"a combination of comparison units often does a better job of reproducing the characteristics of the treated unit than any single comparison unit alone or an equally weighted combination of several control units."* The strategy is to make explicit the contribution of each comparison unit to the counterfactual outcome, with proper weights that sum to unity[9]. This enables us to focus more on the similarity and divergence between the treated and control groups, which helps to cautiously select comparison units in order to reduce bias and discretion in observational case studies.

The method considers a $J \times 1$ vector W of weights, and each particular vector W represents a potential synthetic control, that is, a specific weighted average of control units. In general, the optimal vector W is chosen to minimize $\left\|\mathrm{X}_1 - \mathrm{X}_{other}\mathrm{W}\right\|_v = \sqrt{(\mathrm{X}_1 - \mathrm{X}_{other}\mathrm{W})'V(\mathrm{X}_1 - \mathrm{X}_{other}\mathrm{W})}$ [10], where $X_1$ is the $k \times 1$ vector of the observed pre-intervention characteristics (in the study, these can be the saving rate and its determinants) of treated unit over *k* years. $X_{other}$ is a $(k \times j)$ matrix of the same variables in the comparison units (*J* units in total). The method gauges whether the characteristics of the treated unit are efficiently matched by those of the synthetic controls. In other words, the synthetic control method is intended to employ a systematic algorithm—in common with the conventional least-squares estimation—to derive the optimal weights by which the comparison units best resemble the treated one.

[9] That is, $w_2 + w_3 + \cdots + w_{j+1} = 1$, with $0 \leq w_j \leq 1$, where $\mathrm{j} = 2, 3 \ldots \mathrm{j} + 1$.

[10] The process is to minimize the Euclidean distance between the pre-event values of the treated unit and those of its synthetic version. The equation can also be written as $\sum_{k=1}^{k} v_k(X_{1,k} - X_{other,k}\,W)^2$, where $X_{1,k}$ is the recorded value of the *k*-th variable for the treated unit; $X_{other,k}$ is the recorded values of the *k*-th variable for the comparison units. In this regard, $X_{other,k}\,W$ is the predicted value of *k*-th variable for the treated unit as the weighted average of the variables in the control units.

Notice that there are two matrices to be solved: The algorithm-derived weights W, and the $K \times K$ positive semidefinite matrix V—meant to sketch the relative importance of each predictor[11]. The choice of V influences the mean-square error of the estimators, but the estimated results are generally robust to different approaches for choosing V[12]. For instance, it can be subjectively assessed under scrutiny, or it can be derived from cross-validation (Abadie et al., 2015), by "nested" optimization (Kaul et al., 2015), or by regression approaches (Bohn et al., 2014). A common practice is to select the optimal matrix V among all positive and diagonal matrices that minimizes the mean-square error of the synthetic control estimators over the pre-intervention period. Once the matrix V is obtained, the vector W becomes derivable; then, the causal effect can be assessed as $A_{1,t} = S_{1,t} - \sum_{j=2}^{j+1} w_j S_{j,t}$, for the treated unit at time *t* in the post-intervention period.

Although the synthetic control method has never put the long debate on "the best overall approach" to rest, there does appear to exist a consensus among academicians that this method offers superiorities over other approaches in many ways (Saunders et al., 2015; Gobillon and Magnac, 2016; Athey and Imbens, 2017; Gardeazabal and Vega-Bavo, 2017). The methodology is deemed to be a bridge—which is theoretically sound as well as empirically feasible—between quantitative and qualitative approaches in comparative case studies, and its application is becoming increasingly popular in diverse research topics[13].

### 3.3 Data and variables

In the current study, the main objective is to capture the short- and long-term effects of the 2008 Sichuan earthquake on household saving. We will focus primarily on the rural household

[11] Variables with a larger explanatory power in predicting the outcome variable can be assigned larger weights.

[12] For a detailed discussion on different procedures for computing "V," see Abadie et al. (2003, 2010, 2015), Kaul et al. (2015), and Klößner et al. (2017).

[13] The interested reader can consult Kaul et al. (2015) for a comprehensive survey of the empirical applications of the synthetic control method.

saving rate for several considerations: First, the epicenter (Wenchuan County) is located in rural districts, surrounded by dozens of other villages, which subsequently became the worst devastated regions. According to the official figures and anecdotal evidence, mountainous and less wealthy areas in Sichuan province suffered the most, both from the direct economic losses and from the casualties during the shock. Second, largely due to the inferior rural welfare benefits as well as the greater fluctuation in agricultural income, rural residents rely more on household saving as a self-insurance mechanism against risk, and they have a greater need for precautionary saving. On the other hand, urban residents have highly subsidized social securities and relatively diverse financial approaches, making it difficult to capture the disaster impact only by specifying the effect on their household savings. The rural saving rate suits our objectives better in assessing the precautionary motive as well as the effect of the direct disaster losses, which can translate into more pronounced and precise estimates.

The outcome variable of interest—rural household saving rate—is calculated in a traditional manner as the average ratio of household saving to household disposable income by prefecture. We also include several standard determinants of saving behaviors as predictors (i.e., the contents in matrix X), such as the share of housing and education expenditures, sex ratio (the number of males to that of females), transfer income ratio (share of intra-family and government transfers in total disposable income), level (logged) and growth rate of disposable income, total bank lending (proportion of total bank lending in prefectural nominal GDP), and the lag terms of the outcome variable[14]. We have also conducted experiments with an array of alternative predictors of saving behaviors, such as the dependency ratio, urbanization ratio, life expectancy, inflation rate, FDI and

[14] According to Kaul et al. (2015), in applying the synthetic control method, the introduction of *all* outcome lags as separate predictors renders other covariates irrelevant, which might generate bias and lead to totally different implications. To be conservative, we restrict the number of incorporated lags to a value less than 3—a reasonable setting adopted in Abadie et al. (2003, 2010).

CPI indexes; their inclusion did not change the results substantively, and we dropped these observations in the interest of space. In the robustness tests, we exploit the level and growth of cash deposits, and total retail sales of consumer goods as alternative outcome indicators, to be revealed in the next section. For completeness, descriptive statistics are displayed in Table 1.

