Extreme Events and the Resilience of Decentralized Governance

ABSTRACT

Extreme events, such as economic crises, natural disasters, or military conflicts, can affect the balance between centralization and decentralization forces across countries and transform, temporarily or more permanently, the design of multilevel governance. Using a panel for 91 developing and developed countries from 1960 to 2018, and another one for OECD countries during 1995-2018, we examine the effects of extreme external shocks on the decentralization level. We find that internal conflicts boost decentralization, while natural disasters reduce it only in non-OECD countries, with long lasting effects in both cases. Economic recessions do not have significant effects on the level of decentralization, except for expenditure decentralization in OECD countries.

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KEY WORDS: Fiscal decentralization, extreme events, governance, resilience, political decentralization

1. Introduction

Recent times have witnessed a rise in the frequency and severity of extreme events with global reach, from the Great Recession and the Covid pandemic to natural disasters associated with climate change. The emerging global challenge is how to control and reduce the impact these extreme events have on society.

Most often, the causes and scope of these events represent huge externalities with regional, national, and international reach. Given these large externalities, upper levels, rather than subcentral governments, would be the most adept to address these types of problems and mitigate their impact.

Thus, one question that has accompanied all along the substantial worldwide trend toward more decentralized governance over the last several decades is whether decentralization needs to be rethought and recalibrated so to enable public sectors to combat national level crises more effectively (Bartolini et al., 2018; Lago-Peñas et al., 2019 and 2020; Canavire-Bacarreza et al., 2021).

The main question researched in this paper is how these extreme events have in fact affected the level of decentralization across countries and for how long. The level of decentralization in any country is the result of the interaction of a complex set of determinants, ranging from history and political forces to the level of income, and to other determinants such as area size, geography, or ethnic and linguistic fragmentation. All these factors tend to change slowly or not at all, and therefore we can think of them in combination yielding a long-term trend in the decentralization level in each country.

Extreme events, on the other hand, can be thought of as shocks to the decentralized governance system, potentially leading to changes in the level of decentralization. Although there has been plenty of research on the factors determining the level of fiscal decentralization across countries, there is still little evidence on the impact of extreme events on the design of decentralized governance across countries and over time. The main contribution of this paper is to help fill this gap in the literature. Some recent papers (De Mello and Tovar, 2022; Tselios, 2021) emphasize the dynamic linkages between shocks and decentralization by calculating impulse responses in the shorter run. This paper moves the research agenda further by trying to estimate both short-term and long-term equilibrium relationships based on large cross-sectional panels of countries. The

specific questions we ask are: Do the consequences of extreme events affect the design of multilevel governance? Are those changes short lived or long lasting?

The paper analyzes those questions utilizing two panel data sets, a large panel of 91 developing and developed countries covering close to six decades, from 1960 to 2018, and a panel of only OECD countries covering the period 1995 to 2018. The level of fiscal decentralization is measured by both the RAI index (Hooghe et al., 2016; and Shair-Rosenfield et al., 2021) and the conventional revenue and expenditure measures. We focus on several salient types of extreme events –economic crises, natural disasters, and armed conflicts- that can potentially affect previous equilibrium levels of decentralization.

We find that economic recessions do not have lasting effects on decentralization. In contrast, armed conflicts boost decentralization in both OECD and non-OECD countries, while natural disasters reduce it in non-OECD countries, with no effects in OECD members. Moreover, these effects are long lasting in both cases. An important implication is the need to reconsider the conventional list of the long-term determinants of fiscal decentralization to include in that list certain types of extreme events.

The rest of the paper is organized as follows. In section two we provide a review of the relevant literature. Section three develops a simple theoretical framework. Section four presents the empirical approach, the data and the empirical analysis and findings. Section five concludes.

2. Literature review

Several strands of the fiscal federalism literature are relevant to the research in this paper. First, the literature examining the socio-economic, geographic, and institutional determinants of fiscal decentralization is relevant to our analysis because we need to fully control for the canonical determinants of the decentralization level to correctly identify any potential impact of extreme events. Second, a much smaller literature has previously examined some aspects of the potential impact of certain extreme events on decentralization. Third, while most of the extreme events we consider can be identified as fully exogenous, that may not be the case for national conflicts; therefore, we also review the relevant literature explaining the potential endogeneity of fiscal decentralization and national conflicts.

There is abundant empirical evidence on a clear positive relationship between population size and decentralization (Delgado, 2021; Arzaghi and Vernon, 2005; Jametti and Joanis, 2010). Other social characteristics such as population density have been analyzed, with a negative impact in some cases (Delgado, 2021 and Jametti and Joanis, 2010) and a positive one in others (Arzaghi and Vernon, 2005). In line with the latter, Kee (1977) and Wasylenko (1987) found a direct relationship between urbanization and fiscal devolution.

Ethnic and linguistic diversity have been found to lead to higher decentralization (Pickard, 2020; Letelier, 2005; and Desai et al, 2005), but not so by Panizza (1999). More educated populations may also have pro-decentralization preferences (Bojanic, 2020).

Economic variables have also been extensively studied as potential determinants of fiscal devolution. The evidence of the impact of per capita income is somewhat mixed, with positive effects (Arzaghi and Vernon, 2005; Jametti and Joanis, 2010; Sambanis and Milanovic, 2011), but also negative effects (Wu and Wang, 2013; Panizza, 2013; and Delgado, 2021). The latter perhaps as a result of public sector reforms in developing countries fostered by international organizations. A similar ambiguity is found for income inequality, with negative effects in the EU (Delgado, 2021) and a positive one for a larger sample of 84 countries (Bojanic, 2020).

For the effects of geography, decentralization tends to increase with country size, which generally increases heterogeneity in needs and preferences (Bojanic, 2020; Arzaghi and Vernon, 2005; Martinez-Vazquez and Timofeev, 2009; and Canavire-Bacarreza et al., 2017). Geographic fragmentation and complexity is also a positive factor (Canavire-Bacarreza et al. 2017).

Regarding the role of institutions, political party systems and electoral rules also affect devolution (Roubini and Sachs, 1989; O'Halloran, 1994; Volkerink and de Haan, 2001; Nielson 2003; Panizza, 2013; and Faget, 2012), as does the presence of corruption. But for this latter, both a positive correlation (Shleifer and Vishny, 1993; Litvack et al., 1998; Bardhan and Mookherjee, 2000; Fan et al., 2009; and Nelson, 2013) and a negative correlation (Fisman and Gatti, 2002; Arikan, 2004; Ivanyna and Shah, 2011; and Altunbas and Thornton, 2012) have been found.

