Environmental Vulnerability and Economic Growth: Small States vs Large States

BRITO, JOÃO ANTONIO

University of Coimbra, Faculty of Economics, University of Minho, School of Economics and Management

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João António Brito[a]

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ABSTRACT

The purpose of this paper is to analyze empirically if the effect of environmental vulnerability on economic growth is conditioned by country size. Two groups of countries, large and small, were set up, and by using the System-GMM estimator and panel data in a 5-year rolling window, from 1970 to 2010, the impact of number of people killed or affected and cost of the disaster on growth rate of GDP per capita of the two groups of states was estimated. Also, the difference between small and large states in terms of the channels of transmission of the variables of interest was analyzed. Many studies consider small countries more vulnerable to natural disasters than large countries but this study indicates that, on average, large countries suffer more natural disasters than small countries and in terms of the effect of environmental vulnerability on growth rate of GDP per capita, there is no difference between small countries and large countries. Productivity is the main channel of transmission for both groups of countries.

JEL classification: O44, O47, Q54

Keywords: Country Size, Small States, Environmental Vulnerability and Economic Growth.

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1 – INTRODUCTION

One of the first debates with a specific focus on issues concerning small states occurred in 1962 when the Institute of Commonwealth Studies initiated a series of seminars at the University of London. These seminars took place at regular intervals over a period of two years and they introduced more than 20 works related to the common problems faced by small states (Lockhart, 1993). These works were later edited by Benedict (1967) in his book *Problems of Smaller Territories*, constituting one of the first works about small states. Since then, several studies have been published and numerous debates and conferences focusing on small states have been conducted.

During the period 1970-2010, natural disasters affected about 6.3 billion people, causing 3.4 million deaths and a loss of $ 1,900 billion worldwide (data from Emergency Events Database, EM-DAT). We identify two small states that suffered very high costs caused by natural disaster: Saint Lucia in 1988 with a cost of around 365% of GDP and Samoa in 1991 with a cost of 248% of GDP. On the other hand, we also highlight two large

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[a] Student in the PhD Programme in Economics at University of Coimbra, Faculty of Economics and University of Minho, School of Economics and Management. Contact: e-mail: litosbrito@hotmail.com. This paper is a chapter of my PhD thesis, which is supervised by Professor Francisco Veiga and Professor Pedro Bação.

states: North Korea, which in 1995 was destroyed by flood, causing damage around 310% of GDP and Haiti where the earthquake caused a loss of almost 130% of GDP in 2010.

Many theoretical studies argue that small states compared to large states are disadvantaged due to the negative effect of small size on the economic growth process. Particular characteristics of small states include: small market size, small population, dependence on a limited export market and exported products and scarcity of natural resources. Most small states are islands with vast coastal extensions and are located in regions highly prone to natural disasters, thus increasing their environmental vulnerability. These characteristics may lead environmental vulnerability to have a different impact on the growth rate of GDP per capita in small states compared to large states.

We used the number of people killed or affected by natural disasters and the estimated cost of natural disasters to estimate the impact of environmental vulnerability on growth rate of GDP per capita. Also, the difference of impacts of environmental vulnerability between small and large states was analysed in terms of the channels of transmission (human capital, physical capital and productivity). This analysis will strengthen our conclusion about the impact of country size on the effects of the environmental vulnerability on growth rate of GDP per capita.

In our analysis, we first use the statistical technique of cluster analysis to constitute two groups of countries, small and large, based on the size of the land area and population. Subsequently, we refer to the generic formula used in studies of economic growth and system-GMM estimator for our empirical analysis. Our database is for the period 1970-2010. We conclude that the impact of environmental vulnerability on growth rate of GDP per capita is not statistically influenced by country size. Productivity is the main channel of transmission of the effects of environmental vulnerability on the growth rate of GDP per capita in the two groups of countries.

This paper is structured as follows: the second section provides a review of the literature and some stylized facts; the third section presents the methodology, the model and the database; the fourth section presents the empirical results and discussion; and finally, the fifth chapter is dedicated to the conclusion.