The analysis is based on China's provincial data comprised of 30 units (i.e., provinces, autonomous regions, or municipalities) covering the period 1995-2015, which is to our knowledge the most complete official dataset recording Chinese household surveys assembled to date. The data source provides a pre-event period of at least 13 years (from 1995 to 2007), and an ex-post period of 8 years (from 2008 to 2015). In the robustness tests, we extend the time span to 1990 by employing alternative outcome indicators in the place of household saving rates. All variables are taken and constructed directly from statistics available in the Chinese statistics yearbook, population and employment statistics yearbook, and finance and banking yearbook, published by the National Bureau of Statistics of China.

One limitation of the dataset is that, a handful of variables are not available for certain administrative units over particular periods. For instance, Chongqing city became independent from Sichuan province in 1997; thus, some indicators were not recorded until 1997. Statistics on Tibet are often unavailable and we have to drop this observation when computing certain estimates.

Another issue is that, the synthetic control group has to be constructed as a weighted average of the *unaffected* units. As a result, Chongqing city and Gansu province, which have also been significantly affected by the earthquake, are not likely to serve as suitable comparison units. Thus, we need to discard them from the donor pool or simply make sure that their weights in the synthetic control group are sufficiently small.

As a major drawback, China's historical data appears highly inconsistent across the overall period due to the systematic changes in statistical approaches and in definitions—the revisions of China's statistical systems in 1992, 2002, and 2012. To address this problem, one might be tempted

to smooth the data trends instead of trying to retain all the time-series information. However, this inconsistency in statistical standards does not disturb the estimated results, since the revisions are in essence "exogenous shocks" occurring nationwide simultaneously. That is to say, as long as the revisions only lead to indiscriminate overstatements or understatements on the economic indicators, in applying the synthetic control method, these structural processes will be eliminated through the DID procedure (confirmed in the next section).

# 4. Results

In this section, to estimate the impact of the 2008 Sichuan earthquake on household saving, we construct the "synthetic Sichuan"—a weighted combination of the control units in the donor pool—which most closely reproduces the characteristics of the treated unit preceding the disaster. We begin by studying the evolution of Sichuan's rural household saving rate as well as its synthetic counterpart. As noted, we believe that the rural saving rate suits our objective best in terms of assessing the precautionary motive and the direct economic costs of the event. The 2008 Sichuan earthquake is one of the most economically significant disasters in human history; it is arguably the least predictable type of natural event, and it has caused grave consequences in a relatively short time. In an economic point of view, the earthquake provides a feasible natural experiment to study. The severity of the shock—relative to the frequently occurring events (other natural disasters, political changes, etc.) and other determinants of saving behaviors—helps us to capture the otherwise insignificant impact on the aggregate economy.

Before proceeding, it is important to scrutinize the similarity and divergence among the units. Table 2 demonstrates the pre-intervention characteristics for Sichuan, for the national average (Sichuan excluded), and for the synthetic control group. The comparison between Sichuan and the nationwide average indicates that an equally weighted combination of all the provinces—with a

considerably higher share of housing expenditure, higher growth and level of income, and higher proportion of transfer income—cannot serve as a proper control group for the treated unit. In contrast, the synthetic Sichuan accurately replicates the prior-to-event characteristics of Sichuan (the "inner optimization"), which verifies its overall consistency and comparability. The estimated weights of the control units (i.e., the vector W) show that the pre-intervention trajectory of Sichuan's household saving rate is best reproduced by Inner Mongolia (58.1%), Tibet (22.9%), Fujian (11.8%), and Ningxia (6.7%). These control units resemble Sichuan in geographic features, economic characteristics, and in demographic structures; more importantly, they were not directly exposed to the 2008 Sichuan earthquake, nor were they reported to have been through significant shocks over the post-intervention period.

Figure 2 plots Sichuan's rural household saving rate along with the respective synthetic version, for the period 1995-2015. The synthetic counterpart closely tracks the actual trajectory over the entire pre-event period; in particular, it matches the recorded saving rate in 2008[15], implying a sensible approximation to the counterfactual representing what would have become in the absence of the event (the "outer optimization"). Immediately after the earthquake, the reported saving rate dropped noticeably from 24% to 7%—a decline of 71% in the saving propensity—within one year, whereas the synthetic trajectory appears to maintain the same level after the shock. The discrepancy implies a pronounced negative impact on saving motives, as a manifestation of the direct economic losses from the disaster. The result also confirms the validity of the preferred outcome variable (rural household saving rate), as the adverse effect is proven non-trivial using the

[15] In the estimate, we set 2008 as the end of the pre-intervention period because we observe no significant change in the saving rate in 2008, but in 2009. To be candid, chances are high that there is a time asymmetry as a result of the interruption of household surveys, which leaves the statistical offices no choice but to rely on pre-intervention statistics to complete their work. In this sense, our estimate based on the survey data is inclined to understate the adverse impact on household saving. However, our main conclusion remains intact, since even the underestimated effect suffices to verify its statistical significance, to be explored below.

proxy. The inference is broadly in line with historical experience and with the empirical findings over the short-term disaster effects on saving behaviors (such as Sawada and Shimizutani, 2008; Berlemann et al., 2015; Filipski et al., 2015).

As Figure 2 suggests, however, in the second year of the catastrophe, the saving rate has rapidly recovered to its synthetic state value, and it almost exactly matches its synthetic counterpart in the period ahead. This finding is somewhat in support of the "target saving" hypothesis[16], which indicates that a typical agent will retain a certain amount of savings as a buffer stock against risk (Chamon and Prasad, 2010; Nabar, 2011). It also lends support to the traditional macroeconomic theories, which predict that exogenous shock is neutral to the steady-state growth as the temporary loss would be recovered in the future (Charvériat, 2000). In summary, our finding implies that the earthquake did not significantly influence the long-term saving propensity of the affected population.