Turning now to the literature on how the vertical distribution of powers may adapt to external shocks, several types of extreme events have been identified as potential sources of recentralization (Bahl and Martinez-Vazquez, 2006; Fedelino, 2008; Cabrera-

Castellanos and Lozano-Cortés, 2008; Martinez-Vazquez and Smoke, 2011; Bos, 2012; Bordo and James, 2009; Arnold et al., 2020; Canavire-Bacarreza et al., 2021).

In economic crises, decentralization may weaken macroeconomic stabilization policy (Treisman, 1999; Ter-Minassian, 2009), although recent studies identify its specific design rather than the level of fiscal decentralization as the culprit behind the difficulty to implement macroeconomic stabilization policy (De Mello, 2000; Lago-Peñas et al., 2020; Wichowska, 2021).

More recently, Canavire-Bacarreza et al. (2021) find cross-country evidence of recentralization trends following economic crises, and similarly Bos (2012) for the Netherlands. However, Arnold et al. (2020) find that the Great Recession pushed expenditure centralization upwards only in unitary countries, but not in federal ones.

Several papers have also studied how the discovery of natural resources influences decentralization (Mehlum et al., 2006; Bhattacharyya and Hodler, 2010, 2014; Bhattacharyya and Collier, 2014). Specifically, Bhattacharyya et al. (2017) find recentralization trends after the discovery of oil resources, although quite diminished in democratic settings.

Regarding other kinds of shocks primarily not economic in nature, such as health crises, Bloom et al. (2022) and Steytler (2022) found that countries became more centralized in response to health emergencies. Tselios (2021) focuses on the decentralizing effects of natural disasters, with the effects contingent on the previous level of regional powers. De Mello and Tovar (2022) estimate reaction functions to both natural disasters and pandemics, finding that decentralized spending (and not revenues) reacts positively to both phenomena mainly in developing countries and during economic booms.

The literature on the effects of military conflicts on decentralization is scarcer. Alesina and Spolaore (2003) find that conflicts lead to larger jurisdictions. A priori, countries may react to an internal military conflict by offering fiscal and political devolution (Alexseev, 2001; Malyarenko and Wolf, 2021), but conceivably, they could do the reverse in fear of federalism working as a solvent (Martinez-Vazquez, 2003; Brancati, 2014). For external conflicts, Serkan and Yilmaz (2008) find them to constitute a major obstacle to decentralization. In a related vein, territories with greater competences may have incentives to have a direct bilateral relationship with the central government in detriment of the common general good (Ehrke, 2012; Rode et al., 2018). Either way, this opens the

potential endogeneity of fiscal decentralization and internal conflicts, an issue we address in the empirical section.

3. A simple theoretical framework, and testable hypotheses

As we have seen, an extensive literature in fiscal federalism has established the socio-economic, political, and geographical factors that work to determine the equilibrium level of fiscal decentralization. This equilibrium should be understood in dynamic terms, since although some determinants may not change over time, such as area size or geographic complexity, other determinants, such as GDP per capita or the urbanization level do change over time.

Our departure point empirically is the canonical model developed over the years to explain the level of decentralization across countries, based on social, economic, geographic and institutional factors of each country:

$$DEC_i = f(Social_i, Economic_i, Geographic_i, Institutional_i) \quad [1]$$

where DEC_i is a measure of fiscal decentralization in country i that depends on each country´s social characteristics, its economic circumstances, its geographic features, and its institutional framework.

As pointed out above, the main objective of this paper is to analyze what impact extreme events may have on the level of decentralization. When extreme events hit, decentralization equilibrium levels are modified in response, with the direction of the effects depending on the type of shock. Our analysis focuses on the effects of economic crises, natural disasters, and military conflicts.

Allowing for the presence of those external shocks in [1], we have:

$$DEC_i = f(Social_i, Economic_i, Geographic_i, Institutional_i, Natural\_Disasters_i, Conflicts_i, Crisis_i) \quad [2]$$

What can be said a priori about the expected direction of each of these shocks on decentralization? First, natural disasters have become more common and intense as the result of climate change, calling for more nationally coordinated mitigation policies and nationally funded adaptation programs.[1] In this context, it is likely that central

[1] See, for example, Martinez-Vazquez (2021).

governments will be called to take on a more prominent role following the occurrence of natural disasters, since they are better able to address externalities, have greater capacity to generate additional resources, and enjoy better access to capital markets. Institutional reforms in the governance system may be just implemented in the medium term, after dealing with the damages generated by the natural disaster. So, our first testable hypothesis is:

H1: *The occurrence of natural disasters will lead to reductions in the level of decentralization*.

Second, armed conflicts can generate complex responses in the decentralization framework. They usually reflect internal coexistence problems which can lead to institutional changes after they are over. Those changes can include decentralization strategies to contain centrifugal forces, and often involve more generous asymmetric decentralization arrangements. Our second testable hypothesis is:

H2: *The presence of armed conflicts will tend to increase the level of decentralization*.

The third type of extreme event we consider are large economic crises. Traditionally, scholars have questioned the ability of subnational governments to implement countercyclical fiscal policies because of their economic openness and limited access to borrowing. Although those views have not gone unchallenged in the literature, in actual practice it is likely that with the occurrence of large economic crises, central governments will take the lead to address those macroeconomic disequilibria by implementing aggressive fiscal policies, which likely result in the recentralization of fiscal powers.[2] Thus, our third and last testable hypothesis:

H3: *The occurrence of economic crises is likely to decrease the level of decentralization*.

4. Econometric analysis

To test the hypotheses above, we run several econometric models in which our dependent variable is a measure of decentralized power, and the independent variables are a series of indicators that address the types of external shocks we are interested in, controlling for the canonical determinants of the decentralization level.

[2] See, for example, Canavire-Bacarreza et al. (2021).

