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Local government, political decentralisation and resilience to natural hazard-associated disasters

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ABSTRACT

Natural hazards affect development and can cause significant and long-term suffering for those affected. Research has shown that sustained long-term disaster preparedness combined with appropriate response and recovery are needed to deliver effective risk reductions. However, as the newly agreed Sendai framework recognises, this knowledge has not been translated into action. This research aims to contribute to our understanding of how to deliver longer term and sustained risk reduction by evaluating the role of political decentralisation in disaster outcomes. Specifically, we investigate whether countries which devolve power to the local level experience reduced numbers of people affected by storms and earthquakes, and have lower economic damage. Using regression analysis and cross-country data from 1950 to 2006, we find that, in relation to both storms and earthquakes, greater transfers of political power to subnational tiers of government reduce hazard impacts on the population. The downside is that more politically decentralised countries, which are usually wealthier countries, can increase the direct economic losses associated with a natural hazard impact after the storm or earthquake than those which are more centralised. However, overall, it seems advantageous to give subnational governments more authority and autonomy in storm and earthquake risk planning.

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1. Introduction

Disasters, which are the result of natural hazards, can act as a confounding factor in development.[1] Estimates suggest that from 1992 to 2012, disasters killed 1.3 million people, and caused US$2 trillion of damage – far exceeding the amount provided in development assistance over the same period (Foresight, 2012). In a 20-year study from 1995 to 2015, the Centre for Research on the Epidemiology of Disasters (CRED) and the United Nations Office for Disaster Risk Reduction estimated that, on average, 30,000 deaths were attributed to weather-related disasters (UNISDR, 2015). The fact that natural hazard-associated disasters delay development and cause significant harm is undisputed, and theories of how to reduce this level of harm are well developed (Wisner, Blaikie,

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Cannon, & Davis, 2004). There is widespread agreement internationally that action is needed, seen most recently through the adoption of the Sendai Framework on Disaster Risk Reduction (UNISDR, 2015). This framework espouses improved understanding of disaster risk; strengthening disaster risk governance to manage disaster risk; public and private investments in disaster risk reduction for widespread societal resilience and to deliver better recovery, rehabilitation and reconstruction through enhancing disaster preparedness. These principles build on previous international efforts to reduce the damage from natural hazards, notably, the 'Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters' and the 'International Decade for Natural Disaster Reduction Programme Forum 1999'. Although reports indicate some success in declining disaster fatalities, this contrasts with slow progress in reducing damage and loss. This slow progress stresses the importance of the role of governance, especially at local scales, in reducing disaster risks.

This paper aims to investigate whether political decentralisation, especially more locally representative democracy, can minimise disaster losses, after controlling for factors recognised as key determinants of human and economic disaster outcomes. Political decentralisation here refers to the distribution of power in public decision-making from the central government to citizens or their elected representatives. It is usually present where there is representative government and pluralism in politics. There is an argument that decentralisation can improve the provision of local public goods and services, as there is more local accountability and representation (Bardhan, 2002; Faguet, 2014; Marks & Lebel, 2016; Oates, 1972; Tiebout, 1956). Our central hypothesis in this paper is that more politically decentralised countries fare better, when affected by natural hazards, in terms of damage to the population and the economy. If this hypothesis proves correct, we will be able to provide concrete guidance on governance improvements that can reduce disaster losses and deliver on the Sendai framework.

Our analysis focuses specifically on disasters triggered by storms and earthquakes due to differences in their predictability (i.e. earthquakes are less predictable than storms) and hence the ability of governance bodies to prepare for them. In the 40 years from 1972 to 2012, earthquakes, storms and droughts were the three largest causes of disaster mortality (Foresight, 2012), despite some advances in development and participatory application of early warning systems (Basher, 2006; Twigg, 2003).

Significant and widespread advances can be seen in the science of short term and seasonal forecasting of storms (DeMaria, Sampson, Knaff, & Musgrave, 2014; Kahn, 2005). Earthquakes remain less predictable than storms, although in some countries there is more effective integration of earthquake risk into planning than for storms (Sorensen, 2000). We argue that there is a lack of political decentralisation and, more specifically, a lack of local representation in decision-making about information needs for disaster preparedness. Hence, weather forecasts and early warning systems are not necessarily developed with the users' needs in mind. Delegating power may help to reduce disaster risks. In other words, giving citizens or their elected representatives more power in public decision-making may improve community resilience to disasters. This is associated with pluralistic politics, representative government and democracy.

Political decentralisation, which is a top-down process, can occur in multiple economic and political contexts. Hence, we also explore the role of national wealth, political orientation and local representation in the relationship between political decentralisation

and damage associated with natural hazards. More specifically, we identify whether there are differences in this relationship: (a) between middle-income and high-income countries, (b) between countries with left, centre and right-wing politics and (c) between countries with different types of local representation. Thus, national wealth, political orientation and local representation are examined as mediating variables. Previous research has shown that meditating factors play a key role in the effect of decentralisation on the reduction of damage associated with natural hazards. Yamamura (2012), for instance, shows that decentralisation makes a greater contribution to mitigating damage in countries with higher quality institutions.

Various studies have been undertaken which allude to the importance of governance mechanisms in disaster outcomes (e.g. Brooks, Adger, & Kelly, 2005), but no macro-level study has been undertaken on the relationship between political decentralisation and natural hazard-associated disaster outcomes while analysing the mediating role of national wealth, political orientation and local representation. Cross-national studies in this area either have dwelt on fiscal decentralisation (Ahmed & Iqbal, 2009; Escaleras & Register, 2012; Skidmore & Toya, 2013; Yamamura, 2012) or are case studies (Ainuddin, Aldrich, Routray, Ainuddin, & Achkazai, 2013; Blackburn, 2014; Marks & Lebel, 2016). Using cross-country data over the 1950–2006 period, our study reveals that political decentralisation is correlated with disaster outcomes, and hence indicates the importance of focusing new disaster mitigation initiatives and future disaster risk reduction research on this area.

2. Literature review

2.1. Disaster risk reduction as an evolving field

A rich body of literature on natural hazards and disasters, dating back over 60 years, highlights the complexity of interactions between politics, economics, society, hazards and the resulting human and economic disaster outcomes. Vulnerability theory, for example, recognises both the role of exposure to hazards and the impact of social and economic deprivation on disaster outcomes (Adger, 2006). Hazard theory catalogues the root causes of vulnerability that create worsening disaster outcomes, pointing to power structures, political ideologies and economic systems that contribute to people living in unsafe conditions (Wisner et al., 2004). Sadly, the catalogue of recent major disasters (e.g. Hurricane Katrina in New Orleans in 2005; Cyclone Sidr in Bangladesh in 2007; the Haiti earthquake in 2010; Typhoon Haiyan in the Philippines in 2013; the Amatrice earthquake in Italy in 2016 to name a few) indicates that despite improved theoretical explanation of why disasters happen, appropriate mitigating actions are not being taken, so tragic disasters still happen.

Globally, it is now recognised that disaster losses are most effectively lowered by reducing disaster risks. In this context, government plays a vital role in both the preparation for and response to disaster events. Recent research has started to unravel the components of community resilience to hazards and disasters to clarify the role of the governance context. For example, Norris, Stevens, Pfefferbaum, Wyche, and Pfefferbaum (2008) recognise the importance of the equitable distribution of post-disaster resources. Twigg (2007) identifies the importance of integrated multi-scale decision-making, accountability and

community participation. Djalante, Holley, and Thomalla (2011) recognise the importance of polycentric and multi-layered institutions, and following Tompkins, Lemos, and Boyd (2008), the central role of participation and collaboration, self-organisation and effective local networks in post-disaster recovery. Ainuddin et al. (2013) identify the usefulness of efficient preparedness and coordination of provisional and national level agencies to enhance community awareness and preparedness. According to Wisner et al. (2004) and Marks and Lebel (2016), greater local participation in decisions is expected to lead to more appropriate and sustainable disaster risk reduction interventions. All of these areas are linked to the extent to which the political system is decentralised, as this determines whether resources can flow to those who need them quickly.

2.2. Local government and political decentralisation

Although the vulnerability and hazard literature explains the causes of natural hazards, this paper takes a step forward by examining whether political decentralisation, whereby power and resources flow to the local level, can reduce the human and economic damage associated with natural hazards. Both natural hazards and political decentralisation have a local or regional dimension. Natural hazards strike a local or regional part of a country (Escaleras & Register, 2012), they rarely affect entire nations. Political decentralisation refers to the degree to which central government allows local or regional government entities to undertake the political functions of governance (Pike, Rodriguez-Pose, Tomaney, Torrisi, & Tselios, 2012), and hence to prepare for region-specific risks and respond effectively to regional crises. Moreover, international organisations, such as the World Bank, recognise the importance of decentralisation, by including it as a requirement in their development assistance programmes (Escaleras & Register, 2012). However, local government and political decentralisation have both pros and cons for humans and the economy.