2 – AN OVERVIEW OF THE LITERATURE

2.1 – Country Size

We found several criteria used to define country size, such as population, land area, total GDP or external trade, but there is no consensus about the best and most complete criteria to be applied. However, population size is the most common. According to Read (2001), the common use of population as a criterion to define countries size is due to the wide availability of the data and the easy way that the limits can be established. However, we did not find any authors that present theoretical or statistical justification for the use of a certain limit.

The population size used to define small states has been varying over time. In the 70s and 80s it was 5 million (Jalan, 1982), in the 90s and the first decade of this century, it was 1.5 million (Commonwealth Secretariat, 1997) and 3 million (Armstrong et al., 1998). Some authors criticize the use of the population as a measure of country size. Read (2001) critiqued the use of the population, because, first, it is a continuous variable and there is no theoretical natural reason to explain the arbitrary choice of a structural limit and, secondly, the limits are not robust over time due to the different growth rates of population.

We found some studies that define the countries through a combination of population, land area and GDP. Jalan (1982) identified small states as those with a population up to 5 million, a land area less than 65,000 km^2 and a GDP lower or equal to $3,000 million. Thorhallsson (2006) defines small states as having less than 3,000 people working in the foreign services. There are others studies that define country size by external trade. Mattoo and Subramanian (2004) classifies small states are those with imports of goods and services less than 0.05% of world trade.

In this paper we define countries sizes by a combination of land area and total population. We used cluster analysis to classify the countries according to the size of population and land area.[1] Some studies in this subject use the combination of population, land area and GDP to classify countries. In our case we did not consider the GDP because this variable could also serve as an indicator of the country's level of development. Moreover, the object of our research is small states and not states with small economic size.

We used the data of 2009 for 215 states and we set up two groups of states, a group with 83 small states (we can consider 45 as "small" and 38 as "micro") and the other with 132 large states (we can consider 127 as "medium" and 5 as "large").[2]

2.2 – Some Characteristics of Small States

The theoretical literature suggests several factors that can explain the economic growth of a country as a result of their size. Since this study focuses on small states, we will describe the benefits and constraints of small country size. In dichotomous terms, some of these constraints/benefits can be seen as a benefits/constrains to large states:

1) High per capita cost of some goods and services due to small population – this high cost is explained by indivisibility of the cost of various public goods and services and the political costs. This indivisibility is indicated as a barrier to international competitiveness of small states (Briguglio, 1995).

2) Small domestic market – the small domestic market does not support multiple companies producing the same goods and services, thus, the economic structure is less diversified in small states (Briguglio, 1995). The small size of the market (in terms of land area and population) may lead to less diversification of raw materials and resources, which restricts domestic production (Castello and Ozawa, 1999). These characteristics imply that small states have strong geographic concentration of exports and limited diversification of production and exports, which increase the exposure to external shocks. The small domestic market leads the country to a high level of openness to external trade, which also increases exposure to external shock.

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[1] There are various techniques, methods and measures that can be applied in the clusters analysis, depending on the type of data and the purpose of the study. For our study, because the number of objects is reduce, we used the hierarchical technique (which is the most appropriate for reduce objects), the measure Squared Euclidean Distance and the method Average Linkage Between Groups. The statistical program used to do the calculations was SPSS 17.0.

[2] The group of countries is in the appendix. Even considering a more recent data of population and land area there is no change in the country groups classification.

3) High environmental, economic, social and political vulnerability – the environmental vulnerability is due to the location of countries (small and large) in areas subject to these disasters. However, the greater vulnerability of small states, according to Briguglio (1995), is due to the disproportionate effect (in terms of unit area and per capita cost) that a disaster of the same intensity may have in a small state compared with a large state. The economic vulnerability of small states according to Armstrong and Read (2003), is explained by the high degree of external trade, small domestic market, high per capita cost of certain goods and services, export concentration and little diversification of production. Downes and Mamingi (2001) link the social vulnerability of small states to their inability to withstand external cultures and social influences which have proven to be very costly in financial and human terms for these states. Political vulnerability results from direct or indirect dependence of small states on political intentions of large and powerful countries, in terms of trade and other assistance (Castello and Ozawa, 1999; Downes and Mamingi, 2001).