4.1 Econometric specifications, key variables, and data

Our benchmark specification is as follows:

$$DEC_{it} = \alpha_i + \rho \cdot DEC_{it-1} + \beta_j \cdot SHOCKS_{jit-n} + \delta_k \cdot CONTROLS_{kit} + \epsilon_{it} \qquad [3]$$

where *DEC* is the measure of decentralization; *SHOCKS* include three kinds of events potentially affecting decentralization: economic recessions, natural disasters, and war conflicts; and *CONTROLS* include a number of time-variant determinants of decentralization: population density, openness of the economy, the share of urban population, and per capita GDP. [3] The lagged value of *DEC* in also included to deal with sluggishness in dynamics. The effects of time invariant variables, such as surface area or orography, are captured by country-fixed effects.[4] Table 1 reports variable labels, definitions and data sources for all variables.

To capture the several dimensions of decentralization, five alternative measures are utilized: the Regional Authority Index (*RAI*) based on Hooghe et al. (2016) and Shair-Rosenfield et al. (2021); its two main components of self-rule (*SELFRULE*) and shared-rule (*SHAREDRULE*); and the share of central expenditure and revenues over total expenditures and revenues. Regarding the RAI, this is a multidimensional decentralization index for regional governments that includes several complementary indicators of self-rule (institutional depth, policy scope, fiscal autonomy, borrowing autonomy, and representation), and shared-rule (law making, executive control, fiscal control, borrowing control and constitutional reform). It covers 96 countries for almost seven decades, from 1950 to 2018.[5]

As for the share of expenditure and revenue, we will be using a centralization index, instead of a decentralization one, due to availability of data. Therefore, therefore we are

[3] Controlling for income distribution with the GINI index was discarded because of the sharp decline in sample size.

[4] The effect of population size would be included in the countries´ fixed effects. The correlation between country dummies and population for the large panel is 0.94, involving multicollinearity when included both at the same time.

[5] At this point, it is important to highlight that the fiscal autonomy sub-index is based on regional taxing powers, but it does not include any information regarding the amount of expenditure managed by regional governments. Moreover, the sub-indexes "institutional depth" and "policy scope" are mainly based on qualitative aspects of regional autonomy, and therefore they do not capture how much is spent by regions.

expecting opposite signs of the variables in these specifications as compared to the ones using the RAI index.

Concerning economic shocks, two possibilities are explored: first, a dummy variable capturing recession years and coded 0 for years with non-negative GDP growth rates, and second, the actual drop in GDP for recession years.

Regarding natural disasters, we created both a qualitative and a quantitative variable of extreme events, based on the EM-DAT database. This database offers information on many kinds of natural disasters from 1900 to 2022, including more than 16.000 separate episodes classified into nine different types: earthquake, flood, drought, landslide, extreme temperature, insect infestation, storm, epidemic, and wildfire. To select which of them are considered extreme, we used a statistical criterion by extracting only those with larger than average plus two standard deviations economic costs. This left us with 62 (13) extreme events for our large (small) panel. Finally, the natural disaster variable was coded in two different ways: a dummy variable to identify countries and years with extreme events; and a quantitative variable measuring the extent of the corresponding economic costs (as a share of GDP) generated by the disaster.

Last, for conflicts we used the Uppsala Conflict Data Program dataset, which offers information about military conflicts since 1960, classifying them into three different categories: state-based armed conflict, non-state conflict, and one-sided violence. Our *CONFLICT* variable is a dummy coded as 1 in those years in which a military conflict comes to an end and 0 otherwise. In this context, we have 133 military conflicts within our large panel, and 6 in the OECD countries smaller panel.

[insert table 1 about here]

As already mentioned, we use two complementary datasets in the estimations. The first is an unbalanced panel from 1960 to 2018 covering 91 countries. Considering lags in estimates, the number of valid observations is 3714, involving a T average of 41. And the second one is a shortened panel, including 33 OECD countries and 675 observations from 1995 to 2018 (average T=20), using as inputs central governments´ expenditure and revenue shares (IMF´s Government Finance Statistics). Both N and T are determined by the availability of data on RAI, and revenue and expenditure centralization.

Table 1 in the Appendix summarizes the main descriptive statistics, and Figure 1, also in the Appendix, report the average value of the main four variables for the five samples used to help understand differences in the results. Those averages show that: i) decentralization tends to be larger in OECD countries and increases over time; ii) the frequency of natural disasters is higher in non-OECD countries and over time; iii) the probability of conflicts in developed countries is much lower (almost six times) and decreases over time.

4.2 Econometric issues

Several checks are implemented to check for potential autocorrelation, unit roots, unobserved constant territorial heterogeneity, multicollinearity, cross-sectional dependence, and inverse causality.

Regarding the presence of autocorrelation, preliminary estimates showed the need to include the first lag of the endogenous variable on the right-hand of the equation. However, we discarded the presence of common unit root using a Levin-Lin-Chu test including individual effects and linear trends. Corresponding p-value is 0.01 in the case of *RAI* and lower in the case of *REVENUE* and *EXPENDITURES* (see Table 1 below for definitions). While the coefficient on the lagged endogenous is close to 0.9 in many cases, standard errors are systematically very small. Moreover, to capture delays in the response of decentralization to shocks, we tried different lags. Two lags were included in final specifications.

We also found that individual country effects were significant and correlated with regressors. Hence, a set of country dummy variables was included. Although the simultaneous inclusion of both lagged values of the explained variable and fixed effects involves biases in Pooled Ordinary Least Squares (POLS), this bias is of the order 1/T; and since T is large in our case, we chose to rely upon POLS (Beck and Katz, 2011).

We checked that multicollinearity is not a serious concern in estimates according to computed VIF (Variance Inflation Factors). To control for both contemporaneous correlation and cross-sectional heteroskedasticity, t-statistics relying on Panel Corrected Standard Errors (Beck and Katz, 1995) were also included in the estimates.

Finally, bidirectional causality on all regressors was also checked using a series of Granger tests. Results confirmed the existence of bidirectional causality between RAI and the dummy capturing war conflicts only. Hence, for both variables we also computed a VAR model treating both variables as endogenous.

4.3 Base empirical results

Table 2 reports the estimation results for the impact of economic shocks using the RAI as the dependent variable and covering for different specifications of POLS for the full period 1960-2018. Results are shown using our large 91-country sample, and two smaller subsamples for both OECD and non-OECD countries.

