Disasters by Design: A Disaggregated Study of the Ethnic and Institutional Determinants of Natural Disaster Vulnerability

Rune Busch

Master's Thesis

Department of Political Science
Faculty of Social Sciences
University of Oslo

May 2012

Disasters by Design: A Disaggregated Study of the Ethnic and Institutional Determinants of Natural Disaster Vulnerability

Rune Busch

May 15, 2012

2012
Disasters by Design: A Disaggregated Study of the Ethnic and Institutional Determinants of Natural Disaster Vulnerability
Rune Busch
http://www.duo.uio.no
Printed by: Reprosentralen, Universitetet i Oslo

Abstract

Natural hazards are epistemically random events that can cause massive losses on human lives. However, *how* natural disasters affect human lives is a matter of human resilience. Do institutions provide mechanisms for people's vulnerability in natural disasters, and are some institutions more impairing than others? The growing literature on politically motivated disaster relief has found that measures to ensure against and prepare for disastrous events to a large extent are used as 'porks' to buy constituent support. However, there is as yet no global large-n study that sufficiently captures how this affects politically excluded groups. This thesis develops a novel approach, and examines these matters by studying all rapid onset natural disasters in the world from 1980-2008. The contributions of this project are twofold. I disaggregate institutions and study how specific institutional subcomponents affect natural disaster vulnerability. Secondly, by using geography information systems (GIS) this thesis is able to make local level inferences about which political groups that are more vulnerable, and under which conditions natural disasters are more deadly. The empirical evidence of this project reveals core features of the political dimension behind disaster vulnerability, which has not been empirically evident until now. Estimates suggest that areas that are populated by politically excluded groups on average experience twice as many casualties as areas that are not populated by excluded groups. This finding yields support to a core rational choice argument: political representation in central government affects the allocation of goods, and incumbents allocate goods favoring those constituents that ensure them in power. I also find evidence that presidential institutions on average experience 50 casualties more than parliamentary institutions. This finding lends support to the literature arguing that allocation of global goods in presidential regimes are characterized by local distribution, short-term policy, and large transaction costs, which all hampers global goods provisions.

Acknowledgements

Having completed the most enduring academic project ever experienced, the author is left with a certain self-satisfaction. Albeit this project in times of hardship has felt solely my own, many people have contributed to its making, and they deserve my unreserved appreciation. First, I would like to thank my supervisor Halvard Buhaug for his continuous availability, and always constructive efforts to pull me in the right direction. A special thanks goes to professor Håvard Hegre who I have enjoyed working closely with throughout the master's program. Together with Carl Henrik Knutsen he gave me the opportunity to write this thesis in conjunction with the project *Conceptualization and Measurement of Democracy* (RCN project 204454/V10, see http://www.sv.uio.no/isv/english/research/projects/conceptualization- and-measurement/index.html). For that I am grateful. I would also like to thank my good friends and family: My mother, father, and brothers for their always unrestrained support; Lars Petter Berg for always being funny; Tarald Laudal Berge for his carefulness; Victor Lund Shammas for reading my final draft; Stein Omar Gjendem for his lovely seriousness; Anders Ravik Jupskås for his attentiveness; Sofie Hove Stene for her vigorousness in correcting my spelling mistakes; Tore Wig for seeding the reseach idea; my technical support team, Jonas Nordkvelle, Espen Geelmuyden Rød, and Bjørn Hoyland; and finally the Department of Political Science for being a place of intellectual stimulus.

I alone am responsible for the content of this thesis.

Rune Busch
Wordcount: 35,775

Contents

1 Introduction **1**

1.1 Puzzle I . . . 2
1.2 Puzzle II . . . 2
1.3 Puzzle III . . . 3
1.4 Research questions . . . 4
1.5 Defining concepts . . . 4
1.5.1 Natural disasters . . . 4
1.5.2 Political exclusion . . . 5
1.5.3 Institutional mechanisms . . . 6
1.6 Structure . . . 7
1.7 Findings . . . 7

2 Literature review **9**

2.1 Institutions and natural disasters . . . 9
2.2 Institutions and goods provisions . . . 12
2.2.1 The role of the executive . . . 12
2.2.2 Elections . . . 13
2.2.3 Centralization . . . 13
2.3 Political exclusion and natural disasters . . . 13

3 Theorizing natural disaster resilience **17**

3.1 Incentives for disaster spending . . . 18
3.2 Propositions . . . 19
3.2.1 Institutional mechanisms . . . 19
3.2.2 Political exclusion . . . 24
3.3 Interplay between institutions and exclusion . . . 25

4 Research design **27**

4.1 Why a statistical analysis? . . . 27
4.2 Why disaggregate? . . . 28
4.2.1 PRIO-GRID . . . 29
4.2.2 GIS procedure . . . 30

4.3 Data issues and selection bias . . . 30
4.4 From concept to indicator - making inferences . . . 34
4.4.1 Baseline model . . . 34
4.5 Dataset and unit of analysis . . . 34
4.6 Dependent variable . . . 35
4.7 Independent variables . . . 36
4.7.1 Political exclusion . . . 36
4.7.2 Institutional variables . . . 38
4.7.3 Operationalizing control variables . . . 40
4.7.4 Regression models . . . 43
4.8 Statistical model . . . 43
4.8.1 The negative binomial regression model . . . 43
4.8.2 Model specifications . . . 45
4.9 Missing data . . . 46
4.9.1 Summary . . . 47
4.10 Summary statistics . . . 47
4.11 Multicollinearity . . . 48

5 Analysis **51**
5.1 Country level analysis . . . 51
5.1.1 Regressions . . . 53
5.1.2 Institutions and exclusion . . . 56
5.1.3 Democratic institutions . . . 59
5.1.4 Summary country level analysis . . . 61
5.2 Disaggregated analysis . . . 61
5.3 Summary . . . 65

6 Robustness and model fit **67**
6.1 Disaggregated analysis . . . 67
6.2 Country level analysis . . . 69
6.3 Democracy . . . 69
6.4 Multilevel model . . . 70

7 Conclusion **71**
7.1 Hypotheses . . . 71
7.1.1 Summary . . . 73
7.2 Policy implications and further research . . . 74

A Diagnostics and additional results. **77**

B Relevant Stata codes and data **87**

List of Figures

4.1 International borders and country assignment. The figure illustrates the border between Thailand, Cambodia, and Laos (dashed line), with grayscale coloring indicating the country to which each cell is assigned. The numbers in the cells refer to the Gleditsch and Ward (1999) numeric code for the corresponding country (800 is Thailand; 811 is Cambodia; 812 is Laos). Figure is taken from Tollefsen, Strand and Buhaug (2012*b*, 368). 29

4.2 The figure illustrates how a high-resolution raster (top) is represented in PRIO-GRID (below). The string codes denote different land cover classes (Hansen et al., 2000; $0.08^\circ \times 0.08^\circ$ resolution); CR cropland, CS closed shrubland, DB deciduous broadleaf forest, EB evergreen broadleaf forest, GR grassland, WO woodland, WT water(Tollefsen, Strand and Buhaug, 2012*b*, 366). 30

4.3 Number and Magnitude of Disasters, 1970-2010. The figure is based on Figure 1 in Strömberg (2007, 202), but with my own data. 31

4.4 Distribution of the number killed, country level analysis. 44

4.5 Observed vs. predicted counts (PRM), poisson model and negative binomial model (NBRM). Note: positive deviations shows underprediction. 45

5.1 Democracy and disasters 55

5.2 Simulated marginal effect of presidentialism on various levels of democracy, with political exclusion at its median value. Confidence intervals in grey shadings. . . 58

5.3 Simulated average difference in casualties for parliamentary and presidential institutions by region. Confidence intervals in grey shadings. 60

5.4 Simulated average casualties in cells with and without exclusion. 64

5.5 Simulated marginal effect of political exclusion for presidential systems over various levels of democracy. 65

6.1 Predicted number events from model 2 in table 5.9. 68

6.2 Predicted number casualties from model 2. 69

List of Tables

4.1 Natural disasters events and casualties by disaster type, country level analysis. . 32
4.2 Natural disasters events and casualties by disaster type, grid-cell analysis. . . . 32
4.3 Regional number of disasters and casualties, country level analysis. 33
4.4 Regional number of disasters and casualties, grid-cell analysis. 33
4.5 Sample of natural disaster events 36
4.6 Summary statistics, country level analysis. 47
4.7 Summery statistics, disaggregated analysis. 48
4.8 Cross-correlation table of the hypothesized variables, and the interaction terms. Disaggregated analysis. 49

5.1 Casualties by regime type 51
5.2 Casualties by size of excluded groups 52
5.3 Casualties by institutional characteristics 52
5.4 Democracy and disasters, country level analysis 54
5.5 Institutions, exclusion and natural disasters, country level analysis 57
5.6 Democratic institutions, and natural disasters, country level analysis 59
5.7 Average casualties in grid-cells by institutions. 62
5.8 Casualties for grid-cells with and without excluded groups. 62
5.9 Institutions, exclusion and natural disasters, disaggregated analysis. 63

A.1 Possion vs Negative regression model. 78
A.2 Institutions, exclusion and natural disasters, disaggregated analysis. Hybrid institutions coded as belonging to majoritarian, predidential, and federal. 79
A.3 Institutions, exclusion and natural disasters, disaggregated analyses. Including all observations. 80
A.4 Cross-correlation table of the hypothesized variables, and the interaction terms. Country level analysis. High correlations are in bolded text. 81
A.5 Institutions, exclusion and natural disasters, country level analysis. Hybrid institutions coded as belonging to presidential, majoritarian, and federal. 82
A.6 Institutions and natural disasters, country level analysis. All observations are included. 83

A.7 Exclusion and natural disasters, NBRM and OLS. Dependent variable is the count of more than zero killed. This is transformed to its natural logarithm in the OLS model. 84
A.8 Exclusion and natural disasters, Logit models. Dependent variable in Model 1 is 1 if number killed is more than 0. Dependent variable in model 2 is 1 if number killed is more than 50. 85
A.9 Political exclusion and presidential institutions, estimated on earthquakes only. . 86

Chapter 1

Introduction

Natural hazards such as floods, earthquakes, tsunamis, and hurricanes, are exogenous and epistemically random events that can cause massive losses of human lives. However, *how* natural hazards affect human lives is a matter of human resilience and vulnerability. While natural hazards may be beyond our control, *natural disasters* are not. How governments prepare for, and respond to such low-probability high-consequence events, is a question of great importance to political scientists. As anthropogenic climate change is expected to increase the frequency of natural disasters worldwide (IPCC, 2012, 18-21), this issue should increase its hold on the agendas of both the policy and research community.

My research motivation starts off with two important findings in the political science/political economy literature. To begin with, well functioning and democratic institutions are associated with substantially lower death tolls from natural catastrophes (e.g. Sen, 1983; Besley and Burgess, 2002; Kahn, 2005; Raschky, 2008; Flores and Smith, 2010; Plümper and Neumayer, 2009). However, these studies commonly use highly aggregated measures of democracy, which makes it hard to study the effects of specific institutional drivers of natural disaster resilience. By focusing on institutional *subcomponents*, this study attempts to identify some of the underlying mechanisms linking institutions and natural disaster vulnerability.

Secondly, important contributions have been made that identify the political motivations behind disaster management. A consistent finding is that incumbents often use disaster relief as pork-barrel projects in electorally important areas (Garrett and Sobel, 2003; Albala-Bertrand, 1993; Healy and Malhotra, 2009). However, there is as yet no global large-n study that systematically examines how disaster relief is used as means to buy constituent support, and deprive excluded groups from state power. My research project fills a gap in this literature by studying how political status based on ethnicity affects natural disasters vulnerability.

Finally, a third and yet undiscovered component relating to the aforementioned puzzles, is the interaction between these distinct processes. How do institutions provide mechanisms for excluded groups; and are particular forms of government more impairing than others?

If my assumptions are correct; that members of politically excluded groups are more likely to die in natural disasters; and that specific institutional subcomponents might provide mechanisms for increased natural disasters resilience, my research project reveals important aspects

of the relationship between natural disasters and the toll on human lives. In doing so I conduct a large-n study covering all rapid onset natural disasters in the period 1980-2008, drawing on theory related to the interplay between institutions and the provision of public goods. The novelty of the analysis is twofold. (1) I disaggregate the unit of analysis down to the local level, and examine disastrous events where they actually took place. This enables me to make local level inferences about whom, and under which conditions, people are more vulnerable. (2) I disaggregate institutions, and examine the effects of *de jure* political institutions on the toll on human lives. Below, I present the three puzzles in more detail.

1.1 Puzzle I

What seems to be a robust finding in the political science/political economy literature is that better institutions, that is, wealthy, stable, and democratic regimes with comprehensive political rights and civil liberties, are significantly related to lower death tolls from natural catastrophes (Kahn, 2005; Besley and Burgess, 2002; Sen, 1983; Toya and Skidmore, 2007; Raschky, 2008; Flores and Smith, 2010; Plümper and Neumayer, 2009). But how do institutional arrangements shape the outcomes of natural disasters? One proposed logic is that well functioning institutions are more responsive and effective in securing the interests of its citizens through public goods provisions; thus investing more in disaster related preparedness policies directed towards large parts of the population.[1] Although several studies have concluded that democracy mitigates the severity of natural disasters, Strömberg (2007) does not find support for this hypothesis. He argues instead that government effectiveness is the essential driving force behind disaster resilience.[2] Hence, this thesis provides a further examination of the relationship between democratic institutions and natural disaster vulnerability. Secondly, the existing literature is preoccupied with highly aggregated measures of democracy. This makes it hard to study specific subcomponents of the *institutions-disaster* relationship. Gathering inspiration from other fields of the political science/political economy literature, which examine constitutional features of institutional performance, I look at how institutional mechanisms might facilitate natural disaster resilience. In this regard I examine how specific *rules of the game*, such as electoral rules, form of government, and the level of centralization, influence natural disaster vulnerability. I form hypotheses based on the theory related to the constitutional-institutional environment and the provision of public goods.

1.2 Puzzle II

The second puzzle originates from the literature dealing with political motivations behind disaster policies. In their study of the Federal Emergency Management Agency (FEMA) Garrett and Sobel (2003) found that electorally important districts receive more disaster relief, and

[1] See Lake and Baum (2001); Bueno de Mesquita, Smith, Siverson and Morrow (2003) for theory of why democracies produce more public goods/services.

[2] Using a measure of quality of public services, infrastructure, and civil services.

they predicted that nearly half of all disaster relief was politically motivated. But what drive incumbents to exploit disaster relief in return for constituent support? Healy and Malhotra (2009) made corresponding inquiries, and found that electorates in the United States offer scant incentives for public preparedness policies by rewarding incumbents for private disaster relief. Albala-Bertrand (1993, 93) focused on the economic side of protective measures, and found that economic support tends to be directed to politically aligned areas. In the study of the 2001 flood in Rawalpindi, Pakistan, Mustafa (2003, 6) described several reports of relief cheques being distributed to political supporters and family members. These findings illuminate how natural disaster relief can be used as an effective tool to channel constituent support. There are similar studies that show how racial and ethnic commonality increase natural disaster vulnerability (e.i. Bates, Folgeman, Parenton, Pittman and Tracy, 1963; Peacock, Morrow and Gladwin, 1997; de Silva, 2009). However, they focus only on a small number of cases, which do not yield healthy grounds for generalizations. Cohen and Werker (2008, 805) provide the only attempt to systematically examine this relationship on a global scale, and find that death tolls are three times as high in countries with high levels of ethnic fractionalization compared to more homogeneous countries. Although their empirical model confirms their hypothesis, it relies on a crude measure of ethnic fractionalization, which does not incorporate the political dimension of ethnic cleavages. Secondly, they operate with country-level data, which fails to reveal relevant characteristics of whom that are more vulnerable in natural disasters.

However, the introduction of geographic information systems (GIS), and specifically geo-referenced data on political status, allows me to examine how disasters affect different political groups on the sub-national level, and lets me draw inferences about how political exclusion affects natural disaster vulnerability more accurately. Building on the aforementioned studies and the existing literature on the relationship between institutions and political exclusion, I examine how political exclusion affects natural disaster vulnerability.

1.3 Puzzle III

The last puzzle relates to the specific interaction between institutional components and political exclusion. Are particular institutions more conducive to political exclusion, and are politically excluded groups more vulnerable in natural disasters in particular institutional environments? This part of the thesis is explorative in its nature, and builds on related theory from other fields of political science. Several studies show that particular institutional mechanisms are more beneficial for universal policies (e.g. Crepaz, 1998; Persson and Tabellini, 2004), and that ethnic fractionalization shrinks public services (e.g. Alesina, Baqir and Easterly, 1999). However, the potential relationship between these factors remains unobserved. Building on the notion that disaster policy is more likely to be directed towards politically important constituents, and that particular institutional subcomponents are more sensitive to pork-barrels (Strömberg, 2003; Ashworth and Bueno de Mesquita, 2006), I examine the interaction between institutional mechanisms and the vulnerability of politically excluded groups.

1.4 Research questions

Based on these separate, but related puzzles, my research project attempts to systematically examine the relationship between institutions, political exclusion, and the severity of natural disasters. I use data from the OFDA/CRED International Disaster Database (*EM-DAT*, 2012), and conduct a large-n study covering all rapid onset natural disasters in the period 1980-2008. By combining local level data on political exclusion and natural disasters (in GIS format), I make use of a empirically novel approach enabling me to make local level inferences that are closer to the actual observed event. Hence, I provide the first global study that examines the effects of institutions and political status at specific disastrous locations. Three research questions guide my thesis:

1. How does political exclusion affect natural disaster vulnerability?
2. How do institutional mechanisms affect natural disaster vulnerability?
3. How do institutional mechanisms affect the relationship between political exclusion and natural disaster vulnerability?

As the reader will see, there are two questions that relates to the specific role of a set of variables, and a third query that relates to the specific interplay between these variables. The research questions will be formulated into distinct propositions, which will be tested in the empirical analysis.

1.5 Defining concepts

In the proceeding section I clarify the key concepts examined in this thesis.

1.5.1 Natural disasters

Natural hazards are geophysical shocks that *might* lead to natural disasters. The hazard itself cannot cause a natural disaster; it is dependent on affecting a specific socio-economic environment (Dilley, Chen, Deichmand, Lerner-Lam, Arnold, Buys, Kjekstad, Lyon and Yetman, 2005, 115). This does not mean that hazards cannot affect the magnitude of disasters, it only points to the specific assumption that natural disasters involve the particular impact of the natural environment on the human/economic environment (Alexander, 1993, 4). Hazards that occur in unpopulated areas and therefore do not affect human lives are not disasters. In this regard natural hazards work as stochastic shocks on the socio-economic environment, and can develop into a natural disaster, depending on human resilience and vulnerability.[3]

Natural disaster *resilience* refers to all human activity that affects the ability to adapt to and absorb natural hazards (Cannon, 1994, 19). Resilient societies have greater capacity to absorb and adapt to natural hazards, and therefore suffer less. The corresponding term *vulnerability* refers to how sensitive societies or individuals are to natural hazards. The two terms should not be understood as having different implications; they simply refer to the capacity

[3] In a natural science perspective, natural hazards are of course not random events, although they can be hard to predict.

to tackle hazardous events (Pelling, 2003, 5). There is a large literature that nuances these terms, and discusses how they relate to human capacity to handle natural hazards (see Pelling, 2003; Alexander, 1993; Cannon, 1994; White, 1974; Wisner and Luce, 1993). However, what is pertinent for this project is the distinction between the physical hazard *per se* and the ability to affect the disasters that may follow (see Wisner and Luce, 1993, 127). A second and related point, is that vulnerability to natural disasters is not simply a function of technological measures directed at preparing and responding to a disastrous event, but also related to social and environmental management in general (White, 1974, 13). An illustrative example of how decisive the socio-economic environment can be is to compare the Loma Prieta earthquake striking San Francisco in 1989, and the 2010 earthquake in Haiti. With similar strength, the Haiti earthquake killed more than 220,000, while the San Francisco earthquake killed just over sixty. Obviously, these massive different outcomes originated from different policies, institutional arrangements, and socio-economic conditions.

In this project the focus is on the physical impact of natural disasters, and specifically look at the number of casualties. Other aspects, such as economic and psychological consequences, are not addressed here.

As mentioned, this study regards natural hazards as exogenous events. By this I mean that natural hazards strike autonomously, independent of the human environment. As most of social science research deals with highly endogenous phenomena, it is usually a tricky task to identify the actual relationship between the variables, as the effects often go both ways. Although natural disasters explicitly refer to the effect on the human environment – and in this project the toll on human lives – the hazard is beyond our control and therefore contributes to exogenous variation. It can of course be argued that even hazards are more or less anthropogenic, as human impacts on climate change or famines are well documented.[4] To minimize the endogeneity effect, this study relies on data from rapid-onset natural disasters alone, that is; earthquakes, floods, volcanic eruptions, storms, wildfires, extreme temperatures, and mass movements (dry and wet). Details on specific measures and operationalizations are elaborated in the methods section.

1.5.2 Political exclusion

The second key concept in this thesis is political exclusion. Political exclusion builds on the notion that groups experience unequal access to central state power, and the extent to which groups are represented in central authorities makes them hold unequal political status. If an ethnic group, say, whites in the United States in the 1950s, would occupy all governmental positions, they enjoy high political status and have monopoly on state power. The assumption is that access to central state power yields opportunities for political concessions, and that excluded groups are less likely to enjoy the benefits as included groups do. Political exclusion refers in this context to politically relevant ethnic groups and their access to central state power (Cederman, Wimmer and Min, 2010, 98). Ethnicity is defined as any subjectively experienced

[4]See Sen (1983) for famines, and Parry, Canziani, Palutikof, van der Linden and Hanson (2007, IPCC) for climate change.

sense of commonality based on the belief in common ancestry and shared culture (Ibid.). Such markers can be language, phenotypical features, faith and so on.

Data on political exclusion is collected from the Ethnic Power Relations (EPR) dataset, and the geo-referenced version, the GeoEPR dataset. The EPR data identifies all politically relevant ethnic groups around the world, and measures how access to state power differs among them in all years from 1946 until today (Cederman, Wimmer and Min, 2010, 98).

1.5.3 Institutional mechanisms

Institutional mechanisms are defined as subcomponents of a broader institutional system. It refers to the specific *rules of the game*, such as, electoral rules, political centralization and the role of the executive. These rules are often a part of a written contract, the constitution, and act as the "primary mechanisms for disciplining officials" (Persson, Roland and Tabellini, 1997, 1). Although these mechanisms have been ignored by the literature dealing with natural catastrophes, there is a large literature on their effects on economic performance (see Persson, Roland and Tabellini, 1997; Persson and Tabellini, 2004; Crepaz, 1996; Knutsen, 2011), and especially on their effects on public provisions. As this study in part examines how central governmental features affect natural disaster resilience, which has many of the characteristics of a public good, theory related to institutions and public goods provision provides the basic theoretical tools. Data on institutions is collected from the Database of Political Institutions (DPI) (Beck, Clarke, Groff, Keefer and Walsh, 2001), and the data collected by Schjølset (2008).

Central to the notion that institutions affect natural disasters is the activity of central governments in two closely related but distinct areas: *ex-ante disaster preparedness*, and *ex-post disaster mitigation* policies. This distinction is also drawn in the political science/political economy literature on natural disasters (Skoufias, 2003; Healy and Malhotra, 2009; Anbarci, Escaleras and Register, 2007; Cohen and Werker, 2008). Disaster preparedness includes all ex-ante measures to insure against, and prepare for a disastrous event. Examples of such measures are construction regulations to make buildings more robust to earthquakes, tsunami-warning systems, dikes and terraces, and funding for governmental and non-governmental organizations that will carry out the help-effort once a disaster has struck. Ex-post disaster response includes all measures that are undertaken by governments after disaster has struck. Such measures include the targeted channeling of funds, personnel and other resources to a particular disaster mitigation operation, and/or special legislation targeted at dealing with a specific disaster.

Government preparedness and response spending provide the mechanisms for which institutions affect natural disasters resilience. However, as the literature conclude that ex-ante preparedness spending is the foremost effective tool for natural disaster resilience (Healy and Malhotra, 2009; Skoufias, 2003; Cohen and Werker, 2008), my theoretical discussion relates to the allocation of ex-ante preparedness policies. I adopt a distinction from Ashworth and Bueno de Mesquita (2006) on global public goods, and local goods. Global public goods are goods that are directed to benefit all citizens, while local goods are directed to specific con-

stituents.[5] Applying this distinction leads me to investigate how institutions shape the incentives and the abilities of incumbents to provide global public preparedness measures instead of local preparedness measures.

1.6 Structure

I proceed as follows: In Chapter 2 I review the relevant literature on institutions, political exclusion and natural disasters. This provides the background for the theoretical framework, and places my theoretical and empirical contribution in the scholarly literature. In Chapter 3 I narrow the scope, and present the theoretical arguments for which the effects of institutions and political exclusion can be formulated into distinct propositions. In Chapter 4 I outline my research design; addressing methodological and data issues. In Chapter 5 I present my empirical tests, and the following results. In Chapter 6 I examine the robustness of the results, and address how my model fits the data. Finally, I make some concluding remarks, before addressing where to go forward.

1.7 Findings

The results provide clear rejections and confirmations of my propositions. The two major findings are that (1) areas which are inhabited by politically excluded groups experience systematically higher death tolls in natural disasters, compared to areas which are not inhabited by politically excluded groups. Estimates suggest that on average, areas with politically excluded groups suffer twice as many casualties in natural disasters. Secondly, (2) presidential institutions are related to around 50 casualties more in natural disasters than parliamentary institutions. This confirms my theoretical assumptions that political representation directly affects ethnic groups' vulnerability in disasters, and that incumbents favor those constituents that ensure them in power. It also provides support to the hypothesis that institutional incentives in presidential systems disrupt global goods provisions, and increase the vulnerability of peoples. The empirical model rejects my hypotheses relating to electoral rules, while finding no clear support for how level of centralization affects natural disaster vulnerability.

[5] Neither are perfect public or private goods. In this context the two terms must be understood as referring to two distinct processes, and being placed on separate sides of a continuous scale, where perfect public and private goods are at each end.