4) Strong social cohesion and homogeneity of the population – Castello and Ozawa (1999) consider small states more open to changes, with greater political integration and better prepared to face uncertainties and external shocks, due to the prevalence of greater solidarity and social cohesion. These behaviours have positive impacts on economic growth (Armstrong and Read, 2003). The stability of many national governments had been threatened by serious domestic conflicts, associated with racial, religious and linguistic diversity. Hence, greater homogeneity of population involves more stable government.

Thus, the economic impacts of the constraints and benefits linked to country size imply that the growth strategies of small and large states must be different. Armstrong and Read (2003) suggest that small states should follow growth policies related to small scale production and with more emphasis on human capital, such as services sector.

2.3 – Environmental vulnerability and economic growth

Guillaumont (2010) considers the vulnerability of a country as a result of three components: the size and frequency of exogenous shocks (observed or anticipated); exposure to shocks; and, the ability to respond to shocks.

The environmental vulnerability is mainly linked to catastrophes and natural disasters. We have not found a widespread consensus in studies on the effects of natural disasters on economic growth. Noy (2009) used the variables people killed or affected and the cost of the damage caused by natural disasters to study the impact of environmental vulnerability in the economic growth. The author concluded that the number of people killed or affected has no impact on economic growth, but the cost of the damage has a negative effect. Cavallo et al. (2010) measured the effects of natural disasters by the number of people killed. He found that only the major natural disasters (when the magnitude is 2 standard deviations above the world average), followed by political revolution, has negative effects on economic growth. Hochrainer (2009) found a slightly negative impact of natural disasters on economic growth.

The various indices and variables used to measure vulnerability classify small countries, especially island countries, as the most vulnerable. According to Briguglio (1995), this is due to the specific characteristics of this group of countries such as the insularity and remoteness (leads to high transportation costs and uncertainty in supply), propensity to natural disasters (the small country size leads to major disasters by area units and cost per capita) and environmental factors (pressures of economic development can lead to depletion of agricultural land, coastal zone exploitation for tourism and maritime activities). Moreover, since most small countries are islands, global warming and increased sea levels can lead to loss of a large proportion of land. Our hypothesis is that such characteristics increase the negative effects of natural disasters on economic growth of small countries compared with large countries.

2.4 – Stylized Facts

The low population and land area are presented as the main constraints to economic growth of small states, since these dimensions translate into small domestic market (population) and natural resources (land area). In the period 1970-2010 the average annual growth rate of GDP per capita was statistically significantly higher in small states (2.1%) compared to large states (1.7%).[3] The growth rate of GDP per capita was higher in small states during the period 1970-2005, but in the last five years (2006-2010), large states had higher growth performance. The average level of GDP per capita is statistically significant higher in small states (US$12,262) compared to large states (US$8,244) in the period 1970-2010. Even with the elimination of the five small states (Bermuda, Brunei, Kuwait, Qatar and Luxembourg) with the highest average level of GDP per capita, the average level of the group remains higher than the group of large states. [4] These facts show that the small size compared to large size is not a handicap to economic growth.

We compared the environmental vulnerability of small and large countries by analyzing the data of people killed or affected and the estimated costs of damage caused by natural disasters. The data are from the Emergency Events Database (EM-DAT) for the period 1980-2010.[5] We divide the number of people killed or affected by the population size in the year prior to the disaster year. Similarly, we also divide the direct estimated cost of the disaster by the last year's GDP in order to compare the effects in the two groups of countries.

During the period 1980-2010, 8,357 natural disasters occurred in the group of large countries, which represents an average of 63.3 disasters per country, and 597 disasters in the group of small states, which corresponds to an average of only 10.3 disasters per country. The annual average of people killed by natural disasters was 0.0009% of the population in small countries and 0.0015% of the population in the large countries. This average is significantly higher in the group of large countries.[6] The annual average of people affected by natural disasters in small countries (1.71% of the population) is not significantly different from the average in the large countries (1.44% of the population).[7] The annual average of estimated cost of the disaster is significantly higher in small countries (0.63% of GDP) compared to large countries (0.14% of GDP).[8]

With this analysis, we conclude that despite the higher frequency of disasters in large countries, the negative impact of environmental vulnerability is not stronger in large countries compared to small countries.