Regarding our variables of interest, we first highlight that the coefficients of *RECESSION* and *DROP IN GDP*, our two measures of economic shocks, were not statistically significant in any of the columns. For natural disasters (*ND*), the variable measuring the economic costs (*ND DAMAGE*) does not seem to have any effect on the level of countries decentralization in any of the specifications. However, the coefficients for the dummy variable measuring the presence of a natural disaster show a different and interesting result. Although there is no obvious immediate impact of the natural disaster on the institutional framework (ND_{-1}), the statistically significant positive coefficients for ND_{-2} point to a significant lagged centralizing effect after this kind of shocks take place. This corroborates the intuition that these institutional reforms are usually implemented in the medium term, after the country has had the opportunity to address the most important damages generated by the natural disaster. These results apply for the whole panel and for non-OECD countries, but not for the OECD sub-panel.

Concerning military conflicts, we find evidence of the positive impact of these shocks on decentralization, and this applies both for the whole sample, for OECD countries and for non-OECD countries. The nuance here is that this positive effect seems to take place faster in OECD countries, with larger significant coefficients for *CONFL-1*, while the impact is slower in non-OECD countries, for which the relevant variable becomes *CONFL-2*.

[insert Table 2 about here]

As for the time variant control variables, *URBAN* seems to have strong explanatory power, being significant in every specification of the model, with a positive coefficient. This result applies for all countries, although the impact in OECD countries is smaller. However, OPENESS and per capita GDP are not significant on the RAI index in any of the specifications. The same applies for density, except for non-OECD countries, in which a positive effect is present.

We run the same specifications with the RAI index decomposed into its two main components *SELFRULE* and *SHAREDRULE.* The results are shown in Table 3. The explanatory variables have a similar behavior than in the previous results for the whole RAI index. With respect to economic shocks, we find similar results as the ones displayed in Table 2. They do not appear to have any impact on countries´ vertical distribution of powers, with the exception for non-OECD countries, which experience an increase of decentralization when it is measured with *SHAREDRULE*.

[insert table 3 about here]

In the case of natural disasters, our results are also in line with the previous ones for *ND-2*, showing that when this kind of crises hit, devolution tends to shrink in both the large panel and the non-OECD panel. But in contrast, decentralization also seems to increase right after one of these shocks occurs (ND_{-1}), probably due to the immediate response of subnational governments. The nuance of this immediate effect can be found in the specific aspects affected by this change: an increased *SELFRULE* takes place in OECD countries, while it is *SHAREDRULE* that does so in non-OECD ones.

Our results regarding armed conflicts also corroborate previous estimations, pointing out to a decentralization effect of this type of extreme events. In particular, they have more significance in the *SELFRULE* sphere, although they also lead to increases in

decentralization measured by *SHAREDRULE* in OECD countries. Another interesting result is that this effect takes place faster in OECD (t+1) than in non-OECD countries (t+2). For the control variables, the results are in line with the ones obtained for the aggregated RAI index.

Recapping, the results displayed in Table 3 show that the effects of extreme events on RAI are mostly on its *SELFRULE* component, while *SHAREDRULE* appears to be less sensitive to external shocks.

4.4. Short-run vs long-run effects

In an Auto-Regressive Distributed Lag (ARDL) model like ours, coefficients β capture the short-run effect of the explained variables. But long-run (or total) effects are different. Let be a model with one lag of the endogenous and two lags of the explicative variables or ARDL (1,2):

$$y_t = \propto + \rho y_{t-1} + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \varepsilon_t \qquad [4]$$

The long-run coefficient λ can be computed as:

$$\lambda = \frac{\beta_1 + \beta_2}{1 - \rho} \qquad [5]$$

As intuitively explained by Riveros (2021), the numerator captures the cumulative impact of variable X on Y, computed as the sums of the corresponding coefficients; and the denominator represents the weight associated to the response of the autoregressive structure.[6]

In our case, the effects captured in the estimations are long-lasting, since lagged endogenous coefficients (ρ) are between 0.8 and 0.9 in most cases. Hence, long-run effects tend to be much stronger than short-run effects; up to ten times. Some of the exogenous shocks we are analyzing would suggest that they indeed affect the institutional design of fiscal decentralization, and that therefore they should be included among those in the conventional lists of the determinants of the fiscal decentralization level.

[6] See Blackburne and Frank (2007) for a more detailed technical discussion.

In Table 4 we compute long-rung impacts for all statistically significant exogenous shocks in tables 2 and 3 using expression [5]. The table is also useful to present the main results in a straightforward manner:

- Recessions are not relevant shocks in explaining changes in decentralization
- Conflicts boost decentralization in both OECD and non-OECD countries, but the effect is especially stronger in the former (double).
- Natural disasters reduce decentralization in non-OECD countries, but not in OECD countries. In fact, there is evidence of a positive effect on the self-rule dimension of the RAI index.
- The effect on the RAI index is concentrated in the self-rule dimension.

[insert table 4 about here]

4.5 Robustness checks

As a first robustness test, we run the main specifications for the two sub-periods 1960-1990 and 1991-2018, and the results are shown in Table 5. The reason to split the sample into two periods is for purely econometric reasons, to check for temporal heterogeneity (changes in the slope). The coefficients for natural disasters are negative and significant in both periods in line with our previous results, although they are a bit stronger in the first period. The estimated coefficients for military conflicts also show similar patterns to those in previous estimations, with stronger decentralization effects during the 1960-1990 period. Overall, the decomposition of the sample into the two sub-period yields no evident structural changes in the impact of our variables of interest in the decentralization level.

[insert table 5 about here]

As a second robustness test, we replicate the base estimations using a different dependent variable: the share of revenues and expenditure ratios for central governments in OECD countries over the period 1995-2018. Results are shown in Table 6. As noted, here we are using a centralization index, and thus we should expect the opposite signs for the estimated coefficients of the explanatory variables.

[insert table 6 about here]

The coefficients of the lagged dependent variable are a bit smaller than in the base results using *RAI* as the dependent variable, but they still reveal the presence of an autoregressive behavior.

Regarding our variables of interest, the most interesting result is the positive and significant coefficient of the recession variable in t-1: economic crises tend to increase expenditure centralization, probably because of automatic stabilizers within the central budget and the implementation of central discretionary programs to sub-national governments during economic downturns. The short run effect would be 0.55, but the long-run effect computed using expression [5] above is much stronger, around 4.2. However, they do not seem to affect the centralization of revenue sources, in line with the evidence found in De Mello and Tovar (2022) and Canavire-Bacarreza et al. (2021). Neither natural disasters nor war conflicts show statistically significant coefficients.