Chapter 2

Literature review

Amartya Sen is a scholar famous for many contributions to the field of political science. Still, he is perhaps most famous for linking democratic governance to famine prevention. By stating that "(...) starvation is the characteristic of some people not having enough food to eat. It is not the characteristic of there *being* not enough food to eat" (Sen, 1983) he described what has later been elaborated in many scholarly works; that human related disasters are precisely that – human related. I center my theoretical starting point to human devised constraints, and ask which incentives drive some institutions to produce many public goods, and what drives some institutions to produce so few. The proceeding section goes through the most relevant theoretical and empirical literature on natural disaster mitigation, and links institutions to political exclusion and the allocation of public goods. In chapter 3 I construct a theory grounded in this literature and form empirically testable predictions.

2.1 Institutions and natural disasters

A consistent finding in the literature on the determinants of natural disasters is that rich and well-functioning institutions are associated with substantial lower death tolls from natural disasters (Kahn, 2005; Besley and Burgess, 2002; Raschky, 2008; Flores and Smith, 2010; Plümper and Neumayer, 2009). The logic is that democratic institutions are more responsive and effective in providing public goods, and hence invest more in natural disaster preparedness measures that reduce peoples vulnerability when the hazard strikes. Together with tougher institutional constraints and a free press, democracies are able to reduce incentives for under provisions in ex-ante preparedness measures. Besley and Burgess (2002) find that flood impacts in India are negatively correlated with newspaper distribution, and attribute this effect to the fact that information circulation drives political accountability, which causes governments to be more active in both preventing and responding to the impacts of disasters.

Skoufias (2003) as well as Cohen and Werker (2008) elaborated on the important differences between preparedness and response policies. Two important aspects were pointed out. First, there are substantially different incentives driving preparedness and response policies. Response spending is like any other spending; resources that are directed toward specific ac-

tions. Preparedness spending, however, is characterized by profound uncertainty (Cohen and Werker, 2008, 8-10). The government only knows with an estimated probability if a natural hazard is going to strike, and in the trade-off between other government policies, this uncertainty causes governments to undervalue ex-ante preparedness spending.[1] The second aspect is that preparedness spending excessively exceeds response spending in effectiveness when a natural disaster develops (Healy and Malhotra, 2009; Skoufias, 2003, 1097). Given that a natural hazard strikes, each dollar invested in preparedness yields more resilience than each dollar in response. Healy and Malhotra (2009, 396) found that in the US, the ratio between preparedness and response was 15/1 in the favor of preparedness. As public goods in general are assumed to have decreasing marginal returns, and that the United States is a highly developed country, it is reasonable to think that the ratio between ex-ante preparedness spending and ex-post response could be even higher in less developed countries where the marginal returns are higher.[2]

Flores and Smith (2010) and Plümper and Neumayer (2009) attach the capacities of institutions to the size of win-sets. Democracies are usually constructed on larger win-sets (large coalitions of constituents). Thus, they have greater incentives to provide public provisions directed toward large populations, and therefore are more resilient in natural disasters. Conversely, autocracies built on smaller win-sets (small coalitions) have incentives to provide their winning coalition with private directed means, and therefore have a more unequal distribution of disaster resilience, which again leads to larger catastrophes.

Another proposed reason for the effect of institutions on disasters is collective action problems caused by inefficiencies and transaction costs. Corruption may be one such cause of inefficient bureaucracies (e.g. Besley and Burgess, 2002; Persson and Tabellini, 2003; Alesina, Devleeschauwer, Easterly, Kurlat and Wacziarg, 2003). Anbarci, Escaleras and Register (2005, 2007) argue that institutionalized corruption leads to lack of enforcement of building codes, and hence weaker infrastructure and housing. Strömberg (2007, 209) finds that the mitigating effect of institutions indeed can be related to bureaucratic effectiveness. However, he provides the only empirical rejection of the hypothesis that democratic institutions as such are related to fewer disasters casualties – essentially contesting the large literature that have found evidence for this. He recognizes that countries with extensive reporting procedures may be correlated with democratic institutions, and acknowledges that the lack of effect may be due to overrepresentation of countries with democratic institutions. Nevertheless, his finding provides the basis of deeper look into the 'democracy–disaster' relationship.

A common belief is that democracies perform better because they experience fewer and less powerful natural hazards. Although Dilley et al. (2005) find that the distribution of natural hazards is biased to a few geographical areas, the risks associated with them are largely contingent on country development and environmental quality (Peduzzi, Dao, Herold and Mouton, 2009). Strömberg (2007) finds that high-income areas in Europe, North America, and Japan,

[1] Uncertainty causes inefficiency in the ex-ante allocation of resources. Response spending excludes this uncertainty and allow governments to allocate resources under complete information.

[2] Assuming that less developed countries are at a lower level of the supply curve, where the slope is steeper, and hence the marginal revenue is higher.

are in fact equally exposed to natural disasters, but that the magnitude is contingent on level of development. Wealth is by far the most crucial determinant of natural disaster severity (Kahn, 2005; Anbarci, Escaleras and Register, 2005; Toya and Skidmore, 2007; Peduzzi et al., 2009). Estimates suggested by Strömberg (2007) indicate that the number of fatalities are around 70 percent lower in high- than low-income countries. Wealth affects infrastructure and housing through stronger and more durable materials, and wealthy governments can for example afford more complex warning systems. Besley and Burgess (2002) argue that in addition to large sufferings, poor countries are unable to counter the effect through fiscal policies. This constraints reconstruction and causes a spiral of risk inducement.

In this brief review I have pointed out some of the most relevant theories and empirical findings that link institutions to natural disaster vulnerability. Institutions have been argued to have an effect through democratic institutions (Flores and Smith, 2010; Kahn, 2005; Strömberg, 2007); bureaucratic effectiveness and corruption (Anbarci, Escaleras and Register, 2005, 2007; Strömberg, 2007); government stability and investment climate (Raschky, 2008; Toya and Skidmore, 2007); and institutional quality (Kahn, 2005).[3] The literature on determinants of natural disasters has given institutions a great portion of explanatory power, and for this reason it is puzzling that institutional subcomponents to such a large extent have been ignored. To come closer to the institutional mechanisms that drive disaster resilience, my research project is directed at a more detailed analysis of institutional constraints and the ability to provide protective measures. Sobel and Leesen (2006) and Gopalakrishnan and Okada (2007) provide the only attempts to systematically argue how government institutions, that is, level of centralization, can affect natural disaster mitigation. Sobel and Leesen (2006) argue that centralized systems are characterized by collective action problems, transaction costs, and ineffectiveness, so that institutions are incapable of reaching optimal provisions of disaster spending. However, they do not test general predictions, but argue based on a study of Hurricane Katrina. Gopalakrishnan and Okada (2007) on the other hand argue that decentralization creates unclear responsibilities between the local and the federal government, and that the prospects of receiving federal aid reduces the incentives for local disaster management. They also claim that local authorities lack incentives to provide rigorous restrictions on land use, adopt national policies and rigid regulations, which may lead to increased vulnerability (Ibid.).

As the theoretical and empirical literature on the effects of institutional mechanisms on natural disasters are limited to the aforementioned contributions, I have looked for inspiration from other fields of the political science/political economy literature, examining constitutional features of institutional performance. In addition to level of centralization, I examine how electoral rules, and the role of the executive influence natural disaster vulnerability. My specific theoretical predictions will be elaborated in chapter 3.

[3]Protection against expropriation, regulatory quality, rule of law, control over corruption

2.2 Institutions and goods provisions

Although institutional subcomponents to such a large extent have been missing in the literature on natural disaster vulnerability, the literature on institutions' effect on goods provisions is substantial. Torsten Persson and Guido Tabellini (with co-authors) have researched a wide range of constitutional/institutional factors in economic performance (Persson and Tabellini, 1996; Persson, Roland and Tabellini, 1997, 2000; Persson and Tabellini, 2003, 2004). Even though these models were not developed with the intention to include institutions' effect on natural disasters, the models' theoretical implications allow for further empirical testing (see King, Keohane and Verba, 1994, 19-23). The reasons for choosing the institutional mechanisms investigated, are both qualitative and quantitative; they are core features of the state, and they have been issued considerable attention in the literature on institutional performance. The proceeding section touches upon the most relevant theoretical and empirical literature on the subject, in order to create a background for the theoretical discussion in the following chapter.

One of the distinctive differences between institutions is the incentives driving accountability and representation (e.g. Powell, 2000; Przeworski, Stokes and Manin, 1999; Ashworth and Bueno de Mesquita, 2006; Persson and Tabellini, 2004). On one hand *accountability* creates incentives for good behavior through the risk of losing power. The logic is that the political leaders produce good policies when they know that they can be kicked out of office. Accountability does not simply refer to voters punishing or rewarding politicians through re-election, but also to the ability to elect the "right" candidate. Ashworth and Bueno de Mesquita (2006) argue that this makes voters value candidate abilities over ideologies, and that public services rise with skillful incumbents. On the other hand *representation*, meaning that the government reflects the constituents, embodies the state with multiple interests, reflecting the potential cleavages in society in general. This creates incentives for bargaining, coalition building, and in turn; policies taking into account larger parts of society.

2.2.1 The role of the executive

Following this path, many argue that presidential systems are more accountable than parliamentary systems, because of a simpler chain of delegation, and a more rigorous separation of power. At the same time, accountability might lead governments to resort to short-term policies in fear of being displaced, and consequently lower output of public goods. Persson and Tabellini (2004) find evidence of such a rationale, and argue that coalition building in parliamentary regimes leads to higher levels of government spending. On the flip side, parliamentarian systems are linked to increased corruption (Persson and Tabellini, 2003), which again has been related to large natural disasters (Anbarci, Escaleras and Register, 2007; Strömberg, 2003). However, Persson, Roland and Tabellini (2007) find that across parliamentary systems, coalition government significantly increases public spending, which indicate that broad based representation increases public goods provisions.

2.2.2 Elections

The 'accountability-representation' trade-off is also argued to function differently in electoral systems. Proportional representation systems create larger coalitions, which lead to more spending and long term policies. On the other hand majority elections, or plurality rule, is argued to be more accountable. Persson, Roland and Tabellini (1997) however, find that majoritarian systems are associated with lower public spending (Persson, Roland and Tabellini, 1997). Just as for the executive dimension, electoral rules also differ in incentives for corruption. Persson, Roland and Tabellini (1997) find evidence of such a relationship, and link PR systems to higher levels of corruption. Ashworth and Bueno de Mesquita (2006) argue that because legislators in parliamentary systems do not hinge on independent executive, voters care more about policy views than abilities, which they predict to lead to lower output of goods.

2.2.3 Centralization

Persson and Tabellini (1996) construct a model trying to tease out the general effect of centralization on country-level risk sharing.[4] They predict that centralization causes inter-regional coalitions to be built, which tilt public goods provision in favor of risk prone areas. On the other hand decentralized systems are characterized by inter-regional conflicts, leading to under provision of public goods. This approach contests the classic notion argued by Olson (1965), who stated that the driving mechanism behind global goods provisions is how far people that provide the good are to that particular good. In this context federal institutions, being closer to the people providing the good, are more effective in securing public goods provisions.

2.3 Political exclusion and natural disasters

Studies of political motivation behind disaster relief, leaves government officials with a rather gloomy portrayal. Garrett and Sobel (2003) found that politically important states in the US received more disaster relief than non-decisive states. In their study of the allocation of FEMA (Federal Emergency Management Agency) expenditures, the authors found that politically important states have a higher rate of presidential disaster declarations, and that states having congressional members overseeing FEMA committees receive disproportional amount of mitigation expenditures.

In a recent work, Healy and Malhotra (2009) make several important contributions to the literature. They also use data from the United States, and find that preparedness spending excessively exceeds response spending, but that voters reward response spending, and not preparedness spending. Citizens may weakly respond to preparedness projects because it is impossible for them to observe the counterfactual. Ex-post response, however, is easier to observe and thus has greater media value. Relief expenditures are more easily attributed to current administration, which creates incentives for short-term mitigation policies. The authors conclude

[4]The theoretical predictions are formulated to explain variations in labor market insurance, i.e. welfare programs.

that direct payments to individual groups lead to incumbent support (Healy and Malhotra, 2009, 401). This view is moderated by Chen (2008, 2009), who concluded that poor voters are more responsive to pork-barrels, than wealthy voters (2008), and that Republican voters respond more to direct aid than Democratic voters (2009). Achen and Bartles (2004) took a swing at rational interpretations of voting behavior, and showed that voters regularly punish governments for 'the act of God'. Albala-Bertrand (1993, 93) has also contributed to this rising literature, and found evidence of how politically motivated disaster relief impair already vulnerable areas.

What these studies show is that even though investments in long-term preparedness is more efficient in reducing disaster risk, both voters and incumbents have strong incentives to neglect efficient allocation of disaster mitigation policies, and instead value direct funding that increase incumbents chance of reelection. Following this, one would expect that groups that are less important for securing incumbent in office, receive less attention and less protective measures.

Cohen and Werker (2008) has made the only attempt to test this logic in a global large-n study. They find that death tolls in countries with high levels of ethnic fractionalization are three times as high as they are in more homogenous countries. However, they make use of a simple model, which relies on a crude measure of ethnic fractionalization. The model does not incorporate the political dimension of ethnic cleavages, and include only aggregate levels of ethnic divisions. Secondly, they operate with country-level data, which do not tell us much about who that are more likely to suffer in natural disasters. In his study of institutional determinant of natural disasters, Kahn (2005) use ethnic fragmentation as a proxy for institutional quality. However, his results are non-conclusive, and suffer from the same shortages relating to highly aggregated country-level indices.

There are case studies that look at the role of ethnicity in natural disasters, but most of them use data from the United States (see Fothergill, Maestas and Darlinton, 1999). Fothergill, Maestas and Darlinton (1999) have collected and reviewed the empirical literature on the subject, and find that ethnicity is related to natural disaster vulnerability, and more specifically, that blacks in the US are especially vulnerable. The explanation pulls in direction of housing factors, such as unreinforced masonry (URM), and poorly built homes (Fothergill, Maestas and Darlinton, 1999, 161). Peacock, Morrow and Gladwin (1997) make similar findings, and conclude that ethnic minority communities are more vulnerable in natural disasters.

More generally, Alesina, Baqir and Easterly (1999) concluded in their work on the relationship between ethnic division and the provision of public goods that ethnic fractionalization lowers public goods, and that ethnic polarization shrink public finances. The proposed mechanisms indicate that when a majority group believes that another ethnic group consumes their input of tax, they are not willing to keep providing the good. More generally ethnic fractionalization literature assumes that ethnic divisions are destabilizing to societies (e.g. Alesina et al., 2003; Cederman and Girardin, 2007; Buhaug, Cederman and Rød, 2008; Cederman, Wimmer and Min, 2010; Østby, 2011). The civil war literature has in later years provided a variety of works on the effects of ethnic fractionalization and political exclusion, which has drawn the

focus away from highly aggregated country level indices on fractionalization and towards indices more explicitly measuring the political dimension of ethnic cleavages.

Chapter 3

Theorizing natural disaster resilience

Even though the distinction between ex-ante and ex-post mitigation has received much attention, my model only views incentives driving government actions ex-ante disaster. Since preparedness spending is *the* crucial determinant of natural disaster resilience, I develop a model that looks at institutional incentives for effective *allocation* of ex-ante disaster preparedness measures. If institutions are driven by rational expectations, and institutions evaluate the risk concerning the losses in natural disasters to be high, and therefore invest in preparedness, it is likely that those institutions would just as likely value response in the face of a disaster. The cost of committing to ex-ante allocation is high (Cohen and Werker, 2008), but when risk averse institutions accept this cost, it is just not very likely that they would not valuate the costs ex-post also to be acceptable. Hence, this model assumes that what characterizes institutions is the incentives driving ex-ante allocation goods. Institutions can provide two sorts of goods: global goods and local goods. Global public goods are goods that are directed to benefit all citizens, while local goods are directed to specific constituents.[1](Ashworth and Bueno de Mesquita, 2006, 168) The relationship between institutions and preparedness spending is modeled as a regional conflict of interests, where allocation of resources is contingent on the political status of a particular region. When I make inferences about why some institutions are better than others, it is important to note that I do not observe and measure the actual difference in government spending allocation. I assume that when preparedness policies are allocated globally, that is, distributed universally covering all segments of society, countries are more resilient to natural disasters. Such activities may include construction regulation, housing regulation, public infrastructure, and other measures to insure against and prepare for disastrous events.

The political system in which political actors operate consists of constitutional and/or institutional structures that yield opportunities and put limitations for how incumbents act. Institutions consist of both formal and informal rules that lay constraints on human interactions, thus providing the incentive structure for feasible government policy (North, 1991, 1). In the theoretical discussion I use provisions of global goods and local goods as a theoretical framework to capture the logic behind preparedness policies that affect globally, or locally. I

[1]Neither are perfect public or private goods. In this context the two terms must be understood as referring to two distinct processes, and being placed on separate sides of a continuous scale, where perfect public and private goods are at each end.

assume that where global spending is the highest, there will be fewer casualties from natural disasters. Such an assumption might not capture the details of natural disaster resilience, but nevertheless should provide a fruitful logic to institutional and political incentives for ex-ante policies. What policies governments prefer is a complicated matter, and consists of manyfolded and dynamic processes. The object in this theoretical discussion is an attempt to outline some general effects of institutional mechanisms, and tidy up what in the real world would be hard to generalize.

The point of departure is that the political system consists of a government and a number of contenders seeking to maximize access to power (e.g. Tilly, 1978). Political leaders are assumed to be rational actors, who ultimately want to hold office. Governments spend resources on two types of goods: local goods and global goods. They provide and utilize the most appropriate spending that maximizes their goal of holding office (see Downs, 1957; Bueno de Mesquita et al., 2003). I assume that institutions shape the abilities and incentives of policy output. Partly, the theoretical framework builds on "a political model of disasters" (Cohen and Werker, 2008), which assumes a basic consumer model. I do not adopt the model precisely as it was intended, and replace the distinction between ex-ante and ex-post with local and global public goods (see e.g. Ashworth and Bueno de Mesquita, 2006).[2]

3.1 Incentives for disaster spending

The model has a simple structure. Governments can prepare for disastrous events ex-ante by spending on global public preparedness, or they can direct goods at the local level, distributing unequally based on the highest political payoff. I assume that the geographical risk is unequally distributed. The impact of a disaster on human lives is a function on the total spending on disaster preparedness, which consists of both global and local measures.

The government's utility is a function of the welfare of the population (natural disaster resilience); and its access to power. I assume that regions are heterogenous and that government has unequal interests in regions, depending on the populous size; their value in swinging elections or securing the leader in office; and political organization. In ethnically polarized countries, government interest in regions might vary considerably (Cohen and Werker, 2008, 799). It is easier for constituents to observe local spending than global public spending, which increases incentives for local goods and mitigation policies. However, as governments also care about the welfare of its citizens, it must evaluate the local goods to more efficient global public goods.[3] It can be argued that local goods may be more effective than global goods if they are distributed to particularly vulnerable regions. However, because locally directed goods are driven by the returning effect it has on incumbents' access to power, local goods are directed according to the political status of these regions. Global provisions, however, are more effective in securing the needs of the most vulnerable citizens, since incumbents cannot exclude the vulnerable and the

[2]Please note that I do not share their predictions.

[3]The model is not a general equilibrium model as it does not take into account supply-side responses to government actions.

low-status groups from consuming the good.

The key logic is that governments provide the goods that optimize allocation between local and global goods. However, the incentives driving this allocation are determined by the institutional structure. When institutional mechanisms provide incentives for short-term pork barrels, the optimal allocation between local and global goods is pushed toward local and short-term provisions. This sort of allocation is characterized by inequality and misallocation, as the social optimum would be higher if incumbents would allocate according to the welfare needs and not incumbent's access to power. Assuming this would mean that:

Assumption 1: The more the government derives utility from local goods and pork barrels, the more vulnerable people will be in natural disasters, ceteris paribus.

3.2 Propositions

Below, I formulate three sets of hypotheses that build on **Assumption 1**. The first set deals with the effects of institutional mechanisms, the second with political exclusion, and the last takes into consideration the interplay between institutions and political exclusion.

3.2.1 Institutional mechanisms

Constitutions are the foundation in which institutions operate (Persson and Tabellini, 2004, 76). They provide the 'rules of the game' and work as disciplining mechanisms for government policy. I formulate three hypotheses based on the effect of institutional mechanisms on natural disaster vulnerability. The hypotheses build on the assumption that there are some core institutional features that provide incentives for either global goods or local goods provisions. While I do not model the actual legislative bargaining that determines the resources provided, my model is consistent with the notion that members of the leading coalition will be more able to pork-barrel than non-incumbents. It should be noted that my focus is on three specific constitutional features, which leaves other potential important aspects, such as judicial institutions; subnational institutions; vertical arrangements; and other institutions untouched.

The electoral dimension

Electoral rules are core features of any political system, often regarded as *the* foremost indicator of democratic rule (e.g. Przeworski, Alvarez, Cheibub and Limongi, 2000). However, rules for elections differ among democratic as well as autocratic polities. Even though the role of elections in autocracies is questionable, and have been issued a great deal of attention (Przeworski et al., 2000; Bueno de Mesquita et al., 2003; Geddes, 2006; Rød, 2012), they can potentially function as disciplining mechanisms, especially when viewing the democracy-autocracy dimension along a continuous scale. A suggested mechanism is that autocratic leaders set up democratic institutions to grant contesting elite members concessions so that they will have more to lose in a coup (Geddes, 2006). Thus, the extent to which governments provide natural disaster policies can be

contingent on electoral rules. I separate between proportional representation (PR) systems and majoritarian systems. Given the dazzling variation of pros and cons concerning electoral rules, the task of finding a clear cut rationale behind theoretical expectations is not easy. When I make such predictions, I do not suggest that the mechanisms proposed capture the exact process of policy output, but that given my assumptions the rationale tilts the output in the proposed way.

I follow the definition by Gabel and Hix (2005, 4-5), which states that:

> "[I]n their purest form, in PR systems voters choose between list of candidates presented by parties in multi-member districts and seats are allocated in proportion to the share of votes its received. In majoritarian systems, in contrast, voters choose between individual politicians in single-member districts and the winning candidate in each district is the one who receives the most votes in a district".

There are also intermediate systems, or semi-systems if you will, that produce a mix of the two mentioned (Knutsen, 2011). However, as a simple solution, I limit myself to consider only PR and majority elections.

In single districts and plurality vote, as most majority elections are, the competition over voters is inherently more sensitive to the abilities of each candidate (Ashworth and Bueno de Mesquita, 2006), as small shifts in the allocation of voters might completely change the outcome of the votes. This creates incentives for candidates to focus more on pork-barrels and local goods, instead of global public goods. Local goods are more easily observed among the constituents, and constituents, at least in regions with balanced competition, know that their vote, compared to a PR-systems, are more likely to affect the electoral outcome. Thus, voters in majority systems have incentives to focus more on the abilities of each candidate's bid for votes, and candidates correspondingly derives more utility from goods directed at particular constituents. Persson and Tabellini (2004, 85) write that

> "[S]ingle districts and plurality vote both tend to pull in the direction of narrowly targeted programs benefiting small geographic constituencies and swing states. Conversely, multimember districts and proportional representation both pull in the direction of programs targeting broad groups".

Elections in multimember/proportional representation systems do not have the 'winner takes it all' logic, which creates incentives for constituents to care more about their actual policy preferences instead of the abilities and the 'porks' of each candidate. Additionally, multimember districts have stronger incentives to seek support from broad coalitions, which create incentives for broad redistributive provisions.

Majority systems are characterized by a stronger declaration of accountability (Persson and Tabellini, 2004). This may create incentives for good behavior. However, because accountability also makes incumbents more sensitive to the media and the opposition, it may also contribute to more politically directed and local provisions, and underinvestment in global goods. Strömberg (2003) shows that majoritarian electoral systems imply a much more lopsided distribution of

goods across states. Spending is focused on states where a relatively small number of votes might tip the entire state.

Even though PR-systems are often viewed as less accountable, PR-systems have lower barriers to enter and exit the political space, and build larger coalitions and therefore have fewer incentives to allocate goods based on the political status of groups. Knutsen (2011, 1) argues that proportional representation systems, by their "propensity to generate broad-interest policies" produce relatively larger quantities of public services. Political parties mitigate the incentive problems from non-recoverable costs. As long as parties internalize entry costs, they permit individuals to compete for office without risking the full costs in each election. Hence, parties reduce costs of entering and exiting the political space (Lake and Baum, 2001, 9). In parliamentary systems, which are strongly related to multipartyism, the costs of entering and exiting the political space are lower than in one- or two-party systems. As low costs of entering and exiting the political arena decreases the risk of being excluded, it follows that multiparty systems will have a more complete representation of constituents, which yield incentives for bargaining across parties and political cleavages.

However, it has been argued that PR-systems are more inefficient in allocation of goods, and that they produce higher levels of global goods than they can afford. As this might produce inefficient economic systems and higher deficits, the negative effect on disaster resilience is not clear. PR-systems are also correlated with higher levels of corruption, which can be attributed to higher intraparty competition, and lower interparty competition. As indicated in section 2.1, levels of corruption are related to higher death tolls in natural disasters. Nevertheless, I argue that the negative effects of corruption and inefficiency in PR-systems are countervailed by their positive effects of redistribution and provision of public goods. I assume that plurality/majority systems lead to suboptimal allocation between local and global public goods, which again lead to higher death tolls in natural disasters. Correspondingly, PR-systems are less sensitive to pork barrels, and hence produce more global goods, and are more robust in natural disasters.