Is this inference empirically relevant? Noted that the saving accumulation of household has long been the main force behind China's economic success, referring to the official figures, one can observe that the growth rate of Sichuan's nominal GDP has been increasing steadily from 8.5% to 14.5% during the period 2000-2007, dropped to 11.0% in 2008, then quickly rebounded to 14.5% in 2009, and maintained its value at around 15% until 2012. The aggregate growth of Sichuan moves in a direction consistent with its saving cycle, sharing an acute "V-shaped pattern" over the turbulent period.

Looking at Figure 2, one might be curious about the drastic declines in the recorded saving rates and wonder whether this problem impairs the reliability of the analysis. As stated in Section 3, this inconsistency (triggered by the revisions of statistical systems) does not disturb the statistical inference, since the structural processes have driven the economic indicators indiscriminately

[16] Also refer to the conventional saving hypotheses known as "habit persistence," "habit formation," and "stickiness of consumption," proposed by Modigliani, Duesenberry, and other numerous researchers.

across spaces, and it is evident that the synthetic trajectory perfectly reflects the abnormal fluctuations over the transition periods (the revisions in 1992, 2002 and 2012).

### 4.1 Placebo test

To derive the statistical significance of the estimate, we conduct an "in-space placebo" test frequently used in comparative case studies (e.g., Abadie et al., 2003, 2010, 2015; Bertrand et al., 2004). The strategy is to find out whether other regions (the control units) have experienced even greater shocks relative to the treated unit, probably as a result of the "spillover effect."[17] We conduct the placebo experiment by applying the synthetic control method to every unit in the donor pool. That is, in each exercise the intervention is artificially *re-assigned* to one of the control units, with the treated unit (Sichuan) shifted to the donor pool. Figure 3 displays the results, where the gray line represents the divergence between the recorded value of the saving rate and that of its synthetic counterpart for each region[18]; the black line is the estimate for Sichuan, the one obtained in Figure 2. The gap over the pre-intervention period can be interpreted as the "prediction error" in the context of comparative case studies. If the deviation is negligible, we consider that the synthetic control precisely reproduces the prior-to-event outcome for the treated unit. In this case, the gap over the post-intervention period closely approximates the impact of the specific event. As Figure 3 makes apparent, the prediction error in the estimate for Sichuan is minor, verifying the validity of the methodology. The cliff-fall drop in Sichuan's rural household saving rate in 2009 is by far the largest one-year shock among all the estimates, and the resilience in 2010 is the most rapid

[17] It is possible that the earthquake has caused non-negligible short-term effects on the saving rates of other provinces, because some of them were directly exposed, although modestly, to the event (Shaanxi and Gansu, etc.). Further, the adverse impact might not be restricted to Sichuan and its surrounding areas, since most of the administrative units have been putting their efforts in the relief work, which has cost enormous amounts of resources and human capital. In this regard, the estimated result might be contaminated and ill-advised if the affected regions are identified as the synthetic control units.

[18] In each estimate, we use the same modeling strategy as the estimate in Figure 2.

recovery in the overall observations, let alone the fact that deviations (prediction errors) in some estimates are already large prior to the event.

To obtain a comprehensive statistical significance of the result, we follow the works of Abadie et al. (2003, 2010, 2015) and Rosenbaum (2005). Given that the process has generated 29 placebo runs for control units, under the random permutation, the probability of receiving an adverse effect or obtaining a recovery—of the magnitude greater than those for Sichuan in 2009 and in 2010—is considered to be less than 3.3% (1/30) for each instance, a sufficient significance in the statistical sense. The placebo test validates the transitory negative effect on rural household saving. To be precise, the 2008 Sichuan earthquake has led to a sharp decline in Sichuan's rural household saving rate by 17% within a year, but it has no long-term impact, since the saving rate rebounded to the baseline shortly after the shock.

**4.2 Robustness test**

As Hayashi (1986) notes it, in studying saving issues, the relevant concept to be considered is not only the household saving rate, but also other prominent features, reflections, and manifestations of "savings." To test the robustness, we make attempts to incorporate alternative outcome variables to replace the rural household saving rate, evaluating to what extent the main conclusion is limited to particular outcome specifications. The estimated results presented below confirm that the main inference derived from the previous estimates is fairly robust to alternative outcome indicators. In each sensitivity test, we have also conducted the placebo tests but these are not reported here in the interest of space, and because they will only strengthen our conclusion that the earthquake has no long-term impact on saving accumulation. To recapitulate, as we change the observation angle from "the most affected" to "the less affected" and from "the micro" to "the macro," the adverse disaster impact diminishes and the estimates do not exhibit much of a long-run impact on the patterns of saving and consumption.

**(1) Urban household saving rate**

To test the robustness, a basic solution is to employ the saving rate of urban household as well. However, one should be cautious that this intuition might not provide accurate answers, since urban regions in Sichuan are remarkably different from others in many aspects. According to the official figures, urban residents in Sichuan have the lowest household saving rate and the highest share of leisure expenditure among all the prefectures (except Tibet). Moreover, Sichuan's urban population has long been known for its high proclivity to consumption and an epicurean life-style. Recall that the synthetic control method is designed to replicate certain outcome variables for the treated unit through exploiting the available information in the control units with respect to the outcome of interest, it is crucial to make sure that the economic indicators of the treated unit are in the middle of the convex hull derived from the control units. However, saving predictors on Sichuan's urban residents are either in the low-end or in the high-end among the overall observations. This makes it rather difficult to precisely track down the saving rate, since there is no combination of control units that could accurately reproduce an outlier, except by itself or by allowing for negative weights (see footnote 9).

Using the same modeling strategy, we estimate the disaster effect on Sichuan's urban household saving rate. As predicted, Table 3 implies that the synthetic control does not well approximate the treated unit. For certain variables, the discrepancy between the actual value and the synthetic scenario value turns out even larger than that between the actual value and national average. Of necessity, Figure 4 suggests that the prediction error of the estimate is non-negligible. In light of this deficiency, we will be conservative in interpreting this part and limit its discussion. However, the estimate clearly points out that the urban saving rate has also been declining in the initial period of the shock, and it ascended to the synthetic state before long. This evolution has a lot in common with the finding in the rural part, in which the earthquake has a transitory but significant adverse effect on household saving.

