


RESEARCH ARTICLE

Shock me like a Hurricane: how Hurricane Katrina changed Louisiana's formal and informal institutions

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Abstract

Institutions matter for postdisaster recovery. Conversely, natural disasters can also alter a society's institutions. Using the synthetic control method, this study examines the effects that Hurricane Katrina (2005) had on the formal and informal institutions in Louisiana. As measures of formal institutions, we employ two economic freedom scores corresponding to government employment (GE) (as a share of total employment at the state-level) and property tax (PT). These measures serve as proxies for the level of governmental interference into the economy and the protection of private property rights respectively. To assess the impact on informal institutions, we use state-level social capital data. We find that Hurricane Katrina had lasting impacts on Louisiana's formal institutions. In the post-Katrina period, we find that actual Louisiana had persistently higher economic freedom scores for both GE and PT than the synthetic Louisiana that did not experience the hurricane. These findings imply that the hurricane led to a reduction in both PTs and GE, which indicates a decrease in the relative size of the public sector as a share of the state's economy. On the other hand, we find no impact on our chosen measure of informal institution.

Keywords: Hurricane Katrina; institutional change; natural disaster; property tax; social capital; synthetic control

JEL Codes: : B52; D02; D23; E2; Q54

Introduction

The impact of natural disasters on economic performance constitutes an extensive and multidisciplinary body of expanding literature. The inevitability of natural disasters and their disproportionately adverse effects on lower-income communities make understanding the factors that improve economic recovery postdisaster a critical topic within this research programme (Kahn, 2005; Yamamura, 2012). A better understanding of these factors is also timely. From 1980 to 2020, the number of climate and weather-related disasters in the US has steadily increased. Fatalities and the number of disasters resulting in at least \$1 billion in damages have also increased since 1980 (Rayamajhee and Paudel, 2023; Smith, 2021).

While geographical, environmental, economic, technological, and other disaster-specific factors have been the traditional focus of disaster studies, recent scholarship has devoted significant attention to the role of institutions in postdisaster recovery. Often described as the 'rules of the game', institutions constitute the formal laws and informal mechanisms that govern societies (North, 1990). Formal institutions can be understood as codified, impersonal rules. Laws, policies, edicts, and constitutions are some examples. Formal economic institutions refer to the rules and policies that govern market interactions. Although states have constitutional provisions that dictate formal procedures to modify such institutions, either partly or wholly, these changes tend to be time-consuming and difficult. As far as a lone citizen, a small community, or a local political jurisdiction is concerned, formal institutions are static and inflexible.

On the other hand, informal institutions are not formally codified, and their origins are traceable to traditions and customs. Some aspects of informal institutions are internalized by the members of the community and are thus difficult to change. Concurrently, other aspects such as social norms can be highly adaptive, especially in extreme circumstances such as postdisaster contexts. Although no formal monitoring or sanctioning mechanisms are in place to enforce informal institutions, they work because community members devise informal and tacit accountability measures. For empirical purposes, studies commonly proxy informal institutions using various measures of social capital (Aldrich, 2012a; Rayamajhee and Bohara, 2021; Storr *et al.*, 2021). Although what constitutes social capital – or if the word ‘capital’ is appropriate at all – has remained a contentious topic for decades (Arrow, 2000; Durlauf, 2002; Hodgson, 2014), it is a powerful concept to explain social phenomena from social mobility to postdisaster collective action. Many studies, including ours, use it to describe both weak and strong social ties among members of the same communities and across communities. Some common measures of social capital in the empirical literature include levels of generalized trust, social attitudes and beliefs, membership and/or participation in social groups, clubs, religious organizations, political parties, and civil society associations (Chetty *et al.*, 2022a, 2022b; Jackson *et al.*, 2015; Rayamajhee and Bohara, 2021).

Both formal and informal institutions affect societal wellbeing and economic development (Acemoglu *et al.*, 2001; Williamson, 2009; Williamson and Kerekes, 2011). They also determine how disasters affect societies, how they respond, and how they recover from them (Barone and Mocetti, 2014; Rayamajhee, 2020; Rayamajhee and Bohara, 2021). While a large literature finds that institutions play a vital role in assisting or hindering disaster recovery, this relationship can cut both ways. Major disasters can drive institutional change (Higgs, 1987; Yamamura, 2016). They can reveal vulnerabilities of existing formal institutional arrangements and provide impetus for institutional change. Current arrangements may undergo adjustments to address governance challenges in unchartered environments. Where this is infeasible, new formal institutions may emerge altogether. Disasters can also create conditions where informal institutions are either incompatible or insufficient to respond to and recover from disasters, thus requiring formal institutional arrangements (Rayamajhee *et al.*, 2021). That said, how existing institutions adapt and change and/or how new institutions emerge following natural disasters are largely empirical questions. These are also questions that remain underexplored, relative to a voluminous literature examining the effects of natural disasters.

This paper contributes to this underexamined but critically important topic by examining the impact of Hurricane Katrina on Louisiana’s formal and informal institutions. We focus on hurricanes because they are relatively common, predictable, and quantifiable.¹ Hurricane Katrina in particular remains an intriguing natural disaster for its strength (category 5 and third strongest on record), size of area impacted, and devastation (Vigdor, 2008). Klotzbach and Landsea (2015) and Weinkle *et al.* (2018) document a recent increase in category 4 and 5 hurricanes, making storms like Katrina relevant for academic research and disaster management policies. Examining Hurricane Katrina is also insightful because it unravelled rich social, political, and economic complexities in the aftermath, allowing us to identify sources of resilience and frailty (Boettke *et al.*, 2007; Chamlee-Wright and Storr, 2009, 2010). These considerations lend themselves to institutional analyses and comparative studies.

We use the synthetic control method (SCM) because it allows us to parsimoniously tease out causal effects of a singular event on a treatment unit by comparing it with a synthetically constructed, untreated counterfactual unit comprising of a weighted combination of ‘donor’ units (Abadie *et al.*, 2010, 2015). The method can be particularly useful when real comparison units are unavailable and conventional research designs such as difference-in-difference are inapplicable (for example, when parallel trends assumptions cannot be met). The method has been used extensively to estimate causal effects of policy and political changes (Abadie *et al.*, 2010; Bohn *et al.*, 2014; Hinrichs, 2012). A

¹Hurricanes occur in the Southeastern region of the US during hurricane season (May–December with most activity from August–October). They are also quantifiable by category (ranging from categories 1–5 based on the maximum estimated wind speed).

handful of studies have also used it to study the impact of natural disasters (Barone and Mocetti, 2014; Cavallo *et al.*, 2013; Coffman and Noy, 2012). A couple of recent studies have used the SCM to examine the impact of Hurricane Katrina on economic outcomes such as GDP per capita and income inequality (Cordoba and Uliczka, 2021; Yun and Kim, 2022). However, to our knowledge, no study utilizes this or related quasi-experimental methods to assess the impact of Hurricane Katrina on measures of formal and informal institutions. Thus, we make several new contributions to different strands of literature examining disasters and institutional change.