Proposition 1: *PR-systems experience fewer casualties from natural disasters than majoritarian systems, ceteris paribus.*

The executive dimension

The second institutional distinction is between parliamentarian and presidential systems. In parliamentary systems "the executive (...) is chosen by and to an elective body (the legislator), thus creating a single locus of sovereignty" (Gerring and Moreno, 2010, 337). In presidential systems "policy-making power is divided between two separately elected bodies: the legislator and the president" (Gerring and Moreno, 2010, 337). Although there are many variations within these ideal forms, including semi-systems (Cheibub, 2007), presidential systems are institutionally more fragmented (Knutsen, 2011, 3). Many argue that presidential democracies have tougher checks and balances (Olson, 1993), thus being more accountable (Benhabib and

Przeworski, 2005). As policy in parliamentary systems are fully determined by the legislator, the policy outcome in presidential systems builds on bargains between the president and the legislators cabinet (Ashworth and Bueno de Mesquita, 2006). Although this might indicate that legislation is pushed toward the median, separation of power under presidentialism may also enhance rigidity (Linz, 1990) as well as contribute to more market asymmetries (Olson, 1982). Rigidity may decrease heavy redistributive programs (Linz, 1990, 66). Secondly, constituents know that presidents only in part affect national policy, which lead voters to concern more about candidate abilities instead of policy preferences. This create incentives for candidates to bid for votes in pork-barrels, and forces them to focus on local policy projects, instead of global goods provisions.

Presidential systems are more sensitive to electoral contestation and strategic voting (Strömberg, 2003). There are examples that few districts, even as few as one, has altered the election in favor of one candidate instead of another. This is exacerbated by strategic voting, which might lead candidates elected in one round to be voted out in the next round. The logic is similar to the electoral dimension. Candidate selection in presidential systems is distinctively more dependent on individual charisma and abilities, compared to parliamentary systems (Ashworth and Bueno de Mesquita, 2006, 169). In parliamentary systems voters to a larger extent choose leaders among the party leaders, which have been chosen by members of parties and not by the general public. In all likelihood members of parties are more occupied with policy preferences than the general public. Intra party discipline is a mechanism that drives the functioning of parliamentary systems, as opposed to presidential systems. Because parliamentary systems elect their executive by and to their legislator, government would not function without parties holding at least some of their promises. In presidential systems policy-making is divided, which make preferences less vital for policy output.

As for PR-systems, parliamentary democracies are related to more corruption (Persson, Roland and Tabellini, 2000). Studies have shown that bureaucratic corruption is related to higher death tolls (Anbarci, Escaleras and Register, 2005), which might drive the effect of parliamentary systems toward inefficient allocation of goods. Nevertheless, my assumption is that presidential systems extract more utility from direct payments and local goods provisions, and therefore should increase the tolls on human lives in natural disasters.

Proposition 2: *Parliamentary systems experience fewer casualties in natural disasters than presidential systems, ceteris paribus.*

The centralization dimension

The last institutional mechanism is the level of centralization. Because polities are divided in geographical areas, and constituents and therefore political cleavages are unevenly dispersed throughout geographical areas, the level of centralization might affect how natural disaster policies are distributed across regions.

My approach builds on a model from Persson and Tabellini (1996) on social insurance and

risk sharing. The model assumes that there is a trade-off between regional risk sharing and redistribution. Although the concept of risk did not refer to natural disasters in their model, the observable implications are applicable also here. Essentially, their model predicts that when there are geographically based cleavages, centralized provision leads to higher levels of global goods provision, while decentralized provisions lead to under provisions of global goods.

The model assumes that regions are exposed to a risk. The distribution of risk between individuals is unequal, and are concentrated to a minority of the population. There are two levels of government; the local and the federal. The local government chooses to allocate public goods between the vulnerable and the robust part of the population. In decentralized systems there are no aggregation of individual risk to the country level. This limits interregional transfers to only reach the robust population. The logic is that because risk is distributed unequally, there is a conflict over the allocation of resources. In decentralized systems, the bargaining power depends on the regional welfare under autarky (self-sufficiency), and because the most robust regions are better off with no interregional transfers, no aggregate coalition of constituents is formed. The bargaining between regions will accordingly be tilted in the favor of the low risk regions, leading the high risk regions to be underprovided (Persson and Tabellini, 1996, 996-1005).

For centralized federal insurance, the case is different. A centralized system redistributes by collecting more income tax in the robust region than in the vulnerable region. In such a system, the bargaining power is no longer only at the regional level, but also between individuals (aggregation of risk). This means that risk prone individuals create coalitions across regions to form a aggregated demand for global disaster mitigation policies. So what intuitively captures the difference between decentralized and centralized systems is the bargaining situation. Decentralized systems are characterized by pure regional conflicts of interests, while centralized systems are characterized by regional conflicts *and* individual conflicts, which create aggregate risk and coalitions across regions (Persson and Tabellini, 1996, 999). This ultimately leads to broad global redistributive programs instead of local underinsurance (Persson and Tabellini, 1996, 998).

Federal highway spending in the US can illustrate this conflict of interest. In the Federal Highway Aid Program a large proportion of funds were earmarked by legislators to specific projects and districts. Additionally, even though funding was supposed to be distributed according to some fixed standards, this was manipulated, targeting favored states (Besley and Coate, 2003, 2612).

The relationship between centralization and public goods has also been connected to mechanisms such as uncertainty and misallocation. This approach builds on the classic notion argued by Olson (1965), which states that the further away people are from the good provided, the fewer incentives they have to pay for that particular good. The rationale is that each district is not sure if they will receive the same share of the good as the share they provide. This again creates incentives to shrink. Besley and Coate (2003) argue that centralized provisions lead to conflict between representatives of heterogenous regions, which will play out in the legislator.

Secondly, they argue that as districts become more heterogenous, allocation in centralized systems worsen. Nevertheless, I argue that cost sharing in centralized systems causes allocation to be more directed at global public goods, instead of local goods. However, If I find that centralized systems increase the likelihood of casualties, the mechanism of aggregate risk most likely is outdone by interregional conflict.

Proposition 3: *Centralized governments experience fewer casualties than federal governments, ceteris paribus.*

3.2.2 Political exclusion

I view the state as comprised of institutions that to different extents include representativeness of particular ethnic/political communities (see Cederman, Wimmer and Min, 2010). Political officeholders thus have institutional incentives to distribute goods, favoring those political or ethnic groups that ensure them in power (Bueno de Mesquita et al., 2003). However, as incentives for holding office and maximizing access to power constitute strategic motivations for public policy, institutional arrangements might discipline leaders to unequal distribution of goods. Hence, institutional rules that increase cooperation and coalitions across ethnic cleavages should provide disciplining mechanisms for impairing the conditions for politically excluded groups.

The strong and robust effect of wealth on disaster vulnerability indicates that the effects of natural hazards are functions of the human environment. Since ethnic minorities and politically excluded groups often constitute a substantial part of the poor community in developing countries, ethnicity is regarded as important for understanding vulnerability (Peacock, Morrow and Gladwin, 1997). Excluded groups can also be less informed and are therefore less likely to participate, either in elections or through other forms of political participation (Besley and Coate, 2003). My theory postulates that leaders and candidates have unequal interest in regions and political groupings, and prefer to enrich their own coalition. When political groups lack access to central authorities, and therefore are impaired of political power as well as to communicate their needs, one would expect that politically excluded groups receive fewer government actions targeting risk reduction in natural disasters.

Fearon and Laitin (2003) argue that not only incentives affect how central government relates to peripheral groups, but the fact that material capabilities, that is, the ability to effectively control territory, makes it harder and less feasible for the central state to give concessions to peripheral groups. Buhaug, Cederman and Rød (2008) and Cederman, Girardin and Gleditsch (2009) argue in the same direction, but focus on how soft power also contributes to making peripheral groups more excluded. This leads me to think that politically excluded groups are less likely to receive effective disaster help. Excluded groups also want to maximize their access to power, and therefore pose a threat to incumbent leaders. Hence, incumbents not only have the incentive to prefer its own coalition, it has the incentive to impair excluded groups. It

follows that:

Proposition 4: *Politically excluded groups experience more deaths in natural disasters than politically included groups.*

3.3 Interplay between institutions and exclusion

Drawing on the abovementioned theoretical framework, the interplay between institutions and political exclusion should be clear. PR-elections are more inclusive, provide mechanisms for larger coalitions, and are less sensitive to pork-barrels compared to majoritarian elections, which leads to larger global goods provisions. Even though we can argue that parliamentary regimes are less accountable, they have fewer incentives for direct and local payments, they build larger coalitions, and constituents are more occupied with policy preferences than abilities, which leads to higher output of global public goods. Lastly, because risk is unequally dispersed at the local level, individuals in centralized countries are forced to build coalitions across regional boundaries, which make allocation of goods in favor of risk prone individuals. In decentralized systems, the bargaining between regions only reflects regional and not individual cleavages, which makes resilient regions alter the provisions to their advantage, and hence reduce the output of global goods. Since local goods are driven by the returning effect the good has on incumbents' ability to stay in power, institutions that are driven by local goods allocate goods based on the constituents' political status. Hence, such institutions are more impairing to politically excluded groups than institutions that allocate goods globally.

Proposition 5: Excluded groups experience more casualties in majority systems than in PR-systems.

Proposition 6: Excluded groups experience more casualties in presidential systems than in parliamentary systems.

Proposition 7: Excluded groups experience more casualties in federal systems than in centralized systems.

Chapter 4

Research design

4.1 Why a statistical analysis?

When confronted with a problem, researchers must choose how to investigate that particular problem, and think hard about the reason for investigating the problem in that particular way. The research method yields grounds for inferences about a particular issue, and is at the core of scientific research (King, Keohane and Verba, 1994, 3-9). Scientific methods may sometimes be more complicated than everyday practices to resolve problems, but are essentially nothing more than what 'everyman' does, but in a more systematic way.

Often, there is a trade-off between making general inferences about a particular problem, say, what factors make societies in general more robust to natural disasters, and why so many people died in the 2004 Indian Ocean tsunami. If you want to say something general about a social phenomenon, it is not sufficient to study only one or a few incidences. Correspondingly, if you want to make causal inferences about what made the Indian Ocean tsunami so deadly, it is not sufficient to study natural disasters in general, without looking deep into that particular case.

A problem with studying a large number of cases, is that the inferences you make are founded upon many, and sometimes crude assumptions about the observations at hand. For example, that the underlying story is stable throughout the population. This means that it makes sense to compare different sorts of natural disasters and geographical regions, even though we know that some catastrophes are more deadly, and that some regions more prone to natural hazards than others. Another problem is that the phenomenon we are interested in saying something about, and the data at hand, do not fit perfectly together. The indicators used are often not precise or all-encompassing measurements of the concept we are trying to measure. This creates a distance between what we *want* to say something about, and what we *really* say. Although such assumptions moderate the extent to which inferences about particular social phenomena can be generalized to the universe of events, statistical tools help researchers to handle complexities and limited cognitive abilities; so that we at least are able to say something about the relationship between phenomenon.

Apart from validity issues and other related problems, the reason for a large-n statistical

analysis should be clear: statistical models allow us to draw systematic and precise inferences about a large number of cases. A large number of cases are closer to the universe of cases, which lowers the danger of selection bias.

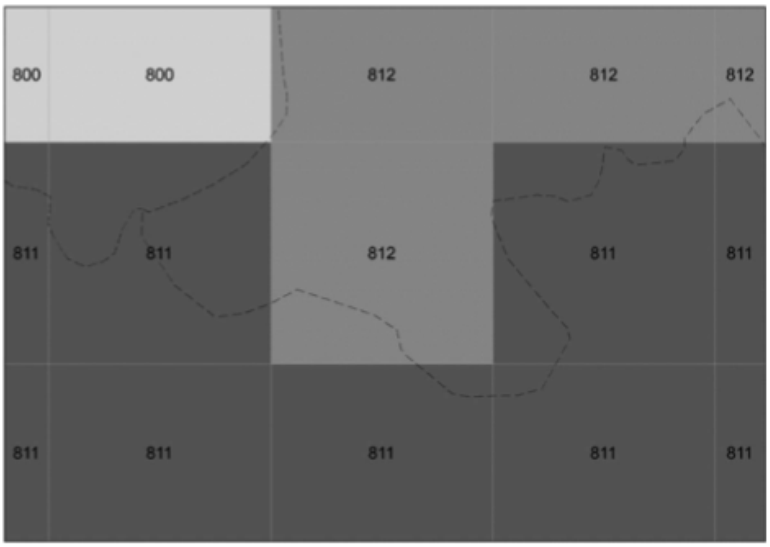
Lastly, statistical tools are useful for analyzing input-output relationships. Since it is difficult to observe the actual decision-making process that affects natural disaster vulnerability, the analysis builds on the relationship between countervailing effects of the input of individual indicators on one hand, and the aggregate output on the other. The variables enter as individual effects, while the output is the overall benefit that produces this effect Wig (2011, 48). Given the dazzling variations of the pros and cons concerning the effects of institutions, my theoretical assumptions build on mathematical expected utility models, that calculate certain parameter values and looks at the aggregate output given a combination of these values. As these parameter values can be very difficult to measure, a second best choice is to assume the theoretical relationship with the limits that follows, and focus on the aggregate output estimation. A further discussion on methodological and statistical issues will be elaborated under Section 4.3.

4.2 Why disaggregate?

Contemporary research on the effects of institutions and ethnicity have based many of their analyses on country level indices.[1] This often leads to inferences built on significant discrepancy between theories and the empirical analysis (see Buhaug and Lujala, 2005; Buhaug and Rød, 2006; Buhaug, Cederman and Rød, 2008). However, research on determinants of natural disasters demand smaller units (e.g. Dilley et al., 2005; Peduzzi et al., 2009). Smaller units give more precise measurements of local conditions, which is essential when modeling relationship between geographically confined factors and human related events. Secondly, aggregate country level indices do not allow for within country variation, which results in large parts of the variation being unobserved. This may potentially lead to wrong conclusions. By narrowing my analysis to the local level and select 0.5 decimal degree grid-cells as the main observational unit, I adhere to such problems. A disaggregated approach makes more sense when empirically evaluating actor-centered theories, and yields more valid inferences about whom, and under which conditions natural disasters are more deadly.

Another reason for choosing grid-cells as observational unit, is that they are not socially determined, meaning that they are exogenous to the political and social environment. As grid-cells are not affected by changes over time and place, this makes them more stable as observational units compared to countries (Tollefsen, Strand and Buhaug, 2012*b*, 4).

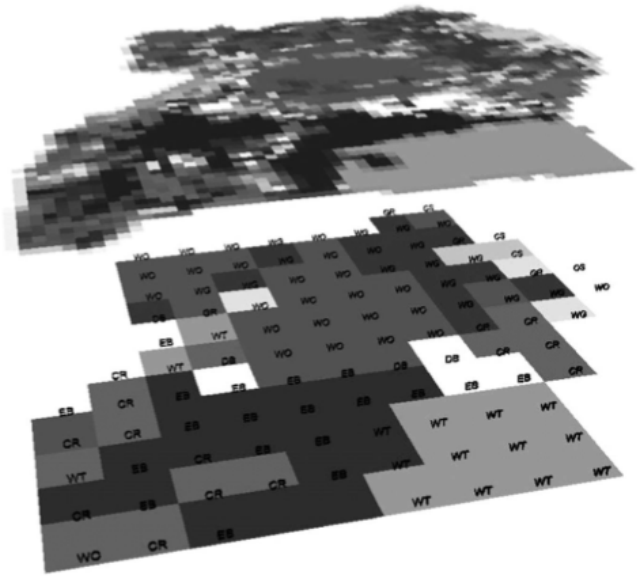
Figure 4.1: International borders and country assignment. The figure illustrates the border between Thailand, Cambodia, and Laos (dashed line), with grayscale coloring indicating the country to which each cell is assigned. The numbers in the cells refer to the Gleditsch and Ward (1999) numeric code for the corresponding country (800 is Thailand; 811 is Cambodia; 812 is Laos). Figure is taken from Tollefsen, Strand and Buhaug (2012*b*, 368).



4.2.1 PRIO-GRID

Grid-level data is provided by the PRIO-GRID dataset (Tollefsen, Strand and Buhaug, 2012*a*). A grid is a quadratic cell on the two-dimensional terrestrial plane. The PRIO-GRID is constructed using vector shape-files where each cell is represented by a square polygon vector feature (Tollefsen, Strand and Buhaug, 2012*b*, 6). The grid is based on the dominant geographical coordinate system, the World Geodesic System (WGS84). The grids are defined as 0.5 decimal degrees intervals latitude and longitude. The global matrix consists of 360×720 columns, which yields $259,200$ cells in total. Most of the cells have little relevance as they cover water or unpopulated areas. The 0.5 decimal degree (long/lat) corresponds to roughly 50×50 km at the equator. This means that even small countries are represented by multiple grid-cells, which makes it possible for within country variation. All grid-cell control variables in the disaggregated analysis are taken from the PRIO-GRID dataset. The dependent variable was imported into the PRIO-GRID using ESRI's ArcMaps Geography Information Systems (GIS). Figure 4.1 shows how the grids look like, and exemplifies how each cell is assigned to the country that covers the largest share of the cell area (Tollefsen, Strand and Buhaug, 2012*b*, 368).

Figure 4.2: The figure illustrates how a high-resolution raster (top) is represented in PRIO-GRID (below). The string codes denote different land cover classes (Hansen et al., 2000; $0.08° \times 0.08°$ resolution); CR cropland, CS closed shrubland, DB deciduous broadleaf forest, EB evergreen broadleaf forest, GR grassland, WO woodland, WT water(Tollefsen, Strand and Buhaug, 2012*b*, 366).



4.2.2 GIS procedure

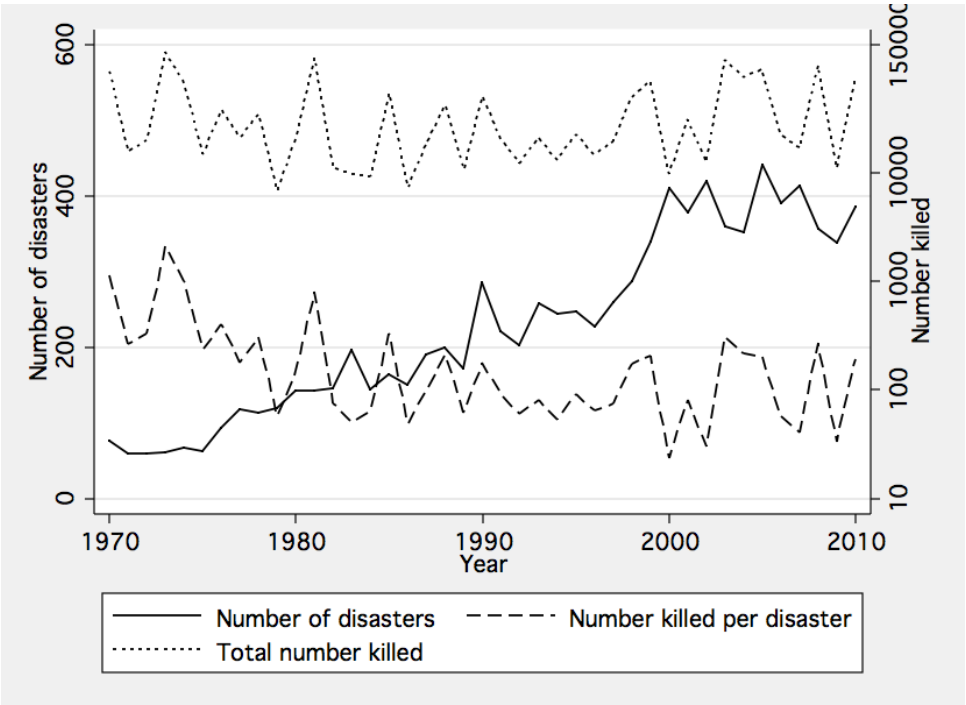
Data on natural disasters were merged with the PRIO-GRID using GIS tools. The data merges as layers using a spatial joint command. This is done by constructing each variable onto a geographical map as a layer using shape-files (with spatial longitude-latitude coordinates). Each layer is merged together by placing them on top of each other, and finally, spatially joining them together. Now all observations consists of information on the natural disaster and is ready for regular modeling using Stata 12. Figure 4.2 illustrated how high-resolution data are aggregated into smaller set of observations in the vector-based grids (Taken from Tollefsen, Strand and Buhaug, 2012*b*, 366). It also illustrated how the data is constructed as layers, and spatially joint together by placing them on top of each other.

4.3 Data issues and selection bias

Many of the concerns in the analysis are due to the nature of the data and statistical analyses. Figure 4.3 shows the yearly number of disasters, together with total and average number killed. Even as the number of reported disasters has increased the last 40 years, the number of killed in each disaster has decreased. The total number of deaths has been fairly stable. A reasonable explanation is that improved economic conditions have impacted the effects of natural disasters

[1]E.g. literature explaining public goods distribution, natural disasters, conflict, and regime stability.

Figure 4.3: Number and Magnitude of Disasters, 1970-2010. The figure is based on Figure 1 in Strömberg (2007, 202), but with my own data.



on a global scale. However, there might also be unbalanced reporting over time. As there are more small disasters in later years, this may indicate that there has been an increase in disaster events, or that there is a development towards more complete disaster reporting. This likely bias is inherent in the data. Keeping such problems in mind, the EM-DAT database is the most comprehensive database on natural disasters available. It is better to evaluate these questions with caution than not evaluating them at all.

Another concern is that rich democracies are systematically overrepresented in the data. Strömberg (2007, 201) made this concern, and as a example showed that China, with the change of head of state, systematically reported different numbers of disasters in the period 1960 to 1979, compared to the period after. However, as there are no obvious ways of correcting for this, I resort to a second best choice, and complement my disaggregated approach with a country level analysis. The country-level approach tries to limit selection bias that originates from listwise deletions in the disaggregated dataset. Since the disaggregated approach on grid-cell level require data with spatial longitude-latitude information, a large part of the data is lost due lack of geographical data. The sample is reduced to around 730 observations, from the original 6580, and it is likely that there are some sort of selection mechanisms at play. Highly developed countries and regions with better reporting procedures are likely to be overrepresented, which would mean that the effects of institutional quality and political exclusion, being inherent in the democracy indicator, would be underestimated in the analysis. The mean democracy score (Polity IV index) rise to 5.8 in the disaggregated analysis, an increase with 1.6, indicating the such selection mechanisms are at play, and increases the notion that democracies

are overrepresented.[2] However, if the results indicate that such factors are present, the effect may be even greater in the real world.

Table 4.1: Natural disasters events and casualties by disaster type, country level analysis.

Disaster type	*Number*	*Percent of type*	*Number killed*	*Percent killed*
Earthquake	654	9.93921	575802	48.6958
Flood	2687	40.83587	182991	15.47562
Mass movement (wet)	383	5.820669	20414	1.72642
Storm	2092	31.79331	281317	23.79109
Volcano	131	1.990881	24975	2.112145
Mass movement (dry)	36	.5471125	2197	.1858011
Extreme temperature	313	4.756839	93062	7.870289
Wildfire	284	4.316109	1689	.1428394
Total	6580	100	1182447	100

Source: EM-DAT (2012).[3]

Secondly, some natural disasters are more easily geographically placed than others. Since the geo-coding of natural disasters rely on shape-files with a centered point, it is easier to geo-reference volcanic eruptions or earthquake, than for example floods or storms. Comparing table 4.1 and 4.2 we can see that this has resulted in an overrepresentation of earthquakes compared to other disaster categories, in the disaggregated sample. Earthquakes are by far the deadliest in both analysis. Especially storms are underrepresented in the disaggregated analysis. Again, I remind the reader to keep in mind these biases, as it might affect the outcome of the regressions.

Table 4.2: Natural disasters events and casualties by disaster type, grid-cell analysis.

Disaster type	*Number*	*Percent of type*	*Number killed*	*Percent killed*
Earthquake	354	48.49315	171689	92.17261
Flood	285	39.0411	9746	5.232218
Mass movement (wet)	6	.8219178	253	.1358251
Storm	40	5.479452	3677	1.974027
Volcano	45	6.164384	904	.4853196
Total	730	100	186269	100

Source: EM-DAT (2012)

The same problem accounts for regions. Table 4.3 and 4.4 show disaster statistics by regions, country level and grid-cell level, respectively. Asia is the region which is the most prone to disasters and the number of killed in both samples. However, there are discrepancies between the two datasets. Asia is to some degree overrepresented in the disaggregated data, which might lead to biased results. Americas is also overrepresented, however only in number events. This should be kept in mind when analyzing the data.

[2]There is also a small increase in GDP per capita with 465 US dollars.

Table 4.3: Regional number of disasters and casualties, country level analysis.

Region	*Number of disasters*	*Percent of disasters*	*Number killed*	*Percent killed*
Americas	1734	26.352	133313	11.274
Europe	999	15.182	86099	7.281
Asia	2819	42.841	933192	78.920
Africa	764	11.610	26112	2.208
Oceania	264	4.012	3731	.315
Total	6580	100	1182447	100

Source: EM-DAT (2012)

Table 4.4: Regional number of disasters and casualties, grid-cell analysis.

Region	*Number of disasters*	*Percent of disasters*	*Number killed*	*Percent killed*
Americas	220	30.136	21532	11.559
Europe	88	12.054	2973	1.596
Asia	299	40.958	153763	82.548
Africa	84	11.506	5477	2.940
Oceania	39	5.342	2524	1.355
Total	730	100	186269	100

Source: EM-DAT (2012)

Another reason to include a country level analysis is that the institutional variables should have country level effects when looking at the number killed in general. A more pragmatic reason is that the theoretical effects of institutional mechanisms exhibit a large variation of costs and benefits concerning public goods distribution. This may create rather small and demanding effects, empirically. Since the listwise deletion in the disaggregated approach reduces the data with 5850 observations, it should be easier to tease out the effects of institutions on a larger dataset.

The two approaches should be evaluated discretionary. Since the country level analysis does not really say much about which groups that are more vulnerable in a natural disaster, the country level analysis should function as a preliminary test of the hypotheses relating to political exclusion. Correspondingly, the effect of the institutional variables should play out in the country level analysis. Both analyses should be interpreted as complementary, and as robustness tests, although the specific variables are more valid in one of the models than in the other.