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[3] The groups of small and large states are the groups defined in this study.
[4] Source of data: GDP per capita are from Penn World Table - PWT 7.1.
[5] For a disaster to be considered in the database of the EM-DAT at least one of the following criteria must be fulfilled: Ten (10) or more people killed; one hundred (100) or more people affected; declaration of a state of emergency; or call for international assistance. Natural disasters can be: drought, earthquake, epidemic, extreme temperature, flood, insect infestation, storm, volcanic eruption and forest fires.
[6] T-test: $Pr(|T| > |t|) = 0.0878$ - Rejects the null hypothesis of equal means.
[7] T-test: $Pr(|T| > |t|) = 0.2959$ - Accept the null hypothesis of equal means.
[8] T-test: $Pr(|T| > |t|) = 0.0007$ - Rejects the null hypothesis of equal means.

3 – EMPIRICAL MODEL AND DATA

3.1 – Empirical Model

Our empirical model follows the generic formula used in studies of economic growth, which includes Augmented Solow model plus other determinants of growth. Considering the studies of Caselli et al. (1996), Levine et al. (2000) and Aisen and Veiga (2013), this is our model of economic growth:

$$lnY_{i,t} - lnY_{i,t-1} = \gamma lnY_{i,t-1} + \psi X_{i,t} + \theta Z_{i,t} + \mu_i + \omega_t + \epsilon_{i,t} \quad (1)$$

where: $lnY_{i,t}$ – logarithm of real GDP per capita of country i at the end of period t; $X_{i,t}$ – vector of basic variables; $Z_{i,t}$ – variables of interest; μ_i – country individual effect; ω_t – period specific effect; $\epsilon_{i,t}$ – error term; γ, ψ, and θ – parameters to be estimated; i = 1,…,N (represents countries); and, t = 2,…,T (period).

The standard assumption concerning the error terms μ_i and $\epsilon_{i,t}$: $E(\mu_i) = E(\epsilon_{i,t}) = E(\mu_i \epsilon_{i,t}) = 0$ for i = 1,…,N and t = 2,…,T; And, $E(\epsilon_{i,s}\epsilon_{i,t}) = 0$ for $\forall\, s \neq t$. Assuming $\vartheta = 1 + \gamma$ and $y_{i,t} = lnY_{i,t}$ the equation (1) is equivalent to:

$$y_{i,t} = \vartheta y_{i,t-1} + \psi X_{i,t} + \theta Z_{i,t} + \mu_i + \omega_t + \epsilon_{i,t} \quad (2)$$

In this dynamic model the lagged dependent variable ($y_{i,t-1}$) may be correlated with the error term ($\epsilon_{i,t}$) and the individual effect (μ_i). Also, we have the situation of the endogenous variables X and Z. The use of the OLS estimator in equation (2) will be inconsistent and biased. First-difference of equation (2) eliminates the individual effects (which solves the problem of heterogeneity and thus prevents the estimator bias), as $\mu_i - \mu_i = 0$. The equation becomes:

$$\Delta y_{i,t} = \vartheta \Delta y_{i,t-1} + \psi \Delta X_{i,t} + \theta \Delta Z_{i,t} + \Delta\omega_t + \Delta\epsilon_{i,t} \quad (3)$$

But, we still have the problem of autocorrelation, because $y_{i,t-1}$ term in $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$ is correlated with the $\epsilon_{i,t-1}$ in $\Delta\epsilon_{i,t} = \epsilon_{i,t} - \epsilon_{i,t-1}$, and, on the other hand, any predetermined variables in X or Z that are not strictly exogenous become potentially endogenous because they may be related with $\epsilon_{i,t-1}$ (Roodman, 2009b).