**(2) Cash deposit and consumer goods**

In the preceding parts, we employed household saving rates as the outcome variables. In general, subjective measures derived from household surveys are often plagued by the problems of non-randomization, reporting bias, and sample attrition. In comparison, aggregate/macro accounts have a widespread availability, and they can be instructive in mirroring the objective reality regarding saving behaviors. Based on this idea, considering the provincial economy as a whole, we interpret the gross domestic product as "income," and the total cash deposits as "saving." We incorporate two kinds of deposit ratio: in "stock" and in "flow."[19] In a similar vein, the consumption ratio is proxied by the proportion of total retail sales of consumer goods in nominal GDP, meant to capture the tendency for consumption at the provincial level.

Tables 4-6 suggest that these outcome variables have been well reproduced by the synthetic control units. According to Figures 5 and 6, the earthquake appears to have slightly promoted the level and flow of deposits accumulation, inferring that the total dis-saving to finance rebuilding and other follow-on costs is more than compensated by the growth effects. The net growth in deposits is more likely a reflection of the reconstruction expenses and disaster reliefs, which need to be operated through the banking systems. Nevertheless, these effects appear statistically insignificant in consideration of the highly volatile nature of both indicators. In Figure 7, again, despite a seemly large inconsistency in the predictor (due to the 1992 and 2002 revisions of statistical systems), the synthetic control closely tracks the actual trajectory and it perfectly fits the post-intervention trend. This implies that, at the aggregate level, Sichuan's propensity to consume has not been influenced by the earthquake.

[19] "Stock" denotes the proportion of total cash deposit to annual GDP by prefecture; "flow" denotes the proportion of growth in total cash deposit to annual GDP by prefecture. The "flow" is more consistent with the conventional notion of household saving, which is a residual concept representing the income flow, rather than stock.

# 5. Conclusion and reservation

In the current study, exploiting the synthetic control method formalized in Abadie et al. (2003, 2010, 2015), we estimate the impact of the 2008 Sichuan earthquake on the saving behaviors of the local residents. The findings suggest that the earthquake has a significant short-term adverse impact on household saving rates, as a reflection of the direct economic losses from the event. However, contrary to the popular beliefs that people will become more conservative and save more after extreme shocks, or that they might simply abandon themselves with irrational consumption, we reveal that the earthquake has not influenced the patterns of saving and consumption of the affected population in the long-run. The main conclusion is confirmed by a "placebo test," and the inference is proven robust across a series of experiments employing alternative outcome predictors and explanatory variables. This study explores a brand new angle to investigate the growth impact of natural disasters; it presents new evidence on the short- and long-run disaster effects on saving behaviors. Some of our findings might be helpful for reconciling the diverse conclusions of recent studies.

On the other hand, we would like to caution that these findings *do not* necessarily imply a neutral disaster impact on saving propensity or that consumers are perfectly resilient to extreme shocks. Rather, it might well be that some victims (households, corporations, and sectors) suffered devastating losses whereas others moved ahead, with the overall effects canceling out on net. More importantly, there are several aforementioned factors that might have contaminated the statistical inferences, and the quick recovery in saving rates might be an indication that the victims have received generous disaster relief as a combination of government compensation, external aids, and other transfers. Perhaps the most important concern in this regard is the unprecedented scale of

formal and informal donations, as well as the immediate emergency responses by Chinese governments at all costs, irrespective of ideology and affiliation. The warm-hearted and cool-headed assistance has unquestionably succeeded in lessening the direct economic consequences of the disaster. In our estimates, we have taken into account some of the channels through which the results might be disturbed, ruling out the confounding effects such as income fluctuations, enlarging housing expenses, and the receipt of transfers. Yet, due to the data limitation, drawing a definitive conclusion on the subject is beyond the scope of this paper[20]. We are looking forward to further exploration on the topic.

# Reference


Aghion, P., & Howitt, P. (1990). *A model of growth through creative destruction* (No. w3223). National Bureau of Economic Research.

Albala-Bertrand, J. M. (1993). Political economy of large natural disasters: with special reference to developing countries. *OUP Catalogue*.

Abadie, A., & Gardeazabal, J. (2003). The economic costs of conflict: A case study of the Basque Country. *The American Economic Review, 93*(1), 113-132.

Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. *Journal of the American statistical Association, 105*(490), 493-505.

Abadie, A., Diamond, A., & Hainmueller, J. (2015). Comparative politics and the synthetic control method. *American Journal of Political Science, 59*(2), 495-510.

Athey, S., & Imbens, G. W. (2017). The state of applied econometrics: Causality and policy evaluation. *The Journal of Economic Perspectives, 31*(2), 3-32.

Bertrand, M., Duflo, E., & Mullainathan, S. (2004). How much should we trust differences-in-differences estimates?. *The Quarterly journal of economics, 119*(1), 249-275.


[20] The interested reader can refer to the literature on the effectiveness of insurance markets and government transfers in coping with natural events (such as Raschky and Weck-Hannemann, 2007; Berlemann et al., 2015; Gignoux and Menéndez, 2016). This line of research presents comprehensive background surveys, which help to draw an initial impression on the mechanism and magnitude of disaster relief in real-world economies.

Bohn, S., Lofstrom, M., & Raphael, S. (2014). Did the 2007 Legal Arizona Workers Act reduce the state's unauthorized immigrant population?. *Review of Economics and Statistics, 96*(2), 258-269.

Berlemann, M., Steinhardt, M. F., & Tutt, J. (2015). Do natural disasters stimulate individual saving? Evidence from a natural experiment in a highly developed country.

Caballero, R. J., & Hammour, M. L. (1991). *The cleansing effect of recessions* (No. w3922). National Bureau of Economic Research.

Charvériat, C. (2000). Natural disasters in Latin America and the Caribbean: An overview of risk.

Chamon, M. D., & Prasad, E. S. (2010). Why are saving rates of urban households in China rising?. *American Economic Journal: Macroeconomics, 2*(1), 93-130.

Coffman, M., & Noy, I. (2012). Hurricane Iniki: measuring the long-term economic impact of a natural disaster using synthetic control. *Environment and Development Economics, 17*(2), 187-205.