Lastly, although democratic constitutions rarely change, and that a potential endogenous relationship between political output and constitutions is unlikely, cross-country variation in institutions is strongly correlated with stable country characteristics (Persson and Tabellini, 2004, 77). Presidential regimes are mostly concentrated in Latin America, former British colonies tend to have adopted british electoral rules, and continental Europe is predominantly ruled by parliamentary systems with proportional representation elections (Persson and Tabellini, 2004, 77). This may result in that the effects of institutions are driven by unobserved country characteristics. Such self-selection mechanisms is clearly nonrandom and most likely correlated with other

unobserved variables that also influence a country's policy outcomes. Acknowledging this, Persson and Tabellini (2004) estimated the effects using matching models, that is, models that take into the account what would happen if institutions did not inhibit these stable characteristics. The results showed that institutions still produced the same effects, which indicate that there might be a causal relationship between institutions and policies.

4.4 From concept to indicator - making inferences

Measurement validity is concerned with whether operationalization and the scoring of cases adequately reflect the concept the researcher seeks to measure (Adcock and Collier, 2001, 529). Measurement is valid when the scores derived from a given indicator can meaningfully be interpreted in terms of the systematized concept that the indicator seeks to operationalize (Adcock and Collier, 2001, 531). As I do not perform validation procedures, the operationalization of the variables should be validated discretionary, based on the theoretical linkage between the concept and the indicator.

4.4.1 Baseline model

I follow Mileti (1999); Strömberg (2007); IPCC (2012) who argue that a model of natural disasters must include at least three components to sufficiently control for spurious effects: *vulnerability*, *exposure*, and the *natural disaster event*. I start by operationalizing and describing the dependent variable, before moving on to the independent variables. Finally, I go through the control variables.

4.5 Dataset and unit of analysis

Data on natural disasters stem from the Emergency Events Database (*EM-DAT*, 2012, CRED). A natural disaster is classified when; ten or more people where killed; 100 or more people where affected or injured; a declaration of state emergency was made; or if a call for international assistance was made.[4] The analysis deals with specific natural disasters, that is, rapid-onset natural disasters. This include earthquakes, floods, volcanic eruptions, wildfires, hurricanes, tsunamis, storms and mass movement (dry and wet). Slow-onset disasters such as drought are excluded from the analysis. The rationale is that rapid onset disasters are more exogenous to institutions and the socio-economic environment than for example droughts, and hence reduce endogeneity problems. Secondly, since slow-onset disasters evolve over longer time-periods, government actions ex-ante and ex-post are more difficult to separate. Rapid onset events are therefore theoretically more relevant as I hypothesize about the institutional constraints ex-ante catastrophe. Natural disasters are defined as a rather common event in the EM-DAT dataset, which yields a large variation in my dependent variable. The EM-DAT database is the only publicly available data on such a large scale, and is by far the most commonly used data source.

[4]For more information on the extensiveness of the reporting and entry procedures please visit the webpage: http://www.emdat.be/.

The dataset includes all rapid-onset disasters in the world from 1980-2008.[5] The time period was chosen because the data prior to 1980 is not as homogenous as after 1980 (Peduzzi et al., 2009, 1150). The decision to end the time series in 2008 is due shortcomings in available data on institutions and socio-economic variables.

The observations in the raw dataset are in the form of 'natural disaster event' in country-year, thus being a unbalanced panel. As one of the contributions of this project is to illustrate the empirical benefits of a disaggregated approach at the grid-cell level, the analysis deals with both country level and grid-cell level observations. In the country level approach the unit of analysis is *natural disaster event in country year*. In the disaggregated approach the unit of analysis is *natural disaster event in grid-cell year*. I have chosen to include observations as events instead of adding the events together to make up 'annual death count'. There are studies that operationalize the dependent variables as annual death counts, (e.g. Kahn, 2005; Raschky, 2008; Cohen and Werker, 2008), however, this limits the possibility to control for disaster type characteristics (earthquakes are different from storms etc.). The ability to control for such characteristics is essential when modeling natural events, and limits the danger that conclusion are drawn on spurious relationships. Secondly, operationalizing the dependent variable as annual counts would treat countries that are more risk prone the same as countries which suffers few events over the time period. As my model cannot control for 'risk', keeping the observations as single events does incorporate some of the natural 'risk' component. In the country level data, only 896 of the 6580 disasters were single event years. 30 percent of the countries suffered at least 10 events in each disaster year. This trend is not apparent in the disaggregated analysis as the unit is much smaller. However, there were grid-cells that had multiple disasters in a single grid-cell year. Following the aforementioned rationale for controlling for disaster type characteristics, I chose to include only the largest disaster, measured as the number killed, in a grid-cell year.[6]

4.6 Dependent variable

The dependent variable is operationalized as the count of *number killed* in a natural disaster. Damage from natural disasters can however be both economic, human, or cultural. The EM-DAT database provides information on the number of killed, injured, affected, made homeless, and economic damage measured in US dollars. However, the number killed is by far the most reliable source (Peduzzi et al., 2009, 1150), and is therefore used. Because the EM-DAT data registers disasters accordingly to areas that are affected, the same disaster can be counted several times.[7]

The number of killed reach from 0 to 165,708 in the country level analysis, and 0 to 73,338 in the disaggregated analysis. Table 4.5 shows a randomized sample from 30 natural disaster

[5]The dataset can be provided by request.
[6]The geo-coded disaster data had originally 123 duplicate grid-cell year observations that were excluded.
[7]This means that a disaster that hit five different countries is coded as five different disasters.

events from the disaggregated analysis.[8] It shows the number of casualties, together with the grid-cell identifier from the PRIO-GRID, and the geografical coordinates that identifies this cell. More details concerning the dependent variable are addressed in section 4.10 Summary statistics.

Table 4.5: Sample of natural disaster events

Grid-cell id.	*Latitude*	*Lonigtude*	*State*	*Year*	*Disaster type*	*Number killed*
116124	-78.25	-9.25	Peru	1983	Earthquake	10
186259	69.25	39.2	Tajikistan	2007	Flood	1
136290	-75.25	4.75	Colombia	2007	Flood	24
217415	167.25	60.7	Soviet Union	1991	Earthquake	0
97474	-43.25	-22.0	Brazil	2008	Flood	9
152807	-96.75	16.2	Mexico	1999	Earthquake	31
145233	76.25	10.7	India	2006	Flood	32
137365	102.25	5.25	Malaysia	2006	Flood	0
97472	-44.25	-22.0	Brazil	2007	Flood	59
177021	130.25	32.7	Japan	1984	Earthquake	0
189091	45.25	41.2	Armenia	1997	Earthquake	0
199839	19.25	48.7	Slovakia	2006	Flood	1
171854	66.75	29.2	Pakistan	1992	Earthquake	4
133038	98.75	2.25	Indonesia	1987	Earthquake	2
169740	89.75	27.7	India	2008	Flood	142
85935	-52.75	-30.0	Brazil	2007	Flood	4
186203	41.25	39.2	Turkey	2005	Earthquake	0
194058	8.75	44.75	Italy	2003	Earthquake	0
151648	43.75	15.25	Yemen	2007	Flood	7
190525	42.25	42.25	Soviet Union	1991	Earthquake	270
125208	143.75	-3.25	Papua New Guinea	1990	Earthquake	0
156751	75.25	18.75	India	2006	Flood	41
130216	127.75	0.25	Indonesia	1998	Earthquake	33
204677	-81.75	52.25	Canada	2008	Flood	0
135926	102.75	4.25	Malaysia	2006	Flood	0
183313	36.25	37.25	Turkey	2001	Earthquake	0
185400	-0.25	38.75	Spain	2007	Flood	3
146771	125.25	11.7	Philippines	2008	Flood	63
129474	116.75	-0.25	Indonesia	2007	Flood	4
150362	120.75	14.2	Philippines	1992	Volcano	0

Source: EM-DAT (2012); Tollefsen, Strand and Buhaug (2012*b*, PRIO-GRID)

4.7 Independent variables

4.7.1 Political exclusion

The independent variable on *political exclusion* is taken from the ETH Ethnic Power Relations dataset (EPR-ETH),[9] (Cederman, Wimmer and Min, 2010) and the geo-coded version, the

[8] It was done using the 'sample' command in Stata 12.

[9] Eldgenössische Technische Hogschule Zürich.

GeoEPR dataset (Wucherpfennig, Weidmann, Girardin, Cederman and Wimmer, 2011).

The GeoEPR dataset is a geo-referenced extension of the EPR-ETH dataset, which identifies all politically relevant ethnic groups around the world and measures how far access to state power differs among ethnic groups from 1946 to 2005 (Min, Cederman and Wimmer, 2010). The country-years are extended to 2009 in the EPR-ETH 2.0 dataset. The data was collected using online expert survey that included all relevant ethnic groups in all 156 sovereign states with a population of at least one million, and a surface area of at least 50,000 square kilometers as of 2009 (Wucherpfennig et al., 2011, 426).

The EPR-ETH dataset defines ethnicity as any subjectively experienced sense of commonality based on a belief in common ancestry and shared culture.[10] Different markers may be used to indicate such shared commonality: language, phenotypical features etc. An ethnic group is politically relevant if at least one significant political actor claims to represent its interest in the national political arena, or if members are systematically discriminated against in public politics. This can be some sort of political organization, but not necessarily a party. Discrimination is defined as political exclusion directly targeting an ethnic community (Cederman, Wimmer and Min, 2010, 98-99). The strength with a dynamic dataset, such as the EPR/GeoEPR, is that it provides separate coding for sub-periods and changes in political status.

Political status is coded in relation to executive power only, which depends on a given country's power constellations. Executive power amounts to control over the presidency, the cabinet, and senior posts in the administration, including the army. Groups were categorized according to whether (1) those who represented a group's interest held full control over the executive branch with no meaningful participation, whether (2) they divided power with members of other groups, or (3) if they where excluded from decision-making in central power (Cederman, Wimmer and Min, 2010, 99-100). Within these three categories eight different levels of political status where coded.

Absolute power

The categories that represent the highest level of political status were coded as *monopoly power*, or *dominance*. Monopoly power means that elite members hold monopoly power in the executive, excluding other ethnic groups. Dominance means that elite members of the group hold dominant power in the executive but that there is some limited inclusion of other groups (Cederman, Wimmer and Min, 2010, 100).

Power-sharing

In power-sharing regimes relevant ethnic groups can be defined as *senior partner* or *junior partner*. These categories represent formal or informal power-sharing, depending on the extent of this power-sharing (Cederman, Wimmer and Min, 2010, 100).

[10] Drawn from Weber (1978, 385-398).

Excluded groups

The remaining groups are defined as excluded from state power. The two bottom groups are categorized as *powerless* or *discriminated*. The former case refers to elite members that have no power either at central or regional level, and the latter to members that are subject to formal or informal discrimination, with the intention to exclude them from central power (Cederman, Wimmer and Min, 2010, 100-101). Since my theoretical predictions mostly refer to the two bottom groups, powerless and discriminated, I have coded only these as being politically excluded. However, in the original data, there are also two hybrid cases, *regional autonomy* and *separatist autonomy*. The former refers to members that have no access to state power, but that have some influence at the regional level. The latter is a related case, but refers to a distinct category where members have excluded themselves from central office (Cederman, Wimmer and Min, 2010, 100-101). The reasons for not including them in the 'excluded groups' is that they suffer some local level autonomy, and I want to single out the groups that most likely are subjected to underprovisions of goods.

In the country level analysis, political exclusion measures the proportion of politically excluded groups in a country-year event. In the grid-cell analysis, political exclusion is coded as a dummy variable, where 0 indicates that a grid-cell is not inhabited by any politically excluded groups, and 1 if there is at least one excluded group in a grid-cell. Groups that are coded as being excluded are either 'powerless' or 'discriminated'.

4.7.2 Institutional variables

The institutional variables are collected from two different data sources. The variables concerning the electoral and the executive dimension are collected from the Database of Political Institutions (DPI) (Beck et al., 2001, World Bank),[11] and the data on the centralization dimension is collected from the Schjølset (2008) dataset. Even though the DPI data provides indicators of the centralized dimension, I chose to use the Schjølset (2008) dataset as she operates with more aggregate categories, which is more relevant for my project. I remind the reader that if autocracies are registered as for example having parliamentary institutions, or proportional elections, they enter the analysis. A further discussion on the problematic side of this, and how I deal with it, is given in section 4.7.3.

Executive dimension

Data on the executive dimension stem from the DPI dataset (Beck et al., 2001). It provides information on how executive institutions are organized covering all disaster years in my dataset. The indicator has initially four categories, one for non-fitting regimes, such as military regimes, regimes in transition, and regimes with no central state. As these categories are not relevant for my hypotheses, they were excluded from the analysis. The three relevant categories cover presidential institutions, parliamentary institutions, and a third hybrid category, identifying

[11] The DPI dataset is constructed based on two sources: Political Handbook of the World and Europa World Yearbook).

assembly-elected presidents. As I want to single out pure presidential institutions, the main analysis deals with assembly-elected presidents as belonging to parliamentary institutions. Of the 5,285 'parl-pres' event-years, 380 are hybrids.[12] However, to validate my findings I estimate all relevant models when assembly-elected presidents are coded in the other category, e.i. presidential (see table A.2 in appendix). The variable ends up as a dichotomous indicator labeled *Presidential*, where 0 indicates parliamentary institutions, and 1 indicates presidential institutions.

Electoral dimension

The DPI dataset (Beck et al., 2001) also provide the data on electoral rules. The advantage with the DPI datset is not only that it provide the most extensive time-series, covering all the disaster years, it also provide dichotomous coding that separate between majoritarian and proportional electoral rules. The advantage with not having hybrid categories included as a separate choice is that the coders themselves are the ones that evaluate which category that is the most fitting. This is less arbitrary than if I should have done it myself. Nevertheless, hybrid cases are identified as having both majoritarian and proportional characteristics. Of the 5,285 disaster years that enter the country level analysis, 1,897 event-year institutions are registered as having both proportional and majoritarian institutions. In the main analysis I have chosen to estimate the effects of majoritarian institutions when the hybrid cases are coded as belonging to proportional elections. The reason is that I explicitly want to distinguish the pure majoritarian institutions from other types of institutions. Secondly, a more pragmatic reason is that since there is an overweight of events in countries with majoritarian institutions, operating with hybrid categories as proportional makes the data a little more balanced. However, because there are many hybrid institutions, this may affect the results considerably. To validate my findings, all relevant models are estimated when hybrid institutions are coded differently, that is as belong to majoritarian institutions (see A.2 in appendix). All countries that are coded as not having electoral systems are excluded from the analysis. This include military regimes, regimes in transition, and regimes with no central state. The indicator used in the analysis is coded as a dichotomy, labeled *Majoritarian*, where 0 indicates proportional institutions, and 1 indicates majoritarian institutions.

Centralization dimension

Data on the centralization of the state is collected from the Schjølset (2008) dataset. Countries are coded as having federal, central or hybrid institutions. To be consistent with my aforementioned logic, the main analysis treats hybrid institutions as belonging to centralized institutions. Again, to validate my findings I estimate all regressions where hybrid institutions are coded as belonging to federal institutions (A.2 in appendix A). The indicator is coded as a dichotomy, where 0 indicates centralized governments, and 1 federal governments. What should explicitly be noted is that the Schjølset dataset only provides data up to 2002. As institutional change is

[12] For a nice discussion on hybrid cases and coding see Persson and Tabellini (2003, 97-98).

uncommon, and changes in the level centralization are even more rare, I have extrapolated the values up to 2008. According to the DPI data, there was no constitutional changes that would have affected this indicator between 2004 and 2006. Although this does not cover the complete time period which have been extrapolated, it shows that it is highly unlikely that there were many changes in the period 2002 to 2008, and even less likely that any of these changes would affect the results. The are no institutional changes in the observations that enters the disaggregated dataset. In the country level data there are four relevant changes.[13] Regimes that did not fit to either of the categories were excluded from the analysis. This included military regimes, regimes in transition and regimes with no central state.[14] Of the 5,285 disaster years that enter the regression analysis, 3,348 countries are coded as having centralized government institutions. The variable is coded as a dichotomy, labeled *Federal*, where 0 indicate centralized government, and 1 indicate federal/decentralized institutions.

4.7.3 Operationalizing control variables

In order to control for spurious relationships I include control variables. I have selected controls that the literature on natural disasters consistently has found to pose significant effect on natural disaster magnitude. These variables should cover the three basic categories that determine the magnitude of natural disasters: vulnerability; exposure; and the natural event. As my model does not incorporate many important factors concerning the natural event itself, such as earthquake's richter scale, or the Saffir-Simpson hurricane scale, potential findings should be put through more extensive empirical testing. However, if my hypotheses are falsified, which should be the goal according to the Popperian tradition,[15] then more extensive empirical models would most likely not provide us with any different conclusions.

Vulnerability

The major determinant of natural disaster severity is level of development. To control for this I include a measure of (log) Gross Domestic Product (GDP) per capita, and (log) Gross Cell Product (GCP) per capita. GDP is collected from World Development Indicators provided by the World Bank.[16]. In order to calculate the per capita GDP I divided the GDP with total population in each year. As I do not believe that GDP per capita has linear effects, the variable is transformed to its natural logarithm. The variable is labeled *GDP per capita (log)*.

[13] Belgium went from being coded as semi-federal in 1992 to federal in 1993; Ethiopia went through a transition faze in the period 1991-1994 and was coded as unitary in 1990 and federal in 1995; South Africa also went in a transition faze in the period 1992-1993, and was coded as unitary in 1991 and hybrid in 1994; Sudan went from being coded as hybrid in 1997 to federal 1998.

[14] These are coded according to the Polity IV data (Marshall and Jagger, 2002).

[15] See Popper (1964).

[16] The exact indicator is the *ny.gdp.mktp.pp.kd* PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2005 international dollars (World Bank International Comparison Program database).

In the disaggregated model I include both country-level (log) GDP per capita and Gross Cell Product (GCP) per capita. The reason for including both grid-cell and country level data is twofold. First, countries allocate resources from the country level to the local level, making areas more robust. This is something I want to capture in the model. Secondly, the nature of the geo-coded disaster data is such that a single disaster event can only be attributed to one particular grid-cell. However, natural disasters are not bound to the borders of grid-cells, and often affect large areas. This is something that my model does not capture.[17] To account for this, I include the country level GDP in order to capture some of the aggregate level of development. The GCP is the same as the gross domestic products, but at the grid cell level (Nordhaus, Azam, Corderi, Hood, Victor, Mohammed, Miltner and Weiss, N.d.). It is calculated by taking the population in each grid cell and multiplied by the per capita GCP in each cell. It is worth noting that the per capita GDP in each cell is estimated using a mathematical algorithm. This is done differently for each country depending on the level of available data. These data are provided by the G-Econ database but ready to use in the PRIO-GRID dataset.[18] The variable is transformed to its natural logarithm. As the G-Econ data are in the format of 1 degree times 1 degree long-lat scale, they are not completely overlapping with the 0.5 times 0.5 PRIO-GRID polygons. A reason for more concern is that GCP is provided only for the year 1990. This means that my empirical model does not capture local development over time. However, as G-Econ is the only extensive data that covers every grid cell in the world, it provides a second best solution. Further information on GCP data and methods can be found at Nordhaus (2006); Tollefsen, Strand and Buhaug (2012*b*). The variable is labeled *GCP per capita (log)*.

In order to control for for good governance I use the Polity IV index (Marshall and Jagger, 2002). The measure combines an autocracy and a democracy scale that reach from 0 to 10, which aggregates to a complete autocracy-democracy scale reaching from -10 to 10, where 10 indicates full democracy. The variable is labeled *Polity IV*.

As the three hypothesized institutions in different degree relate to democratic governance, I choose to construct a interaction term between Polity IV and each institution. Because I want to include all countries that are coded along the three institutional dimensions, this goes at the expense of a meaningful interpretation of institutions' effect across regimes. Can we expect that the effect of presidential democracies is the same as for presidential autocracies? This question is similarly relevant for the electoral dimension. However, I argue that there are theoretically different mechanisms separating presidential and parliamentary institutions, even among the autocracies. Nevertheless, to control for potential absurdities, an interaction term between institutions and the Polity IV scale is constructed. The terms are labeled *Pres*Polity*, *Maj*Polity*, and *Fed*Polity*.

[17] This is however not something that cannot be modeled. It is possible to geographically model each disaster impact varying how large areas it affected. As this is particularly time consuming, and methodological difficult, it is far beyond the task of this project.

[18] The exact variable is labeled gcppc90 in the PRIO-GRID.

Exposure

Following Strömberg (2007) I have included regional dummy variables to control for regional characteristics and natural hazard risk.

In order to control for population exposure, a measure of population is included. In the country level analysis this measures the total population in a country in a given year.[19] The variable is transformed to its natural logarithm. In the disaggregated analysis I also include a measure of the total population in each grid cell. Grid population is taken from the Gridded Population of the World (CIESIN, 2005), however it is ready to use in the PRIO-GRID dataset. The variable is transformed to its natural logarithm. Since the data only provides information on population in the years 1990, 1995, 2000 and 2005, the values were interpolated in between these years, and extrapolated back to 1980; and up to 2008. As these are the only available data, this estimation procedure must be understood as a imperfect but acceptable solution. A obvious problem with this estimation procedure is that it does not take into account the fact that a particular grid cell can have suffered many casualties in a natural disaster, which would have affected the number of people living there. This should be kept in mind when analyzing the data. However, the variable only functions as a control, meaning that the parameter estimate itself is not particularly important.

In the disaggregated model, I include both country level and grid-cell population. There are several reasons for this. First, grid-cell population obviously capture the local conditions more precisely. However, because of the nature of the data, the grid-cell data may have its limitations. One reason is that population on grid level only include that particular cell. Because natural disasters may not be limited to single cells in the real world, this might lead to absurd episodes. For example, a earthquake hitting Peru in 2007 is registered as causing 593 casualties. However, as it unfolded on a large area,[20] the grid-cell population data, showing that only 7 people lived in that particular area, captures the risk on human lives poorly. This example is an particular outlier, and the only observation in my data that actually had more casualties than inhabitants. Nevertheless, the country level measure tries to account for some of these potential fallacies. The two population indicators are labeled, *Grid population (log)* and *Population (log)*.

I also included a variable measuring disaster ratio. This variable was suggested by Anbarci, Escaleras and Register (2005, 2007), and measures the ratio between the number of events in a country and the total period, that is, the years between 1980 and 2008. If a country suffered 200 disaster is the 28 years, I simply divide 200 with 28. The logic is that societies that frequently are exposed to natural disasters learn more past experiences and become more robust. The variables is supposed to capture this logic. The variable is labeled *Disaster ratio*.

Natural event

To control for factors relating to the natural hazard, I have included a dummy variable indicating which kind of natural hazard that triggered the natural disaster. I section 4.3 I showed that

[19] The specific indicator is labeled *sp.pop.totl* (World Bank)

[20] The areas of: Pisco, Ica, Chincha, Canete, Lima, Paracas, San Vicente de Canete.

the number of casualties in natural disasters vary considerably. Earthquakes are by far the most deadly, while floods, constituting 40 percent of the total reported events, only contribute to around 15 percent of the total casualties. However, this should provide enough evidence of including this control variable. This project is not intended to predict the number of casualties, but to assess how a political and institutional dimension affect the outcome of natural disasters. Thus, the vast amount of natural and environmental factors contributing to the outcome in a natural disaster is not as theoretically relevant for this project. However, there are considerable options when estimating regression models that can correct for some of the clear uncertainties and violations in my models. I address these model specifications in section 4.8.2.

4.7.4 Regression models

In order to determine the relationship between institutions, political exclusion, and the death tolls in natural disasters, the following regression models are derived. For the country level analysis:

$$\begin{aligned} Y(Numberkilled) = \beta_0 + \beta_1(Exclusion) + \beta_2(Institution) + \beta_3(Excl \times Insitution) \\ +\beta_4(Polity \times Pres) + \beta_5(PolityIV) + \beta_6(Disasterratio) + \beta_7 Ln(GDPpc) \\ +\beta_8 Ln(Population) + \beta_9(Region) + \beta_{10}(Disastertype) + \epsilon \end{aligned} \quad (4.1)$$

For the disaggregated analysis:

$$\begin{aligned} Y(Numberkilled) = \beta_0 + \beta_1(Exclusion) + \beta_2(Institutions) + \beta_3(Excl \times Insitution) \\ +\beta_4(Polity \times Pres) + \beta_5(PolityIV) + \beta_6(Disasterratio) + \beta_7 Ln(GDPpc) \\ +\beta_8 Ln(GCPpc) + \beta_9 Ln(Population) + \beta_{10} Ln(Cellpopulation) \\ \beta_{11}(Region) + \beta_{12}(Disastertype) + \epsilon \end{aligned} \quad (4.2)$$

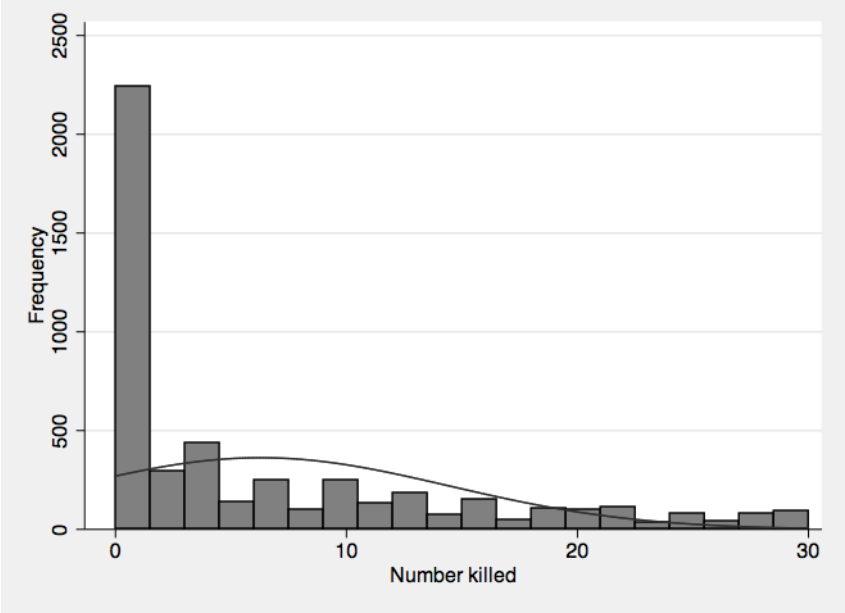
4.8 Statistical model

To evaluate the relationship between the explanandum and the explanans I employ statistical regression models. As the dependent variable is in the form of counts, I estimate count models, and more specifically, negative binomial regression models.