We use the government employment (GE) and property tax (PT) freedom measures from the Economic Freedom of North America (EFNA) Index and state-level social capital measures from Hawes (2017) to assess the impact of Hurricane Katrina on Louisiana's formal and informal institutions. We find that both GE and PT freedom measures posttreatment were higher for actual Louisiana relative to its synthetic counterfactual that did not experience the hurricane. This indicates that Hurricane Katrina led to increases in the size of the private sector as a share of the state's total economy. It also increased PT freedom score over time, indicating that the state's PT laws became less burdensome following the hurricane. We conduct a similar analysis using the social capital index (SCI) to assess the impact of Hurricane Katrina on informal institutions. We find minimal changes in real Louisiana relative to its synthetic counterfactual after 2005, which suggests that informal institution remained robust to the shock. These findings contribute to the literature examining the impacts of Hurricane Katrina and the effects of natural disasters on social change. More broadly, our findings suggest that natural disasters can provide an important avenue for institutional change.

The remainder of the paper proceeds as follows. Section 'Literature and context' reviews the relevant literature on formal and informal institutions in the context of natural disasters. It also provides an overview of post-Katrina research examining formal (governmental) and informal (community-based, private) institutions in Louisiana. Section 'Data and method' describes the data and econometric method employed for empirical analyses. Section 'Results' provides main empirical results and additional results for robustness check. Section 'Conclusion' concludes by discussing implications and exploring potential avenues for future research on the topic of crisis and institutional change.

Literature and context

The impacts of natural disasters on economic and social performance vary considerably (Barone and Mocetti, 2014; Belasen and Polachek, 2008; Park and Wang, 2017; Skidmore and Toya, 2002). Many of these effects last generations after the disaster end (Berlemann and Wenzel, 2018; Botzen *et al.*, 2019; Caruso, 2017; Paudel and Ryu, 2018; Shakya *et al.*, 2022). A commonly cited reason for this discrepancy in outcomes is institutional condition – which is broadly defined to include a host of variables such as governmental quality, security of property rights, cultural factors, and levels of corruption (Barone and Mocetti, 2014; de Vries, 2010; Rayamajhee, 2020). For example, Park and Wang (2017) find that Chinese governmental response to the Wenchuan earthquake, in particular their targeted subsidies programme, led to a decrease in poverty rate and an increase in income per capita. The authors specifically note that governmental subsidies following the earthquake, 'were so large that mean income per capita was 17.5% higher in 2008 than in 2007 and the poverty rate actually declined from 34% to 19%' despite considerable income and asset losses (p. 38). Attary *et al.* (2020) find that disaster-related aid is often disseminated unevenly, depending on various institutional factors, impacting recovery rates. Because governmental administrative apparatus responsible for disseminating aid to disaster-impacted areas are largely determined by formal institutional arrangements, short-term disaster recovery is especially affected by formal institutions' ability to allocate and distribute financial resources post disaster.² Barone and Mocetti (2014) attribute varying levels of economic recovery in two earthquake-impacted regions of Italy to the differences in their underlying institutional structures.

²Sobel and Leeson (2006) examine many ways through political and bureaucratic actors may exploit formal institutional arrangements put in place to disseminate postdisaster aid or facilitate postdisaster recovery to engage in rent seeking behaviour.

Using a variety of political and social proxies to measure institutional quality, the authors argue that the divergence in GDP per capita following the earthquake was due to institutional precursors.

Institutions matter for postdisaster recovery. Governing bodies, often tasked with implementing and enforcing formal rules and programs, can provide avenues to overcome collective action problems, increase security of property rights, and mobilize resources towards recovery (Col, 2007; Pathak and Ahmad, 2018). Rayamajhee (2020) and Rayamajhee and Paniagua (2021) show that formal property-rights-protecting-institutions can aid recovery by validating ownership and transfer of assets, and alleviating fears of confiscation and predation. However, governments' haphazard actions and usurpation of control can lead to irreversible policy blunders (Schneider, 2005; Sobel and Leeson, 2006). When formal institutions fail to secure property rights, they can have lasting consequences. In a paper highly relevant to this research, Callais (2021) links historical corruption within the French civil law system that Louisiana inherited 200 years ago to its modern era institutional frailties and the underperformance of its existing legal system. These factors worked jointly to worsen governmental responses to address Hurricane Katrina in many documented cases (p. 668).

Informal institutions play critical roles in postdisaster recovery (Aldrich, 2012a; Rayamajhee and Bohara, 2021; Rayamajhee *et al.*, 2022) They are often comparably more effective in providing targeted, group-specific governance during crises than formal institutions (Aldrich, 2012b; Rayamajhee and Bohara, 2020; Rayamajhee *et al.*, 2022; Skarbek, 2014; Storr *et al.*, 2015). They can also provide effective avenues for self-governance and autonomy that are critical for long-term postdisaster recovery (de Vries, 2010).

While existing institutions impact disaster recovery, disasters can also impact institutions.³ They offer opportunities for societies to cooperate, discover social and economic opportunities to rebuild, and overcome collective action problems (Calo-Blanco *et al.*, 2017; Lee, 2019; Lee and Fraser, 2019; Storr and Haeffle-Balch, 2012). These and other challenges associated with postdisaster efforts involve both formal informal institutional channels. Yamamura (2016) and Rayamajhee (2020) note these collective problems pave paths for institutional change. For instance, Solecki (2015) observes a 'broad-scale strengthening of local social capacity via social media and a variety of informal networks' following Hurricane Sandy (p. 91). Jessamy and Turner (2003) find that existing informal institutions adapted to meet societal needs in many areas affected by Hurricane Lenny. While informal institutions can provide localized solutions to disaster-related social issues, disasters could also incentivize individuals to engage in conflict, thus weakening broad social cooperation (Henrich and Henrich, 2007; Tomasello, 2009).