Arellano and Bond (1991) indicate the use of instrumental variables in the regression of the first-differences equation (3) that solves the problem of autocorrelation and endogeneity. The authors propose as instruments the use of the lagged variable into two or more periods if it is endogenous, the use of lagged variable into one or more periods if it is predetermined, and the use of variable as their own instruments if it is strictly exogenous.

The GMM (Generalized Method of Moments) estimator applied to the moment conditions of the equation (3) is known as First-differenced GMM (see: Arellano and Bond, 1991). Blundell and Bond (1998) showed that the First-differenced GMM estimator may be biased when the value of the parameter (ϑ) is close to one. Thus, Blundell and Bond (1998) propose the use of system-GMM estimator which combines in one system the equation in first-difference (3) with the equation in levels (2) as the best estimator to solve the econometric problems associated with our economic model (the endogeneity of explanatory variable and country specific effects). For the equation in levels (2), Arellano and Bover (1995) suggest the use of the lagged values of the variables in first difference as valid instruments if the explanatory variable in level is correlated with the fixed effect (μ_i) and the first difference is not.

Blundell and Bond (1998) presents three advantages associated with system-GMM over other estimation methods for dynamic panel data models: i) The estimator is not biased by the omission of variables that are constant over time; ii) The use of instruments allows parameters to be estimated consistently in models with endogenous explanatory variables; and, iii) The use of instruments potentially allows consistent estimation even in the presence of measurement error.

We tested the consistency of the system-GMM estimator using the following tests: Hansen test – validity of the instrument matrix; difference-in-Hansen – validity of the subsets instruments; and, Arellano and Bond (1991) – independence of the error term.

In addition to the model presented above, we will use another model in order to assess the statistical significance of differences between the coefficients of the variables of interest in small and large states. Thus, we include a third column in the table, where we have common data for the basic variable and the variables of interest are interacted with a dummy variable to identify the two groups of states. The statistical significance of the difference between the coefficients of the interaction terms is analyzed by the Wald test. The model to be estimated is:

$$\Delta y_{i,t} = \vartheta \Delta y_{i,t-1} + \psi \Delta X_{i,t} + \theta \Delta Z_{i,t} * d_L + \lambda \Delta Z_{i,t} * d_S + \Delta \omega_t + \Delta \epsilon_{i,t} \qquad (4)$$

where: d_L – *dummy* = 1 for Large states; d_S – *dummy* =1 for Small states.

From our literature review we conclude that variables such as initial level of GDP per capita, human capital, investment and population growth display similar economic and statistical behaviour in relation to growth rate of GDP per capita in both small and large countries. Thus, we consider these variables basic to our model and are kept in all regressions. On the other hand, we consider people killed or affected and the estimated costs of damage caused by natural disasters as our variables of interest and we will investigate empirically whether their impacts on the economy are significantly different between small and large states.

We used the econometric software STATA.12 to estimates our model. The estimates are made using the command "*xtabond2*" developed by Roodman (2009b). We use the "*robust*" option on the command "*xtabond2*" in all estimations, to ensure that the estimator is robust to heteroskedasticity. Following Roodman (2009a), in all estimations the number of instruments is less than the number of countries in order to prevent bias in statistical tests.

3.2 – Data and variables

Our unbalanced panel data refers to the period 1970-2010 for 181 states, of which 54 are classified as small and 127 as large states.[9] The data were first considered in 5 year periods non-overlapping (1971-1975, 1976-1980,..., 2006-2010), but in the group of small states the observations are fewer and we could not have results with economic and statistical

[9] The table with data is on appendix.

significance for many variables. Thus, we used the 5-year "rolling window" for all variables, which led to a larger number of observations.[10]

Our main data source is the PWT 7.1. Although there is a new version, the PWT 8.0, we chose the PWT 7.1 because it contains more data on the group of countries identified as small in our study. The variables of the model are:

- Initial GDPpc (log) (PWT) – Logarithm of real GDP per capita (PPC, I$, 2005) lagged by 5 year period. A negative coefficient is expected.
- Invest. (% GDP) (PWT) – Average investment (% GDP) over the current 5 year period. A positive coefficient is expected.
- Secondary (%) (World Development Indicators - WDI) – Average of secondary school enrolment rate over the current 5 year period. This is a proxy for the level of human capital. A positive coefficient is expected.
- POP_gr (%) (PWT) – Average of population growth rate over the current 5 year period. A negative coefficient is expected.
- Killed (% pop) (EM-DAT) – Average of percentage of population killed by natural disaster over the current 5 year period. A negative coefficient is expected.
- Affected (% pop) (EM-DAT) – Average of percentage of population affected by natural disaster over the current 5 year period. A negative coefficient is expected.
- Cost (% GDP) (EM-DAT) – Average of estimated costs of damage (% GDP) caused by natural disasters over the current 5 year period. A negative coefficient is expected.
- Time dummy – We divide the period of analysis into 5 year periods, non-overlapping, and we assume each period as a time dummy.

The basic explanatory variables were considered endogenous. The variables of interest (killed, affected and cost) were considered endogenous too because the occurrence and magnitude of natural disasters do not depend on the country's GDP level, but the economic and human impacts of natural disasters are related to the economic and infrastructural capacity of the country. On the other hand, GDP and population were used as weighting measure. So our variables of interest are affected by the GDP.

The "rolling windows" technique allows for a greater number of observations. However, it can create autocorrelation. To overcome the problem of autocorrelation and endogeneity we had to use more lags. So, to limit instrument proliferation, we follow Roodman (2009a and 2009b) and used the "*collapse*" option, available with the command "*xtabond2*" in STATA program.[11] This option generates one instrument for each variable and lag distance, instead of one for each time period, variable, and lag distance. The rolling windows technique can also generate multicollinearity of the regressors. We used the Variance Inflation Factors (VIF) test to detect the collinearity of the regressors. Also, we tested all estimations for sensitivity to reduction in the number of instruments.

[10] Example of studies that used rolling window: Barrell and Gottschalk (2004) and Klomp and de Haan (2009).

[11] The "collapse" option makes this transformation of the instrument matrix (Roodman, 2009b):

$$\text{From: } \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & \cdots \\ y_{i,1} & 0 & 0 & 0 & 0 & 0 & \cdots \\ 0 & y_{i,2} & y_{i,1} & 0 & 0 & 0 & \cdots \\ 0 & 0 & 0 & y_{i,3} & y_{i,2} & y_{i,1} & \cdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{bmatrix} \text{ to : } \begin{bmatrix} 0 & 0 & 0 & \cdots \\ y_{i,1} & 0 & 0 & \cdots \\ y_{i,2} & y_{i,1} & 0 & \cdots \\ y_{i,3} & y_{i,2} & y_{i,1} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{bmatrix}$$

4 – EMPIRICAL RESULTS AND ANALYSIS

4.1 – Environmental vulnerability and Economic Growth

In table 1, the variables of interest have the expected signal of coefficients in the two groups of countries (columns 1, 2, 3, 4, 5 and 6), but only the variable Cost (% GDP) has statistical significance (columns 5 and 6). The basic variables have the expected signals and most are statistically significant. Initial GDP per capita has a negative and statistically significant coefficient in almost all estimations of the two groups. Investment (% GDP) and secondary (%) have positive effects in all estimations of the two groups and most of the effects are statistically significant. The population growth coefficient is negative and statistically significant in almost all estimations. We considered time dummies in all the estimations, but the coefficients are not included in the tables in order to save space. The Hansen test did not reject the validity of the instruments used, the autocorrelation test rejects second-order autocorrelation, the difference-in-Hansen test did not reject the validity of the subsets of instruments and the VIF test does not show the existence of multicollinearity. Therefore, these tests support the validity of our results. [12]

The variables Killed (% pop) and Affected (% pop) have a negative influence on the growth rate of GDP per capita in both groups of countries (columns 1, 2, 3, and 4), but the effects are not statistically significant. When we compare the difference of the coefficients of these variables between the two groups of countries, they continue with the same behaviour in both groups of countries (columns 7 and 9). This means that, independent of country size, environmental vulnerability measured by people killed or affected has a negative impact on the growth rate of GDP per capita. However, the effect is not statistically significant.