4.8.1 The negative binomial regression model

When observations are in the form of counts, the linearity assumption in regular linear regression models, as the ordinary least square (OLS) model, can lead to inefficient, inconsistent and biased estimates (Long and Freese, 2006, 349). Thus, it is safer and more relevant to estimate models that account for the specific count distribution, that is, the poisson distribution. The

Figure 4.4: Distribution of the number killed, country level analysis.



most intuitive way of understanding count outcomes is that we assume that the likelihood of a given outcome decreases as the number rises. Thus, the distribution is skewed to the right, with higher probabilities of one's and two's, whereas the probability of the proceeding values decrease. Figure 4.4 shows the distribution of the dependent variable – number killed. It clearly would have broken the normal distribution assumption in the OLS-model, and shows how the observed values of the dependent variable are highly skewed toward low counts. The values from 0 to 30 of the dependent variable constitute 75 percent of the total number of cases (country level model).

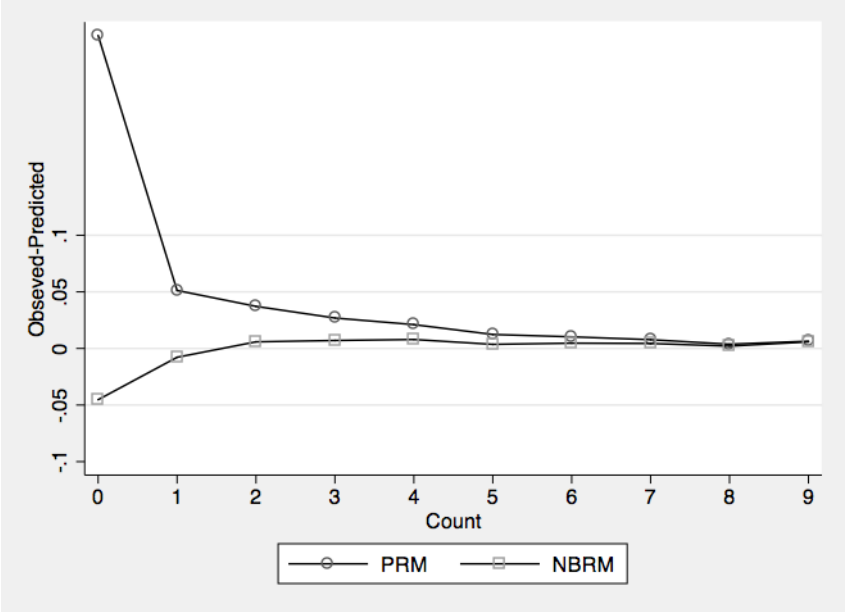
However, the normal poisson regression model (PRM) rarely fits due to overdispersion (Long and Freese, 2006, 372). This means that there is discrepancy between the observed and the predicted values, and that the estimation procedure underpredicts zero values. Figure 4.4 shows that zero counts make up most of the data (28 percent), indicating that the basic poisson model would lead to underprediction. The negative binomial regression model (NBRM) accounts for this by adding a parameter, α, that reflects unobserved heterogeneity among the observations. The negative binomial distribution is:

$$Pr(y \mid x) = \frac{\Gamma(y+\alpha^{-1})}{y!\Gamma(a^{-1})}\left(\frac{\alpha^{-1}}{a^{-1}+\mu}\right)^{\alpha^{-1}}\left(\frac{\mu}{\alpha^{-1}+\mu}\right)^{y}$$

where $\Gamma()$ is a gamma function.

We can test for overdispersion by comparing the poisson model and the negative binomial model. If the assumptions are correct the PRM produces large z-values, and spuriously small p-values (Long and Freese, 2006, 372). The comparison shows that our initial assumption is correct, and the poisson model produced large z-values and small p-values (see A.1 in appendix).

Figure 4.5: Observed vs. predicted counts (PRM), poisson model and negative binomial model (NBRM). Note: positive deviations shows underprediction.



We can further check this by testing for overdispersion with a Likelihood-ratio (LR) test. I estimated the baseline control model with the PRM and the NBRM, and there is significant evidence of overdispersion ($G^2 = 7.8e + 06, p>.01$). Figure 4.5 shows the difference between the observed and the predicted counts for the poisson model and the negative binomial model. The figure clearly shows that the poisson underpredicts zero values (positive deviations indicate underpredictions), and that the negative binomial regression model is a better fit. Thus, the negative binomial is preferred.

4.8.2 Model specifications

In order to reduce some of the problems concerning violations to the assumptions in the model, and the fact that not all observations are independent from each other, all models are estimated with robust standard errors,[21] and clustered by country. The robust option is a procedure that corrects for violations to the assumptions in the model, by producing more accurate and conservative standard errors (Long and Freese, 2006, 86). The clustering option tries to account for the assumption that all observations are independent from each other. This means that the effect of one disaster is not driven by the effect of another disaster. However, as geographic and other environmental factors obviously are not independent from each other, I cluster all events by country. To account for differences in exposure over time and place I use the exposure option in the negative binomial regression model.[22]

[21] Also known as the sandwich standard errors.

[22] This is done using the exposure option in the nbreg (negative binomial regression) command. The formal equation is: $\mu_i t_i = \{exp(\beta_0 + \beta_{1x1} + \beta_{2x2} + ...)\} \times t_i$, where t_i is the amount of time that observation i is at risk. If the rate (number of events over one time period) of that observation is μ_i, then we expect that $t_i \mu_i$ to be the expected count over a period of length t_i.

4.9 Missing data

In this section I briefly address some of the concerns relating to missing data. Both in the country level and disaggregated analysis I estimate my regressions including only observations that do not have missing values on any of the variables. The reason is to exclude the possibility that differences in the estimation parameters is caused by different samples. However, as there are quite a number of observations that are not complete, and that missing data most likely is not at random, this may affect the outcome of the models.

In the country level analysis, 2,139 of the 7,372 observations where excluded from the analysis due to at least on missing value. The variable that contributes to the most missing values is electoral system. Asia constituted 60 percent of the excluded data, while only having 41 percent of the total events. The four countries that had the most missing was Afghanistan, China, Iran and Vietnam. They constituted 40 percent of the missing data. The mean number killed was 228 in the missing data, almost 50 more than in the sample that enters the regressions. The mean Polity IV score was -4 in the excluded observations, 8 units less than the average in the analyzed sample.

In the disaggregated analysis two selection mechanisms are at play. I have already addressed some of the concerns relating to the differences between the country level analysis and the disaggregated analysis that originates from the lack of geo-coding. Here, I address the missing observations resulting from at least one missing on either of the other variables. Again, the variable that contributes to the most missing values is electoral system. The countries that had the most missing were Iran, Afghanistan, China, Vietnam, Indonesia, and Vanuatu.[23] These counties constituted 61 percent of the missing data, while China constituted 30 percent of the missing data by it own. The rest of the missing datapoints was more evenly distributed around the world. Generally also small Caribbean islands had at least one missing data point.[24] The mean killed was 601 for the excluded observations, considerably higher than in the regressed sample. 5 percent of the observations that was excluded from the regressions had more than 1000 killed, compared to 2.5 percent in the regressed sample. The mean Polity IV score was -3, substantially lower than in the sample that enters the regressions. There was no particular discrepancies between the mean GDP per capita, which was 3294 US dollar (log=8.1). Concerning my hypotheses, the executive dimension was fairly evenly distributed among the excluded observations. The same accounted for the majoritarian dimension. However, for the centralization dimension, 91 percent of the excluded observations where centralized governments, compared to 71 percent in the regressed sample. Asia constituted 73 percent of the missing data, while only making up 41 percent of the regressed sample.

[23] Iran had 51 missing, Afghanistan 27 missing, China 112 missing, Vietnam 14 missing, Indonesia 16 missing, Vanuatu 9 missing.

[24] Micronesia, Polynesia, Caribbean, Melanesia, Bahamas, Barbados, Bermuda, Fiji, Guam, Haiti

4.9.1 Summary

There are substantial amounts of missing values in my data that may cause discrepancies between the results in the estimated sample and the universe. To validate my findings I therefore estimate all relevant models on a sample including observations that have missing on at least one of the variables. These results are shown in table A.3 appendix. Still, I am not able to include all observations because of the listwise deletion in the regression command removes incomplete observations. One possible solution to account for missing data is to impute data. However, I do not judge it as appropriate in this analysis as many of the missing values relates to the lack of information on institutions. Nevertheless, the problems relating to missing data should moderate how I generalize my results to the universe. It is however not a problem for running the regressions, as I have enough data to at least say something about the relationship between my variables. Thus, I conclude that it is acceptable, but nevertheless recommend the reader to keep such issues in mind.

4.10 Summary statistics

Table 4.6: Summary statistics, country level analysis.

Variable	*Number*	*Mean*	*Median*	*Standard dev.*	*Min*	*Max*
Number killed	6580	179.703	7	3208.9	0	165708
Excluded size	6580	.112	.0429	.159	0	.915
Parl-Pres	6424	.517	1	.499	0	1
PR-Maj	5254	.375	0	.484	0	1
Cental-Federal	6530	.298	0	.457	0	1
Polity IV	6580	4.211	8	6.558	-10	10
Disaster ratio	6580	6.979	3.821	7.191	0	21.357
Population (log)	6580	17.854	17.913	1.815	12.149	21.005
GDP per capita (log)	6580	8.577	8.614	1.266	5.630	11.056

Source: EM-DAT, PRIO-GRID, DPI, Schjølset dataset, WDI, Polity IV project

Table 4.6 shows the summary statistics for the main variables that enter the country level analysis. *Number killed* is the count of number killed in a natural disaster event. *Excluded size* is the proportion of politically excluded groups in a country-year. The institutional variables are coded as dichotomous variables, 1 indicating presidential, majoritarian, and federal institutions. *Disaster ratio* is the number of events in a single country in the time series, divided by the number of years in the time series (i.e. 28 years). Polity IV is a democracy scale from -10 to 10, where 10 indicates full democracy (Marshall and Jagger, 2002). *Population (log)* is the natural logarithm of the total population in a country year. *GDP per capita (log)* in the natural logarithm of GDP per capita. Please note that since I have excluded all observations that had at least one missing data point, many autocracies do not enter the baseline model, which might

Table 4.7: Summery statistics, disaggregated analysis.

Variables	*Number*	*Median*	*Mean*	*Standard dev.*	*Min*	*Max*
Number killed	730	255.163	4	2948.4	0	73338
Political exclusion	730	.349	0	.477	0	1
Parl-Pres	730	.560	1	.496	0	1
PR-Maj	730	.282	0	.450	0	1
Central-Federal	730	.290	0	.454	0	1
Population (log)	730	17.693	17.926	1.579	12.506	20.854
Cell population (log)	730	11.676	12.007	2.142	0	16.655
GDP per capita (log)	730	8.661	8.680	1.110	5.849	10.673
GCP per capita (log)	730	8.307	8.228	1.185	5.774	11.058
Polity IV	730	5.819	8	4.885	-9	10
Disaster ratio	730	5.312	3.142	5.210	.071	21.357

Source: EM-DAT, PRIO-GRID, DPI, Schjølset dataset, WDI, Polity IV project

lead me to draw different conclusions that would otherwise appear with full data coverage.[25]

Table 4.7 shows the summary statistics from the disaggregated dataset. The mean number killed is higher than in the county level approach. This is due to the fact that earthquakes make up most of the data. Political exclusion is now a dichotomous variable, 1 indicating that a particular grid cell in inhabited by at least one excluded group, and zero if not. The institutional variables are still dichotomies, where 1 identifies presidential, majoritarian, and federal institutions.[26] The mean score on the Polity IV index has risen to 5.8, an increase with 1.6, indicating that there are a higher proportion of democracies in this sample. This increases the suspicion that democracies are overrepresented.

4.11 Multicollinearity

Multicollinearity can pose a problem if one of the independent variables is highly correlated with another independent variable. When this is the case, it is difficult to identify the individual effects of each independent variable on the dependent variable, as the effects of each appears simultaneously (Skog, 2004, 286-288). This may result in inflated standard errors and correspondingly not significant relationships. Since each of my models include two interaction terms, this may create multicollinearty, and difficulties in distangeling the effects from one another. One way to check for high collinearity between the variables is to calculate the Variance Inflation Factor (VIF). The conventional procedure is to be particularly concerned with VIF scores above 10.

The collinearity diagnostics showed that multicollinearity is not a substantial problem, with the highest VIF score of 5.9. Table 4.8 shows the bivariate correlations between the variables that are included in the interaction terms, together with each interaction term, for the disaggre-

[25]The mean Polity IV score is 3 decimals lower if all data points where included in the regressions.

[26]Reference category is parliamentary, proportional and central. Hybrid institutions are still coded as belonging to the reference category.

Table 4.8: Cross-correlation table of the hypothesized variables, and the interaction terms. Disaggregated analysis.

Variables	*Exclusion*	*Presidential*	*Excl*Pres*	*Polity*Pres*	*Polity IV*
Exclusion	1.0000				
Presidential	0.1281	1.0000			
Excl*Pres	**0.7376**	0.4787	1.0000		
Polity*Pres	0.0362	0.6162	0.2463	1.0000	
Polity IV	-0.0658	-0.0746	-0.0799	0.5165	1.0000
Variables	*Exclusion*	*Majoritarian*	*Excl*Maj*	*Polity*Maj*	*Polity IV*
Exclusion	1.0000				
Majoritarian	0.1152	1.0000			
Excl*Maj	0.5118	0.5981	1.0000		
Polity*Maj	0.1290	0.5767	0.4357	1.0000	
Polity IV	-0.0658	-0.1700	-0.0365	0.3815	1.0000
Variables	*Exclusion*	*Federal*	*Excl*Fed*	*Polity*Fed*	*Polity IV*
Exclusion	1.0000				
Federal	0.1516	1.0000			
Excl*Fed	0.5374	0.6155	1.0000		
Polity*Fed	0.1026	**0.8153**	0.4726	1.0000	
Polity IV	-0.0658	0.1232	0.0533	0.3589	1.0000

Source: EM-DAT (2012), DPI, Polity IV Project, EPR-ETH, Schjølset (2008)

gated model. The only two episodes of variables that have a higher correlation than 0.7 are in bolded text. This causes a 40 increase in the standard error for the correlation between Exclusion and Excl*Pres, and 60 percent increase in the standard errors for the correlation between Federal and Polity*Fed (Skog, 2004, 288). In terms of the control variables, the correlation between GDP per capita and GCP per capita in the disaggregated analysis were the only once that showed a particular high correlation (0.856).

For the country level model the VIF test shows no score higher than 5. The correlation matrix showed that there were two cases where the correlations exceeded 0.7. The correlation between Exclusion size and Excl*Pres was 0.85, and between Federal and Polity*Fed was 0.86. This increases the standard error with approximately 67 percent (Skog, 2004, 288). These variables should be interpreted with care. The correlation matrix for the country level analysis is reported in A.4 the appendix.

Chapter 5

Analysis

5.1 Country level analysis

The introductory logic in this thesis was that democratic institutions are associated with lower death tolls in natural catastrophes. Although this relationship was one of the basic *motivations* behind this thesis, and not a necessary *condition* for it, the analysis will address this claim. There are two reasons for this. First, the latest empirical study that addresses this relationship (Strömberg, 2007, i.e) has questioned its empirical validity. Secondly, since the 'democracy-disaster' relationship serves as a motivational aspect in this project, and a democracy indicator (Polity IV) enters the baseline control model, assessing this relationship also provides a pedagogical introduction to the main analysis. After presenting some simple descriptive scores that show how my hypothesized variables relate to natural disaster casualties, I run regression models as the main analytical tool.[1]

Table 5.1: Casualties by regime type

Polity	*Mean*	*Median*	*Standard deviation*	*N*
Autocracies	221.3	11	3599.8	2743
Democracies	173.4	4	3407.6	4478
Total	191.6	6	3481.7	7221

Source: EM-DAT 1980-2008, Cheibub, Gandhi and Vreeland (2009)

Table 5.1 shows the mean and median number killed in autocratic and democratic regimes.[2] The reported number killed show a substantial difference between the polities. Democratic regimes suffer on average around 48 fewer casualties in natural disasters. However, what is hidden in simple summary statistics is other important factors that may explain why democracies have fewer casualties.

[1] As the descriptive statistics only functions as preliminary analyses I chose to incorporate all observations. This means that the total number of observations will vary between the description tables, i.e. 5.1, 5.2 and 5.3.

[2] Polities are defined according to Cheibub, Gandhi and Vreeland (2009) dichotomous classification scheme; coding countries as either autocratic or democratic. This classification scheme was introduced by Alvarez, Cheibub, Limongi and Przeworski (1996) and Przeworski et al. (2000). For more information on the theoretical and empirical rationale behind, I refer to the abovementioned authors.

Table 5.2 shows the mean and median number killed in a natural disaster for countries with more and less than median size of politically excluded groups (0.027 is the median size of political exclusion in disaster years). The median value is chosen as the least of many arbitrary points of reference. Even though I cannot say that there is a significant relationship between political exclusion and the number of casualties in a natural disaster, the summary statistics point to a substantial difference. Countries with more than 2.7 percent politically excluded groups suffer on average 24 more casualties, compared to countries below this threshold. The median value doubles from 4 to 8, moving from the low-exclusion countries to the high-exclusion countries.

Table 5.2: Casualties by size of excluded groups

Proportion of political exclusion	*Mean*	*Median*	*Standard deviation*	*N*
<0.027	177	4	3271	3680
>0.027	201	8	3616	3692
Total	189	6	3448	7372

Source: EM-DAT database 1980-2008, GeoEPR data.

Table 5.3 shows the mean number of casualties in a natural disaster for specific institutional characteristics. The overall view is not as clear as for political exclusion. The largest difference is for the executive dimension. Presidential regimes suffer on average 205 casualties per disaster, while parliamentary regimes suffer 184 casualties. For the electoral and the centralization dimension, the summary statistics does not correspond well to my predictions. PR-systems suffer on average 174 casualties, 20 casualties more than majoritarian systems. Federal systems have on average 155 casualties, 65 fewer than centralized systems. In all, these preliminary statistics give my propositions limited support. Nonetheless, it provides more confidence relating to political exclusion and presidentialism than for the electoral and centralized dimension.

Table 5.3: Casualties by institutional characteristics

Institutions	*Mean*	*Standard Deviation*	*N*
Parliamentary	184.0	3325.3	3454
Presidential	204.5	3713.1	3583
Proportional	174.3	3095.3	3383
Majoritarian	152.3	3377.0	2209
Central	220.2	4068.1	4811
Federal	155.3	1972.8	2050

Source: EM-DAT database 1980-2008, Schjølset (2008); Beck et al. (2001).

5.1.1 Regressions

I begin by presenting the baseline regression model that tests the empirical relationship between democracy and natural disaster casualties. As this assessment is foremost a clarification of the previous literature, I compare my model with two widely cited studies that I have replicated (e.i. Kahn, 2005; Strömberg, 2007). These studies are chosen not only for having opposing conclusions, but because they represent an empirical test that is close to mine. Kahn (2005, 283) concluded that democracy is related to fewer casualties, while Strömberg (2007, 209) did not find this relationship. The reason for comparing my model with the replicated models is to limit the possibility that conflicting conclusions origin from different samples.[3]

Table 5.4 shows four regression models, each a different test of the 'democracy–disaster' relationship. The results indicate that at least as a general statement, democracy is not robustly related to fewer casualties. Model 1 and 3 are estimated with a negative binomial regression. The dependent variable in model 1 is the number killed in a natural disaster event, and the dependent variable in model 3 is annual killed. Model 1 is the baseline model for my later regressions. In model 2 and model 4 I have replicated Strömberg (2007) and Kahn (2005), respectively, with my extended time-series. Model 2 is estimated with an ordinary least square (OLS) regression, where the dependent variable is the natural logarithm of the number killed. Strömberg (2007) concluded in his empirical assessment that democracy is not related to disaster casualties. I find support for this conclusion, both in the replication model, and in my own model assessments (Model 2 and 1, respectively). Model 4 is a replication of the much cited article by Kahn (2005), who concluded that democracies are related to decreased natural disaster casualties. This model is estimated with a zero inflated negative binomial model.[4] My replication model does find the same relationship as Kahn (only .016 difference between the parameters). However, the model is at best very sensitive to model adjustments. The only specification that gave Polity IV a significant negative effect on the number of casualties was when the dependent variable was operationalized as: *annual death counts* in a country year, and when a control variable for ethnic fractionalization was included.[5] First of all, operationalizing the dependent variable as 'annual deaths' is to my understanding not a good idea, as it excludes the ability to control for disaster type characteristics (earthquakes are different from wildfires as shown in section 4.3). When empirically assessing natural events, such controls are essential in limiting the danger for spurious relationships. Secondly, the model is highly sensitive for other specifications. When ethnic fractionalization was excluded from the analysis, the significant estimate for democracy vanishes. This also goes for model 3, which is estimated without any

[3]Please note that I do not replicate the models with their replication data, as I failed to get in contact with the others themselves. I try to specify the models to look as close to theirs as possible, with my extended time-series. The estimates in the replicated models are almost identical to the estimates in the tables presented in Kahn (2005); Strömberg (2007). Thus, it is likely that they are a good representation.

[4]In short, what this model does is that it estimates the effects in two separate equations, one for zero counts and one for positive counts, implying that not all disasters should be expected to result in casualties (Long and Freese, 2006, 394-397).

[5]This result was consistent when estimating the exact zero inflated negative binomial on the period 1980-2002, which is the sample-period in Kahn (2005)

Table 5.4: Democracy and disasters, country level analysis

	(1) Number killed	(2) Number killed (log)	(3) Annual killed	(4) Annual killed
main				
Polity IV	-0.00364	0.0138	-0.0547*	-0.0518*
	(0.0125)	(0.0131)	(0.0259)	(0.0257)
Disaster ratio	-0.101***			
	(0.0297)			
Ethnic frac.			-0.611	-0.605
			(0.492)	(0.495)
Count of disasters in country-year			0.0645	0.0624
			(0.0607)	(0.0596)
GDP per capita (log)	-0.655***	-0.343***	-0.371*	-0.338*
	(0.103)	(0.0720)	(0.166)	(0.169)
Population (log)	0.490***	0.179***	0.699***	0.646***
	(0.0970)	(0.0466)	(0.0988)	(0.111)
Constant	-3.048	1.197	-9.999***	-9.362***
	(1.715)	(0.756)	(2.172)	(2.390)
lnalpha				
Constant	1.585***		1.461***	1.361***
	(0.0568)		(0.0619)	(0.0779)
inflate				
GDP per capita (log)				0.824
				(0.769)
Population (log)				-0.443**
				(0.143)
Count of disasters in country-year				-18.19***
				(3.174)
Constant				16.08
				(9.313)
Observations	6580	6580	1762	1762
ll	-26885.5	-12745.1	-9181.4	-9155.1

Standard errors, clustered by country, in parentheses

Dependent variable in model 1: count of number killed. Dependent variable model 2: log number killed

Dependent variable in model 3 and 4: annual death counts.

Model 1 and 2 include disaster type and regional dummy variables. Model 3 and 4 have only regional dummy variables

All models account for time varying factors. The exposure option for 1,3 and 4. And decade dummies in model 2.

Model 2 is estimated with an OLS reg. Model 4 is a zero inflated negative binomial

Model 4 is inflated on GDP, Population, and Dem.

Model 3 is a negative binomal reg. without inflated variables.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

inflated variables. Model 3 shows that an inflated model does not provide particular improvements (only a small increase in the log likelihood). One can argue that the effect of democracy is in fact dependent on ethnic fragmentation, however, Kahn (2005) fails to address such a concern with explicit theoretical propositions. Ethnic fragmentation, indicated earlier, has been proposed to be bad for public goods distribution (e.g. Alesina, Baqir and Easterly, 1999), and therefore bad for disaster resilience (Cohen and Werker, 2008). However, the estimate itself is not significant (and negative).[6] It ends up looking like a miss-specified model, which fails to explicitly address the theoretical and empirical relationship between the variables.[7] Democracy is either not significantly related to lower death tolls, and in cases it is – the results are highly sensitive.

Figure 5.1: Democracy and disasters

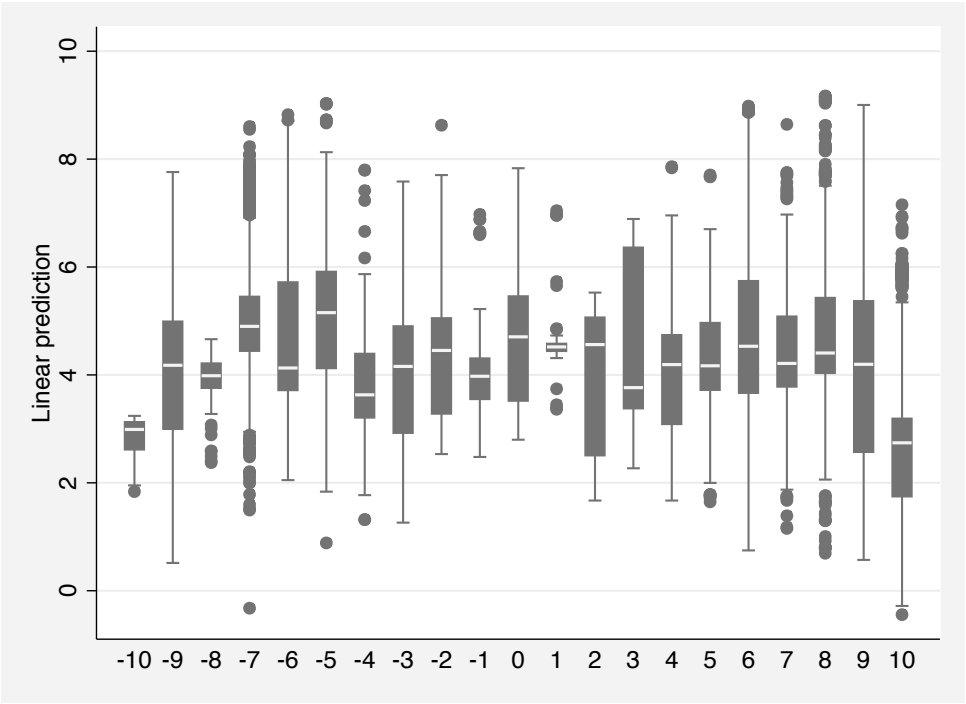


Figure 5.1 shows the linear predicted relationship between the baseline model and the number killed. The box plots show that even though there are large variations within each category, the results are not driven by particular outliers.[8] The figure illustrates that there is no clear

[6]This finding supports my earlier argument that fractionalization as such, is not a good measure of the political dimension of disaster mitigation policies. Secondly, it supports my argument that country level indices do not capture the essence of what it tries to explain. Thirdly, it falsifies Cohen and Werker (2008, 805), which claims that less fragmented societies significantly reduce casualties in natural disasters.