The impact of Hurricane Katrina on Louisiana constitutes its own rich literature, the majority of which estimates the economic and related impacts to the region following the storm (Deryugina *et al.*, 2018; Deryugina and Molitor, 2020; Kessler *et al.*, 2006; Nicholls and Picou, 2013; Paxson and Rouse, 2008; Vigdor, 2008). Blake *et al.* (2007) estimate Hurricane Katrina caused approximately \$108 billion in total damages, including approximately \$86 million in insured property losses.⁴ Relatedly, this literature frequently finds population decreases and considerable declines in GDP growth post-Katrina. Federal Reserve Economic Data (2019) estimates Hurricane Katrina slowed Louisiana's GDP growth by approximately 65% and decreased state population by 250,000 in 2006. Unsurprisingly, the shock also negatively impacted the state's labour markets (Groen and Polivka, 2008).

Another strand of economics literature on Hurricane Katrina shows that governmental blunders and bureaucratic mismanagement led to ineffective postdisaster responses and slowed down economic

³Although the focus here is on natural disasters, these relationships hold for non-natural crises as well. For instance, Pitlik and Wirth (2003) find that deep economic crises – defined as significant shocks in economic growth and inflation indicators – can change a society's institutions and make it more market-friendly. Institutional instability can in turn also affect economic growth, but the direction of effects can vary in rich and poor societies (Berggren *et al.*, 2012). On the other hand, civil war, terrorist attacks, and other forms of conflict can affect various institutional outcomes such as social participation, cohesion, social trust, and governmental repression (Bauer *et al.*, 2016; Bjørnskov and Voigt, 2022; Kijewski and Freitag, 2018).

⁴Figures are in 2020 dollars.

recovery (Callais, 2021; Congleton, 2006; Sobel and Leeson, 2006). Congleton (2006) and Sobel and Leeson (2006) find that Louisiana's layered bureaucracy, coupled with widely perceived public-sector corruption and widespread mistrust in government, was responsible for its sluggish postdisaster governmental response. Even successful relief efforts by non-governmental actors were 'flouted by bureaucratic decision-making processes' (Sobel and Leeson, 2006: 57). They were successful because they 'took action without [governmental] approval' (ibid.). This is unsurprising considering Louisiana's longstanding association with political corruption. Noting Louisiana's French civil law origins and history of public corruption, Callais (2021) attributes much of Louisiana's post-Katrina disaster policy blunders to its preexisting institutional failures. This analysis, if true, suggests that the state's inability to respond effectively post-Katrina may be, in part, due to the persistence of formal legal institutions in the form of internalized corruption-friendly norms.

Concurrently, this line of research highlights that informal institutions were resilient to the disaster shock and stepped up their performance to fill in the gaps in formal governance by facilitating social cooperation and collective action. For instance, Boettke *et al.* (2007) describe the private actors and community-level efforts to overcome postdisaster challenges in the gulf coast as robust and resilient, relative to haphazard and sluggish responses by the federal and state governmental agencies (p. 363). Similarly, Whitt and Wilson (2007) find strong cooperation amongst African-American evacuees to Houston following Katrina, further corroborating the vital role that informal institutions played by establishing and enforcing cooperative norms. Extensive ethnographic research by Storr *et al.* (2015) documents numerous local efforts to restore and revitalize communities in New Orleans' post-Katrina recovery.

However, even after nearly two decades of the disaster, institutional change resulting from Katrina remains an underexamined aspect of this literature. How and which institutions change, emerge, weaken, or become more prominent to meet societal needs after a crisis remains a complex question. Our study contributes to answering this vital question and adds to the growing literature in economics, political science, and other social sciences that extends the notion of resilience to explain the phenomenon of 'bouncing back' after a major disaster (Aldrich, 2012a; Aligica and Tarko, 2014; Brunnermeier, 2021; Rayamajhee *et al.*, 2020; Walker and Salt, 2012). In doing so, it furthers our understanding of institutional change in the context of severe natural disasters. We additionally contribute to the largely qualitative literature examining the link between Hurricane Katrina and institutions by employing a quasi-experimental empirical design, namely the SCM. In the remainder of the paper, we focus on empirically examining how the hurricane affected formal and informal institutions in Louisiana.

Data and method

Determining how (and if) Louisiana's institutions changed following Katrina requires a means of measuring institutions at the appropriate level. While there are no perfect measures for institutions, a large literature uses economic freedom score as a proxy for restrictions on governmental usurpation on a host of economic outcomes (Hall and Lawson, 2014; Lawson *et al.*, 2020; March *et al.*, 2017). Following a well-established literature, we measure formal institutions using the EFNA Index developed and maintained by the Fraser Institute. EFNA provides uniform measures to compare legal, political, and economic institutions across states at a given time and to assess institutional change in states over time. To quantify formal institutions, we rely on two specific measures of GE and PT freedom scores. All EFNA indicators (including GE and PT) are measured at the state-level and range from 1 to 10, with higher values indicating greater levels of economic freedom, and lower levels of governmental restrictions, interference, or intervention into market activities. A higher GE freedom score indicates higher share of the private sector in total employment. Similarly, a higher PT freedom score means less PTs.

Since EFNA provides multiple sub-indicators, a justification for our choice of the two measures is warranted. We choose these measures because they are most closely related to private property rights and governmental interference into the economy respectively, both of which are commonly used

indicators of formal institutions. For instance, Acemoglu and Johnson (2005) unbundle formal institutions into two broad classes: one class supporting private contracts ('contracting institutions') and another class supporting private property ('property rights institutions'). Moreover, unlike many subjective measures of formal institutions, the two indicators we use allow for a more precise quantification and let us draw meaningful implications. The chosen measures are reliable, albeit imperfect, proxies for sub-national level governmental intervention into the economy that we were able to gather from EFNA.⁵ For robustness purposes, we include results from similar analyses using overall economic freedom index, labour market freedom index, minimum wage score and other related measures in the online appendix.⁶

Before proceeding to analyses using the chosen sub-indicators, we first examine changes in economic freedom scores in Louisiana over time. Figure 1 plots economic freedom score from 1997–2019. Prior to Hurricane Katrina (2005), Louisiana's overall economic freedom score ranges from approximately 5.55 to 5.71. Post-Katrina, economic freedom score fluctuates considerably, reaching a maximum value of 6.41, a minimum value of 5.44, and an average of 6.1. These scores are well below the national average of 8.34 (on a ten-point scale) for all the years covered in the study period. Visually, we observe that the overall economic freedom scores are higher during the posttreatment years (2005–2019) compared to the pretreatment period (1997–2004).