Cavallo, E., Galiani, S., Noy, I., & Pantano, J. (2013). Catastrophic natural disasters and economic growth. *Review of Economics and Statistics, 95*(5), 1549-1561.

Cameron, L., & Shah, M. (2015). Risk-taking behavior in the wake of natural disasters. *Journal of Human Resources, 50*(2), 484-515.

Callen, M. (2015). Catastrophes and time preference: Evidence from the Indian ocean earthquake. *Journal of Economic Behavior & Organization, 118,* 199-214.

Cassar, A., Healy, A., & Von Kessler, C. (2017). Trust, risk, and time preferences after a natural disaster: experimental evidence from Thailand. *World Development, 94,* 90-105.

Dercon, S. (2004). Growth and shocks: evidence from rural Ethiopia. *Journal of Development Economics, 74*(2), 309-329.

Deryugina, T., Kawano, L., & Levitt, S. (2014). *The economic impact of hurricane katrina on its victims: evidence from individual tax returns* (No. w20713). National Bureau of Economic Research.

Eckel, C. C., El-Gamal, M. A., & Wilson, R. K. (2009). Risk loving after the storm: A Bayesian-Network study of Hurricane Katrina evacuees. *Journal of Economic Behavior & Organization, 69*(2), 110-124.

Filipski, M. J., Jin, L., Zhang, X., & Chen, K. Z. (2015). Living like there's no tomorrow: Saving and spending following the Sichuan earthquake.

Gignoux, J., & Menéndez, M. (2016). Benefit in the wake of disaster: Long-run effects of earthquakes on welfare in rural Indonesia. *Journal of Development Economics, 118,* 26-44.

Gobillon, L., & Magnac, T. (2016). Regional policy evaluation: Interactive fixed effects and synthetic controls. *Review of Economics and Statistics, 98*(3), 535-551.

Gardeazabal, J., & Vega-Bayo, A. (2017). An Empirical Comparison Between the Synthetic Control Method and HSIAO et al.'s Panel Data Approach to Program Evaluation. *Journal of Applied Econometrics, 32*(5), 983-1002.

Hayashi, F. (1986). Why is Japan's saving rate so apparently high?. *NBER macroeconomics annual, 1,* 147-210.

Horioka, C. Y. (1990). Why is Japan's household saving rate so high? A literature survey. *Journal of the Japanese and International Economies, 4*(1), 49-92.

Horwich, G. (2000). Economic lessons of the Kobe earthquake. *Economic development and cultural change, 48*(3), 521-542.

Hanaoka, C., Shigeoka, H., & Watanabe, Y. (2015). *Do risk preferences change? Evidence from panel data before and after the great east Japan earthquake* (No. w21400). National Bureau of Economic Research.

Kunreuther, H. (1996). Mitigating disaster losses through insurance. *Journal of risk and Uncertainty, 12*(2), 171-187.

Kinugasa, T., & Mason, A. (2007). Why countries become wealthy: the effects of adult longevity on saving. *World Development, 35*(1), 1-23.

Kousky, C. (2014). Informing climate adaptation: A review of the economic costs of natural disasters. *Energy Economics*, *46*, 576-592.

Kaul, A., Klößner, S., Pfeifer, G., & Schieler, M. (2015). Synthetic control methods: Never use all pre-intervention outcomes as economic predictors. Unpublished

Klößner, S., Kaul, A., Pfeifer, G., & Schieler, M. (2017). *Comparative Politics and the Synthetic Control Method Revisited: A Note on Abadie et al.(2015)*. Working Paper. Saarbrücken, Germany: Saarland University. 2100 M Street NW Washington, DC 20037.

Leiter, A. M., Oberhofer, H., & Raschky, P. A. (2009). Creative disasters? Flooding effects on capital, labour and productivity within European firms. *Environmental and Resource Economics, 43*(3), 333-350.

Loayza, N., Olaberria, E., Rigolini, J., & Christiaensen, L. (2009). Natural disasters and growth-going beyond the averages.

Li, J. Z., Li, S., Wang, W. Z., Rao, L. L., & Liu, H. (2011). Are people always more risk averse after disasters? Surveys after a heavy snow-hit and a major earthquake in China in 2008. *Applied cognitive psychology, 25*(1), 104-111.

Noy, I. (2009). The macroeconomic consequences of disasters. *Journal of Development economics, 88*(2), 221-231.

Noy, I., & Vu, T. B. (2010). The economics of natural disasters in a developing country: The case of Vietnam. *Journal of Asian Economics, 21*(4), 345-354.

Nabar, M. M. (2011). *Targets, interest rates, and household saving in urban China* (No. 11-223). International Monetary Fund.

Page, L., Savage, D. A., & Torgler, B. (2014). Variation in risk seeking behaviour following large losses: A natural experiment. *European Economic Review, 71,* 121-131.

Rosenbaum, P. R. (2005). Heterogeneity and causality: Unit heterogeneity and design sensitivity in observational studies. *The American Statistician, 59*(2), 147-152

Raschky, P. A., & Weck-Hannemann, H. (2007). Charity hazard—A real hazard to natural disaster insurance?. *Environmental Hazards, 7*(4), 321-329.

Skidmore, M. (2001). Risk, natural disasters, and household savings in a life cycle model. *Japan and the World Economy, 13*(1), 15-34.

Skidmore, M., & Toya, H. (2002). Do natural disasters promote long-run growth?. *Economic Inquiry, 40*(4), 664-687.

Sawada, Y., & Shimizutani, S. (2008). How Do People Cope with Natural Disasters? Evidence from the Great Hanshin-Awaji (Kobe) Earthquake in 1995. *Journal of Money, Credit and Banking, 40*(2-3), 463-488.

Strobl, E. (2012). The economic growth impact of natural disasters in developing countries: Evidence from hurricane strikes in the Central American and Caribbean regions. *Journal of Development economics, 97*(1), 130-141.

Saunders, J., Lundberg, R., Braga, A. A., Ridgeway, G., & Miles, J. (2015). A synthetic control approach to evaluating place-based crime interventions. *Journal of Quantitative Criminology, 31*(3), 413-434.