On the one hand, delivered effectively decentralisation can bring government closer to the people by improving the provision of local public goods and services (Bardhan, 2002; Faguet, 2014; Marks & Lebel, 2016; Oates, 1972; Tiebout, 1956). Greater transfers of political powers to local and regional bodies can promote a better matching of public policies to local needs. Subnational governments may have an information advantage over central governments when it comes to responding to the heterogeneous needs of local citizens and especially when these needs arise from disasters. Although central government may be better placed to respond due to greater access to resources, locally elected governments are better placed geographically and politically to respond to local needs, due to their proximity to those affected (Adger, Hughes, Folke, Carpenter, & Rockstrom, 2005; Chhotray & Few, 2012; Norris et al., 2008; Rodríguez-Pose & Ezcurra, 2011). Relatively, more decentralised countries may fare better when disasters occur in terms of their effects on the population and on the economy, because local and regional officials are better able to set the optimal mix of local and regional policies prior to the disaster event than bureaucrats in distant central governments (de Mello, 2011; Lessmann, 2009; Tselios, Rodríguez-Pose, Pike, Tomaney, & Torrisi, 2012). It has been argued that decentralisation increases social capital, which has been shown to improve community resilience to natural hazard-associated disasters (e.g. see Brouwer & Nhassengo, 2006; Murphy, 2007; Paton, Millar, & Johnston, 2001; Tompkins, Hurlston, & Poortinga, 2009). When delivered

effectively, decentralisation promotes greater voice and participation and limits the opportunities for corruption (Brenner, 2004; Le Galès, 2002; Weingast, 2009). It empowers underrepresented groups in society, including marginalised groups (e.g. the less well-off, the socially excluded and immigrants) by giving them a local voice. Such empowerment may lead to the adoption of local disaster risk reduction policies involving a wider range of actors and which are thus more sensitive to the local needs to prepare for and manage a natural hazard. Overall, subnational governments are perceived to have a comparative advantage over national governments in the management of land use, economic development, safety and other local-based policies that affect disaster risk (Skidmore & Toya, 2013, p. 45).

On the other hand, political decentralisation can create negative effects for humans and the economy. First of all, there is a role for national governments in setting certain disaster management policies (Skidmore & Toya, 2013). Decentralisation may reduce the capacity of central government to transfer post-disaster resources to those most badly affected, from the less-damaged to the more-damaged localities. In general, the differences in socioeconomic endowment and institutional capacities among regions within any given country may undermine the potential benefits associated with the better matching of policies to local needs (Kamel, 2012; Rodríguez-Pose & Ezcurra, 2010). For example, in regions with extreme poverty and loss of economies of scale, decentralisation may not mean a better matching of the provision of local public goods and services, because these regions face capacity constraints (Pelling, 2011; Prud'homme, 1995; Rodríguez-Pose & Ezcurra, 2011). In some contexts, local government is not capable of interacting effectively with the international disaster relief agencies (Holloway, 2003). Further, subnational governments may attract fewer skilled and capable officials and decision-makers (Prud'homme, 1995), implying that subnational governments can end-up being less efficient at delivering disaster risk reduction. Moreover, some countries often devolve responsibilities but not skills or human and financial resources (Marks & Lebel, 2016). Finally, with higher degrees of decentralisation, there are costs associated with establishing multiple layers of government (Escaleras & Register, 2012). This can create some redundancy in government, which can deliver more flexible responses in times of stress. Poor countries may not be able to afford this cost of providing institutional redundancy. Where there are multiple tiers of government, accountability can be weak as citizens may be less able to identify responsible individuals to attribute blame for failures and credit for successes (Fisman & Gatti, 2002). Local traps can also arise because a narrow focus on local perceptions, knowledge and interests may become a barrier to recognising solutions from other locations or that are available at other levels (Brown & Purcell, 2005). All these factors may offset the assumed benefits of political decentralisation. Overall, there is an optimal mix of responsibility between national and subnational governments in disaster management risk which requires coordination and the sharing of costs between national and subnational governments (Marks & Lebel, 2016; Skidmore & Toya, 2013).

2.3. The role of economic development, political institutions and local representation

Up to this point, we have focused on the question of whether political decentralisation can improve disaster outcomes. However, the distribution of the benefits and costs of

decentralisation is dependent on national economic and political factors. In this subsection, we examine whether economic development, political institutions and local representation affect the possible association between disaster outcomes and political decentralisation.

First, we expect that the relationship between disaster outcomes and political decentralisation varies with levels of *economic development*. Specifically, the negative effects of decentralisation may most affect the poorer regions of the less-developed countries, due to their lack of resources and capacity to address natural hazards. Poorer regions face greater budget constraints than richer ones, while the latter rely on their own revenues, meaning that they are often in a better shape to address problems (Tselios et al., 2012). The positive effects of decentralisation are less likely to occur in less-developed countries, due to the absence of strong local accountability and higher levels of corruption, nepotism and clientelism. Examples of good practice do exist, for example, in Ceará, Brazil, where locally active leaders managed to push for greater accountability in drought management (Lemos, 2007). Cheshire and Gordon (1998) argue that the transfer of powers and resources to subnational tiers of government benefits the most prosperous regions, such as those with better socioeconomic endowments. Richer regions can generally extract greater resources, not only through the taxation of their own citizens but also through a greater political leverage to negotiate with the central government (Rodríguez-Pose & Ezcurra, 2011; Rodriguez-Pose & Gill, 2004). This argument is often reinforced through the literature on social capital and disaster recovery, which highlights the fact that those communities which are better linked to policy-makers, at any level of government, tend to experience more rapid rates of post-disaster recovery (Aldrich, 2012). Hence, the degree to which economic agents benefit from and are able to comply with and employ their own established safety standards depends on the level of economic development (Skidmore & Toya, 2013, p. 45). Despite our assumptions that richer nations will recover more quickly (for example, due to effective building regulations, careful development planning, provision of higher quality infrastructure and resource availability to provide high-quality emergency care (Kahn, 2005)), rich nations are not always the site of best practice. Cuba, a poor country with a centrally planned economy in the Caribbean, is often cited as an exemplar of disaster risk reduction (Sims & Vogelmann, 2002; Thompson & Gaviria, 2004). The United States of America, in contrast, delivered very poor quality disaster risk reduction in response to Hurricane Katrina in New Orleans in 2005 (Colten, Kates, & Laska, 2008; Laska & Morrow, 2006). While the political context of Hurricane Katrina was highly significant, this example serves to show that national wealth is not a straightforward indicator of successful disaster risk reduction.

Second, we expect that the relationship between disaster outcomes and political decentralisation varies with *political orientation*. Notably, the effects of decentralisation and thus the opportunities for citizens to take interest in public affairs may differ in countries with more dominant left-wing or right-wing politics, because of differences in political strategies towards local authorities and central government. Left-wing politics support socioeconomic equality and egalitarianism, often in opposition to the socioeconomic hierarchy and inequality, advocate strong government intervention in the economy and prefer local control of the economy, while right-wing politics support the socioeconomic order, stratification, hierarchy and inequality, advocate little government

intervention in the economy and prefer a decentralised economy based on economic freedom.

Third, we anticipate that the effects of decentralisation will differ according to the extent of *local representation*. There are countries where both the legislature and executive are locally elected, countries where the executive is appointed but the legislature is locally elected, and countries where neither the executive nor the legislature are locally elected, when it comes to the municipal governments or the state/province governments. We argue that countries with different types of local representation are likely to perform differently in disaster recovery, due to differences in approaches to post-disaster macroeconomic stabilisation (Oates, 1999; Tselios et al., 2012) and in regional redistribution of post-disaster resources. The role of local representation is a key factor because an appropriate political setting for downward accountability requires a suitable environment for local elected leaders to act independently and responsively (Yilmaz, Beris, & Serrano-Berthet, 2008). The local leadership will be influenced by at least three sets of factors: the institutional arrangements for the separation of powers among the executive, legislative and judicial bodies; the election laws and the electoral system and the existence and functioning of a party system and political party laws (Yilmaz et al., 2008). Overall, local representation is likely to mediate the relationship between political decentralisation and disaster outcomes.

3. Data, variables and empirical functions

3.1. Data sources

We now explore the relationship between political decentralisation and disaster occurrence associated with natural hazards, after controlling for some economic and natural characteristics. The control variables are used not only to capture some structural characteristics of the countries and to deal with some important sources of heterogeneity but also as statistical controls in order to make the estimated parameters of the main explanatory variable (i.e. political decentralisation) more precise.

Data on the *disaster outcomes* were obtained from the Emergency Events Database (EM-DAT).[2] This database contains essential core data on the occurrence and effects of over 18,000 mass disasters in the world from 1900 to the present. Thus, this is a panel database. In order for a disaster to be entered into the database, at least 1 of the following 4 criteria (known as CRED criteria) has to be fulfilled: 10 or more people reported killed, 100 or more people reported affected, a call for international assistance and a declaration of a state of emergency. The EM-DAT database is an unbalanced panel database, because (a) if a country–year has experienced a disaster, it must satisfy one or more of the above four criteria and must have data available on all the following variables: number of people killed, injured, homeless and affected and estimated economic damage (Escaleras & Register, 2012), (b) a country–year has experienced a disaster but it has not been observed (especially before 1988) and (c) a country–year has not experienced a disaster.[3] Thus, some countries might experience multiple disasters associated with natural hazards in the same year, while others experience none.