[7]See Achen (2005) for a good discussion on garbage-can regressions.

[8]Removing outliers does not affect the estimates. Negative binomial regressions (model 1 from table 5.4) were estimated excluding major disaster with more than 10,000; 1,000; 100; and 50 causalities. All results were consistent with the baseline model, positive effect of population; negative effect of GDP per capita and disaster ratio, and no significant effect of democracy. I have also tested whether the effect of democracy is not on the magnitude of disasters, but on within country variation. The estimates show that democracy is significantly related to reduced disaster variance, however the effect is small. One increase in polity score is associated with a reduction in the variance of casualties with 1.

tendency between democracy and the number of casualties in natural disasters. It shows however that full democracies, that is, democracies that score 10 on Polity IV, on average do better than other. This is probably due to the fact that many of the full democracies have high levels of GDP per capita. Nevertheless, the empirical assessment moderates earlier conclusions – democratic institutions do not seem to be related to the severity of disasters. As pointed out, the reason that my model fails to find this relationship seems to be related to a more stringent model specification. First, I estimate the effects on disastrous events and not annual casualties. Secondly, I include disaster type fixed effects. Thirdly, I exclude the measure of ethnic fractionalization.[9]

5.1.2 Institutions and exclusion

Although the relationship between democracy and natural disaster magnitude was the motivation behind my hypotheses and not a necessary condition for them, I proceed and test my predictions; that countries with presidential systems, majoritarian elections, and decentralized authority, experience higher casualties in natural disasters. I include the hypotheses postulating that excluded groups are more vulnerable, although, these hypotheses are not as important in the country level analysis as it is in the disaggregated analysis.

Table 5.5 shows four negative binomial regression models, with robust standard errors, clustered by country. The models include disaster type and regional fixed effects, and take into account trends over time. The baseline model was estimated on 6580 disasters, but because there are unbalanced data coverage concerning the institutional variables, I chose to exclude all observations that had at least one missing data point on any of the independent variables. As discussed in the methods section, this allows me to estimate on the exact sample in each regression, excluding the possibility that changes in the estimates will be due to changes in the samples.[10] The reference category for the institutional variables is parliamentarian, proportional, and centralized institutions, respectively. The estimated effect should be interpreted as the effect of a particular variable compared to the reference category. However, since each regression include interaction terms, the effects cannot be interpreted as constitutive effects of one variable on the dependent variable, but the effect of one variable on the dependent variable *conditional* on a third, or in my case also a fourth variable (Brambor, Clark and Golder, 2006, 72). Models 2 to 4 in table 5.6, show the estimated effect of each variable when the interaction terms are zero, that is, when exclusion and Polity IV is zero. As multiple interaction terms can make the substantive interpretation of the variables rather messy, I use the stata code written by Brambor, Clark and Golder (2006) and the software program *Clarify*, developed by King, Tomz and Wittenberg (2000) to simulate the marginal effects of more meaningful values. This makes the interpretations of the variables easier.[11]

[9] Ethnic fractionalization does not produce a significant estimate for policy in the baseline model (model 1) in 5.4

[10] I have estimated each regression not doing this. The overall picture does not change. See table A.6 in the appendix.

[11] I simulate 1000 parameters in each simulation procedure.

Table 5.5: Institutions, exclusion and natural disasters, country level analysis

	(1) Number killed	(2) Number killed	(3) Number killed	(4) Number killed
Number killed				
Political exclusion	0.276	1.039^{+}	0.140	0.860
	(0.37)	(1.86)	(0.14)	(1.36)
Presidential		0.996*		
		(2.50)		
Excl*Pres		-1.810		
		(-1.39)		
Pres*Polity IV		-0.0490		
		(-1.29)		
Majoritarian			0.0275	
			(0.07)	
Excl*Maj			0.812	
			(0.61)	
Maj*Polity IV			-0.0300	
			(-0.69)	
Federal				0.419
				(0.79)
Excl*Fed				-2.644^{+}
				(-1.90)
Fed*Polity IV				-0.0427
				(-1.03)
Disaster ratio	-0.118***	-0.112***	-0.117**	-0.0885**
	(-3.53)	(-3.54)	(-3.06)	(-2.86)
GDP per capita (log)	-0.746***	-0.715***	-0.754***	-0.711***
	(-6.59)	(-8.26)	(-6.59)	(-6.14)
Population (log)	0.544***	0.580***	0.542***	0.520***
	(5.19)	(5.09)	(5.07)	(5.37)
Polity IV	0.0192	0.0468*	0.0324	0.0208
	(0.67)	(1.96)	(0.82)	(0.65)
Constant	-3.261^{+}	-4.848*	-3.255^{+}	-3.272^{+}
	(-1.73)	(-2.29)	(-1.75)	(-1.81)
lnalpha				
Constant	1.590***	1.581***	1.589***	1.587***
	(24.23)	(24.89)	(24.50)	(24.25)
Observations	5285	5285	5285	5285
ll	-20729.2	-20702.0	-20725.4	-20719.1

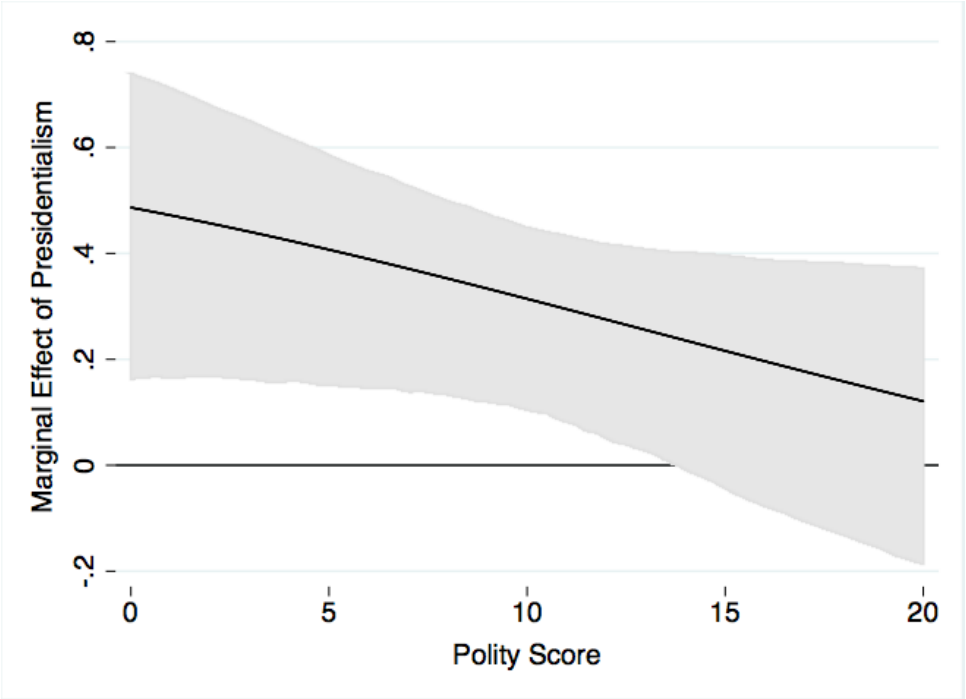
t statistics in parentheses

Robust standard errors, clustered by country

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

However, I begin by interpreting the overall effects; looking at the direction of the estimates, significance and magnitude. The overall view leaves my hypotheses only limited support.[12] There seems to be no significant effect of the size of excluded groups in a country on disaster vulnerability, although it is positive and borderline significant in model 2. More specifically, there is no significant effect of political exclusion for parliamentary institutions (presidential=0) when Polity IV is zero, holding all other variables constant. The only significant effect that corresponds well with my hypotheses is that of presidential institutions. The estimate reports that presidential institutions increase the expected count of casualties with a factor of 0.996, compared with parliamentary institutions, when political exclusion and Polity IV is zero.[13] On average this amounts to 50 casualties more. Figure 5.2 shows the marginal effect of presidential institutions for different levels of the Polity IV index, when political exclusion is at its median value. The figure shows that the effect of presidential institutions decreases when democracy increases. The effect of presidential institutions loses significance when passing around 14 in the figure (equivalent to 4 on the Polity IV indicator). This may be associated with the interaction effect of democracy and presidentialism, which is not significant. Before I investigate this and estimate the effects of institutions on democracies only, I briefly comment on the control variables.

Figure 5.2: Simulated marginal effect of presidentialism on various levels of democracy, with political exclusion at its median value. Confidence intervals in grey shadings.



[12]Hybrid institutions are coded as belonging to parliamentary, proportional, and central institutions, respectively. The results are mostly the same when coding them as belonging to presidential, majoritarian, and federal institutions. See table A.5 in appendix.

[13]I remind the reader that the correlation between Political exclusion and Excl*Pres was high, indicating collinearity and inflated standard errors. This may cause the effects to appear less significant than what they really are.

All control variables play out as expected. Disaster ratio is negative and significant throughout the models, indicating that countries that experience many disasters suffer on average less than countries that experience few, when exclusion and democracy is zero. A marginal increase in disaster ratio is associated with reduced number of killed by 6. Another interpretation is that countries that experience many disasters have a lower threshold of reporting small disasters, and thus display more resilience. GDP per capita (log), and Population (log) are significant, and in the proposed direction. A marginal increase in GDP per capita reduces the count of casualties by 34. Correspondingly, a marginal increase in population (log) increases the number of casualties by 28.[14]

5.1.3 Democratic institutions

Table 5.6: Democratic institutions, and natural disasters, country level analysis

	(1) Number killed	(2) Number killed	(3) Number killed
Number killed			
Presidential	1.000*		
	(0.470)		
Majoritarian		-0.0426	
		(0.268)	
Federal			0.288
			(0.550)
Disaster ratio	-0.131**	-0.115**	-0.119**
	(0.0419)	(0.0431)	(0.0409)
GDP per capita (log)	-0.812***	-0.889***	-0.895***
	(0.0748)	(0.119)	(0.117)
Population (log)	0.649***	0.576***	0.543***
	(0.132)	(0.135)	(0.120)
Constant	-0.354	1.754	2.048
	(1.678)	(1.469)	(1.347)
lnalpha			
Constant	1.585***	1.601***	1.599***
	(0.0763)	(0.0771)	(0.0744)
Observations	4101	4101	4101
ll	-15908.0	-15940.7	-15938.1

Standard errors in parentheses

Include only countries that are coded as democratic according to Cheibub et al.(2009).

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In Table 5.6 I have estimated the effect of institutions on countries that are coded as demo-

[14] Again, both refer to countries that score 0 on polity, with zero political exclusion.

cratic, and when all interaction terms are excluded.[15] The reason for doing this is to be more certain that it is not autocratic polities that are produces the effects. Secondly, excluding the interaction terms ease the uncertainties related to multicollinearity. The effect of presidential institutions is still large and significant, and indicates that presidential institutions are related to higher death tolls, compared to parliamentary institutions. Having presidential institutions increase the expected number of casualties by 170 percent, holding all other variables constant. The simulated average effect indicates that presidential institutions increase the number of casualties by around 50, compared to parliamentary institutions.

Figure 5.3: Simulated average difference in casualties for parliamentary and presidential institutions by region. Confidence intervals in grey shadings.

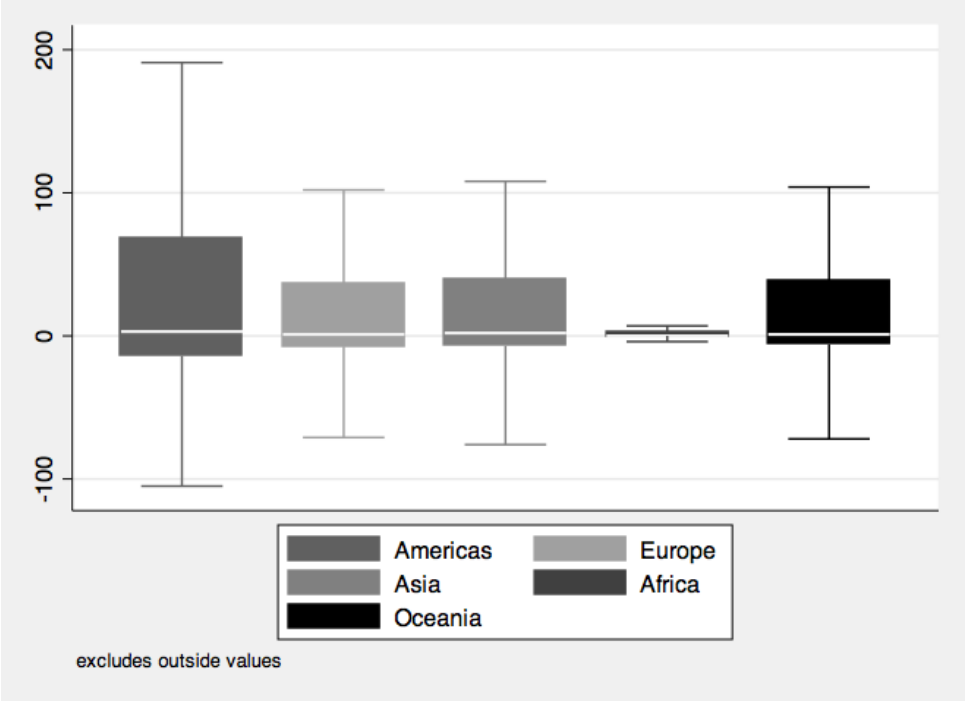


Figure 5.3 shows the simulated marginal difference between presidential and parliamentary institutions for different regions, holding everything else at its mean. The figure shows that presidential institutions increase the average expected number of casualties for all regions, however, more in Americas than other regions. This may reflect that the majority of the institutions in this region are presidential. Looking at the data this is highly likely. Of the 1,515 disastrous events that happened in this region (in countries that are coded as democratic), 91 percent of the events were in countries with presidential institutions.[16] Estimating the regression in model 1 in table 5.6 on a subset that does not include this region, the effect of presidential institutions decreases to 0.862, while the p-value increases to 0.091 (i.e. only borderline significant).

[15]Countries that are coded as democratic by (Cheibub, Gandhi and Vreeland, 2009) I could have chosen countries that score more than for example 6 on the polity scale. But to avoid arguments on why I chose 6 instead of 5, or four etc, I chose a more tangible dichotomy. However, the correlation is high (0.8553) between Cheibub's democracy dichotomy, and polities that score more than 5 on the Polity IV scale.

[16]This ratio is the same when including countries that are coded as autocratic.

5.1.4 Summary country level analysis

From the country level analysis we have learned two basic things. First, that democracy, as measured by the Polity IV score is not systematically related to lower death tolls in natural disasters. This finding is robust to other model specifications, operationalization, and different samples, and lends little support to the notion that democratic institutions *as such* reduce the human losses in natural disasters.

Secondly, even though my hypotheses receive limited support, presidential institutions are consistently related to an increased number of casualties in natural disasters. This provides evidence to my initial proposition, that presidential institutions impede global goods provisions targeted at all citizens. If my assumptions are correct, institutional incentives characterized by local payments, short-term policies, and 'porks', increase people's vulnerability in natural disasters.

As expected, country level measures of political exclusion did not produce significant effects on natural disaster magnitude. The hypotheses concerning the electoral and centralization dimension did not receive any support in any of the models. Nor did the hypotheses concerning the interaction between institutions and political exclusion (however, borderline significant for Excl*Fed). As argued earlier, country level analyses are not always the best choice when evaluating actor-centered theories, nor are they sufficient when trying to understand what happens at the local level. Hence, I proceed to the disaggregated analysis, and evaluate my hypotheses on the local level.

5.2 Disaggregated analysis

Table 5.7 reports the mean and median killed in grid-cells by institutions. The initial picture corresponds well with my hypotheses. The mean and median killed is higher under presidential institutions compared to parliamentary institutions. For majoritarian and federal institutions, the reported numbers correspond much better to my initial hypotheses than the country level analysis did. However, as majoritarian and federal institutions did not produce any significant effects in hypothesized direction in the country level analysis, these estimates should be interpreted with caution. Nevertheless, the overall view is consistent with the initial propositions.

Table 5.7: Average casualties in grid-cells by institutions.

Institutions	*Mean*	*Median*	*Standard dev.*	*Number*
Parliamentary	219.0	2	1600.4	321
Presidential	283.4	6	3677.2	409
Proportional	196.0	4.5	1364.9	524
Majoritarian	405.6	4	5111.7	206
Centralized	196.0	4.5	1364.9	524
Federal	405.6	4	5111.7	206

Source: EM-DAT 1980-2008, Schjølset 2008, Data on Political Institutions, World Bank 2010

Table 5.8 reports the mean and median casualties in grid-cells with and without political excluded groups. Cells that have at least one excluded group experience much higher number of casualties in natural disasters. However, the median value moderates this, and reports the reverse relationship. This apparent discrepancy between the mean and median value is likely due to the Pakistan earthquake in 2005, which affected an area that was populated be politically excluded groups. It is the largest disaster that enters the disaggregated sample, and is registered as causing 73,338 casualties. Thus, table 5.8 shows no clear tendency of how political status affects natural disaster vulnerability. The following section provides a more rigorous test.

Table 5.8: Casualties for grid-cells with and without excluded groups.

Political status	*Mean*	*Median*	*Standard dev.*	*Number*
Included groups	191.0	5	1411.2	475
Excluded groups	374.6	4	4605.7	255
Total	255.1	4	2948.4	730

Source: EM-DAT 1980-2008, GeoEPR.

Table 5.9 shows the regressions in the disaggregated analysis. Model 1 tests the hypothesis relating to political exclusion, while model 2-4 test the institutional hypotheses and the hypotheses concerning the interplay between institutions and exclusion. The unit of analysis is natural disaster event in grid-year. All models include gross cell product (GCP) per capita (log), and GDP per capita (log). They also include grid population (log) and country population (log).

The estimate of political exclusion in model 1 is positive and significant, indicating that grid cells that are populated by politically excluded groups are related to higher number of casualties in natural disasters, compared to grid-cells that are not populated by politically excluded groups. Figure 5.4 shows the simulated average number killed in casualties in cells with and without political exclusion. Cells with excluded groups suffer on average approximately 50 casualties more, that is, around twice an many casualties. Even though there is a clear difference, the simulated confidence intervals are overlapping, indicating that my model cannot

Table 5.9: Institutions, exclusion and natural disasters, disaggregated analysis.

	(1) Number of killed	(2) Number of killed	(3) Number of killed	(4) Number of killed
Number of killed				
Political exclusion	0.737**	-0.443	0.559	0.999**
	(0.273)	(0.318)	(0.411)	(0.334)
Presidential		-0.109		
		(0.368)		
Excl*Pres		1.661***		
		(0.424)		
Pres*Polity IV		0.0394		
		(0.0538)		
Majoritarian			-0.319	
			(0.548)	
Excl*Maj			0.569	
			(0.553)	
Maj*Polity IV			-0.0327	
			(0.0892)	
Federal				2.037**
				(0.759)
Excl*Fed				-1.829**
				(0.678)
Fed*Polity IV				-0.389***
				(0.0796)
Grid population	0.169**	0.208***	0.161**	0.0872+
	(0.0580)	(0.0585)	(0.0580)	(0.0509)
Population (log)	0.637***	0.693***	0.604***	0.739***
	(0.148)	(0.133)	(0.154)	(0.119)
Disaster ratio	-0.108*	-0.146***	-0.0945+	0.0160
	(0.0434)	(0.0433)	(0.0507)	(0.0348)
GCP per capita 1990 (log)	0.578	0.495	0.560	0.871*
	(0.359)	(0.338)	(0.345)	(0.379)
GDP per capita (log)	-1.147**	-0.992**	-1.133**	-1.271**
	(0.377)	(0.338)	(0.365)	(0.393)
Polity IV	-0.0265	-0.0372	-0.0196	0.0375+
	(0.0311)	(0.0357)	(0.0413)	(0.0224)
Constant	-10.11**	-12.31***	-9.420**	-13.38***
	(3.133)	(2.730)	(3.170)	(2.171)
lnalpha				
Constant	1.590***	1.566***	1.587***	1.534***
	(0.0733)	(0.0712)	(0.0740)	(0.0820)
Observations	730	730	730	730
ll	-2900.3	-2890.3	-2898.8	-2876.9

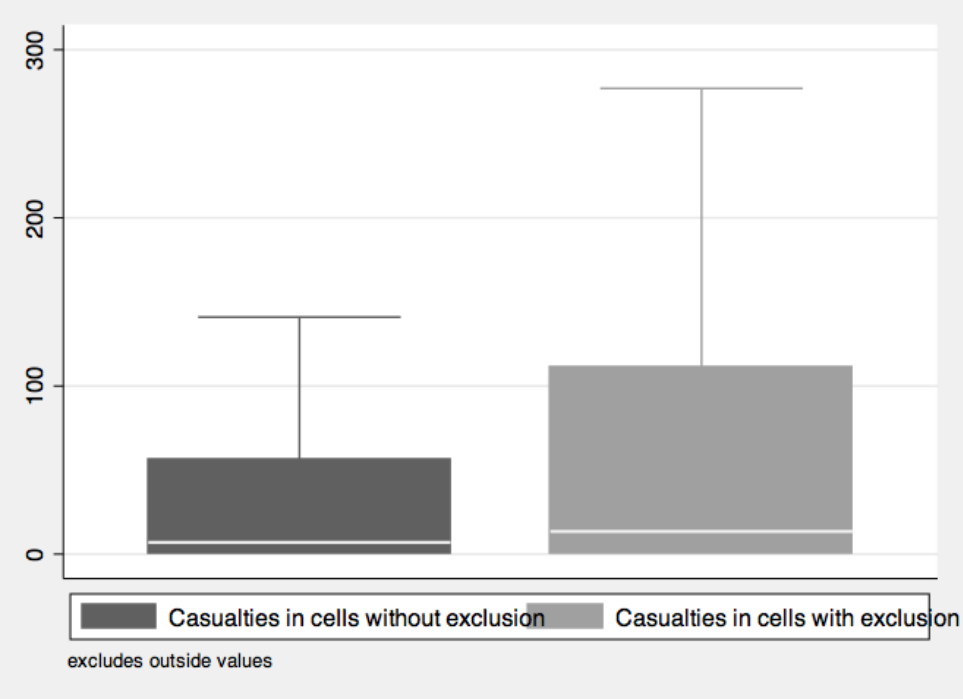
Standard errors in parentheses

Political exclusion is a dummy variable, where 1 indicates that grid-cell is populated by politically excluded groups.

Reference categories: Parl., PR. and Centalized

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 5.4: Simulated average casualties in cells with and without exclusion.

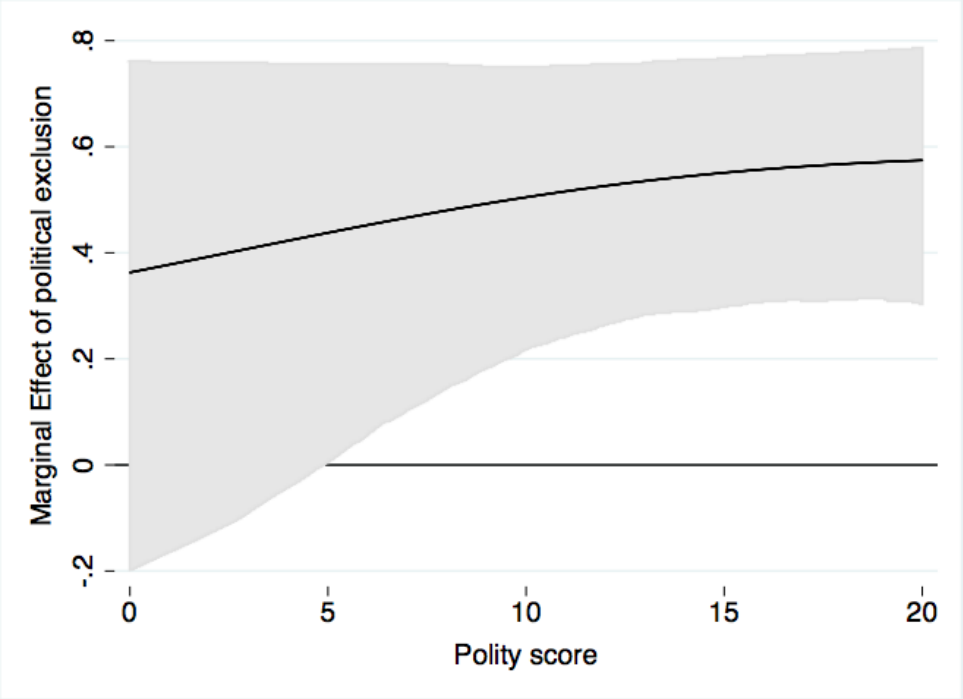


predict anything more than average differences.

Model 2 to 4 provides further tests of my hypotheses. In Model 2 political exclusion no longer has a significant effect by its own, but plays out through presidential institutions, when democracy is zero, all variables held constant. Please note that the initial correlation matrix in section 4.11 indicated collinearity between Political exclusion and Excl*Pres. This may cause the standard errors for these variables to be inflated. Figure 5.5 shows the simulated marginal effect of political exclusion for presidential institutions over various level of democracy. The effect of political exclusion in presidential regimes increases as polity increases, and becomes significant after 5 on the figure (equivalent to -5 on the Polity IV scale). As there are only 45 event observations that have less than -5 on the Polity IV score, this is not surprising.