4.6. Addressing the endogeneity of military conflicts

One last issue we need to address is that of the potential endogeneity of decentralization and military conflict. As it was previously mentioned, we used the Granger test to check for the presence of bidirectional causality for all regressors of interest with decentralization. The only variable that turned out to show bidirectional causality with our dependent variable RAI was *CONFLICT*. Therefore, in this section we estimate a two-equation VAR model of RAI to CONFLICT innovation, treating the latter as endogenous. Innovation is defined as a one period change in state from 0 to 1. Figures 2 and 3 display the impulse response resulting from that model. The effect is significant and highly persistent because of the high coefficients of the lagged terms. While the short run effect after the second period is around 0.3, the accumulated effect over ten years is over 2 points in RAI. Overall, these results obtained from the VAR model confirm the ones obtained in our base estimations, with conflict leading to significant increases in the level of decentralization.

[insert figure 1 about here]

5. Conclusions

Fiscal federalism literature has devoted a great deal of attention to identifying the determinants of decentralization. Socio-economic, institutional, and geographical factors have been found to partially explain how countries decide to allocate spending and taxing

powers among different levels of government. Changes on some of those variables, such as population growth, urbanization or GDP per capita have been shown to affect the level of fiscal and political decentralization around the world.

However, much less attention has been paid to the potential effects that extreme events can have on nations´ institutional decentralization framework. This paper tries to fill this gap in the literature by analyzing how those shocks alter the vertical distribution of powers among public administrations, and for how long. With that objective we estimate several fixed effects models using alternative measures of decentralization. Our variables of interest belong to three different kinds of extreme events: economic recessions, natural disasters, and military conflicts.

We find robust empirical evidence of extreme events affecting the vertical distribution of powers, with the impact of each kind of external shock having different effects. In the case of natural disasters, there is a negative impact on decentralization when this is measured with the RAI. This effect is robust to different specifications, although it is stronger for non-OECD countries and for the self-rule component of the RAI. In contrast, we find no statistically significant effect of natural disasters on the vertical distribution of expenditure and tax resources. These two different results suggest a larger sensitivity of regional power measured by the RAI, while both quantitative measures of regional spending and tax collections do not seem to be strongly affected.

In the case of military conflicts, we also find empirical evidence that they can alter the vertical institutional framework of governance, increasing subnational powers when these are measured with the RAI. These results are robust to the different specifications, although they seem to be stronger in the case of the self-rule component of the RAI, which measures the power of regional governments to make decisions that affect their own citizens and territories. In line with the results for natural disasters, our quantitative measures of fiscal decentralization (share of total revenues and expenditures) do not seem to be affected by military conflicts.

Regarding large economic shocks, they also seem to be a source of institutional change in the vertical governance system when decentralization is measured by the vertical share of expenditures, although not so when the RAI is used. Specifically, when economic recessions hit, central governments tend to absorb a larger share of public spending, with this effect taking place almost immediately in the (t+1) period. This effect is probably a

combination of the effects of automatic stabilizers and discretionary policies by central authorities.

Overall, this paper contributes to the fuller understanding of the forces that shape the extent of decentralization across countries. An extensive literature in fiscal federalism has established the socio-economic, political and geographical factors determining the equilibrium level of fiscal decentralization. When extreme events hit, those equilibrium levels of decentralization are modified in response, with the direction of the effects depending on the type of shock. These long-term effects strongly suggest that the recurrence of certain types of extreme events should be considered for their inclusion in the conventional lists of the determinants of fiscal decentralization.

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Tables and Figures

Table 1: List of variables, definitions, and data sources.

Common variables (both panels)		
RAI	Regional authority index, which is the sum of SELFRULE and SHAREDRULE	Hair-Rosenfield et al. 2021 Hooghe et al. 2016
SELFRULE	The authority exercised by a regional government over those who live in the region	Hair-Rosenfield et al. 2021 Hooghe et al. 2016
SHAREDRULE	The authority exercised by a regional government or its representatives in the country as a whole	Hair-Rosenfield et al. 2021 Hooghe et al. 2016
ND	Natural Disasters. Dummy variable coded 0 for non-extreme natural disaster and 1 for extreme natural disaster	EM-DAT database
ND DAMAGE	Damage of extreme natural disasters in current US$ over country GDP	EM-DAT database
CONFLICT	Dummy variable coded 1 if the country finished an armed conflict that year and 0 otherwise. We include all the conflict types stablished on the database (Interstate, intrastate, and internationalized intrastate) and a variation of the extrasystemic type, to exclude governments involved on non-border foreign conflicts.[1]	UCDP/PRIO Armed Conflict Dataset
DENSITY	Population density is midyear population, in thousands, divided by land area in square Kms.	World Bank
OPENNESS	Economic Openness is calculated as the ratio of imports plus exports over GDP	Own elaboration using World Bank data
URBAN	Urban population refers to people living in urban areas as defined by national statistical offices. Values in percentage of total population.	World Bank
World Panel - 1960-2018		
GDP	Per capita GDP is gross domestic product divided by midyear population. Data are in thousands current U.S. dollars.	World Bank
RECESSION	Recession dummy is coded 0 for non-negative GDP growth rates and 1 for negative GDP growth rates	Own elaboration using World Bank data
DROP IN GDP	GDP growth rate *RECESSION	Own elaboration using World Bank data
OECD Panel – 1995-2018		
REVENUE	Consolidated central government revenue as percentage of total general government revenue	OECD Fiscal Decentralization Database
EXPENDITURES	Consolidated central government expenditure as percentage of total general government expenditure	OECD Fiscal Decentralization Database
GDP	Gross domestic product per capita, volume in thousands USD, at constant purchasing power parities.	OECD Economic Outlook
RECESSION	Recession dummy is coded 0 for non-negative GDP growth rates and 1 for negative GDP growth rates	Own elaboration using OECD data
DROP IN GDP	GDP growth rate *RECESSION	Own elaboration using OECD data

[1] We also used alternative definitions of the variable. Main results hold when conflicts are limited to intrastate or the combination of interstate and intrastate.