To measure informal institutions, we use the SCI data made publicly available by Hawes (2017). While informal institutions are notoriously difficult to measure, social capital provides a reasonable proxy to capture social cohesion and cooperation. Across the social sciences, Robert Putnam's conceptualization of social capital is the most widely accepted one. Putnam (2000) breaks down social capital into five components: two attitudinal (social trust and informal sociability) and three behavioural (community organizational life, public engagement, and volunteerism). He develops a state-level SCI for US states by conducting factor analysis on 14 items representing the five components. The data generated by Hawes and McCrea (2018) extends Putnam's measure in a longitudinal setting to analyse variation over time. To create their SCI variable, the authors utilize twenty-two indicators: six for associational membership, ten for public engagement, and six for voluntary and philanthropic activities. Their social capital data is available for all US states from 1997–2010, which covers 8 pre-Katrina years and 6 post-Katrina years.

To assess the true effects of Hurricane Katrina on Louisiana's institutions, we would need to observe two otherwise identical realities: one in which Hurricane Katrina occurred (the observed reality) and another in which it did not. We would then track our outcome variables of interest over time in the two realities. Any divergence in their post-Katrina trends could then be attributed to the hurricane. Because we can only observe one reality, this comparison is not feasible using conventional methods. The SCM allows us to artificially construct a 'synthetic' or counterfactual Louisiana whose pre-Katrina outcomes closely resemble those of the observed Louisiana (Abadie *et al.*, 2010; Cunningham, 2021). Then, by comparing the outcomes between the two Louisianas post-Katrina, we can estimate the treatment effect over time.

The closeness-of-fit of outcomes between the observed and synthetic Louisianas during the pretreatment period relative to their fit in the posttreatment period lets us draw conclusions regarding the causal effect. In other words, the degree to which the pretreatment institutional outcomes of the observed and synthetic Louisianas overlap lends credibility to our methodological choice. We

⁵Although indicators for governmental expenditure, and transfers and subsidies were available, they are less suitable measures for our purpose because they include large transfers from the federal government following the disaster. We do find that government spending increased substantially following the hurricane. However, placebo test results show that the differences in outcomes between synthetic and actual LA were not statistically significant for most posttreatment years. See online appendix (link: <https://veeshan.rayamajhee.com/files/Katrina%20Appendix.pdf>).

⁶We were able to generate plausible synthetic counterfactual states for many of these variables. Results are consistent with the narrative proposed in the paper. For instance, we observe that labour market freedom, minimum wage freedom score, and overall economic freedom were higher for Louisiana relative to its synthetic counterfactual that did not experience the hurricane.

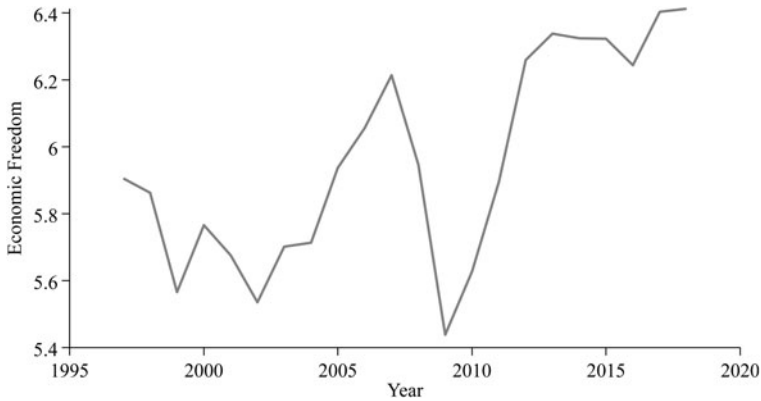


Figure 1. Economic freedom in Louisiana, 1997–2019.

measure closeness-of-fit by using the Root Mean Square Prediction Error (RMSPE) (Abadie *et al.*, 2015).⁷ All else equal, a smaller pretreatment (posttreatment) RMSPE value for an experiment indicates a better pretreatment (posttreatment) fit between the actual and synthetic Louisianas compared to an experiment that yields a larger pretreatment RMSPE value. If the treatment is genuine, we should expect the ratio of posttreatment RMSPE to pretreatment RMSPE (joint post standardized *p*-value) to exceed 1, indicating that posttreatment period is estimated with larger error relative to pretreatment. To construct institutional outcomes for Louisiana, we calculate the weighted average of the outcomes of ‘donor’ states – which are selected with the objective of minimizing pretreatment RMSPE. We constrain the weights to be non-negative and sum to 1 to avoid any extrapolation biases.

For a state to qualify as a donor (‘control’) unit, it cannot be impacted by the treatment under consideration or any similar shocks. However, unlike a governmental policy or a significant political event, natural disasters (even major ones) are inevitable and recurring. So, there are no perfect donors – all potential donors have experienced a major disaster at some point in history. In other words, if we extend our analysis to long enough time, there will be no potential donors left. Thus, we face a tradeoff between the number of years we can include in our analyses and the size of the donor pool. Moreover, for the synthetically constructed counterfactual to serve as a reliable comparison unit requires a good pretreatment fit in outcomes between the real and synthetic units (Abadie *et al.*, 2010; Cavallo *et al.*, 2013). To satisfy this requirement, while also accounting for the years-donors tradeoff, we adopt a transparent and systematic procedure to ensure we have at least twenty years and thirty potential donors for empirical analyses. First, we exclude states which were also impacted by Hurricane Katrina and other coastal states within the Southeast region of the US from our donor pool. Then, using the fatalities data from the Spatial Hazard Events and Losses Database for the United States (SHELDUS), we tally the total number of major disasters experienced by all remaining US states for each year from 1961–2020 (the years SHELDUS data are available). Following Cavallo *et al.* (2013), we consider a state to have experienced a major natural disaster if it experienced 99th percentile or higher fatalities (from the entire sample) in any given year. If a state experienced a major disaster within 30 years prior to the treatment year (2005), we consider the state to be ineligible as potential

⁷RMSPE is calculated as follows:

$$\text{RMSPE} = \left(\frac{1}{T_0} \sum_{t=1}^{T_0} \left(Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt} \right)^2 \right)^{1/2}$$

where $t = 1 \dots T_0$ is the study period, Y_{1t} is the outcome of interest for the treated unit during the period t , w_j^* is the synthetic control weight assigned for each unit $j = 2 \dots J + 1$, and Y_{jt} is the outcome of interest for each unit j .

donor. Doing so left us with less than 10 potential donors. We then adopted the same procedure by reducing the number by 5 years (for example, to 25, 20, 15, and 10 years prior to 2005) until there were 30 or more eligible donor states. In total, these restrictions prevent us from using Alabama, Alaska, Arkansas, California, Colorado, Florida, Georgia, Hawaii, Kansas, Kentucky, Missouri, Mississippi, North Carolina, New York, Montana, Nebraska, North Dakota, Pennsylvania, Tennessee, Texas, and West Virginia as potential donors.