Tol, R., & Leek, F. (1999). Economic analysis of natural disasters. *Climate change and risk,* 308-327.

Toya, H., & Skidmore, M. (2007). Economic development and the impacts of natural disasters. *Economics Letters, 94*(1), 20-25.

Vigdor, J. L. (2007). The Katrina Effect: Was There a Bright Side to the Evacuation of Greater New Orleans?. *The BE Journal of Economic Analysis & Policy, 7*(1).

Vigdor, J. (2008). The economic aftermath of Hurricane Katrina. *The Journal of Economic Perspectives, 22*(4), 135-154.

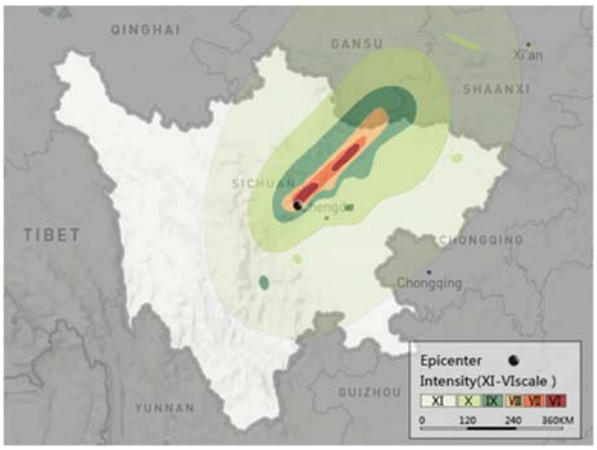
Van Den Berg, M., Fort, R., & Burger, K. (2009, August). Natural hazards and risk aversion: Experimental evidence from Latin America. *In International Association of Agricultural Economists Conference, Beijing, China* (pp. 16-22).

***Table 1: Descriptive statistics***

| Variable | N | Mean | SD | Min | Max | Variation decomposition | |
|---|---|---|---|---|---|---|---|
| | | | | | | Cross provinces | Over time |
| Saving | 630 | 0.309 | 0.149 | -0.162 | 0.656 | 39% | 61% |
| Education | 630 | 0.072 | 0.023 | 0.005 | 0.160 | 47% | 53% |
| Housing | 630 | 0.121 | 0.041 | 0.018 | 0.255 | 38% | 62% |
| Sex-ratio | 630 | 1.046 | 0.036 | 0.923 | 1.204 | 47% | 53% |
| Income | 630 | 3.576 | 0.304 | 2.945 | 4.366 | 49% | 51% |
| Pension | 630 | 0.068 | 0.050 | 0.010 | 0.292 | 30% | 70% |
| Income-G | 630 | 0.115 | 0.074 | -0.117 | 0.507 | 20% | 80% |
| | | | | | | (Part 1: rural household saving behaviors) | |
| Saving | 609 | 0.248 | 0.059 | 0.129 | 0.402 | 35% | 65% |
| Education | 609 | 0.090 | 0.017 | 0.047 | 0.145 | 37% | 63% |
| Housing | 609 | 0.079 | 0.028 | 0.031 | 0.238 | 21% | 79% |
| Sex-ratio | 609 | 1.046 | 0.036 | 0.923 | 1.204 | 50% | 50% |
| Income | 609 | 4.024 | 0.287 | 3.457 | 4.724 | 27% | 73% |
| Pension | 609 | 0.236 | 0.057 | 0.091 | 0.375 | 45% | 55% |
| Income-G | 609 | 0.109 | 0.047 | -0.023 | 0.313 | 15% | 85% |
| | | | | | | (Part 2: urban household saving behaviors) | |
| Deposit | 754 | 0.657 | 0.208 | 0.144 | 1.781 | 51% | 49% |
| Propensity | 609 | 0.098 | 0.059 | -0.268 | 0.645 | 31% | 69% |
| Consumption | 754 | 0.368 | 0.071 | 0.124 | 0.727 | 45% | 55% |
| Sex-ratio | 754 | 1.043 | 0.054 | 0.506 | 1.204 | 37% | 63% |
| Income | 754 | 3.455 | 0.383 | 2.633 | 4.366 | 31% | 69% |
| Bank lending | 754 | 1.101 | 0.570 | 0.091 | 4.893 | 60% | 40% |
| Income-G | 754 | 0.123 | 0.088 | -0.173 | 0.635 | 6% | 94% |
| Dependency | 754 | 0.421 | 0.094 | 0.193 | 0.680 | 46% | 54% |
| | | | | | | (Part 3: robustness tests) | |

**Source**: All variables are taken and constructed directly from statistics available in the Chinese statistics yearbook, population and employment statistics yearbook, and finance and banking yearbook, published by the National Bureau of Statistics of China.

***Figure 1: the 2008 Sichuan earthquake***




**Source**: From the National disaster reduction and management council of China.

***Figure 2: Rural household saving rate***

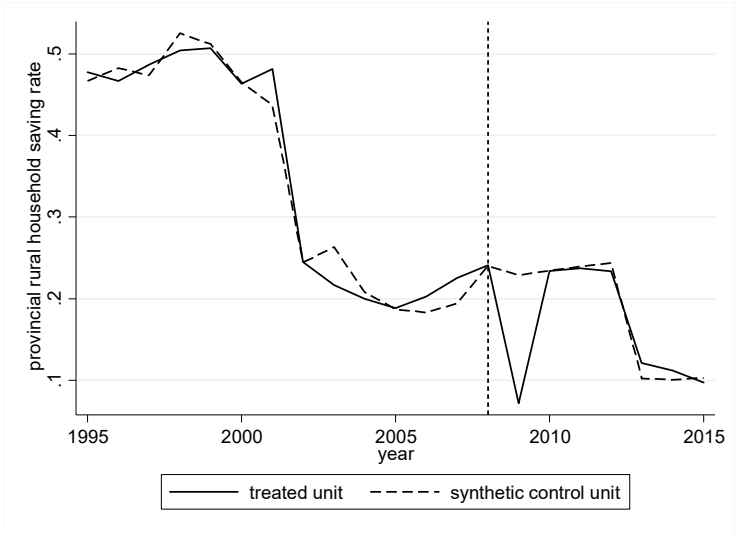



***Table 2. Predictor means (Rural)***

| Variables | Sichuan province | | Average of control groups |
|---|---|---|---|
| | Observed | Synthetic | |
| Education | 0.075 | 0.075 | 0.072 |
| Housing | 0.091 | 0.091 | 0.121 |
| Sex-ratio | 1.049 | 1.038 | 1.046 |
| Income | 3.315 | 3.323 | 3.576 |
| Transfer | 0.046 | 0.046 | 0.068 |
| Income-growth | 0.109 | 0.109 | 0.115 |

**Note**: All variables are averaged over the period 1995-2008 by prefecture. The last column presents the national average (excluding Sichuan) over the 1995-2008 period.