Table 2: POLS estimates of the effects of all shocks on the RAI. All countries, OECD countries and non-OECD countries. 1960-2018

	RAI	RAI NON-OECD	RAI OECD	RAI	RAI NON-OECD	RAI OECD
Intercept	-0.58 (-3.15)*** [-3.46]***	-0.85 (-3.58)*** [-3.89]***	-0.046 (-0.17) [-0.22]	-0.58 (-3.20)*** [-3.49]***	-0.85 (-3.62)*** [-4.06]***	-0.065 (-0.24) [-0.31]
LAGGED	0.90 (131.98)*** [64.76]***	0.87 (81.49)*** [45.39]***	0.93 (124.83)*** [73.41]***	0.70 (131.81)*** [64.56]***	0.87 (81.31)*** [39.81]***	0.93 (125.04)*** [73.5]***
$RECESSION_{-1}$	0.075 (1.16) [1.20]	0.090 (0.93) [1.00]	0.055 (0.74) [0.69]			
$RECESSION_{-2}$	0.059 (0.92) [0.96]	0.053 (0.55) [0.61]	0.060 (0.80) [0.74]			
$DROP\ IN\ GDP_{-1}$				-0.77 (-0.58) [-0.68]	-1.07 (-0.60) [-0.77]	0.51 (0.26) [0.29]
$DROP\ IN\ GDP_{-2}$				-1.25 (-1.09) [-1.31]	-1.09 (-0.74) [-0.98]	-1.10 (-0.57) [-0.62]
ND_{-1}	0.12 (0.73) [0.59]	0.065 (0.29) [0.24]	0.25 (1.15) [1.1]			
ND-2	-0.46 (-2.86)*** [-2.25]**	-0.65 (-2.95)*** [-2.43]**	-0.034 (-0.15) [-0.14]			
$ND\ DAMAGE_{-1}$				0.0021 (0.35) [0.82]	0.0020 (0.29) [0.76]	-0.018 (-0.057) [-0.11]
$ND\ DAMAGE_{-2}$				-0.0023 (-0.38) [-0.89]	-0.0024 (-0.33) [-0.88]	0.055 (0.17) [0.34]
$CONFL_{-1}$	-0.068 (-0.59) [-0.36]	-0.13 (-0.90) [-0.60]	0.45 (2.20)** [2.09]**	-0.063 (-0.54) [-0.33]	-0.13 (-0.85) [-0.55]	0.44 (2.18)** [2.07]**
$CONFL_{-2}$	0.31 (2.70)*** [1.65]*	0.39 (2.62)*** [1.75]*	0.070 (0.33) [0.31]	0.31 (2.66)*** [1.62]	0.38 (2.57)** [1.69]*	0.061 (0.29) [0.27]
DENSITY	0.045 (0.42) [1.16]	0.15 (0.87) [1.62]	1.32 (0.70) [0.73]	0.047 (0.44) [1.21]	0.14 (0.86) [1.74]*	1.17 (0.62) [0.65]
OPENNESS	0.013 (0.12) [0.17]	-0.037 (-0.24) [-0.45]	-0.020 (-0.12) [-0.1]	0.085 (0.074) [0.10]	-0.042 (-0.27) [-0.49]	-0.032 (-0.18) [-0.16]
URBAN	0.027 (7.72)*** [7.82]***	0.037 (6.81)*** [7.25]***	0.013 (2.28)** [2.51]**	0.027 (7.79)*** [7.9]***	0.037 (6.82)*** [6.88]***	0.014 (2.41)** [2.65]***
GDP	-0.00005 (-0.019) [-0.026]	-0.0076 (-0.78) [-1.26]	-0.00066 (-0.32) [-0.36]	-0.00011 (-0.048) [-0.064]	-0.0073 (-0.75) [-1.33]	-0.00055 (-0.27) [-0.30]
R2	0.98	0.97	0.99	0.98	0.97	0.99
Number of countries	91	53	38	91	53	38
Observations	3714	2132	1582	3714	2132	1582

Notes: ***, **, * indicates statistical significance at 0.01, 0.05 and 0.10 levels, respectively. All estimates include country fixed-effects. Standard t-statistics in parenthesis and PCSE robust t-statistics in brackets.

Table 3: POLS estimates of the effects of all shocks on the RAI components (Selfrule and Sharerule). All countries, OECD countries and non-OECD countries. 1960-2018

	SELFRULE	SELFRULE NON-OECD	SELFRULE OECD	SHAREDRULE	SHAREDRULE NON-OECD	SHAREDRULE OECD
Intercept	-0.50 (-3.39)*** [-3.79]***	-0.60 (-3.26)*** [-3.75]***	-0.28 (-1.15) [-1.30]	-0.025 (-0.35) [-0.33]	-0.20 (-2.19)** [-2.30]**	0.27 (2.45)** [2.72]***
LAGGED(-1)	0.91 (139.88)*** [71.23]***	0.90 (92.42)*** [46.95]***	0.93 (113.79)*** [78.67]***	0.88 (118.40)*** [44.52]***	0.82 (65.04)*** [23.23]***	0.92 (123.76)*** [52.22]***
RECESSION-1	0.072 (1.38) [1.53]	0.086 (1.14) [1.35]	0.050 (0.76) [0.73]	0.032 (0.13) [0.12]	0.0095 (0.25) [0.23]	0.0057 (0.20) [0.20]
RECESSION-2	0.040 (0.69) [0.76]	-0.0078 (-0.10) [-0.12]	0.093 (1.42) [1.35]	0.024 (0.95) [0.9]	0.065 (1.77)* [1.67]*	-0.034 (-1.16) [-1.19]
ND-1	0.060 (0.46) [0.36]	-0.065 (-0.37) [-0.29]	0.36 (1.91)* [2.00]**	0.064 (1.02) [0.94]	0.15 (1.69)* [1.66]*	-0.11 (-1.34) [-1.18]
ND-2	-0.36 (-2.77)*** [-2.15]**	-0.50 (-2.90)*** [-2.26]**	-0.028 (-0.14) [-0.15]	-0.10 (-1.58) [-1.38]	-0.13 (-1.58) [-1.48]	-0.0049 (-0.058) [-0.050]
CONFL-1	-0.030 (-0.29) [-0.17]	-0.075 (-0.65) [-0.40]	0.31 (1.73)* [1.88]*	-0.043 (-1.03) [-0.78]	-0.063 (-1.17) [-0.96]	0.14 (1.78)* [1.83]*
CONFL-2	0.27 (2.87)*** [1.71]*	0.32 (2.75)*** [1.71]*	0.073 (0.4) [0.42]	0.043 (0.95) [0.71]	0.063 (1.12) [0.91]	-0.00079 (-0.01) [-0.01]
DENSITY	0.053 (0.62) [1.60]	0.16 (1.26) [2.60]***	0.81 (0.49) [0.60]	-0.0053 (-0.13) [-0.48]	-0.048 (-0.74) [-1.46]	0.60 (0.81) [0.61]
OPENNESS	0.024 (0.26) [0.37]	0.0021 (0.017) [0.032]	-0.020 (-0.12) [-0.10]	-0.032 (-0.71) [-1.00]	-0.060 (-1.02) [-1.56]	-0.0062 (-0.093) [-0.12]
URBAN	0.021 (7.38)*** [7.35]***	0.025 (6.06)*** [6.28]***	0.014 (2.81)*** [3.30]***	0.0046 (3.54)*** [3.73]***	0.0090 (4.62)*** [4.74]***	-0.0018 (-0.83) [-0.68]
GDP	-0.00012 (-0.65) [-0.86]	-0.010 (-1.33) [-2.66]***	-0.0014 (-0.77) [-0.86]	0.00092 (1.03) [1.30]	0.0047 (1.25) [1.82]*	0.00078 (0.99) [1.15]
R2	0.98	0.97	0.99	0.98	0.95	0.99
Countries	91	53	38	91	53	38
Observations	3714	2132	1582	3714	2132	1582