We use measures of demographic and economic factors as predictor variables to construct synthetic Louisiana. Our economic predictor variables include the number of new private housing units, number of employees in construction, unemployment rate, per capita income, private home ownership rate, and the overall EFNA score. These variables aid our synthetic by proxying for economic conditions and concurrent institutional factors prior to the treatment period. Our demographic variables include total population, percentage of population that is black, percentage of population that is Hispanic, percentage of population that is Asian, murder rate, and marriage rate.⁸ Population similarities and differences constitute congruencies and obstacles to achieving social cooperation either informally or formally (through the legislative process), which makes them pertinent factors that influence institutional outcomes.

Data on population, percentage of population that is Black, percentage of population that is Hispanic, percentage of population that is Asian, and marriage rate (available for the years 1999–2019⁹) were obtained from the US Census Bureau. Data on per capita GDP, unemployment rate, and home ownership rate come from the Federal Reserve Economic Database (FRED). State-level murder rate data for 1999–2018 come from the death penalty information centre. We obtained state-level economic freedom data from the EFNA. Data for other predictor variables are available from 1997–2019. [Table 1](#) presents summary statistics for the variables.

Results

Our primary experiments examine three outcome variables: measures of GE freedom and PT freedom from EFNA and SCI from Hawes (2017). We compare the three outcomes from each synthetically created Louisiana to those from the real Louisiana with 2005 serving as the treatment year. Tables A1 and A2 (online appendix) provide predictor mean comparisons for all three outcomes between the real Louisiana and its synthetic counterfactual. The closer the synthetic Louisiana's values are to the observed values for the state, the greater their variable's contribution is to constructing our synthetic unit.

The differences between the predictor mean values of the actual Louisiana and its synthetic counterfactual vary considerably for different variables. For the GE outcome, the differences for the per cent of population that is Asian, and marriage rate are both below 5%. The differences for other variables range from 5% to a 111%. The predictor mean value difference is largest for the per cent of population that is Hispanic (111.96%), which means that the variable contributed the least in creating the synthetic Louisiana. Similarly, for the PT outcome, synthetic and real Louisiana had very similar unemployment rates, per capita incomes, and home ownership rates (differences less than 6%), whereas they varied drastically in terms of their racial compositions. For instance, the synthetic Louisiana had significantly higher proportion of Hispanic population compared to the actual Louisiana (over 1,100% different), indicating that the variable contributed very little to creating the synthetic state. For social capital, both synthetic and real Louisianas had similar levels of economic freedom, unemployment rates, per capita income, and home ownership rates, whereas they differed most in terms of their racial composition.

Primary experiments

The degree of overlap or the closeness of fit between our synthetic and actual Louisianas in the pre-treatment period (1997–2004 for formal; 1998–2004 for informal) gives credence that the

⁸Each synthetic control model and corresponding robustness checks use the same set of predictor variables.

⁹Data on state-level marriage rate were unavailable for Georgia from 2013–2014, Louisiana in 2006, and in Oklahoma from 2000–2003.

Table 1. Summary statistics

Variables	N	Mean	SD	Min	Max
Gov employment freedom score	667	6.46	1.97	0	10
Property tax freedom score	667	4.74	2.58	0	9.94
Social capital index	714	0.03	0.76	-2.36	2.4
Economic freedom score	667	7.36	1.67	2.06	10
Construction sector employees	667	98.83	66.92	4.6	227.6
Population (in 1,000)	667	4,511	3,274	4,895	12,900
New private homes	667	1,566	1,300	61	7,499
Unemployment	667	5.24	1.95	2.3	13.7
Per capita income	667	39,747	10,648	20,576	77,289
Home ownership rate	667	69.53	4.40	54.5	77.5
Per cent Black	667	9.01	9.04	0.18	32.5
Per cent Hispanic	667	10.12	9.30	0.72	49.3
Per cent Asian	667	2.90	2.07	0.42	9.8
Marriage rate	604	8.40	8.24	4	82.3
Murder rate	638	4.39	2.69	0.83	15.67

posttreatment period (2006–2019 for formal; 2006–2010 for informal) divergence in outcomes is due to the treatment (Hurricane Katrina). As discussed previously, this allows us to estimate the causal effect of the treatment on the three outcome variables. We were able to construct a plausible synthetic Louisiana corresponding to the GE freedom measure using a weighted average of several donor states: Wyoming (weight = 66.6%), Minnesota (weight = 16.3%), and Maryland (weight = 10.3%) were the three largest contributors. Similarly, New Mexico (weight = 91.7%) and Illinois (weight = 8.3%) were the largest donors for the PT freedom variable. Finally, South Carolina (weight = 45.3%), Kentucky (weight = 34%), Nevada (weight = 20.4%), and Maryland (weight = 0.3%) were the largest contributors for SCI.¹⁰

Figure 2 displays graphical results from our primary experiments. The solid lines display outcomes for the treated unit (real Louisiana), whereas the dashed lines show outcomes for the synthetically created Louisiana. Visually, all three figures depict a strong pretreatment fit. The solid and dashed lines overlap for almost all the years before 2005. RMSPE measures reflect this near perfect fit: RMSPE values are 0.1 for government expenditures, 0.07 for PT, and 0.19 for social capital experiments. Results presented in panels A and B (Figure 2) show that outcomes for the treated unit are substantially higher than those for its synthetic counterfactual. This suggests that economic freedoms pertaining to GE and property taxation increased in the observed Louisiana compared to its synthetic counterpart that did not experience Hurricane Katrina. More specifically, the divergence in outcomes between the actual and synthetic Louisianas indicates that the proportion of total workers employed by the state decreased and the total amount of property (and other) taxes collected as a per cent of state income decreased as a result of the hurricane. Moreover, we find that the treatment effects for both outcomes exhibit an increasing trend, indicating that institutional divergence due to the disaster persisted much longer than its immediate aftermath.¹¹

¹⁰Table A3 in the appendix provides estimated synthetic control weights.