Political decentralisation is proxied by regional authority indices defined by Hooghe, Marks, and Schakel (2008b). These indices cover 42 middle-income and high-income countries (but not low-income countries), and cover 8 dimensions of regional authority, for the years 1950 to 2006. Countries are coded on an annual basis for years in which a country is independent and (semi-)democratic (Hooghe, Marks, & Schakel, 2008a, p. 259). Hooghe et al. (2008b) consider two domains of regional authority: 'Self-rule' and 'Shared-rule'.[4] The aggregate 'Self-rule' and 'Shared-rule' score constitutes the overall regional authority: the Regional Authority Index, or *'RAI-total'* score. We recognise that the level of political decentralisation varies between countries. For instance, in 2006, Bosnia and Herzegovina (score = 30.5), Germany (score = 29.3), Belgium (score = 29), United States (score = 23), Canada (score = 22.7) and Italy (score = 22.7) have the highest 'RAI-total' score. All these political decentralisation indices have several advantages over rival ones, such as the Schneider (2003) index, as they measure political decentralisation along a multitude of dimensions and allow for some change over time (Tselios et al., 2012). For example, the 'RAI-total' score for Belgium is 14 from 1950 to 1969, 22.9 from 1970 to 1979, 25.8 from 1980 to 1988, 32.1 from 1989 to 1994 and 29 from 1995 to 2006. Regional Authority Indices have been used in many recent studies (Rodríguez-Pose & Ezcurra, 2010, 2011; Tselios et al., 2012); however, as with the EM-DAT database, this is an unbalanced database, because it does not provide regional authority scores for all of the years 1950–2006.[5]

Data on *controls* were obtained from the Penn World Table (PWT)[6] and the EM-DAT database. The PWT provides economic data for 189 countries for some or all of the years 1950–2010. This database is produced by researchers at the University of Pennsylvania and is based on the so-called benchmark comparisons of the International Comparison Programme. It allows for real quantity comparisons both between countries and over time and it has been used in many comparative studies. However, the PWT database is also an unbalanced database.[7]

We combined EM-DAT, Hooghe et al. (2008b) and PWT, to generate a database of 41 countries from 1950 and 2006 (i.e. Albania, Australia, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States). This resulting database contains only high- and upper middle-income countries and is amenable to estimation methods that manage potential heterogeneity bias (Rodríguez-Pose & Tselios, 2009). The missing year–country observations of political decentralisation for those countries which have experienced a storm or earthquake according to the CRED specific criteria is low and thus unlikely to affect the association between disaster outcomes and political decentralisation (see Appendix).

3.2. Variables and descriptive statistics

For the purposes of this project, we consider two types of disaster associated with natural hazards: storms[8] and earthquakes (seismic activities). In this study, we also use three indices (variables) to measure the impacts of these two natural hazards.

(A) The number of total people affected. This includes three categories:
- number of people injured (i.e. people suffering from physical injuries, trauma or an illness requiring medical treatment as a direct results of a disaster);
- number of people made homeless (i.e. people needing immediate shelter); and
- number of people affected (i.e. people requiring immediate assistance during a period of emergency; this can also include displaced or evacuated people).

(B) The number of people killed, i.e. persons confirmed as dead and persons missing and presumed dead.

(C) The disaster-related economic damage (in 000' US$).

Several methodologies exist to quantify disaster losses, but there is no standard procedure to determine a global figure for economic impact. Economic damage is defined as the direct losses associated with a natural hazard impact after the event, but the indirect damage and longer term macroeconomic effects are not considered (Pielke, Rubiera, Landsea, Fernandez, & Klein, 2003). The first two indices (i.e. the number of total people affected and the number of people killed) provide information on the *human* impact of disasters, while the last index provides information on the *economic* impact of disasters.

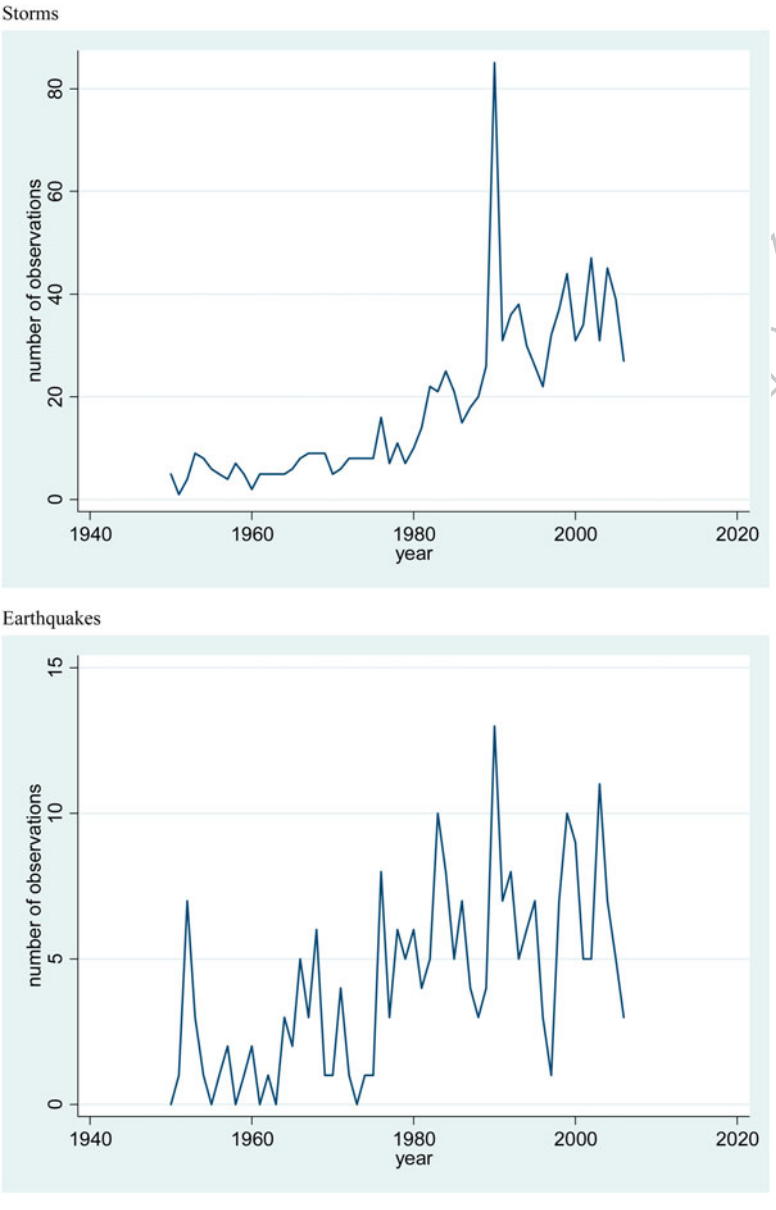
Figure 1 shows the number of observations for the 41 countries over 1950–2006 which have experienced a storm or earthquake according to the CRED specific criteria. This figure clearly shows that the number of observations has risen. This increase has been discussed and is attributed to societal change and economic development (Bouwer, Crompton, Faust, Höppe, & Pielke , 2007; Escaleras & Register, 2012), as well as improvements in data collection and reporting in the EM-DAT database (Guha-Sapir, Hargitt, & Hoyois, 2004).

Figure 2 shows the number of people killed as a result of storms or earthquakes for 41 countries over 1950–2006.[9] We observe that there are two spikes in the number of people killed as a result of storms between 1950 and 1960 and two spikes in the number of people killed as a result of earthquakes between 1988 and 2000. The spikes for storms may reflect the improvements in the prediction of storms (through technology, such as computer modelling in storms) and in health care, while the spikes for earthquakes may depict the improvements in the EM-DAT database.

Noting the wide variation in the observations on all disaster outcome variables (i.e. the number of total people affected, the number of people killed and the economic damage), we take the log form (ln) of these variables.[10] Since some disasters in the sample resulted in no deaths, we add one death to each observation (Escaleras & Register, 2012; Kahn, 2005).[11]

For the political decentralisation variables, we use all three Regional Authority Indices developed by Hooghe et al. (2008b): Self-rule, Shared-rule and RAI-total. We also transform these variables taking the natural logarithm, to make them more normally distributed. The logarithm transformation also helps the interpretation of the results, as the natural disaster outcome variables are also in natural logarithmic form.