Notes: ***, **, * indicates statistical significance at 0.01, 0.05 and 0.10 levels, respectively. All estimates include country fixed-effects. Standard t-statistics in parenthesis and PCSE robust t-statistics in brackets.

Table 4: Long-run coefficients of exogenous shocks.

	RECESSION	ND	CONFL
RAI		-4.6	3.1
SELFRULE		-4.0	3.0
SHAREDRULE			
RAI OECD countries			6.4
SELFRULE OECD countries		5.1	4.4
SHAREDRULE OECD countries			1.8
RAI NON-OECD countries		-6.5	3.0
SELFRULE NON-OECD countries		-5.0	3.2
SHAREDRULE NON-OECD countries	0.4	0.8	

Note: Only significant effects at 10% or less are reported.

Table 5: POLS estimates of the effects of all shocks on the RAI and its components. 1960-1990 and 1991-2018

	1960-1990			1991-2018		
	RAI	**SELFRULE**	**SHAREDRULE**	**RAI**	**SELFRULE**	**SHAREDRULE**
Intercept	-1.19 (-2.17)** [-2.36]**	-0.88 (-2.15)** [-2.66]***	-0.30 (-1.24) [-1.29]	0.40 (1.05) [1.53]	0.33 (0.99) [1.35]	0.17 (1.45) [1.81]*
LAGGED	0.85 (58.92)*** [25.26]***	0.86 (61.7)*** [27.98]***	0.81 (51.77)*** [18.64]***	0.83 (74.06)*** [26.07]***	0.84 (81.17)*** [29.67]***	0.77 (57.51)*** [17.33]***
RECESSION-1	0.12 (0.95) [0.86]	0.12 (1.27) [1.22]	0.0034 (0.060) [0.053]	0.0085 (0.12) [0.17]	0.0091 (0.15) [0.21]	-0.0029 (-0.14) [-0.20]
RECESSION-2	0.065 (0.50) [0.47]	-0.020 (-0.20) [-0.20]	0.086 (1.51) [1.37]	0.030 (0.45) [0.63]	0.051 (0.87) [1.18]	-0.023 (-1.12) [-1.56]
ND-1	0.56 (1.66)* [1.46]	0.35 (1.40) [1.16]	0.22 (1.50) [1.4]	-0.082 (-0.49) [-0.37]	-0.079 (-0.55) [-0.42]	0.0019 (0.040) [0.030]
ND-2	-0.69 (-2.04)** [-1.79]*	-0.46 (-1.83)* [-1.51]	-0.22 (-1.46) [-1.37]	-0.33 (-1.99)** [-1.41]	-0.29 (-2.01)** [-1.50]	-0.040 (-0.80) [-0.56]
CONFL-1	-0.19 (-0.84) [-0.56]	-0.18 (-1.06) [-0.68]	-0.0057 (-0.058) [-0.043]	-0.10 (-0.76) [-0.42]	-0.052 (-0.47) [-0.26]	-0.037 (-0.96) [-0.59]
CONFL-2	0.46 (2.02)** [1.31]	0.34 (2.00)** [1.25]	0.13 (1.31) [0.95]	0.090 (0.69) [0.38]	0.080 (0.71) [0.42]	0.020 (0.52) [0.31]
DENSITY	0.22 (0.33) [0.99]	0.17 (0.36) [0.96]	0.066 (0.23) [0.65]	0.15 (0.77) [2.28]**	0.16 (0.95) [2.66]***	-0.020 (-0.35) [-1.53]
OPENNESS	-0.16 (-0.39) [-0.72]	-0.034 (-0.12) [-0.21]	-0.14 (-0.80) [-1.22]	0.19 (1.34) [1.52]	0.17 (1.38) [1.53]	-0.012 (-0.28) [-0.43]
URBAN	0.050 (4.34)*** [4.89]***	0.034 (4.18)*** [5.28]***	0.013 (2.66)*** [2.88]***	0.020 (3.22)*** [4.12]***	0.015 (2.76)*** [3.43]***	0.0041 (2.19)** [4.01]***
GDP	0.0023 (0.17) [0.2]	0.0015 (0.14) [0.18]	-0.0015 (-0.25) [-0.25]	-0.0014 (-0.47) [-0.71]	-0.0028 (-1.06) [-1.54]	0.0020 (2.09)** [2.95]***
R2	0.97	0.97	0.96	0.99	0.99	0.99
Countries	64	64	64	91	91	91
Observations	1386	1386	1386	2328	2328	2328

Notes: ***, **, * indicates statistical significance at 0.01, 0.05 and 0.10 levels, respectively. All estimates include country fixed-effects. Standard t-statistics in parenthesis and PCSE robust t-statistics in brackets.