¹¹One notable exception is the sudden dip of property tax freedom score for the year 2009. This is likely due to the 2008 Great Recession.

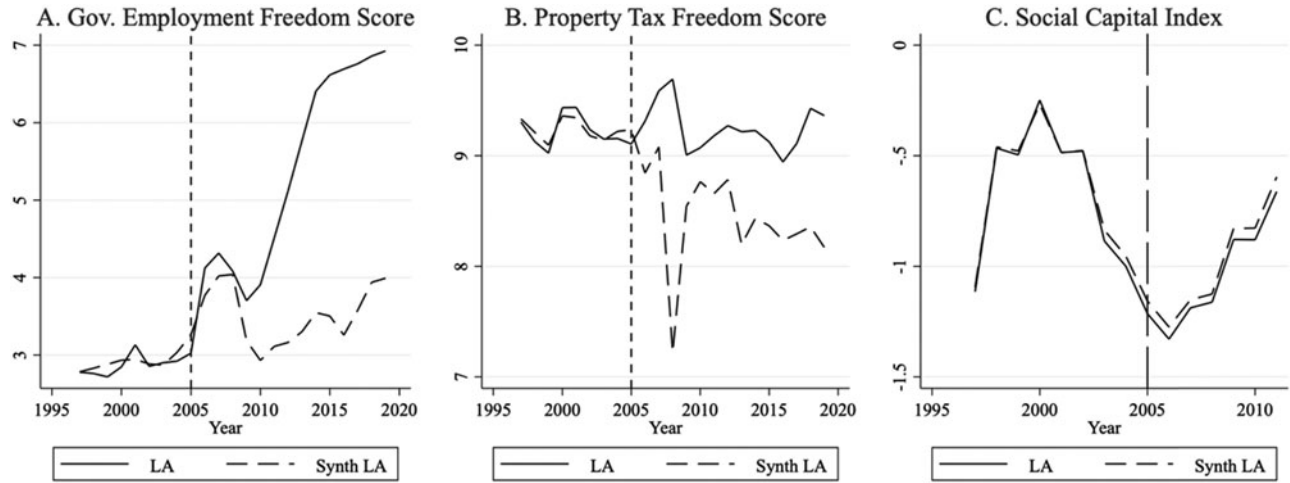


Figure 2. Effects of Hurricane Katrina on Louisiana's institutions.

With respect to social capital, we find that the hurricane had no discernible impact. While social capital fluctuated over time, we find minimal differences between the synthetic and actual Louisiana after Katrina struck. This indicates that informal institutions were not affected by Hurricane Katrina. While the results are null, this does not mean informal institutions are not responsive to shocks. Instead, it can imply that they are resilient – as informal institutions are malleable and adaptive and can withstand major shocks. In fact, evidence from a range of ethnographic and qualitative research and quantitative case studies examining the roles that religious and civic organizations, private businesses, and charitable organizations play in the aftermath of crises support this interpretation (Aldrich, 2012a; Rayamajhee and Bohara, 2019, 2021; Shahid *et al.*, 2022; Storr *et al.*, 2021). Naturally, aggregative measures such as the one employed for empirical analyses in this paper can mask substantial micro-level heterogeneity. Thus, social institutions can adapt after a disaster without being diminished or altered in quantitatively observable ways. Alternatively, observed micro-level increases in social capital could have been counteracted by social capital depletion due to an abrupt population decline that followed the hurricane.

Quantitatively, we find an average treatment effect of 1.89 (approximately one standard deviation) and a maximum treatment effect of 3.44 (approximately 1.5 standard deviations) for our GE experiment. Our PT experiment finds an average treatment effect of 0.84 (approximately 1/3rd of 1 standard deviation) and a maximum treatment effect of 2.47 (approximately 1 standard deviation). Because economic freedom measures are indexed on a 1–10 scale, it is difficult to interpret the precise effect sizes. Nonetheless, the direction and magnitude of the effects tell that Hurricane Katrina led to significant changes in formal institutions. Specifically, the size of the public sector as a share of the state's total economy decreased due to the hurricane. Although employment in the governmental sector relative to the state's total employment has been increasing over time, our analysis shows that the hurricane directly led to a decrease in the share of GE. Similarly, the state's PT laws were adapted in a manner that increased overall PT freedom. Moreover, we find that the divergence grew over time, indicating that the disaster had profound long-term consequences on Louisiana's formal institutions.

SCM does not provide standard errors to compute confidence intervals and test for statistical significance. To circumvent this, we conduct several placebo tests to rule out that the results are not due to random chance. We do so by running alternative models as if other donor states received the treatment instead of Louisiana. Table 2 provides the results from these 'placebo tests.' They indicate that the results are very likely to be driven by the treatment under consideration. Placebo tests for the GE freedom measure find that 60% of posttreatment periods (8 of 14) are significant. Similarly, placebo tests conducted for the PT freedom measure show that 66.7% of posttreatment periods (9 of 14) are significant. Both figures indicate our results are not likely to be obtained due to random chance. We do not report findings from placebo tests for SCI, because we find no discernable treatment effect for any posttreatment year.

Robustness checks

To test the validity of our main findings, we conduct two sets of robustness tests. First, we perform an 'in-time placebo' test by running an alternative model which falsely assumes that the treatment occurred in 2002 instead of 2005. If the hurricane had true effects, we should expect to see no treatment effects during the 2002–2005 period, because the false treatment only exists in the model specification but not in the data. If we do find significant effects during the period, we cannot rule out that events predating the hurricane could have led to the divergence. Because hurricanes are frequent occurrences in Louisiana, testing the sensitivity of the treatment year is critical. Next, we rerun the model by dropping the largest donors from the donor pool. If our results remain largely similar, we can rule out that they are driven due to peculiarities of specific donor states.

In-time placebo test: 2002 as the Katrina year

Figure 3 (panels A and C) displays results from our in-time placebo tests for GE and PT freedoms. Moving our pretreatment period from 2005 to 2002 reduced our pretreatment fit minimally.