For the controls, we use three variables obtained from the PWT: (a) government consumption share of GDP per capita (%), (b) openness (%) and (c) annual growth rate in GDP per capita ($\ln(GDPpc_t/GDPpc_{t-1})$). We do not include other controls, such as the population, economic development (GDP per capita),[12] consumption share of GDP per capita and investment share of GDP per capita, due to their high correlation (above 0.5) with the three control variables or the political decentralisation variables. Finally, we

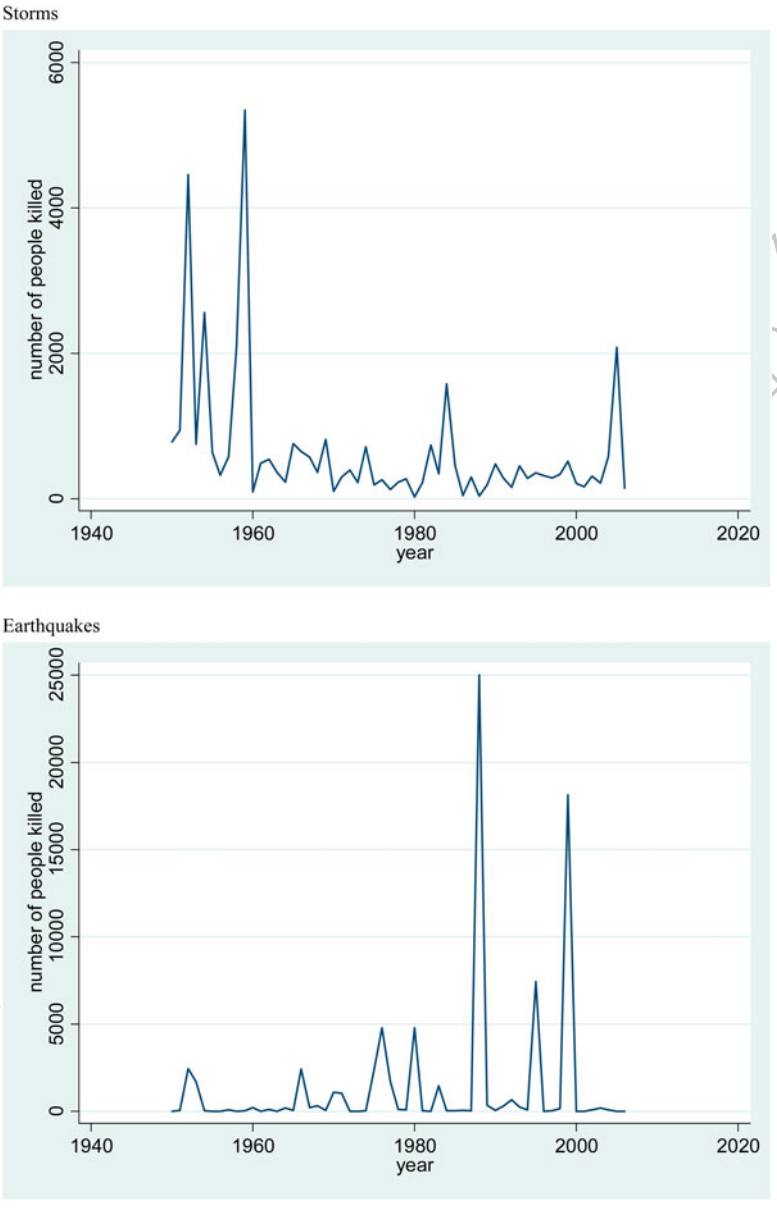


Colour online, B/W in print

Figure 1. Number of observations by year.

include the number of disasters in log form (ln) (due to the wide variation in the observations) as a control variable (source: EM-DAT).[13] We believe that these control variables capture some features of the nations and take into account some important sources of heterogeneity.

The mean, standard deviation and minimum and maximum value for the above variables are reported in Table 1. It should be noted that the descriptive statistics refer to those observations where there are data for all variables (i.e. 392 observations for storms and 144 observations for earthquakes).



Colour online, B/W in print

Figure 2. Number of people killed by year.

3.3. Empirical functions

We use the following empirical function to examine the association between disaster outcomes and political decentralisation

$$\text{Dis}_{it} = f(\text{PolDec}_{it},\ \text{Control}_{it},\ u_t) \tag{1}$$

where Dis_{it} is the disaster outcomes from storms or earthquakes for country i ($i = 1, 2, 3, \ldots, 41$) at time (year) t ($t = 1951, 1952, \ldots, 2006$), PolDec_{it} is a proxy for the degree of political

Table 1. Descriptive statistics, 1951–2006.

Storms (392 observations)	Mean	Std. Dev.	Min	Max
Number of people affected (ln)	3.3309	4.3889	0	15.4408
Number of people killed (ln)	2.2903	2.0053	0	8.5688
Economic damage (ln)	7.1825	6.1143	0	18.8796
Political decentralisation (ln) (RAI-total)	2.5881	0.7350	0	3.4995
Political decentralisation (ln) (self-rule)	2.4275	0.6434	0	3.1987
Political decentralisation (ln) (shared-rule)	0.9957	0.9448	0	2.5649
Government consumption	7.8707	2.3090	3.1681	19.2755
Openness	46.1956	34.4722	5.0043	212.8417
Annual growth rate	0.0258	0.0304	−0.1321	0.1238
Number of disasters (ln)	0.5549	0.7498	0	3.2958
Earthquakes (144 observations)	**Mean**	**Std. Dev.**	**Min**	**Max**
Number of people affected (ln)	7.1196	3.7138	0	14.2801
Number of people killed (ln)	2.3399	2.4074	0	9.7972
Economic damage (ln)	6.8706	6.0728	0	18.4207
Political decentralisation (ln) (RAI-total)	2.1549	0.8989	0	3.4995
Political decentralisation (ln) (self-rule)	2.0636	0.8125	0	3.0910
Political decentralisation (ln) (shared-rule)	0.5824	0.8562	0	2.5649
Government consumption	7.2802	2.5979	2.6949	15.9205
Openness	30.4823	23.1837	5.0687	130.9326
Annual growth rate	0.0301	0.0401	−0.1608	0.1900
Number of disasters (ln)	0.2620	0.4067	0	1.7918

decentralisation for country i at time t, Control_{it} is a vector of controls for country i at time t and u_t represents time-dummies. We include time-dummies to control for all time-specific space-invariant variables (Baltagi, 2005). In this study, these variables may include climate change and improvements in technology. Time-dummies also control for possible improvements in the EM-DAT database after 1988.

As part of our analysis, we also examine whether the association between disaster outcomes and political decentralisation differs by national wealth, political institutions and local representation. In other words, we examine whether GDP per capita, party orientation with respect to economic policy, electoral level of the municipal governments and electoral level of the state/provincial governments influence the relationship between disaster outcomes and political decentralisation. We apply an interaction analysis, because comparing subgroup-based correlation coefficients has lower explanatory capacity as the division into subgroups reduces the sample size (Tselios et al., 2012).

We use the following empirical function to examine the role of *economic development* in the association between disaster outcomes and political decentralisation.

$$\text{Dis}_{it} = f(\text{PolDec}_{it} x D_{\lambda it},\ \text{Control}_{it},\ u_t) \tag{2}$$

where $D_{\lambda it}$ is a vector of dummy variables[14] for economic development with $\lambda = 1, 2$, where $\lambda = 1$ is the dummy variable for the medium-income countries and $\lambda = 2$ is the dummy variable for the high-income countries. We classify the countries into medium-income and high-income using the World Bank's definition of development (Escaleras & Register, 2012).

We use the following empirical function to examine the role of *political institutions* and *local representation* in the association between disaster outcomes and political decentralisation.

$$\text{Dis}_{it} = f(\text{PolDec}_{it} x D_{\mu it},\ \text{Control}_{it},\ u_t) \tag{3}$$

where $D_{\mu it}$ is a vector of dummy variables for political institutions or local representation. Data were obtained from the Keefer (2012) database. This database is available from 1975 to the present. More specifically,

- if μ denotes the party orientation with respect to economic policy, $\mu = 1, 2, 3$, where $\mu = 1$ is the dummy variable for the left-party countries (i.e. for parties that are defined as communist, socialist, social democratic or left-wing), $\mu = 2$ is the dummy variable for the centre-party countries (i.e. for parties that are defined as centrist or when party position can best be described as centrist such as the party advocating strengthening private enterprise in a social-liberal context) and $\mu = 3$ is the dummy variable for the right-party countries (i.e. for parties that are defined as conservative, Christian Democratic or right-wing); and
- if μ denotes the electoral level of either the municipal governments or the state/province governments, $\mu = 1, 2, 3$, where $\mu = 1$ is the dummy variable for the countries where both the local legislature and the local executive are locally elected, $\mu = 2$ is the dummy variable for the countries where the executive is appointed, but the legislature is locally elected, and $\mu = 3$ is the dummy variable for the countries where neither local executive nor legislature are locally elected.

4. Results and discussion

4.1. Political decentralisation and storm disaster outcomes

Table 2 displays the regression results for empirical function (1) above, using the number of people affected (ln) (Regression 1), the number of people killed (ln) (Regression 2), and the economic damage (ln) (Regression 3) as dependent variables. Political decentralisation (ln) constitutes the overall regional authority score ('RAI-total' score). Regression 1 and 2 show that there is a negative and statistically significant association between political decentralisation and human outcomes caused by storms. The coefficient on the number of people affected (−1.1705) is higher than that on the number of people killed (−0.1847), i.e. decentralised countries experience lower numbers of people affected, and to some degree numbers killed as a result of storms. Thus, there seems to be a

Table 2. Political decentralisation and storms' disaster outcomes.