Model 3 does not find evidence of electoral institutions being significantly related to an increase in disaster magnitude. Political exclusion is no longer significant, however this is probably due collinearity between the variables (see table 4.8 in section 4.9). When the inflated standard errors are corrected, political exclusion is borderline significant. The last model in table 5.9 shows that federal institutions are related to an increased death count in the disaggregated sample. However, this effect is contingent on both political exclusion and level of democracy. The estimates shows that centralized institutions are worse in cells with political exclusion, and for high levels of democracy. Put differently, federal institutions reduce the number killed for cells with political exclusion, with high levels of democracy, but increase the number of casualties for included groups when democracy is low. What to make out of this is not clear, as federal institutions did not produce any significant results in the country level analysis.

Figure 5.5: Simulated marginal effect of political exclusion for presidential systems over various levels of democracy.



However, the proposed interaction term is significant and in the opposite direction, a finding that was evident also in the country level analysis. This finding lends little support to my initial hypothesis, and point to a complete reversed relationship. Besley and Coate (2003) argued contrary to my predictions that the effect of centralized institutions on public goods distribution is negative when the bargaining in the legislator is characterized by conflict. In such a state representatives from heterogeneous regions have less incentives to contribute to establishing public goods because they value the costs of committing to the good be too high. If countries with high levels of political exclusion are characterized by conflict in the legislator, and hence produce low levels of public goods, this logic may provide a more sound explanation of the empirical results.

5.3 Summary

Although the analysis does find evidence for a few of my hypotheses, the results are not clear-cut. As anticipated, political exclusion did not play out in the country level analysis, substantiating the rationale behind the disaggregated approach. In the disaggregated analysis the overall results indicate that grid-cells that have at least one politically excluded group are significantly related to an increase in the number of casualties in natural disasters, compared to grid-cells that are not inhabited by excluded groups. The result corresponds well to the predicted relationship – politically excluded groups are more vulnerable in natural disasters than politically included groups. Albeit case studies have shown that politically marginalized groups experience

disproportional losses in natural disasters, as a general statement, this has not been empirically evident until now. This yields support to a rational explanation of goods allocation: goods are distributed unevenly based on the recipient's political status, and being impaired from central state institutions affect people's vulnerability in natural disasters.

This view is modified by institutional characteristics. The positive effect of exclusion seems to be related with presidential institutions, providing evidence for one of my interaction hypothesis. This result lends support to the assumption that presidential institutions are driven by incentives characterized by local goods allocation and direct payments to high-status constituents. Being marginalized in presidential institutions increases excluded group's vulnerability in natural disasters.

The electoral dimension does not produce any significant relationships in either direction, and therefore does not receive any support in my models. The hypotheses that address this dimension are falsified at this point. As proportional and majoritarian elections have distinctly different incentive stucture, PR-systems being charaterized by 'representation' and majoritarian being characterized by 'accountability', this may indicate that the pros and cons relating to each of them do not result in systematically different outcomes in natural disasters.

For the federal dimension, the results are a little ambiguous. I do not find any support that federal institutions are related to higher death tolls in the country level analysis. However, on the local level, federal institutions have conditioned effect on natural disaster magnitude. Federal institutions are related to increased number of casualties for included groups when democracy is low, but are related to fewer casualties in cells with excluded groups when democracy is high. One should be careful to make too much out of these results as they do not correspond well with my initial theory. However, as already pointed out, Besley and Coate (2003) argue that the effect of federal institutions is contingent on the legislative bargaining. If the assumption is true that countries with excluded groups are characterized by conflict in the legislator, and hence have low levels of global goods distribution, then this may provide a more sound explanation of the empirical results. Thus, the effect of centralized authority on goods provisions may after all be explained by the classic notion argued by Olson (1965): when people fear the costs of committing to the establishment of global public goods, the goods will not be underprovided.

Finally, the analysis supports the notion that rich countries are related to lower death tolls, and that large populations increase the toll on human lives. A more novel indicator that produced large and significant effects throughout the models was disaster ratio. The estimates show that countries with a higher disaster ratio of natural disasters are more robust. This supports the belief that natural disasters are a function of the political and socio-economic environment, and that countries can learn from and prepare for such events.

Chapter 6

Robustness and model fit

In the main analysis I have tried to be as straightforward as possible. I have included all disasters, stuck to my baseline control model, and estimated all regressions with a negative binomial regression model. In this section I will comment on how different operationalizations, samples, and estimations affect the results. Lastly, I address how my model fits the data, and the ability to predict future events.

6.1 Disaggregated analysis

As my dependent variable have a large standard deviation, several missing data points, and many zero values, I have tried to estimate the regression models on different subsets. When estimating the effects excluding all disasters that did not have any casualties, the disaggregated model showed that excluded groups still are positively related to disaster casualties, however only significant in an OLS regression (see A.7 in appendix). Logit estimations of 0 and more than 0 casualties, or less than 50 or more than 50 casualties, showed no significant effect of political exclusion (see table A.8 appendix). When estimating the effect of political exclusion on earthquakes only, the parameter rises from 0.737 (Model 1 in table 5.9) to 1.711 (See table A.9 in appendix). When removing large disasters, political exclusion is significant until around 600 casualties (results not shown). Lastly, when estimating on all observations, not taking into account missing data on some of the institutional variables, political exclusion was still significant at the 5 percent level (see table A.3 in appendix). All in all, political exclusion seems to be related to an increase in death tolls, however the results do point in the direction that large disasters, i.e. disasters with more than 600 casualties drive significance of the parameter estimate.

For the hypothesis concerning presidentialism, I estimated the effect of presidential institutions on earthquakes only. The effect was still significant, however, now not for the interaction with exclusion, but for presidential by its own (See table A.9 in appendix). For the other institutional dimensions the estimates looked like those in table 5.9 (results not shown). Presidential institutions were still significantly related to higher casualties when not estimating on the exact same sample (see A.3). The results were the same for the electoral dimension and the central-

ization dimension as in table 5.9 (see A.3). To sum up, presidential institutions were related to higher number of casualties under most operationalizations, supporting the assumption that presidential institutions weakens global goods provisions. Elections and centralization did not produce the proposed effect.

Figure 6.1: Predicted number events from model 2 in table 5.9.

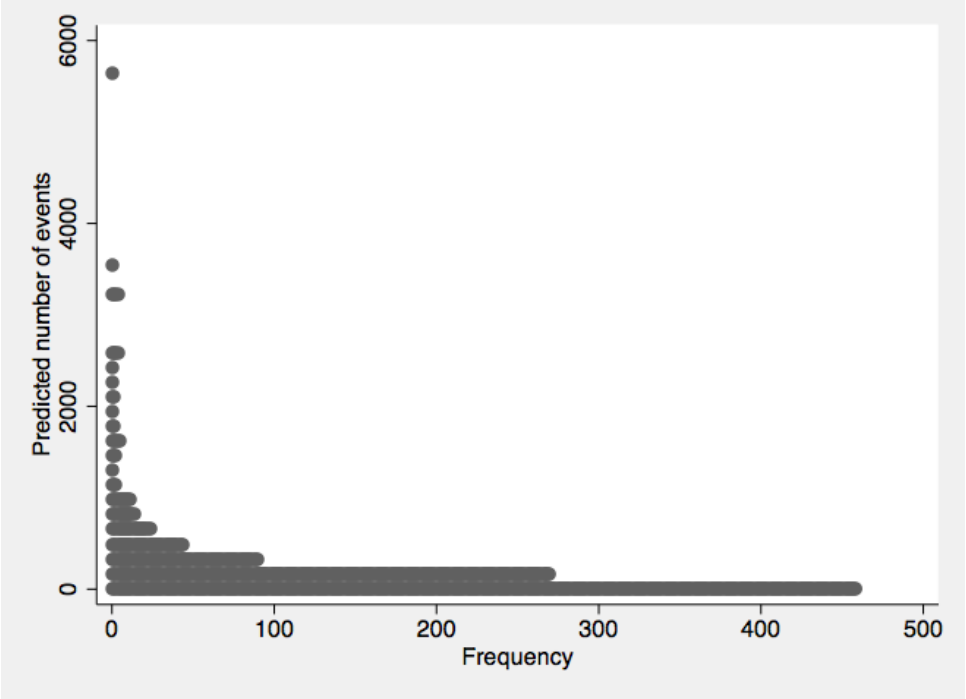
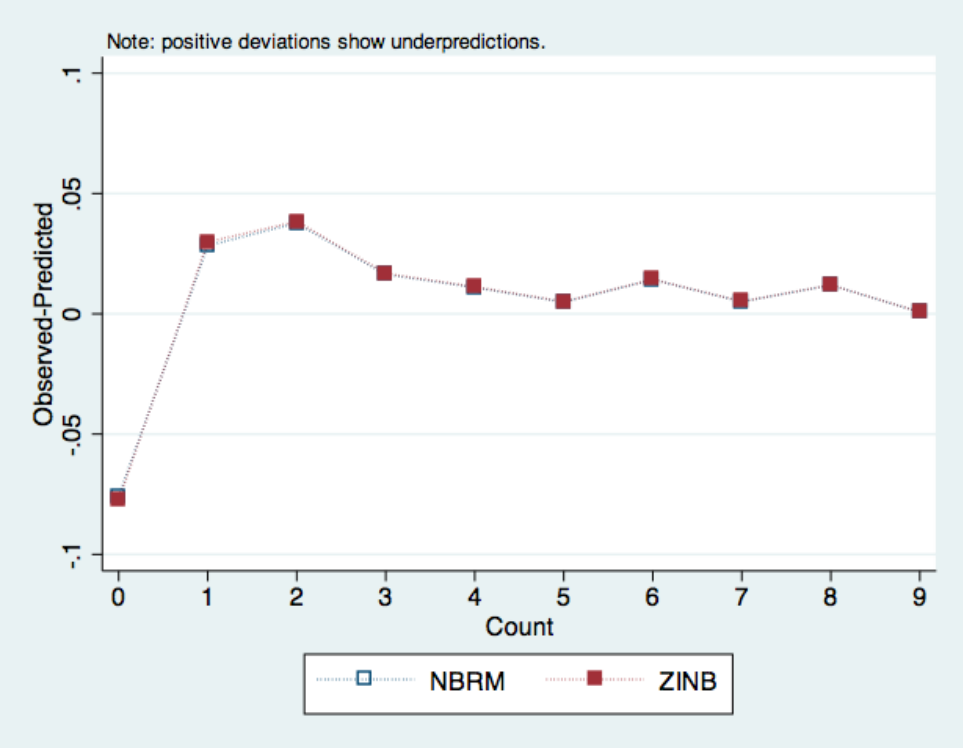


Figure 6.1 shows the predicted number of events from model 2 in table 5.9. It shows that my model fails to predict large disasters. For better predictions my model should incorporate more information on the natural hazard event, together with other environmental factors. However, even more complex models are not able to predict disaster casualties, and focus on predicting country level and grid-cell risks instead (see Peduzzi et al., 2009). Even though my model is unable to predict large disasters, the zero inflated negative binomial regression does not provide improvements that are worth talking about. Figure 6.2 shows the differences between the observed and the predicted values from the negative binomial regression model (NBRM) and the zero inflated negative binomial (ZINB). A perfect model would follow Y=0. Both models clearly overpredicts zero values (positive deviations show underpredictions), but the differences in the two models are hardly visible. One possible reason that the zero inflated model does not provide improvements to the regular negative binomial is that there are no grid-cells that have more than one event in a single year, and as much as 85 percent of the data was registered as having only one event. This may explain why the model is unable to distinguish between the always zero group, and the not always zero group.

Figure 6.2: Predicted number casualties from model 2.



6.2 Country level analysis

In the country level analyses the only finding that corresponded well with my hypotheses was the estimate for presidential institutions. This finding was consistent when estimating on the three most frequent disasters, floods, earthquakes, and storms.[1] Presidential institutions were significantly related to higher number of casualties when excluding all disasters with zero counts. However, presidential institutions were not significant when estimating only on disasters with less than 100 casualties. This may indicate that there are a few extreme events that unfolded in countries with presidential institutions, and that this pulls the estimate in the proposed direction. When including observations that did have missing data on one of the other variables, presidential institutions were still significantly related to an increase in the expected number of casualties. The results for the other institutional dimensions were the same.

6.3 Democracy

I will briefly go through the most relevant robustness test concerning the non-significant effect of democracy. A core problem with these estimations is that democracies might be over represented in the dataset, and that the corresponding effect of the democracy indicator is underestimated. There is no obvious way of controlling for this concern, but one way is to increase the threshold for disasters, including only disasters that caused more than 50 casualties. Doing this might limit

[1] Positive but not significant for storms.

overreporting of small disasters, which could explain the non-significant effect of democracy. The results, however, do not change. Polity IV actually became positively related to higher death tolls when doing this. I estimated logit regressions with a dichotomous dependent variable, where 1 is more than 1, 50 or 100 killed, and 0 is less. Still, democracy was not systematically related to fewer casualties. Lastly, to handle differences between different disasters, I have estimated the baseline model on each subset of the most frequent disasters (i.e. storms, floods and earthquakes). For earthquakes and storms, the estimates were consistent with the previous models. However, for floods, democracies are on average significantly related to fewer casualties. What to make out of this is not clear, but one possible explanation is that floods are more easily foreseeable and develop over larger time periods, and that democratic institutions in this context are more efficient in disaster mitigation. This should provide reasons to examine how specific institutions relate to specific natural disasters, and develop testable predictions of a more detailed relationship.

6.4 Multilevel model

As my data has a multilevel structure, this could help explain why several of my hypotheses did not receive support. However, a simple test of intraclass correlation did not provide reasons for modeling two-level models. The rule of thumb is to estimate multilevel models when the intraclass correlation (ICC) is more then 0.06. None of my hypothesized variables had more than 0.008 ICC score, which made such an analysis not worth exploring.

Chapter 7

Conclusion

The empirical analysis has tested 7 distinct hypotheses concerning how institutions and political status affect natural disaster vulnerability. This chapter ends the empirical discussion, and goes through the hypotheses, one by one, before concluding on the major findings. I will also address some of the policy implications of my findings, and where the research community should go from here.

7.1 Hypotheses

I will briefly go through the hypotheses, and comment on how the analysis corresponded to each of them.

Proposition 1: *PR-systems experience fewer casualties in natural disasters than majoritarian systems, ceteris paribus.*

Proposition 1 did not receive any support in the empirical assessment. The estimates were not significant, nor were they consistent in the hypothesized direction. The proposition is falsified at this point. The implications of this may indicate that albeit electoral institutions having distinctly different incentive structure, the output side of this incentive structure does not directly affect the allocation of goods in the extent that countries with majoritarian elections systematically suffer more in natural disasters. Put differently, the countervailing pros and cons balance each other off.

Proposition 2: *Parliamentary systems experience fewer casualties in natural disaster than presidential systems, ceteris paribus.*

In most of the presented models, and in the majority of the robustness checks, parliamentary systems were significantly related to fewer casualties in natural disasters. The results do indicate that there are regional variations, but that the main story is consistent under most conditions. The hypothesis is confirmed at this point. This result lends support to the assumption

that presidential institutions are driven by incentives characterized by local goods allocation and direct payments to high-status constituents. The incentives driving goods allocation in parliamentary and presidential institutions systematically result in different outcomes in natural disasters, and indicate that the countervailing effects do not balance up. Political representation and coalition building in parliamentary institutions directly affect people's vulnerability through global public goods targeting all citizens. Again, this substantiates the notion that protective measures targeting globally are more effective in securing the robustness of the peoples than policy measures directed locally.

Proposition 3: *Centralized governments experience fewer casualties than federal governments, ceteris paribus.*

The result for the federal dimension is rather ambiguous. The country level analysis did not find any significant difference between centralized and federal governments. However, in the disaggregated analysis, federal governments were related to higher death tolls. A likely reason for this discrepancy is that the disaggregated sample has a lot fewer observations, and that the sample is biased. Thus, the proposition is tentatively rejected. As the results do not point to a clear tendency in any direction, I conclude that the mechanisms behind centralized authority do not exceed the countervailing mechanisms behind federal authority. However, the results relating to proposition 7 leaves the level of centralization with a conditioned effect.

Proposition 4: *Politically excluded groups experience more deaths in natural disasters than politically included groups.*

For the hypothesis relating to political exclusion, the analysis has two basic findings. First, there are substantial differences between the country level approach, and the grid-cell approach. The country level analysis did not find support for the hypothesized effect of political exclusion, while the effect on the local level is large and consistent. Grid-cells that are inhabited by politically excluded groups experience approximately twice as many killed in a natural disaster. This leads me to conclude that country level indices do not sufficiently capture what goes on the local level, and that empirical testing of local events should try to narrow the unit closer to each particular case. The analysis confirms this proposition.

Proposition 5: Excluded groups experience more casualties in majority systems than PR-systems.

I do not find systematic evidence of proposition 5, which indicates that there is no significant difference between vulnerability of excluded groups under different electoral institutions. The results suggest that the 'accountability–representation' trade-off concerning different electoral rules does not have a systematic effect on politically excluded groups' vulnerability in natural

disasters. Proposition 5 is rejected.

Proposition 6: Excluded groups experience more casualties in presidential systems than parliamentary systems.

Proposition 6 receives support in the disaggregated analysis, but not in the country level analysis. However, as the disaggregated model captures the theoretical linkage between institutions and exclusion more explicitly, this implies that there is such a relationship. As there are substantial concerns relating to biases in the disaggregated sample, I conclude that it receives partial support. Nevertheless, there seems to be tendencies pointing in the direction that presidential institutions are more impairing than parliamentary institutions, and that the effect of being excluded from central state institutions is worse in presidential than in parliamentary institutions.

Proposition 7: Excluded groups in federal governments experience more casualties than excluded groups in centralized governments.

The disaggregated model finds a strong and significant relationship of the opposite direction, indicating that excluded groups experience fewer casualties under federal than centralized institutions. This effect is also borderline significant in the country level analysis. I therefore reject my last hypothesis, and conclude that the proposed theoretical linkage does not capture the essence of how centralization affects politically excluded groups in natural disasters. As discussed in section 5.3 Besley and Coate (2003) argue that the effect of federal institutions is contingent on the legislative bargaining. If the assumption is true that countries with excluded groups are characterized by conflict in the legislator, and hence produce low levels of global goods, then this may provide a more sound explanation of the observed relationship. Thus, the effect of centralized authority on goods provisions may be explained by the classic notion argued by Olson (1965): when people fear the costs of committing to the establishment of global public goods, the goods will not be underprovided. This finding is present under most conditions, which implies that further research should be directed at studying how centralized institutions may be impairing to goods allocation when heterogeneous regions fight over the allocation of goods.

7.1.1 Summary

The overall view leaves my hypotheses partial support. The two major empirical findings reveal core features of the political dimension behind disaster vulnerability, which has not been empirically evident until now. Politically excluded groups are more vulnerable in natural disasters than politically included groups, and estimates suggest that areas that are populated by excluded groups on average experience twice as many casualties. This finding yields support to a core rational choice argument: political representation in central government affects the

allocation of goods, and incumbents allocate goods favoring those constituents that ensure them in power. Secondly, the empirically novel approach developed in this thesis demonstrates that supplementing country level data with grid-cell data allows researchers to more accurately observe what goes on at the local level, and lets researchers make more precise inferences about how political status affects group's vulnerability in natural disasters.

Regarding political institutions, I find evidence that presidential institutions on average experience 50 casualties more than parliamentary institutions in natural disasters. This finding lends support to large parts of the literature arguing that allocation of global goods in presidential regimes are characterized by local distribution, short-term policy, and large transaction costs, which all hamper global goods provisions. Secondly, it leaves me reason to believe that the proposed theoretical framework, separating between ex-ante local and global goods, can function as a helpful theoretical distinction when arguing how goods affect the outcome in natural disasters.

7.2 Policy implications and further research

The empirical evidence of this project reveals important features of how natural disasters are a function of the political environment. In all, disasters can at least partially be explained by different institutional arrangements. The most important policy implication stemming from this project is that political representation directly affects how goods are distributed. Being excluded from central state institutions makes groups more vulnerable in natural disasters. Thus, securing ethnic groups' representation in central government institutions is vital for making politically marginalized groups more robust.

This project has also revealed that democratic institutions are not necessarily related to increased robustness. This implies that *de jure* institutions cannot act as excuse in exchange for *de facto* political and civil liberties.

This project has by and large tested hypotheses that have never before been tested. Thus, further research should be directed at developing concrete theory on how institutions are linked to public goods distribution, and how they affect the vulnerability of politically excluded groups. This should provide the basis of more solid tests of how institutions and political status affect people's vulnerability in natural disasters. Secondly, the analytical approach developed in this thesis shows that only by complementing country level data with disaggregated data, researchers are able to observe and understand what goes on at the local level. Therefore, this thesis substantiates the empirical benefits of grid-cell data, and encourages the research community to employ a similar approach when studying local level events. Thirdly, estimates suggest that the effects of institutions may be contingent on the nature of the disastrous event. Thus, further research should investigate how specific institutions are able to reduce the severity of specific types of disasters. Are democratic institutions better at combating natural disasters that develop over time, such as climate change, or are 4 or 5-year terms insufficient for democratic governments to act on such challenges? Lastly, the quality of the inferences made here, is at least

partly a function of the data available. As discussed in detail, the disaggregated analysis suffers from data shortages stemming from missing values. Improving the quality and availability of the data therefore is paramount to developing our understanding of how natural disasters affect human lives. CRED, being a World Health Organization (WHO) Collaborating Center, receives its funding from the policy community. Thus, the policy community should be able to facilitate improvements in the data.

Appendix A

Diagnostics and additional results.

Table A.1 shows overdispresion in poisson model, which leads to large z-values and small p-values. Tabel A.2 shows the disaggregated analysis when hybrid institutions are coded as belonging to majoritarian, presidential, and federal. Table A.3 shows the disaggregated analysis when all observations are included. Table A.5 shows hybrids coded as belonging to presidential, majoritarian, and federal. Tabel A.6 shows the country level analysis when all observations are included. Table A.7 shows a NBRM and an OLS-regression including disasters with more than 1 killed. The dependent variable in the OLS is transformed to its natural logarithm. Table A.8 shows two logit models. Table A.9 shows NBRM on earthquakes only.

Table A.1: Possion vs Negative regression model.

	(1) Number killed	(2) Number killed
Number killed		
Disaster ratio	-0.109***	-0.099***
	(-328.58)	(-12.48)
GDP per capita (log)	-0.414***	-0.663***
	(-368.64)	(-18.80)
Population (log)	0.441***	0.477***
	(345.36)	(14.77)
Polity IV	0.024***	-0.002
	(147.54)	(-0.34)
1b.d_type	0.000	0.000
	(.)	(.)
2.d_type	-2.549***	-2.649***
	(-936.62)	(-25.75)
3.d_type	-3.057***	-2.499***
	(-428.76)	(-16.59)
4.d_type	-1.747***	-2.207***
	(-742.63)	(-19.89)
5.d_type	-1.369***	-1.474***
	(-211.06)	(-6.66)
6.d_type	-2.595***	-2.270***
	(-121.36)	(-5.93)
7.d_type	-1.141***	1.029***
	(-323.75)	(5.90)
8.d_type	-4.437***	-3.448***
	(-181.89)	(-19.81)
1b.regional	0.000	0.000
	(.)	(.)
2.regional	-0.046***	-1.597***
	(-10.56)	(-14.53)
3.regional	0.497***	-0.569***
	(143.80)	(-5.68)
4.regional	-1.454***	-1.867***
	(-203.01)	(-15.98)
5.regional	-1.495***	-1.765***
	(-89.50)	(-10.96)
Constant	5.665***	8.120***
	(350.40)	(17.08)
alpha		4.907
N	6605.000	6605.000

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.2: Institutions, exclusion and natural disasters, disaggregated analysis. Hybrid institutions coded as belonging to majoritarian, predidential, and federal.

	(1) Number of killed	(2) Number of killed	(3) Number of killed
Number of killed			
excl	-0.547	0.878^{+}	0.999**
	(0.336)	(0.500)	(0.334)
pres	-0.907*		
	(0.385)		
Excl*Pres	1.701***		
	(0.435)		
maj		0.440	
		(0.437)	
Excl*Maj		-0.382	
		(0.555)	
Maj*Polity IV		-0.0932^{+}	
		(0.0480)	
fed2			2.037**
			(0.759)
Excl*Fed			-1.829**
			(0.678)
Fed*Polity IV			-0.389***
			(0.0796)
Pres*Polity IV	0.0836^{+}		
	(0.0450)		
Grid population	0.191***	0.170**	0.0872^{+}
	(0.0539)	(0.0559)	(0.0509)
Population (log)	0.641***	0.621***	0.739***
	(0.119)	(0.143)	(0.119)
GCP per capita 1990 (log)	0.475	0.598^{+}	0.871*
	(0.340)	(0.357)	(0.379)
Disaster ratio	-0.123**	-0.0771^{+}	0.0160
	(0.0402)	(0.0454)	(0.0348)
GDP per capita (log)	-0.993**	-1.139**	-1.271**
	(0.350)	(0.392)	(0.393)
Polity IV	-0.0939*	0.0259	0.0375^{+}
	(0.0374)	(0.0306)	(0.0224)
Constant	-10.25***	-10.54***	-13.38***
	(2.248)	(2.740)	(2.171)
lnalpha			
Constant	1.570***	1.583***	1.534***
	(0.0714)	(0.0735)	(0.0820)
Observations	730	730	730
ll	-2891.9	-2897.3	-2876.9

Standard errors in parentheses

Political exclusion is a dummy variable, where 1 indicates that grid-cell is populated by politically excluded groups.

Reference categories: Parl., PR. and Centalized

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.3: Institutions, exclusion and natural disasters, disaggregated analyses. Including all observations.