Table 2. Pseudo *t*-statistics from primary experiments

Posttreatment year	Government employment		Property tax	
	<i>p</i> -values	Standardized <i>p</i> -values	<i>p</i> -values	Standardized <i>p</i> -values
2006	0.57	0.57	0.89	0.54
2007	0.25	0.39	0.54	0.04
2008	0.39	0.5	0.54	0.04
2009	0.68	0.68	0	0
2010	0.11	0.29	0.68	0.11
2011	0.07	0.11	0.75	0.36
2012	0	0.04	0.68	0.07
2013	0	0.04	0.79	0.14
2014	0	0.04	0.36	0.04
2015	0	0.04	0.5	0.04
2016	0	0.04	0.571	0.04
2017	0	0.04	0.571	0.11
2018	0	0.04	0.5	0.04
2019	0	0.04	0.286	0

RMSPE for our GE synthetic moderately increased from 0.1 to 0.11 and decreased for our PT synthetic from 0.07 to 0.06. We attribute the latter to a comparatively stronger pretreatment fit from 1997–2002 than over 1997–2005. Minimal changes in RMSPE values indicate events close to our treatment year likely did not significantly impact our findings.

Results from our in-time placebo tests for GE and PT freedoms show that no divergence occurs for either outcome variables from 2002 to 2005, which indicates that 2005 is the true treatment year. The average and maximum treatment effects also remained quantitatively and qualitatively similar. They are mostly reflective of the post-2005 treatment effects. Our GE average treatment decreased to 1.55 (from 1.89), and maximum treatment effect increased to 3.68 (from 3.44) after changing the treatment date. The average treatment effect for the PT in-time placebo experiment decreased to approximately 0.59 (from 0.84), and the maximum treatment effect decreased to 2.39 (from 2.47).

The number of significant posttreatment periods decreased by adding three posttreatment periods to our original experiments. Significant posttreatment periods for our GE synthetic reduced to approximately 39% (from 60%) and our PT synthetic to approximately 44% (from 66.7%). However, none of the new (fake) posttreatment periods (2002–2005) were significant, suggesting exogenous events during that time frame did not impact our primary experiment findings. Our original significant posttreatment periods maintained statistical significance for both experiments.¹²

Drop largest donors (or add more donors)

Next, we drop the two largest donors and rerun the analyses for both GE and PT freedom scores. This meant removing Wyoming and Minnesota from the donor pool for GE and removing New Mexico and Illinois for PT. In the new analyses, Maryland and New Mexico appeared as the largest donors (comprising 64% and 36% weights respectively) for the GE synthetic control. Visual representation of this robustness check is provided in [Figure 3](#) panel B. Unfortunately, we were unable to conduct

¹²We do not include results from pseudo *t*-statistic values for robustness checks to meet the journal's length requirements.

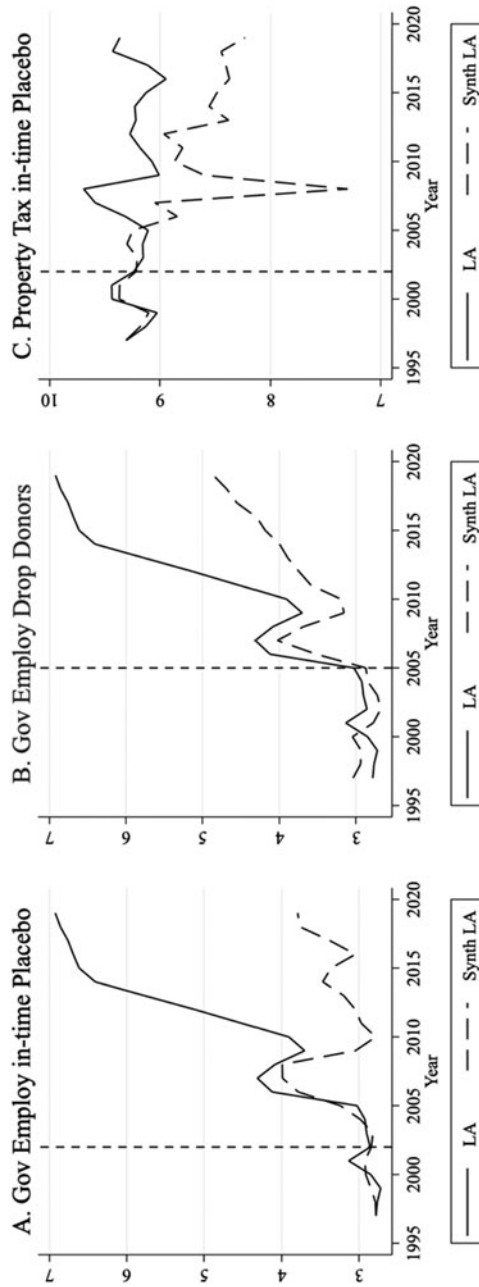


Figure 3. Robustness checks.

a ‘drop largest donors’ robustness test for PT because we could not obtain suitable donors to construct the synthetic counterfactual. Nonetheless, to examine the sensitivity of findings to donor pool selection, we reran our analysis by additionally including Mississippi and Alabama, which were also impacted by Hurricane Katrina. Including these states made minimal difference to our findings, suggesting that our findings are not dependent on our selection of donors.¹³

As expected, removing the original two largest donors reduced our pretreatment fit. RMSPE for our GE synthetic approximately doubled from 0.1 to 0.21. Placebo tests show that approximately 53% of posttreatment years experienced significant effects, a modest decrease compared to 60% from the GE primary experiment. This indicates that our findings for GE are not driven by specific donors. We did not perform robustness checks for social capital because posttreatment differences between the synthetic and actual Louisianas were not statistically significant.

Lastly, it is important to note several external events which could impact our analysis. First, other hurricanes impacted Louisiana before and after 2005. Roth (2010) documents that eight hurricanes (including Katrina) made landfall in Louisiana between 1997 and 2020. However, most of these hurricanes were comparatively weaker storms (category 1). Only Katrina and Rita were considered major hurricanes (category 3 and above), and both occurred in 2005. Second, the deepwater oil spill (often referred to as the British Petroleum or BP oil spill) of 2010 resulted in considerable economic and job loss from environmental damages in the Gulf of Mexico (Reuters, 2011). While we have excluded other states impacted by the oil spill (Mississippi, Alabama, and Florida), it is difficult to separate their effects from the lingering effects of Hurricane Katrina.