***Figure 3: Gaps between recorded household saving rate and its synthetic counterpart***

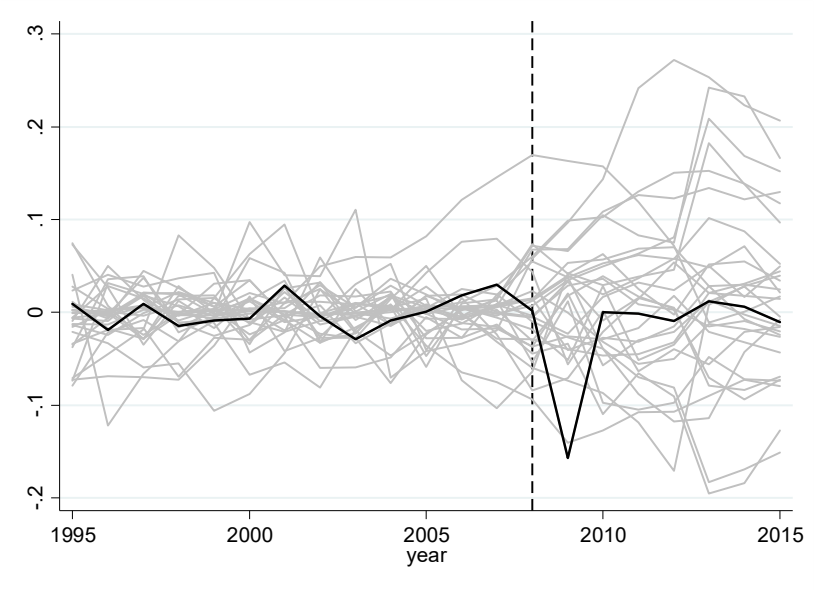


***Figure 4: Urban household saving rate***

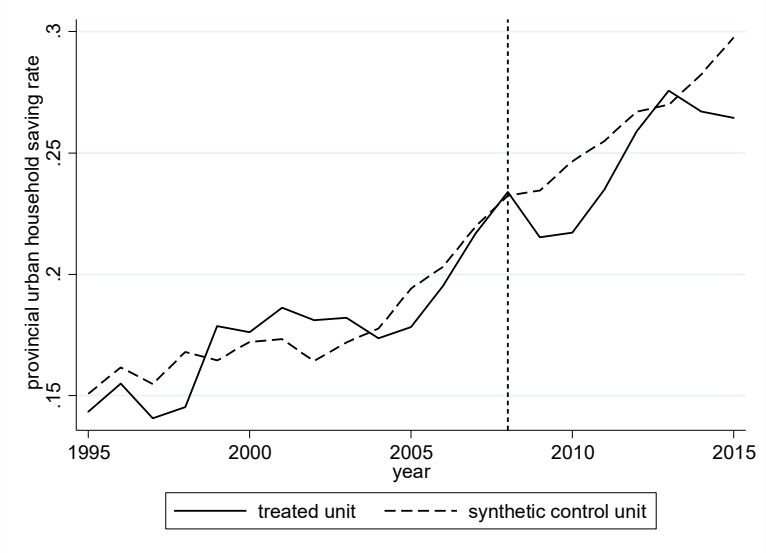



***Table 3. Predictor means (Urban)***

| Variables | Sichuan province | | Average of control groups |
|---|---|---|---|
| | Observed | Synthetic | |
| Education | 0.104 | 0.109 | 0.090 |
| Housing | 0.075 | 0.084 | 0.079 |
| Sex-ratio | 1.049 | 0.999 | 1.046 |
| Income | 3.804 | 3.825 | 4.024 |
| Transfer | 0.226 | 0.233 | 0.236 |
| Income-growth | 0.099 | 0.106 | 0.109 |
| S(1995-2005) | 0.167 | 0.169 | 0.210 |
| S(2007) | 0.217 | 0.218 | 0.274 |

**Note**: All variables are averaged over the period 1995-2008 by prefecture. S (1995-2005) denotes the provincial urban household saving rate averaged over the period 1995-2005; similarly, S (2007) denotes the rate in 2007. The last column presents the national average (excluding Sichuan) over the 1995-2008 period.