	Number of people affected (ln) (1)	Number of people killed (ln) (2)	Economic damage (ln) (3)
Political decentralisation (ln)	−1.1705***	−0.1847*	0.9842**
Government consumption	−0.1746**	0.0120	−0.1293
Openness	−0.0423***	−0.0180***	−0.0008
Annual growth rate	2.4677	2.5543	−31.0671***
Number of disasters (ln)	2.6504***	1.2477***	3.9439***
Time-dummies	Yes	Yes	Yes
Constant	4.5497	6.9612***	2.3343
Observations	392	392	392
R-squared	0.4689	0.6471	0.4617

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.
Note: Standard errors are not reported.

need to further decentralise disaster risk reduction, as local government can be more responsive to the needs of local residents (Marks & Lebel, 2016). Regression 3 shows that there is a positive and statistically significant association between political decentralisation and economic outcomes, that is, more decentralised countries experience higher economic losses with storms. This finding is on the surface counter-intuitive, that is, one would assume that economic losses and human impact go hand in hand. There are two possible causes of this anomaly. One comes from the work of Pielke et al. (2003), who point out that economic losses from storms in the USA are related to rising wealth and population density in storm affected areas. Their work hints that even in decentralised countries with some effective preparedness, the economic impact of storms is rising due to increasing wealth in affected areas. The second argument is that historically disaster risk reduction has focussed on protecting lives, rather than making livelihoods and homes resilient to shocks (UNISDR, 2005, 2009). Both point to the need for a focus on the resilience of livelihoods and economies in the face of storm shocks.

For the control variables, the results are discussed only briefly. First, we find that the relationship between government consumption share and the number of people affected is negative and statistically significant (Regression 1), that is, where government spending in the economy is relatively large, fewer people are affected by storms. This is perhaps due to relatively more spending on storm protection, early warning or disaster recovery. The coefficient on government consumption for Regression 2 and 3 is statistically insignificant. Second, the coefficient on openness is negative and statistically significant for both human outcomes (Regression 1 and 2), that is, the more economically open, the fewer people killed or affected by storms, but it is not statistically significant for economic outcomes (Regression 3). This was a difficult finding to explain, and may simply be an artefact of the data, that is, the European countries which are not affected by major cyclones are part of a shared economic area, whereas the USA and Australia, which are affected by major cyclones, are less open due to their size and physical location. However, this is an interesting finding that requires more investigation. Third, there is a negative association between the annual GDP growth rate and the economic damage (Regression 3), that is, countries with faster growing GDP per capita tend to experience lower levels of economic loss from storms. However, the coefficient on growth for Regression 1 and 2 is statistically insignificant. Fourth, there is a positive (and unsurprising) association between the number of disasters and the human and economic outcomes (Regression 1, 2 and 3).

We now explore whether *national wealth*, *political orientation* and *local representation* intervene in the relationship between political decentralisation and storm disaster outcomes according to empirical functions (2) and (3). Table 3 displays the coefficients on political decentralisation by levels of national wealth, by political orientation and by local representation. We find evidence supporting our main finding (as we saw in Table 2) that relatively more politically decentralised countries fare better when storms strike in terms of the effect on the population (i.e. number of people affected and number of people killed), but with higher economic losses than less politically decentralised countries, though the effect appears much more robust (a) in high-income countries (Regression 1, 2 and 3); and, (b) in countries where the executive of municipal governments is appointed, but the legislature is locally elected (Regression 7, 8 and 9). Table 3 shows that there are no differences in the impact of political decentralisation when

Table 3. Political decentralisation and storms' disaster outcomes by economic development, political institution and local representation.

	Number of people affected (ln)	Number of people killed (ln)	Economic damage (ln)
	(1)	(2)	(3)
Political decentralisation (ln)			
• Medium-income countries *(62)*	−1.1333***	−0.0833	−0.7748
• High-income countries *(330)*	−1.1674***	−0.1761*	0.8360**
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	4.5026	6.8328***	4.5608
Observations	392	392	392
R-squared	0.4689	0.6481	0.4922
	(4)	(5)	(6)
Political decentralisation (ln)			
• Left-party countries *(122)*	−0.9871***	−0.1541	0.9399**
• Center-party countries *(14)*	−1.2970**	−0.1166	1.1366
• Right-party countries *(145)*	−0.8290**	−0.1795	0.9246**
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	8.4944***	3.3652***	9.2107***
Observations	281	281	281
R-squared	0.5154	0.5226	0.4592
	(7)	(8)	(9)
Political decentralisation (ln)			
• Municipal governments: legislature and executive are locally elected *(219)*	−0.9370**	−0.0273	1.1213**
• Municipal governments: legislature is locally elected *(41)*	−0.8813**	−0.5391***	1.4128**
• Municipal governments: no local elections *(0)*	No data	No data	No data
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	4.9053*	1.8793**	8.6225**
Observations	260	260	260
R-squared	0.5315	0.6242	0.4872
	(10)	(11)	(12)
Political decentralisation (ln)			
• State/province governments: legislature and executive are locally elected *(214)*	−1.1411***	−0.1780	1.1997***
• State/province governments: legislature is locally elected *(67)*	−1.3200***	−0.1630	0.2901
• State/province governments: no local elections *(17)*	−1.8772***	0.2442	−0.6188
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	6.9011***	3.2212***	8.1585***
Observations	298	298	298
R-squared	0.4989	0.5379	0.4890

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.
Note: Parentheses in italics show the number of observations for each classification; standard errors are not reported.

there is right-wing or left-wing dominant politics (Regressions 4, 5 and 6). Finally, countries where neither the legislature nor the executive of state/province governments are locally elected manage better storm outcomes on the population (i.e. number of people affected) (Regression 10), while the impact of decentralisation on economic damage is statistically significant only for countries where both the legislature and executive are locally elected (Regression 12).

4.2. Political decentralisation and earthquake disaster outcomes

Table 4 presents the relationship between political decentralisation and earthquake disaster outcomes following empirical function (1). We find decentralisation to be negatively and statistically significant associated with the number of people affected (Regression 1), that is, more decentralised countries have fewer people affected in earthquakes. However, decentralisation is positively and statistically significant associated with the economic damage (Regression 3), that is, more decentralised countries have more economic damage. This mirrors the findings under storms. While the population outcomes from earthquakes refer only to the number of people affected, the population outcomes from storms refer to both the number of people affected and the number of people killed. The conclusion from this is that greater transfers of political power to subnational tiers of governments could be justified as a means to reduce earthquake disaster impacts on the population, but again with a high economic cost.

As for the control variables, the coefficients on the three economic variables are statistically significant for the population outcomes only (Regression 1 and 2). The coefficients on both government consumption and openness are negative, which is consistent with the findings for storms (Table 2). It is remarkable that the coefficient on annual growth rate is positive, that is, the faster the rates of economic growth the higher the economic costs of an earthquake disaster. This supports earlier work noting that 'rapid growth comes at the expense of weak or ignored building codes, poor land zoning controls, and the like' (Escaleras & Register, 2012, p. 171). Finally, as expected, we find that there is a positive association between the number of disasters and the human and economic losses from earthquakes (Regression 1, 2 and 3).

We consider whether political decentralisation influences the earthquakes' outcomes differently across countries with different levels of national wealth and with different political orientation and local representation following empirical functions (2) and (3). Table 5 shows that the negative impacts on the population appear more robust (a) in high-income countries (Regression 1), (b) in right-leaning countries (Regression 4: as the magnitude of the coefficient on political decentralisation is higher for right-party countries than for left-party countries) and (c) in countries where both the legislature and executive of municipal or state/province governments are locally elected (Regression 7, 8 and 11). The positive economic damage effects appear more robust in right-party countries (Regression 6).

Table 4. Political decentralisation and earthquakes' disaster outcomes.

	Number of people affected (ln)	Number of people killed (ln)	Economic damage (ln)
	(1)	(2)	(3)
Political decentralisation (ln)	−0.8624**	−0.1403	1.2615*
Government consumption	−0.3379**	−0.1878**	−0.0436
Openness	−0.0423**	−0.0207*	−0.0453
Annual growth rate	25.6556**	13.5087**	19.2058
Number of disasters (ln)	1.8927**	1.7279***	3.2098**
Time-dummies	Yes	Yes	Yes
Constant	2.1062	2.2694	−3.9603
Observations	144	144	144
R-squared	0.5578	0.6155	0.4128

*$p < 0.1$
**$p < 0.05$.
***$p < 0.01$.
Note: Standard errors are not reported.

Table 5. Political decentralisation and earthquakes' disaster outcomes by economic development, political institution and local representation.

	Number of people affected (ln)	Number of people killed (ln)	Economic damage (ln)
	(1)	(2)	(3)
Political decentralisation (ln)			
• Medium-income countries *(51)*	−0.2581	0.1910	−0.7306
• High-income countries *(93)*	−0.8055**	−0.1091	1.0737
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	2.2089	2.3258	−4.2990
Observations	144	144	144
R-squared	0.5698	0.6241	0.4618
	(4)	(5)	(6)
Political decentralisation (ln)			
• Left-party countries *(28)*	−0.8187*	−0.2594	0.7970
• Center-party countries *(14)*	0.4964	0.0742	1.2444
• Right-party countries *(54)*	−1.1979**	−0.3463	2.0991**
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	12.8831***	8.1904***	7.5139
Observations	96	96	96
R-squared	0.6139	0.6356	0.4867
	(7)	(8)	(9)
Political decentralisation (ln)			
• Municipal governments: legislature and executive are locally elected *(73)*	−1.0777**	−0.5919**	1.4917
• Municipal governments: legislature is locally elected *(5)*	−0.5542	−0.6630	−0.2164
• Municipal governments: no local elections *(2)*	2.5709	3.1199**	4.5276
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	13.0200***	8.5250***	7.7685
Observations	80	80	80
R-squared	0.7197	0.7285	0.5274
	(10)	(11)	(12)
Political decentralisation (ln)			
• State/province governments: legislature and executive are locally elected *(56)*	−0.4596	−0.5133*	0.9901
• State/province governments: legislature is locally elected *(21)*	0.0055	−0.0581	−0.1197
• State/province governments: no local elections *(23)*	1.1602	−0.3287	−1.1476
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	8.4622**	8.4620***	13.1836
Observations	100	100	100
R-squared	0.5690	0.6419	0.4273

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.
Note: Parentheses in italics show the number of observations for each classification; standard errors are not reported.