A summary of all the main findings and robustness tests is provided in Table 3 below:

Additional concern: declines in population and property values

Another potential concern is that our measure of PT freedom score could be capturing the disaster’s impact on population and property values – instead of the effect on underlying PT related institutions. If that were the case, we would expect postdisaster population decline and PT related institutional change to follow similar patterns. For instance, if the PT freedom score was a mere proxy for population density and associated property prices (and taxes collected), we would expect our indicator of PT freedom to drop following Hurricane Katrina and rise again as population rose back up. We do not find that to be the case. We run SCM for state population (not included in the manuscript) and find that PT freedom and state population do not follow similar trends. The former is relatively flat (Figure 2b) compared to the latter. Moreover, we see the changes in population, after a one-time negative shock, exhibits a monotonically increasing trend until 2015 (followed by a small decline thereafter), whereas PT freedom score meanders up and down. Thus, this lets us rule out that it was the displacement of citizens and associated reduction in property values that our PT freedom score is capturing.

Conclusion

Both formal and informal institutions matter for postdisaster economic recovery. Conversely, disasters can also impact institutions, thus providing an opportunity for institutional evolution. The process of institutional change is complex, involving multi-causal interactions between formal and informal processes that are challenging to untangle. We exploit the occurrence of Hurricane Katrina in 2005 as a source of exogenous variation and use the SCM to study the impact of major disasters on institutions in Louisiana. We find that the disaster had lasting effects on the state’s formal institutions, but informal institutions remained robust to the shock.

We use GE (as a share of total employment) freedom measure and PT freedom measure as proxies for governmental interference into the economy and protection of private property rights respectively,

¹³We exclude this result from the manuscript as it is virtually identical to the main result – SCM did not assign significant weight to MS and AL.

Table 3. Results summary

	Experiment	RMSPE	Average treatment effect	Maximum treatment effect	# Significant posttreatment periods	% Significant posttreatment periods
Government employment	Primary	0.1	1.89	3.44	10	60%
	In-time placebo (2002)	0.11	1.55	3.68	10	39% (60% post-2005)
	Drop largest donors	0.21	1.46	2.43	8	53%
Property tax	Primary	0.07	0.84	2.47	11	66.7%
	In-time placebo (2002)	0.06	0.59	2.39	10	44% (66.7% post-2005)
	Drop largest donors	NA	NA	NA	NA	NA
Social capital	Primary	0.19	No effect	NA	0	0%

both of which are established measures of formal institutions in the literature. We find that Hurricane Katrina led to an increase in both measures in Louisiana, indicating reductions in the government's direct involvement in the economy, as an employer and a taxer. Average treatment effects for our two primary experiments ranged from 1.55 to 1.89, approximately 1 standard deviation from our sample data. Our findings are robust to in-time placebo tests and the donor selection tests (dropping largest donors for GE; adding new donors for PT). Moreover, these effects are sufficiently large to be noteworthy.

This study contributes specifically to the literature examining the long-term impacts of Hurricane Katrina and broadly to the literature analysing the impacts of natural disasters on institutions. Our empirical findings suggest that large natural shocks can indeed lead to formal institutional change. In comparison, effects on informal institutions are less discernible. These findings are consistent with swathes of ethnographic and qualitative studies that show that informal institutions are resilient to large natural shocks. Natural disasters are inevitable. Thus, understanding how they impact institutions can better inform our economic and social policies and help to better implement emergency management and postdisaster policies.

Our study contains many shortcomings, including a methodological one. Using econometric tools to study institutional change forces us to focus on just one or two linkages. For instance, although we examine changes in both formal and informal institutions, we are unable to empirically untangle their interactions. Institutions have a highly configurational character. They interact in a myriad of ways generating diverse incentives for actors interacting in a variety of collective action situations. A fruitful path of future enquiry may be to develop a broader framework linking diverse actors (citizens, community leaders, civil society, political leaders, organizations, and governments) engaged in various cooperative and competitive situations, generating new rules and changing existing rules to overcome constraints and address complex postdisaster challenges. This approach may offer a way to untangle the interactions between actors operating within different institutional constraints.

The second limitation relates to measurement issues. Institutions are contextual. Therefore, despite its many strengths such as transparency, the economic freedom index and other similar standardized measures inevitably fail to capture many contextual details that matter for postdisaster recovery. Similarly, social capital indices, and social capital literature broadly, have been the subject of wide criticisms (Arrow, 2000; Durlauf, 1999, 2002).¹⁴ Thus, these measures can be difficult to assess on the relevant margin and their magnitudes are difficult to interpret. Informal institutions are also very difficult to proxy. There is no consensus in the literature regarding the appropriate variable or the level at which to quantify or evaluate informal institutions. Although measures such as social capital are widely used, they generate intense debates. Social capital can be adaptive, but their changes can be difficult to capture in an analytically meaningful manner. Other proxies of informal institutions such as norms and attitudes are equally problematic. Thus, our findings, while important and complementary to existing body of knowledge, require a careful analysis and a thorough consideration of existing qualitative studies that provide a more granular view of informal institutions.

Finally, our analysis examines state-level institutional changes. While examining state-wide changes in formal institutions is useful to estimate aggregate treatment effects, considerable institutional heterogeneity may exist at sub-state or regional levels. Moreover, with respect to informal institutions, there can be significant overlap across states and dissimilarities within states. So, it remains unclear what level of analysis is the most appropriate. Future research on states and jurisdictions with differing institutional structures impacted by natural disasters of similar magnitude may provide important insights. For example, examining institutional changes stemming from Hurricane Harvey's impact on Texas (a comparatively more economically free state than Louisiana) could bolster our

¹⁴Bjørnskov and Sønderskov (2013) argue that the concept of social capital lacks coherence and depth and that the cons of its use outweigh the pros. Similarly, as a preferred substitute for the concept of social capital, Bjørnskov *et al.* (2022) use social trust, which is captured by participants' response to the survey question: 'Most people can be trusted, or you cannot be too careful?'

understanding of institutional change within heterogeneous institutional environments. Further analysis regarding how social capital might change or remain robust following a crisis could be particularly fruitful given the beneficial role informal institutions play in disaster recovery efforts.

Many of the shortcomings in our analysis provide ample opportunities for additional research. Extending SCM and similar study designs to empirically examine the linkages between crises and institutions could bolster our understanding of the process of institutional evolution. Finally, we do find some evidence to suggest that disasters are indeed critical junctures that influence governments' economic roles. However, given the limitations we discussed, the precise ways in which disasters affect institutions are far from generalizable to other states and countries. Their effects in other settings remain unanswered. Answering these questions and uncovering additional details to shed further light on the process of institutional change remain viable avenues of research.

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