***Figure 5: Ratio of total cash deposits***

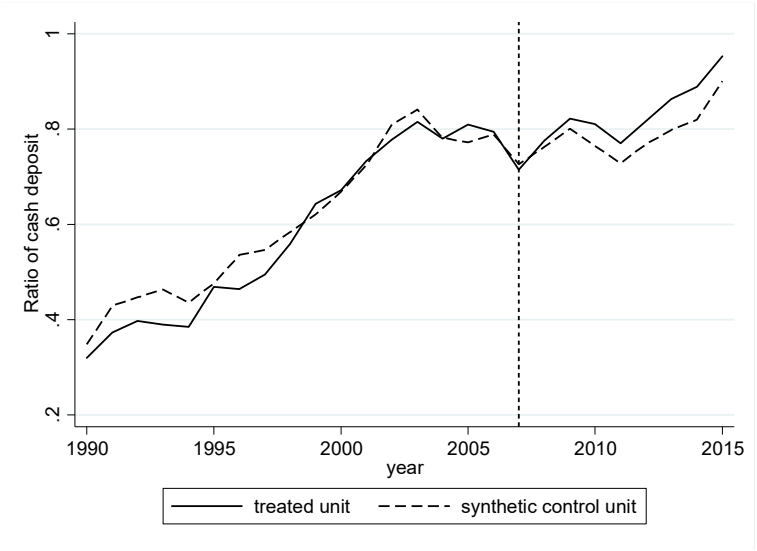



***Table 4. Predictor means (Deposits)***

| Variables | Sichuan province | | Average of control groups |
|---|---|---|---|
| | Observed | Synthetic | |
| Sex-ratio | 1.054 | 1.065 | 1.043 |
| Income | 3.279 | 3.319 | 3.455 |
| Bank lending | 0.106 | 0.104 | 1.101 |
| Income-growth | 0.928 | 0.904 | 0.123 |
| Deposit(1995) | 0.469 | 0.476 | 0.539 |
| Deposit(2000) | 0.672 | 0.669 | 0.686 |
| Deposit(2006) | 0.794 | 0.789 | 0.731 |

**Note**: All variables are averaged over the period 1990-2007 by prefecture. Deposit denotes the provincial deposits proportions in 1995, 2000, and 2006, respectively. The proportion is calculated as the proportion of total cash deposit in the annual GDP by prefecture. The last column presents the national average (excluding Sichuan) over the 1990-2007 period.

***Figure 6: Proportion of growth in cash deposit***

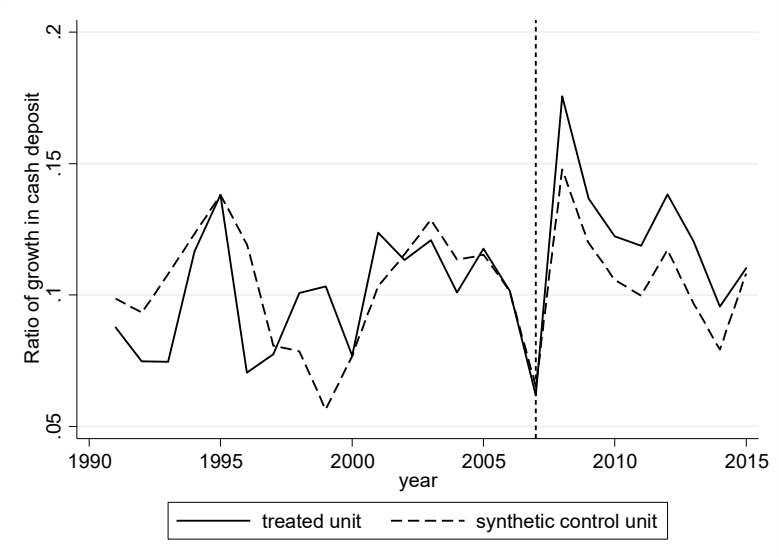



***Table 5. Predictor means (Propensity)***

| Variables | Sichuan province | | Average of control groups |
|---|---|---|---|
| | Observed | Synthetic | |
| Sex-ratio | 1.054 | 1.055 | 1.048 |
| Income | 3.279 | 3.290 | 3.364 |
| Bank lending | 0.106 | 0.104 | 1.068 |
| Income-growth | 0.928 | 0.922 | 0.098 |
| Propensity(1995) | 0.138 | 0.139 | 0.145 |
| Propensity(2000) | 0.077 | 0.076 | 0.063 |
| Propensity(2006) | 0.101 | 0.100 | 0.093 |

**Note**: All variables are averaged over the period 1995-2005 by prefecture. Propensity denotes the provincial deposit growth ratios in 1995, 2000, and 2006, respectively. The proportion is calculated as the proportion of the growth in total cash deposits in the annual GDP by prefecture. The last column presents the national average (excluding Sichuan) over the 1995-2005 period.

***Figure 7: Proportion of consumer goods***

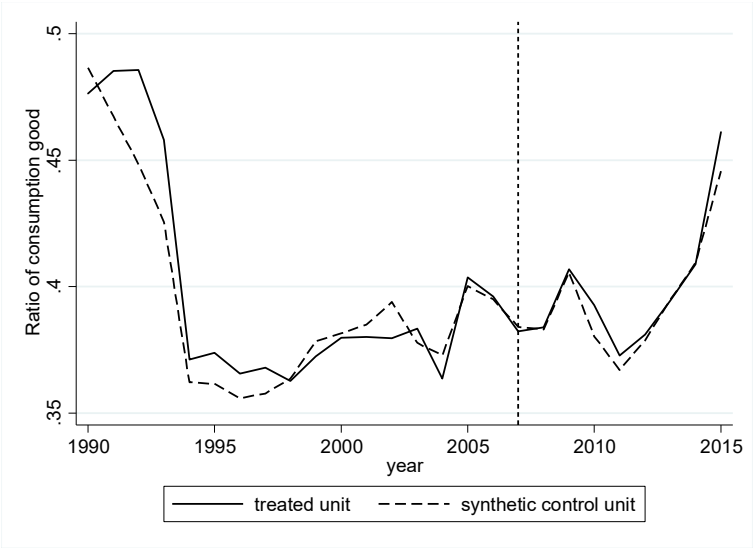



***Table 6. Predictor means (Consumption)***

| Variables | Sichuan province | | Average of control groups |
|---|---|---|---|
| | Observed | Synthetic | |
| Sex-ratio | 1.054 | 1.056 | 1.048 |
| Income | 3.279 | 3.345 | 3.364 |
| Bank lending | 0.928 | 0.933 | 1.068 |
| Income-growth | 0.106 | 0.104 | 0.098 |
| Dependency | 0.444 | 0.438 | 0.442 |
| Consumption(1995) | 0.374 | 0.362 | 0.355 |
| Consumption(2000) | 0.380 | 0.381 | 0.368 |
| Consumption(2006) | 0.396 | 0.395 | 0.328 |

**Note**: All variables are averaged over the period 1995-2005 by prefecture. Consumption denotes the provincial consumption proportions in 1995, 2000, and 2006, respectively. The proportion is calculated as the proportion of total retail sales of consumer goods in nominal GDP by prefecture. The last column presents the national average (excluding Sichuan) over the 1995-2005 period.