4.3. Sensitivity analysis

Tables 2 and 4 showed that there is a negative and statistically significant relation between a country's degree of political decentralisation, measured by 'RAI-total' score, and the number of people affected by disasters triggered by either storms or earthquakes. The same is true when we decompose political decentralisation into 'Self-rule' and 'Shared-rule' scores (Table 6: Regressions 1, 4, 7 and 10). However, the magnitude of the coefficient

Table 6. Decomposition of political decentralisation and disaster outcomes.

	Number of people affected (ln)	Number of people killed (ln)	Economic damage (ln)
Storms			
	(1)	(2)	(3)
Political decentralisation (ln) (self-rule)	−1.3147***	−0.0862	1.0698**
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	4.9953	6.6785***	2.0634
Observations	392	392	392
R-squared	0.4672	0.6441	0.4604
	(4)	(5)	(6)
Political decentralisation (ln) (shared-rule)	−0.8037***	−0.3486***	0.8636***
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	1.3521	6.5080***	4.9794
Observations	392	392	392
R-squared	0.4628	0.6650	0.4650
Earthquakes			
	(7)	(8)	(9)
Political decentralisation (ln) (self-rule)	−0.9101**	−0.1092	1.3632*
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	2.1667	2.2712	−4.0556
Observations	144	144	144
R-squared	0.5548	0.6146	0.4113
	(10)	(11)	(12)
Political decentralisation (ln) (shared-rule)	−0.9694**	−0.4230*	1.5030**
Controls	Yes	Yes	Yes
Time-dummies	Yes	Yes	Yes
Constant	1.6754	2.1170	−3.3039
Observations	144	144	144
R-squared	0.5639	0.6289	0.4210

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.
Note: Standard errors are not reported.

of political decentralisation measured by 'Self-rule' for storms (Regression 1) is higher than that measured as 'Shared-rule' (Regression 4). Table 6 also shows that the negative association between political decentralisation and deaths associated with storms or earthquakes is negative and statistically significant, but only when political decentralisation is measured as 'Shared-rule' (Regression 5 and 11). Finally, no matter how political decentralisation is measured, there is a positive and statistically significant relation between a country's degree of political decentralisation and the economic losses from disasters (Regressions 3, 6, 9 and 12). Overall, both the authority of a regional government over those living in the region ('Self-rule' score) and the authority a regional government co-exercises in the country as a whole ('Shared-rule' score) matter when it comes to the number of people affected and the economic damage, while only the authority a regional government co-exercises in the country as a whole matters for the number of people killed.

We finally replicate the baseline empirical function above [empirical function (1)] through estimation with fixed effects. In other words, we add unobservable national

specific effects into empirical function (1). These are time-invariant nationally omitted variables, such as physical endowments which may affect exposure to hazards (e.g. presence of mountains, rivers and coastal proximity). This estimator controls for the omitted variables that are peculiar to each country, accommodating some national heterogeneity.

Table 7 shows a negative and statistically significant association between decentralisation and the number of storm-related fatalities (Regression 2), as well as a negative and statistically significant association between decentralisation and the number of people affected by earthquakes (Regression 4).

Consequently, we find evidence that greater transfers of political power to subnational tiers of governments are justified as a means to reducing the impacts of storms and earthquakes on the population (Regression 3 and 6). These findings must be interpreted with some caution, because although the fixed effects estimator wipes out all the space-specific time-invariant variables, reducing the risk of obtaining biased estimation results (Baltagi, 2005), this reduction in bias comes at a significant cost as it removes cross-national variation from the data, affecting the efficiency of the parameter estimates, especially when the cross-national variation is high (Higgins & Williamson, 1999; Rodríguez-Pose, Psycharis, & Tselios, 2012; Rodríguez-Pose & Tselios, 2010). Finally, we prefer the pooled ordinary least squared (see Tables 2–6) to the fixed effect (Table 7) coefficients, because the latter are interpreted as time-series effects, or short/medium-run effects, as they reflect within-country time-series variation, whereas the former reflect long run effects (Durlauf & Quah, 1999; Mairesse, 1990; Partridge, 2005).

Table 7. Political decentralisation and disaster outcomes: adding fixed effects.

	Number of people affected (ln)	Number of people killed (ln)	Economic damage (ln)
Storms			
	(1)	(2)	(3)
Political decentralisation (ln)	−0.8643	−0.8400**	0.3555
Government consumption	−0.3707*	0.0502	0.0762
Openness	−0.0329	0.0220**	0.0255
Annual growth rate	−9.8797	−1.9404	−26.4381**
Number of disasters (ln)	2.5009***	0.9943***	2.8898***
Time-dummies	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes
Constant	5.0725	6.3778***	−0.0171
Observations	392	392	392
R-squared	0.4651	0.4008	0.4097
Earthquakes			
	(4)	(5)	(6)
Political decentralisation (ln)	−2.4468**	−0.5551	−3.4492
Government consumption	−0.0376	0.1105	0.3476
Openness	−0.1210	−0.0043	−0.2300
Annual growth rate	41.3474***	13.4828*	46.2483*
Number of disasters (ln)	0.6487	0.8146	3.2856*
Time-dummies	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes
Constant	−0.4953	−0.0568	−0.6761
Observations	144	144	144
R-squared	0.6295	0.6013	0.4867

*$p < 0.1$; standard errors are not reported.
**$p < 0.05$.
***$p < 0.01$.

5. Conclusions

Hazards happen and due to a variety of factors, some hazards result in disasters. Our analysis builds on previous work that highlights the importance of political institutions in disaster outcomes, and reveals that political decentralisation is an important factor in determining the impact of storms and earthquakes. Thus, our analysis underlines the importance of local capability in managing disaster risk. We are aware that this study is limited by both its focus on only two types of hazards and on only high-income and upper middle-income countries. Nonetheless, important conclusions can be drawn for those countries affected by storms and earthquakes.

In relation to both storms and earthquakes, our results suggest that greater transfers of political power to subnational tiers of governments reduce hazard impacts on the population. Hence, not only do countries with more fiscally decentralised governments experience fewer disaster-induced fatalities (Escaleras & Register, 2012; Skidmore & Toya, 2013; Yamamura, 2012) but also countries with more politically decentralised governments. There are several reasons why more effective local government may be able to influence disaster outcomes. It could be argued that local governments can tailor disaster risk reduction resources more closely to the needs of local citizens than national government at all stages of the disaster. The downside is that more politically decentralised countries, which are usually wealthier countries (Rodríguez-Pose & Ezcurra, 2010; Tselios et al., 2012), can increase the direct economic losses associated with a disaster impact after the storm or earthquake more than the less politically decentralised ones. Another explanation is that local officials might be better informed about local needs before, during and after a storm and, hence, are better able to set the optimal mix of local policies than are central bureaucrats. Or it may simply be that local actors, faced by the recurrent risk, can be involved in longer term risk reduction. However, our research generates a clear conclusion: from a policy point of view, it seems advantageous to give subnational governments more authority and autonomy in storm and earthquake risk planning. However, other factors need to be considered to reduce the economic damage following disasters triggered by storms or earthquakes. Finally, our results show that national wealth, political orientation and local representation can moderate the effect of political decentralisation on disaster outcomes.

This leaves us with the difficult task of identifying a way forward for research and policy. Our findings support much of the community resilience literature which argues that more political decentralisation can reduce the human cost of disasters, but we recognise that this analysis has its limits. It is often the collapse of markets, the destruction of stock and the lack of access to capital that creates the longer term damage for poor or fragile economies after a disaster. The next step is to identify the optimal mix of decentralisation and growth policies to enable economies to bounce back more quickly after disasters.