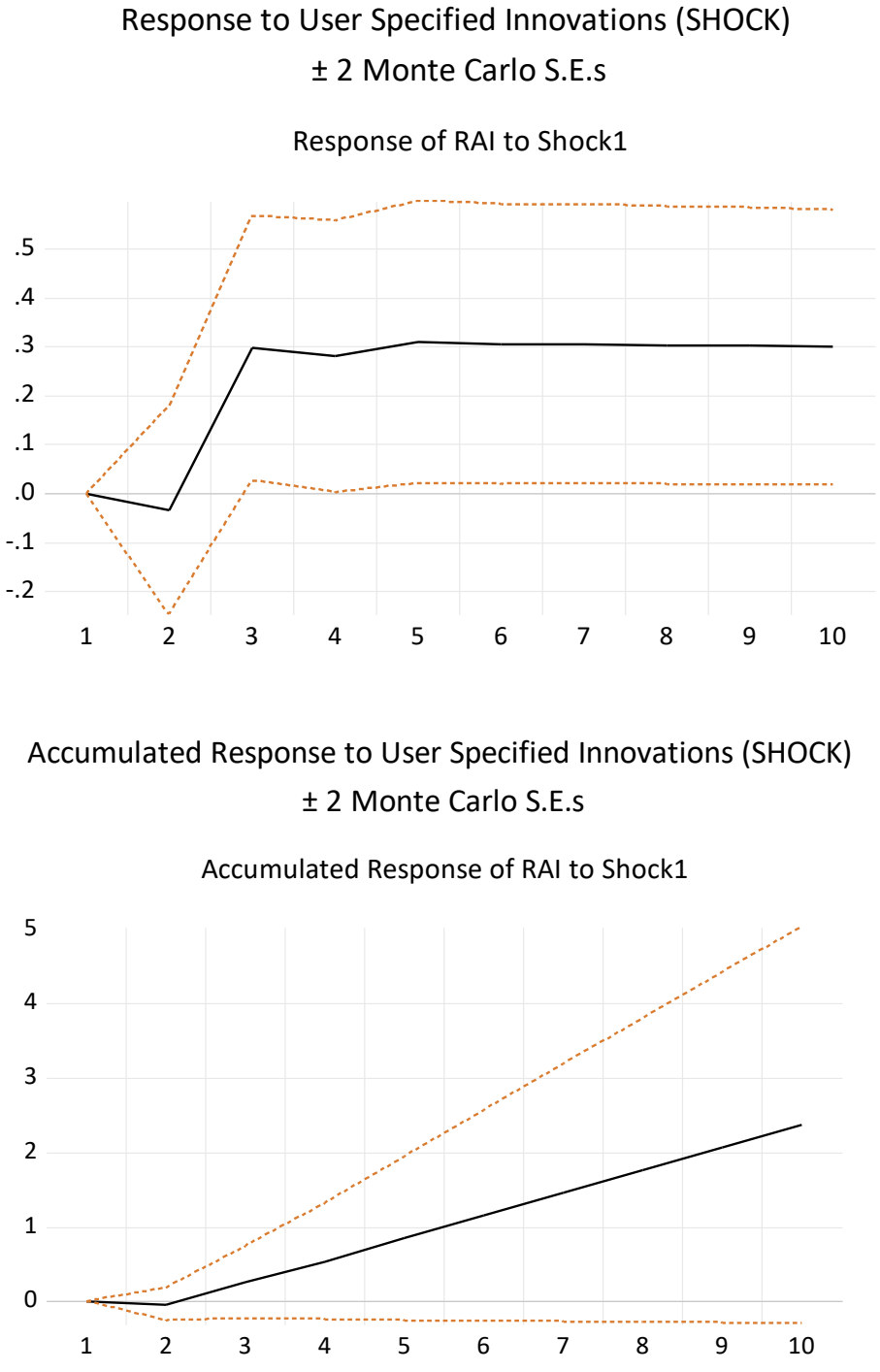
Table 6: POLS estimates of the effects of all shocks revenues and expenditures. OECD countries[2] (1995-2018)

	REVENUE	EXPENDITURES
Intercept	18.43 (7.28)*** [5.08]***	5.30 (1.89)* [1.33]
LAGGED (-1)	0.77 (33.47)*** [19.15]***	0.87 (45.58)*** [17.43]***
RECESSION-1	0.020 (0.14) [0.13]	0.55 (2.62)*** [2.55]**
RECESSION-2	-0.034 (-0.26) [-0.24]	0.084 (0.4) [0.41]
ND-1	0.16 (0.56) [0.56]	-0.05 (-0.11) [-0.19]
ND-2	0.26 (0.87) [0.85]	0.16 (0.33) [0.57]
CONFL-1	-0.25 (-0.57) [-0.85]	-0.060 (-0.08) [-0.24]
CONFL-2	0.051 (0.11) [0.24]	-0.25 (-0.34) [-1.02]
DENSITY	-6.36 (-1.49) [-2.16]**	-5.61 (-0.81) [-1.30]
OPENNESS	1.17 (3.35)*** [3.48]***	0.17 (0.30) [0.23]
URBAN	0.014 (0.61) [0.49]	0.050 (1.29) [1.46]
GDP	-0.028 (-2.22)** [-2.25]**	0.012 (0.58) [0.32]
R2	0.99	0.99
Countries	33	33
Observations	675	675

Notes: ***, **, * indicates statistical significance at 0.01, 0.05 and 0.10 levels, respectively. All estimates include country fixed-effects. Standard t-statistics in parenthesis and PCSE robust t-statistics in brackets.

[2] Due to a lack of data for revenue and expenditure variables, Colombia, Chile, Japan and South Korea were not included in the estimates.

Figure 1: Responses of RAI to a war conflict shock.



Appendix

Table 1: Main descriptive statistics

	Mean	Median	Maximum	Minimum	Std. Dev.	N
RAI	9.74	8.00	37.72	0.00	9.52	3714
SELFRULE	7.93	7.19	30.45	0.00	7.07	3714
SHARERULE	1.81	0.00	14.95	0.00	3.29	3714
RECESSION	0.12	0.00	1.00	0.00	0.33	3714
DROP IN GDP	-0.0039	0.00	0.00	-0.26	0.016	3714
ND	0.017	0.00	1.00	0.00	0.13	3714
ND DAMAGE	0.20	0.00	127.28	0.00	3.47	3714
CONFL	0.036	0.00	1.00	0.00	0.19	3714
DENSITY	0.21	0.080	7.95	0.0014	0.65	3714
OPENNESS	0.76	0.63	4.37	0.049	0.55	3714
URBAN	59.75	63.84	100.00	3.74	22.22	3714
GDP	11.15	3.89	123.51	0.054	16.38	3714
EXPENDITURE	69.92	71.06	97.07	30.89	15.14	675
REVENUE	81.49	85.42	97.53	43.60	13.43	675

Figure 1: Mean difference across samples for variables RAI, Recession, Natural Disasters and Conflicts