	(1) Number of killed	(2) Number of killed	(3) Number of killed	(4) Number of killed
Number of killed				
excl	1.126*	1.314	0.553	1.364*
	(0.572)	(1.370)	(0.411)	(0.635)
pres2		0.861+		
		(0.485)		
Excl*Pres		-0.363		
		(1.230)		
Pres*Polity IV		-0.0218		
		(0.0668)		
maj2			-0.234	
			(0.529)	
Excl*Maj			0.488	
			(0.543)	
Maj*Polity IV			-0.0439	
			(0.0854)	
fed2				1.251**
				(0.452)
Excl*Fed				-1.448**
				(0.538)
Fed*Polity IV				-0.207**
				(0.0803)
Grid population	0.174*	0.182*	0.161**	0.110
	(0.0840)	(0.0722)	(0.0574)	(0.0882)
Population (log)	0.685***	0.716***	0.585***	0.710***
	(0.170)	(0.181)	(0.150)	(0.149)
GCP per capita 1990 (log)	-0.0952	-0.142	0.557	0.229
	(0.393)	(0.350)	(0.340)	(0.534)
Disaster ratio	-0.172*	-0.160**	-0.0861+	-0.109
	(0.0711)	(0.0604)	(0.0474)	(0.0885)
GDP per capita (log)	-0.0472	-0.0593	-1.124**	-0.215
	(0.531)	(0.383)	(0.359)	(0.674)
Polity IV	-0.0176	0.000650	-0.0210	0.0128
	(0.0276)	(0.0476)	(0.0423)	(0.0260)
Constant	-14.64**	-15.55***	-9.159**	-16.26***
	(4.611)	(4.282)	(3.118)	(3.763)
lnalpha				
Constant	1.704***	1.708***	1.582***	1.689***
	(0.0820)	(0.0776)	(0.0735)	(0.0869)
Observations	959	942	737	954
ll	-3981.2	-3867.4	-2943.4	-3951.8

Standard errors in parentheses

Reference categories: Parl., PR. and Centalized

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.4: Cross-correlation table of the hypothesized variables, and the interaction terms. Country level analysis. High correlations are in bolded text.

Variables	Political exclusion	Presidential	Excl*Pres	Pres*Polity IV	Polity IV
Political exclusion	1.000				
Presidential	0.359	1.000			
Excl*Pres	**0.851**	0.562	1.000		
Pres*Polity IV	0.229	**0.681**	0.367	1.000	
Polity IV	-0.141	-0.105	-0.075	0.461	1.000
Variables	Political exclusion	Majoritarian	Excl*Maj	Maj*Polity IV	Polity IV
Political exclusion	1.000				
Majoritarian	0.248	1.000			
Excl*Maj	0.638	0.633	1.000		
Maj*Polity IV	0.174	**0.692**	0.442	1.000	
Polity IV	-0.141	-0.075	-0.044	0.441	1.000
Variables	Political exclusion	Federal	Excl*Fed	Fed*Polity IV	Polity IV
Political exclusion	1.000				
Federal	0.155	1.000			
Excl*Fed	0.614	0.574	1.000		
Fed*Polity IV	0.121	**0.864**	0.480	1.000	
Polity IV	-0.141	0.186	0.091	0.400	1.000

Source: EM-DAT (2012),DPI, Polity IV Project, EPR-ETH, Schjølset (2008)

Table A.5: Institutions, exclusion and natural disasters, country level analysis. Hybrid institutions coded as belonging to presidential, majoritarian, and federal.

	(1) Number killed	(2) Number killed	(3) Number killed	(4) Number killed
Number killed				
Political exclusion	0.163	0.636	0.704	0.668
	(0.24)	(1.36)	(0.61)	(1.16)
Presidential		0.967*		
		(2.07)		
Excl*Pres		-0.478		
		(-0.54)		
Pres*Polity IV		-0.0339		
		(-0.91)		
Majoritarian			0.106	
			(0.18)	
Excl*Maj			-0.903	
			(-0.71)	
Maj*Polity IV			-0.0837	
			(-1.29)	
Federal				0.0581
				(0.13)
Excl*Fed				-1.786
				(-1.19)
Fed*Polity IV				0.0230
				(0.61)
Polity IV	-0.000986	0.0490	0.0508	-0.00771
	(-0.04)	(1.44)	(0.75)	(-0.28)
Disaster ratio	-0.113***	-0.121***	-0.0949**	-0.105**
	(-3.42)	(-3.55)	(-3.16)	(-3.10)
GDP per capita (log)	-0.693***	-0.685***	-0.683***	-0.690***
	(-6.41)	(-7.83)	(-6.95)	(-6.25)
Population (log)	0.524***	0.555***	0.539***	0.511***
	(5.24)	(5.15)	(5.39)	(5.30)
Constant	-3.191+	-4.922*	-3.964*	-2.989+
	(-1.76)	(-2.40)	(-2.20)	(-1.80)
lnalpha				
Constant	1.603***	1.595***	1.595***	1.600***
	(24.67)	(25.23)	(25.41)	(25.00)
Observations	5511	5511	5511	5511
ll	-21740.1	-21715.1	-21715.4	-21731.3

t statistics in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.6: Institutions and natural disasters, country level analysis. All observations are included.

	(1) Number killed	(2) Number killed	(3) Number killed
Number killed			
Political exclusion	0.669	0.180	0.573
	(0.496)	(0.958)	(0.466)
Presidential	0.824**		
	(0.299)		
Excl*Pres	-1.578+		
	(0.880)		
Pres*Polity IV	-0.0326		
	(0.0310)		
Majoritarian		0.0371	
		(0.408)	
Excl*Maj		0.734	
		(1.306)	
Maj*Polity IV		-0.0345	
		(0.0438)	
Federal			0.170
			(0.426)
Excl*Fed			-2.141+
			(1.182)
Fed*Polity IV			-0.0121
			(0.0310)
Disaster ratio	-0.0858**	-0.113**	-0.0867***
	(0.0290)	(0.0380)	(0.0250)
GDP per capita (log)	-0.661***	-0.743***	-0.641***
	(0.0853)	(0.114)	(0.110)
Population (log)	0.524***	0.531***	0.488***
	(0.101)	(0.107)	(0.0841)
Polity IV	0.0107	0.0290	0.00188
	(0.0214)	(0.0413)	(0.0140)
Constant	-4.188*	-3.155+	-3.195*
	(1.843)	(1.852)	(1.527)
lnalpha			
Constant	1.586***	1.590***	1.576***
	(0.0549)	(0.0645)	(0.0561)
Observations	6501	5331	6609
ll	-26327.1	-20919.9	-27008.3

Standard errors in parentheses

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.7: Exclusion and natural disasters, NBRM and OLS. Dependent variable is the count of more than zero killed. This is transformed to its natural logarithm in the OLS model.

	(1) Number of killed	(2) log_no_killed
main		
Political exclusion	0.737	0.346*
	(0.522)	(0.160)
Grid population	0.147+	0.108*
	(0.0886)	(0.0499)
Population (log)	0.210	0.0840
	(0.166)	(0.0795)
GCP per capita 1990 (log)	0.224	0.0159
	(0.299)	(0.114)
GDP per capita (log)	-0.413	-0.300*
	(0.367)	(0.127)
Polity IV	-0.0164	0.00766
	(0.0410)	(0.0184)
Constant	-5.880	2.269
	(3.641)	(1.508)
lnalpha		
Constant	1.228***	
	(0.0777)	
Observations	712	712
ll	-3659.0	-1403.7

Standard errors in parentheses

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.8: Exclusion and natural disasters, Logit models. Dependent variable in Model 1 is 1 if number killed is more than 0. Dependent variable in model 2 is 1 if number killed is more than 50.

	(1) killed1	(2) killed50
main		
Political exclusion	0.0749	0.0532
	(0.174)	(0.196)
Grid population	0.169***	0.143*
	(0.0502)	(0.0622)
Population (log)	0.0311	0.0645
	(0.0730)	(0.0995)
GCP per capita 1990 (log)	-0.0993	0.0221
	(0.117)	(0.177)
GDP per capita (log)	-0.121	-0.458*
	(0.138)	(0.184)
Polity IV	0.00277	0.0141
	(0.0131)	(0.0230)
year80_89	-0.0745	0.303
	(0.187)	(0.370)
year90_99	0.0714	0.677*
	(0.237)	(0.329)
Constant	0.466	-1.217
	(1.304)	(1.754)
Observations	952	959
ll	-489.4	-389.8

Standard errors in parentheses

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.9: Political exclusion and presidential institutions, estimated on earthquakes only.

	(1) Number of killed	(2) Number of killed
Number of killed		
Political exclusion	1.713*	1.819
	(0.743)	(1.575)
Presidential		1.696*
		(0.787)
Excl*Pres		-0.185
		(1.724)
Pres*Polity IV		-0.0497
		(0.144)
Grid population	0.150	0.185+
	(0.108)	(0.104)
Population (log)	0.468+	0.622**
	(0.257)	(0.224)
GCP per capita 1990 (log)	0.692*	0.511
	(0.351)	(0.513)
GDP per capita (log)	-0.147	-0.139
	(0.677)	(0.562)
Polity IV	-0.0259	0.0229
	(0.0718)	(0.0931)
1b.region	0	0
	(.)	(.)
2.region	-2.225*	-1.768*
	(0.923)	(0.810)
3.region	1.416*	1.721**
	(0.698)	(0.567)
4.region	0.744	0.633
	(1.415)	(1.098)
5.region	2.912**	4.348***
	(0.924)	(1.085)
	(.)	(.)
Constant	-17.84**	-20.94***
	(6.101)	(5.806)
lnalpha		
Constant	2.089***	2.053***
	(0.0820)	(0.0788)
Observations	515	515
ll	-2102.6	-2091.6

Standard errors in parentheses

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix B

Relevant Stata codes and data

All relevant do-files and data are on the accompanying CD, or can be provided upon request (contact: runebusch@hotmail.com).

Bibliography

Achen, Christopher H. 2005. "Let's Put Garbage-Can Regressions and Garbage-Can Probits Where They Belong." *Conflict Management and Peace Science* (22):237–339.

Achen, Christopher H. and Larry M. Bartles. 2004. "Blind retrospection electoral responses to drought, flu, and shark attacks." *Mimeo, Princeton University, Princeton NJ* .

Adcock, Robert and David Collier. 2001. "Measurement Validity: A Shared Standard for Qualitative and Quantitative Research." *American Political Science Review* 95(3):529–544.

Albala-Bertrand, J. M. 1993. *Political economy of large natural disasters.* Oxford, UK: Clarendon.

Alesina, Alberto, Arnaud Devleeschauwer, William Easterly, Sergio Kurlat and Romain Wacziarg. 2003. "Fractionalization." *Journal of Economic Growth* 8(June):155–194.

Alesina, Alberto, Reza Baqir and William Easterly. 1999. "Public Goods and Ethnic Divisions." *The Quarterly Journal of Economics* pp. 1243–1284.

Alexander, David E. 1993. *Natural Disasters.* London: University College London Press Limited.

Alvarez, M., J. A. Cheibub, F. Limongi and A. Przeworski. 1996. "Classifying political regimes." *Studies in Comparative International Development* 31(2):3–38.

Anbarci, Nejat, Monica Escaleras and Charles Register. 2005. "Earthquake fatalities: the interaction of nature and Earthquake fatalities: the interaction of nature and political economy." *Journal of Public Economics* 89:1907–1933.

Anbarci, Nejat, Monica Escaleras and Charles Register. 2007. "Public sector corruption and major earthquakes: A potentially deadly interaction Publiv sector corruption and major earthquakes: A potential deadly interaction." *Public Choice* 132:209–230.

Ashworth, Scott and Ethan Bueno de Mesquita. 2006. "Delivering the Goods: Legislative Particularism in Different Electoral and Institutional Settings." *The Journal of Politics* 68(1):168–179.

Bates, F. L., C. Folgeman, V. Parenton, R. Pittman and G. Tracy. 1963. *The Social and Psychological Consequences of a Natural Disaster: A Longitudunal Study of Hurrican Audrey.* Washington: National Research Council.

Beck, Thorsten, George Clarke, Alberto Groff, Philip Keefer and Patrick Walsh. 2001. "New tools in comparative political economy: The Database of Political Institutions." *World Bank Economic Review* 15(1):165–176.

Benhabib, J. and A. Przeworski. 2005. "Economic Growth Under Political Accountability." *Workingpaper* . New York University.

Besley, Timothy and Robin Burgess. 2002. "The Political Economy of Government Responsiveness: Theory and Evidence from India." *The Quarterly Journal of Economics* 117(4):1415–1451.

Besley, Timothy and Stephen Coate. 2003. "Centralized versus decentralized provision of local publiv goods: a political economy approach." *Journal of Public Economics* 87:2611–2637.

Brambor, Thomas, William Roberts Clark and Matt Golder. 2006. "Understanding Interaction Models: Improving Empirical Analysis." *Political Analysis* 14:63–82.

Bueno de Mesquita, Bruce, Alastair Smith, Randolph M. Siverson and James D. Morrow. 2003. *The Logic of Political Survival.* Cambridge, Massachusetts: The MIT Press.

Buhaug, Halvard and Jan Ketil Rød. 2006. "Local Determinants of African civil wars, 1970-2001." *Political Geograpy* 25(3):315–335.

Buhaug, Halvard, Lars-Erik Cederman and Jan Ketil Rød. 2008. "Disaggregating Ethno-Nationalist Civil Wars: A Dyadic Test of Exclusion Theory." *International Organization* (63):531–51.

Buhaug, Halvard and Päivi Lujala. 2005. "Accounting for scale: Measuring geography in quantitative studies of civil war." *Political Geograpy* 24(4):399–418.

Cannon, Terry. 1994. *Disasters, Development and Environment.* John Wiley & Sons Ltd chapter 2.

Cederman, Lars-Erik, Andreas Wimmer and Brian Min. 2010. "Why do Ethnic Groups Rebel? New Data and Analysis." *World Politics* 62(1):87–119.

Cederman, Lars-Erik and Luc Girardin. 2007. "Beyond fractionalization: Mapping ethnicity onto nationalist insurgencies." *American Political Science Review* 101(1):173–185.

Cederman, Lars-Erik, Luc Girardin and Kristian Skrede Gleditsch. 2009. "Ethnonationalist Triads: Assessing the Influence of Kin Groups on Civil Wars." *World Politics* 61:403–437.

Cheibub, J.A. 2007. *Presidentialism, Parliamentarism and Democracy.* Cambridge: Cambridge University Press.

Cheibub, José Antonio, Jennifer Gandhi and James Raymond Vreeland. 2009. "Democracy and dictatorship revisited." *Public Choice* .

Chen, Jowei. 2008. *Are Poor Voters Easier to Buy Off with Money? A Natural Experiment from the 2004 Florida Hurricane Season.* University of Michigan, Ann Arbor: Miemo.

Chen, Jowei. 2009. *When Do Government Benefits Influence Voters' Behavior? The Effect of FEMA Disaster Awards on US Presidential Votes.* University of Michigan, Ann Arbor: Miemo.

CIESIN. 2005. Gridded Population of the World Version 3: Population Grids. Technical report Center for International Earth Science Information Network and Centro Internacional de Agricultura Tropical and Socioeconomic Data and Application Centrer, Columbia University Palisades, NY: .
URL: *http://sedac.ciesin.columbia.edu/gpw/*

Cohen, Charles and Erik D. Werker. 2008. "The Political Economy of "Natural" Disasters." *Journal of Conflict Resolution* 52:795–819.

Crepaz, Markus M. L. 1996. "Consensus Versus Majoritarian Democracy: Political Institutions and their Impact on Macroeconomic Preformance and Industrial Disputes." *Comparative Political Studies* 29:4–26.

Crepaz, Markus M. L. 1998. "Inclusion versus Exclusion: Political Institutions and Welfare Expenditures." *Comparative Politics* 31(61-80).

de Silva, M.W. Amarasiri. 2009. "Ethnicity, politics and inequality: post- tsunami humanitarian aid delivery in Ethnicity, politics and inequality: post- tsunami humanitarian aid delivery in Ethnicity, politics and inequality: post-tsunami humanitarian aid delivering in Ampara District, Sri Lanka." *Disasters* 33(2):253–273.

Dilley, Maxx, Robert S. Chen, Uwe Deichmand, Arthur L. Lerner-Lam, Margaret Arnold, Jonathan Agwe Piet Buys, Oddvar Kjekstad, Bradfield Lyon and Gregory Yetman. 2005. Natural Disaster Hotspots. A Global Risk Analysis. Disaster Risk Managemnet Series 5 World Bank Hazard Management Unit Washington D.C.: .

Downs, Anthony. 1957. *An Economic Theory of Democracy*. New York: Harper.

EM-DAT. 2012.
URL: *www.emdat.be*

Fearon, James D and David D. Laitin. 2003. "Ethnicity, Insurgency, and Civil War." *American Political Science Review* 97(1):75–90.

Flores, Alejandro Quiroz and Alastair Smith. 2010. "Surviving Disasters." Unpublished.

Fothergill, Alice, Enriqie G.M. Maestas and JoAnne DeRouen Darlinton. 1999. "Race, Ethnicity, and Disasters in the United States: A Review of the Literature." *Disasters* 23(2):156–173.

Gabel, Mathew and Simon Hix. 2005. "Reconsidering the economic effects of constitutions." Paper.

Garrett, Thomas A. and Russel S. Sobel. 2003. "The Political Economy of FEMA Disaster Payments." *Economic Inquiry* 41:496–509.

Geddes, Barbara. 2006. "Why Parties and Elections in Authoritarian Regimes?" Revised version of a paper prepared for presentation at the annual meeting of the American Political Science Association.

Gerring, John and S.C. Moreno. 2010. "Are parliamental systems better?" *Comparative Political Studies* 42(3):327–353.

Gopalakrishnan, Channat and Norio Okada. 2007. "Designing new institutions for implementing integrated disasters risk manegement: key elements and future directions." *Disasters* 31(4):353–372.

Healy, Andrew and Neil Malhotra. 2009. "Myopic Voters and Natural Disaster Policy." *American Political Science Review* 103(3):387–406.

IPCC. 2012. Summary for Policymakers. In *Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, ed. C. B. Field, V. Barros, T.F. Stocker, D. Qin, D. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G.-K. Plattner, S. Allen, M. Tignor and P. M. Midgley. Cambridge, UK and New York, USA: Cambridge University Press.

Kahn, Mathew E. 2005. "The Death Toll From Natural Disasters: The Role of Income, Geography, and Institutions." *The Review of Economics and Statistics* 87(2):271–284.

King, Gary, Michael Tomz and Jason Wittenberg. 2000. "Makeing the Most of Statistical Analyses: Improving Interpretation and Presentation." *American Journal of Political Science* 44(2):247–261.

King, Gary, Robert O. Keohane and Sidney Verba. 1994. *Designing Social Inquiry*. Princeton: Princeton University Press.

Knutsen, Carl Henrik. 2011. "Which democracies prosper? Electoral rules, form of government and economic growth." *Electoral Studies* 30:83–90.

Lake, David A. and Matthew A. Baum. 2001. "The Invisible Hand of Democracy : Political Control and the Provision of Public Services." *Comparative Political Studies* 34:587–621.

Linz, J.J. 1990. "The perils of presidentialism." *Journal of Democracy* 1(1):51–69.

Long, J. Scott and Jeremy Freese. 2006. *Regression Models for Categorical Dependent Variables Using Stata*. 2 ed. Texas: Stata Press.

Marshall, Monty G. and Keith Jagger. 2002. *Polity IV Project*. Center for systemic peace.

Mileti, Dennis S. 1999. *Disasters by Design: A Reassesment of Natural Disasters in the United States*. Washington D.C.: Joseph Henry Press.

Min, Brian, Lars-Erik Cederman and Andreas Wimmer. 2010. "Ethnic exclusion, economic growth, and civil war." Typescript.

Mustafa, Daanish. 2003. "Reinforcing Vulnerability? Disaster Relief, Recovery, and Response to the 2001 Flood in Rawalpindi, Pakistan." *Environmental Hazards* 5:71–82.

Nordhaus, William D. 2006. "G-Econ database.".
URL: *gecon.yale.edu*

Nordhaus, William D., Qazi Azam, David Corderi, Kyle Hood, Nadejda Makarova Victor, Mukhtar Mohammed, Alexandra Miltner and Jyldyz Weiss. N.d. "The G-Econ Database on Gridded Output: Methods and Data." Typescript, Yale University.

North, Douglass C. 1991. "Institutions." *Journal of Economic Perspectives* 5(1):97–112.

Olson, Mancur. 1965. *The Logic of Collective Action*. MA: Harvard University Press.

Olson, Mancur. 1982. *The Rise and Decline of Nations. Economic Growth, Staflation and Social Rigities*. New Haven: Yeal University Press.

Olson, Mancur. 1993. "Dictatorship, democracy and development." *The American Political Science Review* 83(3):567–576.

Østby, Gudrun. 2011. Horizontal Inequalities and Political Violence PhD thesis University of Oslo.

Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson. 2007. Summary for Policymakers. Technical report Intergovernmental Panel on Climate Change.
URL: *http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf*

Peacock, W.P., B.H. Morrow and H. Gladwin. 1997. *Hurrican Andrew: Ethnicity, Gender, and the Sociology of Disasters*. New York: Routledge.

Peduzzi, Pascal, H. Dao, C. Herold and F. Mouton. 2009. "Assessing global exposure and vulnerability towards natural hazards: the Disaster Risk Index." *Natural Hazards and Earth System Science* (9):1149–1159.

Pelling, Mark. 2003. *The Vulnerabilities of Cities: natural disasters and social resilience.* London, UK: Earthscan Publications Ltd.

Persson, Torsten, Gerard Roland and Guido Tabellini. 1997. "Separation of Powers and Political Accountability." *The Quarterly Journal of Economics* p. 1163.

Persson, Torsten, Gerard Roland and Guido Tabellini. 2000. "Comparative politics and public finance." *Journal of Political Economy* 108(6):1121–1161.

Persson, Torsten, Gerard Roland and Guido Tabellini. 2007. "Electoral Rules and Government Spending in Parliamentary Democracies." *Quarterly Journal of Political Science* 20:1–34.

Persson, Torsten and Guido Tabellini. 1996. "Federal Fiscal Constitutions: Risk Sharing and Redistribution." *Journal of Political Economy* 104(5):979–1009.

Persson, Torsten and Guido Tabellini. 2003. *The Economic Effect of Constitutions.* Cambridge, Massachusetts: MIT Press.

Persson, Torsten and Guido Tabellini. 2004. "Constitutions and Economic Policy." *The Journal of Economic Perspectives* 18(1):75–98.

Plümper, Thomas and Eric Neumayer. 2009. "Famine mortality, rational political inactivity, and international food aid." *World Development* .

Popper, Karl. 1964. *The Logic of Scientific Discovery.* New York: Harper and Row.

Powell, G. Bingham. 2000. *Elections and Instruments of Democracy - Majoritarian and Proportional Visions.* New Haven: Yale University Press.

Przeworski, Adam, Michael E. Alvarez, José Antonio Cheibub and Fernando Limongi. 2000. *Democracy and Development. Political Institutions and Well-Being in the World, 1950–1990.* Cambridge: Cambridge University Press.

Przeworski, Adam, Susan Stokes and Bernard Manin. 1999. *Democracy, Accountability and Representation.* Cambridge: Cambridge University Press.

Raschky, P. A. 2008. "Institutions and the losses from natural disasters." *Natural Hazards and Earth System Science* 8:627–634.

Rød, Espen Geelmuyden. 2012. Institutions Under Authoritarianism and Coups: 1950-2008. Master's thesis University of Oslo Oslo: .

Schjølset, Anita. 2008. Institutional Variance of the Democratic Peace, 1816-2002: Electoral, Executive, and Federal Systems in Time and Space PhD thesis University of Southern California.

Sen, Amartya. 1983. *Poverty and Famines: An essay on entitlement and deprevation.* Oxford, UK: Oxford University Press.

Skog, Ole-Jørgen. 2004. *Å forklare sosial fenomener: En regresjonsbasert tilnærming.* Oslo: Gyldendal.

Skoufias, Emmanuel. 2003. "Economic Crisis and Natural Disasters: Coping Strategies and Policy Implications." *World Development* 31(7):1087–1102.

Sobel, Russel S. and Peter T. Leesen. 2006. "Governments respons to Hurricane Katrina: A public choice analysis." *Public Choice* 127:55–73.

Strömberg, David. 2003. "Optimal Campaigning in Presidential Elections: The Probability of Being Florida." *Institute for International Economic Studies* .

Strömberg, David. 2007. "Natural Disasters, Economic development and, Human Aid." *Journal of Economic Perspectives* 21(3):199–222.

Tilly, Charles. 1978. *From Mobilization to Revolution.* New York: McGraw-Hill.

Tollefsen, Andreas Forø, Håvard Strand and Halvard Buhaug. 2012*a*. "PRIO-GRID.". **URL:** *http://www.prio.no/CSCW/Datasets/PRIO-Grid/*

Tollefsen, Andreas Forø, Håvard Strand and Halvard Buhaug. 2012*b*. "PRIO-GRID: A unified spatial data structure." Peace Reseach Institute Oslo.

Toya, Hideki and Mark Skidmore. 2007. "Economic Development and the Impacts of Natural Disasters." *Economic Letters* 94(1):20–25.

Weber, Max. 1978. *Economy and Society: An Outline of Interpretative Sociology.* Berkeley, CA: University of California Press.

White, G. F. 1974. *Natural Hazards: Local, National, Gloabl.* New York: Oxford University Press.

Wig, Tore. 2011. The Correlates of Subordination: Transaction costs and the Design of Military Alliances, 1815-2003. Master's thesis University of Oslo.

Wisner, Ben and Henry R. Luce. 1993. "Disaster Vulnerability: Scale, Power and Daily Life." *GeoJournal* 30(2):127–140.

Wucherpfennig, Julius, Nils B. Weidmann, Luc Girardin, Lars-Erik Cederman and Andreas Wimmer. 2011. "Politically Relevant Ethnic Groups across Space and Time: Introducing the GeoEPR Dataset." *Conflict Management and Peace Science* (28):423.