Notes

1. A natural hazard is a natural event (e.g. earthquake, storm, flood, hurricane, volcanic eruption, tsunami) where there is a threat to humans, society and the economy. A hazard has the potential to cause widespread destruction and loss of lives and thus the potential to cause disaster.
2. See www.emdat.be

3. On the one hand, the set of data where some country–year data are not observed due to factors a and c will not produce bias because it has nothing to do with missing observations; and on the other hand, the set of data where some country–year data are not observed due to factor b may produce bias because it has to do with missing observations. Nevertheless, we control for factor b using time-dummy variables.
4. 'Self-rule' refers to the authority of a regional government over those living in the region and considers: *regional authority over institutional depth* (i.e. the extent to which a regional government is autonomous rather than deconcentrated), *policy scope* (i.e. the range of policies for which a regional government is responsible) *fiscal autonomy* (i.e. the extent to which a regional government can independently tax its population) and *representation* (i.e. the extent to which a region is endowed with an independent legislature and executive). 'Shared-rule' refers to the authority a regional government co-exercises in the country as a whole and considers: *regional authority over law making* (i.e. the extent to which regional representatives co-determine national legislation), *executive control* (i.e. the extent to which a regional government co-determines national policy in intergovernmental meetings), *fiscal control* (i.e. the extent to which regional representatives co-determine the distribution of national tax revenues) and *constitutional reform* (i.e. the extent to which regional representatives co-determine constitutional change).
5. Here, the set of data where some country–year data are not observed is due to the missing observations. However, evaluating and understanding the distribution of missing data, we observe that the missing data will produce little or no bias in the conclusions drawn about the population. Moreover, the 'RAI-total' index has been used in many empirical studies.
6. https://pwt.sas.upenn.edu/php_site/pwt_index.php
7. Again, we are confident the missing data will produce little or no bias and the data on controls is still representative of the population as the PWT database has been used in many empirical studies.
8. The disaster type of 'storm' includes tropical storms, extra-tropical cyclones (winter storms) and local/convective storms [thunderstorm/lightening, snowstorm/blizzard, sandstorm/dust storm, generic (severe) storm, tornado and orographic storm (strong winds)].
9. The number of (total) people affected by storms or earthquakes by year and the economic damage from storms or earthquakes by year can be provided by the authors upon request.
10. The distribution of the disaster outcome variables are asymmetric and skewed, so most of the mass is either on the left or on the right, while most of the mass of the logarithmic transformation of these variables is nearly symmetrical.
11. For those countries where there were no resulting deaths (0), we cannot take the natural logarithm because the logarithm of zero is not defined. Adding one death to each observation means the natural logarithm of one is zero, which represents countries with zero deaths.
12. We prefer to use the government consumption share of GDP per capita rather than the GDP per capita because the latter 'no doubt reflects factors such as public desire for enhanced building codes, the existence of early warning systems, and more disaster sensitive land zoning and use decisions' (Escaleras & Register, 2012, 171). All these factors are better captured by the government consumption share of GDP per capita.
13. We do not include the magnitude scale and value of storms (in kph, speed of wind) and earthquakes (Richter scale) because some countries have experienced multiple natural hazards in the same year. Instead, we use the number of disasters each year, which has been used in empirical studies on disasters (Ahmed & Iqbal, 2009; Escaleras & Register, 2012).
14. A dummy variable takes the value of 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome. It is a proxy variable for qualitative facts in regression analysis. A vector of dummy variables includes a set of dummy variables. In other words, it represents levels within multiple variables.

AQ5 Disclosure statement

No potential conflict of interest was reported by the authors.

References

AQ6 Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, *16*, 268–281.

Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockstrom, J. (2005). Social-ecological resilience to coastal disasters. *Science*, *309*, 1036–1039.

Ahmed, M., & Iqbal, K. (2009). *Disaster and decentralisation* (Working Paper Series No. 2009-03). Carleton College: Department of Economics.

Ainuddin, S., Aldrich, D. P., Routray, J. K., Ainuddin, S., & Achkazai, A. (2013). The need for local involvement: Decentralization of disaster management institutions in Baluchistan, Pakistan. *International Journal of Disaster Risk Reduction*, *6*, 50–58.

Aldrich, D. P. (2012). *Building resilience: Social capital in post-disaster recovery*. University of Chicago Press.

AQ7 altagi, B. H. (2005). *Econometric analysis of panel data*. Chichester: John Wiley.

ardhan, P. (2002). Decentralization of governance and development. *Journal of Economic Perspectives*, *16*, 185–205.

Basher, R. (2006). Global early warning systems for natural hazards: Systematic and people-centred. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *364*, 2167–2182.

Blackburn, S. (2014). The politics of scale and disaster risk governance: Barriers to decentralisation in Portland, Jamaica. *Geoforum*, *52*, 101–112.

Bouwer, L. M., Crompton, R. P., Faust, E., Höppe, P., & Pielke Jr R. A. (2007). Disaster management: Confronting disaster losses. *Science*, *318*, 753.

AQ8 enner, N. (2004). *New state spaces: Urban governance and the rescaling of statehood*. Oxford: Oxford University Press.

Brooks, N., Adger, W. N., & Kelly, P. M. (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change*, *15*, 151–163.

Brouwer, R., & Nhassengo, J. (2006). About bridges and bonds: Community responses to the 2000 floods in Mabalane District, Mozambique. *Disasters*, *30*, 234–255.

Brown, J. C., & Purcell, M. (2005). There's nothing inherent about scale: Political ecology, the local trap, and the politics of development in the Brazilian Amazon. *Geoforum*, *36*, 607–624.

Cheshire, P. C., & Gordon, I. R. (1998). Territorial competition: Some lessons for policy. *The Annals of Regional Science*, *32*, 321–346.

Chhotray, V., & Few, R. (2012). Post-disaster recovery and ongoing vulnerability: Ten years after the super-cyclone of 1999 in Orissa, India. *Global Environmental Change*, *22*, 695–702.

Colten, C. E., Kates, R. W., & Laska, S. B. (2008). Three years after Katrina: Lessons for community resilience. *Environment: Science and Policy for Sustainable Development*, *50*, 36–47.

DeMaria, M., Sampson, C. R., Knaff, J. A., & Musgrave, K. D. (2014). Is tropical cyclone intensity guidance improving? *Bulletin of the American Meteorological Society*, *95*, 387–398.

Djalante, R., Holley, C., & Thomalla, F. (2011). Adaptive governance and managing resilience to natural hazards. *International Journal of Disaster Risk Science*, *2*, 1–14.

Durlauf, S. N., & Quah, D. T. (1999). The new empirics of economic growth. In J. B. Taylor & M. Woodford (Eds.), *Handbook of macroeconomics* (pp. 555–677). Amsterdam: North-Holland: Elsevier.

Escaleras, M., & Register, C. A. (2012). Fiscal decentralization and natural hazard risks. *Public Choice*, *151*, 165–183.

Faguet, J. P. (2014). Decentralization and governance. *World Development*, *53*, 2–13.

Fisman, R., & Gatti, R. (2002). Decentralization and corruption: Evidence across countries. *Journal of Public Economics*, *83*, 325–345.

Foresight. (2012). Reducing the risks of future disasters for decision makers. Final project report. In Foresight and UK Government Office of Science (Eds.), *Foresight reports* (p. 132). London: Government Office of Science.

Guha-Sapir, D., Hargitt, D., & Hoyois, P. (2004). *Thirty years of natural disasters 1974–2003: The numbers*. Presses univ. de Louvain.

Higgins, M., & Williamson, J. (1999). Explaining inequality the world round: cohort size, Kuznets curves, and openness (NBER Working Paper No. 7224, National Bureau of Economic Research).

Holloway, A. (2003). Disaster risk reduction in southern Africa. *African Security Review*, *12*, 29–38.

Hooghe, L., Marks, G., & Schakel, A. H. (2008a). Appendix B: Country and regional scores. *Regional and Federal Studies*, *18*, 259–274.

Hooghe, L., Marks, G., & Schakel, A. H. (2008b). Operationalizing regional authority: A coding scheme for 42 countries, 1950–2006. *Regional and Federal Studies*, *18*, 123–142.

Kahn, M. E. (2005). The death toll from natural disasters: The role of income, geography, and institutions. *Review of Economics and Statistics*, *87*, 271–284.

Kamel, N. (2012). Social marginalisation, federal assistance and repopulation patterns in the New Orleans Metropolitan Area following Hurricane Katrina. *Urban Studies*.

Keefer, P. (2012, December). *Database of political institutions: Changes and variable definitions*. Development Research Group, The World Bank.

Laska, S., & Morrow, B. H. (2006). Social vulnerabilities and hurricane Katrina: An unnatural disaster in New Orleans. *Marine Technology Society Journal*, *40*, 16–26.

Le Galès, P. (2002). *European cities: Social conflicts and governance*. New York: Oxford University Press.

Lemos, M. C. (2007). Drought, governance and adaptive capacity in North East Brazil: A case study of Ceará. In UNDP for Human Development Report Office Occasional Paper (Eds.), *Fighting climate change: Human solidarity in a divided world* (p. 15). New York: UNDP Human Development Report 2007/2008.

Lessmann, C. (2009). Fiscal decentralization and regional disparity: Evidence from cross-section and panel data. *Environment and Planning A*, *41*, 2455–2473.

Mairesse, J. (1990). Time-series and cross-sectional estimates on panel data: Why are they different and why they should be equal. In J. Hartog, G. Ridder, & J. Theeuwes (Eds.), *Panel data and labor market studies* (pp. 81–95). New York: North Holland.

Marks, D., & Lebel, L. (2016). Disaster governance and the scalar politics of incomplete decentralization: Fragmented and contested responses to the 2011 floods in Central Thailand. *Habitat International*, *52*, 57–66.

de Mello, L. (2011). Does fiscal decentralisation strengthen social capital? Cross-country evidence and the experiences of Brazil and Indonesia. *Environment and Planning C: Government and Policy*, *29*, 281–296.

Murphy, B. L. (2007). Locating social capital in resilient community-level emergency management. *Natural Hazards*, *41*, 297–315.

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, *41*, 127–150.

Oates, W. E. (1972). *Fiscal federalism*. New York: Harcourt Brace Jovanovich.

Oates, W. E. (1999). An essay on fiscal federalism. *Journal of Economic Literature*, *37*, 1120–1149.

Partridge, M. D. (2005). Does income distribution affect U.S state economic growth? *Journal of Regional Science*, *45*, 363–394.

Paton, D., Millar, M., & Johnston, D. (2001). Community resilience to volcanic hazard consequences. *Natural Hazards*, *24*, 157–169.

Pelling, M. (2011). Urban governance and disaster risk reduction in the Caribbean: The experiences of Oxfam GB. *Environment and Urbanization*, *23*, 383–400.

Pielke, R. A., Jr., Rubiera, J., Landsea, C., Fernandez, M. L., & Klein, R. (2003). Hurricane vulnerability in Latin America and The Caribbean: Normalized damage and loss potentials. *Natural Hazards Review*, *4*, 101–114.

Pike, A., Rodriguez-Pose, A., Tomaney, J., Torrisi, G., & Tselios, V. (2012). In search of the 'economic dividend' of devolution: Spatial disparities, spatial economic policy, and decentralisation in the UK. *Environment and Planning C: Government and Policy*, *30*, 10–28.

Prud'homme, R. (1995). The dangers of decentralization. *The World Bank Research Observer*, *10*, 201–220.

Rodríguez-Pose, A., & Ezcurra, R. (2010). Does decentralization matter for regional disparities? A cross-country analysis. *Journal of Economic Geography*, *10*, 619–644.

Rodríguez-Pose, A., & Ezcurra, R. (2011). Is fiscal decentralization harmful for economic growth? Evidence from the OECD countries. *Journal of Economic Geography*, *11*, 619–643.

Rodriguez-Pose, A., & Gill, N. (2004). Is there a global link between regional disparities and devolution? *Environment and Planning A*, *36*, 2097–2117.

Rodríguez-Pose, A., Psycharis, Y., & Tselios, V. (2012). Public investment and regional growth and convergence: Evidence from Greece. *Papers in Regional Science*, *91*, 543–568.

Rodríguez-Pose, A., & Tselios, V. (2009). Education and income inequality in the regions of the European Union. *Journal of Regional Science*, *49*, 411–437.

Rodríguez-Pose, A., & Tselios, V. (2010). Returns to migration, education and externalities in the European Union. *Papers in Regional Science*, *89*, 411–434.

Schneider, A. (2003). Decentralization: Conceptualization and measurement. *Studies in Comparative International Development*, *38*, 32–56.

Sims, H., & Vogelmann, K. (2002). Popular mobilization and disaster management in Cuba. *Public Administration and Development*, *22*, 389–400.

Skidmore, M., & Toya, H. (2013). Natural disaster impacts and fiscal decentralization. *Land Economics*, *89*, 101–117.

Thompson, M., & Gaviria, I. (2004). *Weathering the storm: Lessons in risk reduction from Cuba*. Boston, MA: Oxfam America, p. 64.

Tiebout, C. M. (1956). A pure theory of local expenditures. *Journal of Political Economy*, *64*, 416–424.

Tompkins, E. L., Hurlston, L. A., & Poortinga, W. (2009). *Disaster resilience: Fear, friends and foreignness as determinants of risk mitigating behaviour in small islands*. (SRI working paper 18).

Tompkins, E. L., Lemos, M. C., & Boyd, E. (2008). A less disastrous disaster: Managing response to climate-driven hazards in the Cayman Islands and NE Brazil. *Global Environmental Change*, *18*, 736–745.

Tselios, V., Rodríguez-Pose, A., Pike, A., Tomaney, J., & Torrisi, G. (2012). Income inequality, decentralisation, and regional development in Western Europe. *Environment and Planning A*, *44*, 1278–1301.

Twigg, J. (2003). The human factor in early warnings: Risk perception and appropriate communications. In J. Zschau & A. Küppers (Eds.), *Early warning systems for natural disaster reduction* (pp. 19–26). Berlin: Springer.

Twigg, J. (2007). *Characteristics of a disaster-resilient community. A guidance note*. London: Benfield UCL Hazard Research Centre and Interagency Coordination Group, p. 36

UNISDR. (2005). *Hyogo framework for action 2005-2015: Building the resilience of nations and communities to disasters*. Geneva: International Strategy for Disaster Reduction, p. 22. Retrieved from www.unisdr.org

UNISDR. (2009). *Global assessment report on disaster risk reduction. Risk and poverty in a changing climate*. Geneva: Author, p. 207

AQ14 UNISDR. (2015). *The human cost of weather-related disasters 1995-2015*. CRED and UNISDR, p. 30.

Weingast, B. R. (2009). Second generation fiscal federalism: The implications of fiscal incentives. *Journal of Urban Economics*, *65*, 279–293.

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At risk. Natural hazards, people's vulnerability and disasters*. London: Routledge.

Yamamura, E. (2012). *Death tolls from natural disasters: Influence of interactions among fiscal decentralization, institutions and economic development*. (EERI Research paper Series No 08/2012). Brussels: Economics and Econometrics Research Institute.

Yilmaz, S., Beris, Y., & Serrano-Berthet, R. (2008). *Local government discretion and accountability: A diagnostic framework for local governance* (Paper No. 113 / July 2008, Local Governance and Accountability Series, Social Development Working Papers). Washington: The World Bank.

Appendix. Number of observations for storms and earthquakes.

		Storms				Earthquakes			
Country	Year	Obs	Obs (1950–2006)	Diff	% of obs	Obs	Obs (1950–2006)	Diff	% of obs
Albania	1992–2006	2	2	0	0.005	1	5	−4	0.007
Australia	1950–2006	31	31	0	0.078	4	4	0	0.028
Austria	1955–2006	9	9	0	0.023	1	1	0	0.007
Belgium	1950–2006	12	12	0	0.030	2	2	0	0.014
Bosnia and Herzegovina	1995–2006	2	2	0	0.005	0	0	0	0.000
Bulgaria	1991–2006	4	5	−1	0.010	1	4	−3	0.007
Canada	1950–2006	26	26	0	0.065	0	0	0	0.000
Croatia	1991–2006	1	1	0	0.003	1	1	0	0.007
Cyprus	1960–2006	4	4	0	0.010	1	2	−1	0.007
Czech Republic	1993–2006	2	2	0	0.005	0	0	0	0.000
Denmark	1950–2006	9	9	0	0.023	0	0	0	0.000
Estonia	1992–2006	1	1	0	0.003	0	0	0	0.000
Finland	1950–2006	1	1	0	0.003	0	0	0	0.000
France	1950–2006	22	22	0	0.055	1	1	0	0.007
Germany	1950–2006	22	22	0	0.055	3	3	0	0.021
Greece	1950–2006	6	6	0	0.015	22	22	0	0.153
Hungary	1990–2006	4	5	−1	0.010	0	0	0	0.000
Iceland	1950–2006	0	0	0	0.000	2	2	0	0.014
Ireland	1950–2006	10	10	0	0.025	0	0	0	0.000
Italy	1950–2006	11	11	0	0.028	16	16	0	0.111
Japan	1950–2006	53	53	0	0.133	22	22	0	0.153
Latvia	1990–2006	2	2	0	0.005	0	0	0	0.000
Lithuania	1992–2006	3	3	0	0.008	0	0	0	0.000
Luxembourg	1950–2006	2	2	0	0.005	0	0	0	0.000
Macedonia	1991–2006	1	1	0	0.003	0	0	0	0.000
Malta	1964–2006	0	0	0	0.000	0	0	0	0.000
Netherlands	1950–2006	12	12	0	0.030	1	1	0	0.007
New Zealand	1950–2006	8	8	0	0.020	3	3	0	0.021
Norway	1950–2006	4	4	0	0.010	0	0	0	0.000
Poland	1990–2006	5	6	−1	0.013	0	1	−1	0.000
Portugal	1976–2006	3	4	−1	0.008	0	0	0	0.000
Romania	1991–2006	6	6	0	0.015	1	3	−2	0.007
Russia	1993–2006	10	14	−4	0.025	7	19	−12	0.049
Slovak Republic	1993–2006	1	1	0	0.003	0	0	0	0.000
Slovenia	1990–2006	0	0	0	0.000	2	2	0	0.014
Spain	1978–2006	10	12	−2	0.025	1	2	−1	0.007
Sweden	1950–2006	5	5	0	0.013	0	0	0	0.000
Switzerland	1950–2006	15	15	0	0.038	0	0	0	0.000
Turkey	1950–2006	6	6	0	0.015	31	31	0	0.215
United Kingdom	1950–2006	19	19	0	0.048	1	1	0	0.007
United States	1950–2006	55	55	0	0.138	20	20	0	0.139
Sum		399	409	−10		144	168	−24	