The variable Cost (% GDP) has negative and statistically significant coefficients in both groups of countries (columns 5 and 6). The Cost (% GDP) in the estimation with comparison of the effects (column 8) has a negative and significant impact in the two groups of countries. The coefficients are different, but the Wald test does not reject the hypothesis of equality of the coefficients.[13]

Thus, we conclude that the effect of environmental vulnerability on growth rate of GDP per capita is negative and is not influenced by country size. However, only the variable Cost (% GDP) has a statistically significant effect on the growth rate of GDP per capita. These results are consistent with those obtained by Noy (2009) where the effects of people killed or affected by natural disasters on growth rate of GDP per capita are not statistically significant. Also, these results are consistent with the conclusion of the stylized facts previously analyzed where there is no difference in the negative impact of environmental vulnerability between the two groups of countries.

[12] The results of the VIF test are in appendix (table A.3). There is evidence of multicollinearity if: i) The largest VIF is greater than 10 (some choose a more conservative threshold value of 30); ii) The mean of all the VIFs is considerably larger than 1.

[13] Wald test: $chi^2(1) = 2.14; Prob > chi^2 = 0.1436$.

Table 1: Environmental vulnerability and Economic Growth

Variables	(1) GDPgr_L	(2) GDPgr_S	(3) GDPgr_L	(4) GDPgr_S	(5) GDPgr_L	(6) GDPgr_S	(7) GDPgr_T	(8) GDPgr_T	(9) GDPgr_T
Initial GDPpc (log)	-0.036***	-0.129**	-0.104***	-0.0427*	-0.030***	-0.000910	-0.0185**	-0.0173*	-0.0165*
	(-5.277)	(-2.451)	(-8.157)	(-1.797)	(-2.764)	(-0.0582)	(-2.065)	(-1.768)	(-1.736)
POP_gr (%)	-1.173**	-3.023	-0.992**	-2.242	-2.412***	-1.302***	-0.904*	-1.420**	-1.245**
	(-1.998)	(-1.348)	(-1.979)	(-1.439)	(-3.649)	(-2.677)	(-1.704)	(-2.269)	(-2.390)
Invest. (% GDP)	0.000845*	0.000155	0.00166**	0.000796	0.00106**	0.000293	0.00096**	0.00113**	0.00111**
	(1.684)	(0.108)	(1.967)	(0.532)	(2.113)	(0.512)	(2.379)	(2.276)	(2.361)
Secondary (%)	0.0014***	0.00467*	0.0036***	0.00189*	0.00079**	3.26e-05	0.00067**	0.000475	0.000533*
	(5.227)	(1.918)	(6.620)	(1.706)	(2.306)	(0.0421)	(2.252)	(1.644)	(1.816)
Killed (% pop)	-0.778	-18.83							
	(-0.132)	(-0.306)							
Affected (% pop)			-0.000572	-0.0566					
			(-0.0300)	(-1.301)					
Cost (% GDP)					-1.164*	-0.139**			
					(-1.648)	(-2.207)			
Affected_S (% pop)							-0.0230		
							(-0.439)		
Affected_L (% pop)							-0.0422		
							(-0.578)		
Cost_S (% GDP)								-0.153*	
								(-1.827)	
Cost_L (% GDP)								-0.899*	
								(-1.687)	
Killed_S (% pop)									-26.59
									(-0.368)
Killed_L (% pop)									-5.784
									(-0.282)
Nº observations	3,632	1,056	3,632	1,056	3,632	1,056	4,688	4,688	4,688
Nº Countries	127	54	127	54	127	54	181	181	181
Nº instruments	83	53	113	53	83	43	134	134	110
Hansen test (p-value)	0.150	0.186	0.237	0.374	0.277	0.487	0.314	0.190	0.137
AR1 test (p-value)	0.387	0.910	0.287	0.409	0.0506	0.114	0.0720	0.0295	0.0368
AR2 test (p-value)	0.352	0.375	0.142	0.603	0.968	0.793	0.297	0.638	0.323
Difference-in-Hansen tests (p-value)									
Instruments level	0.300	0.368	0.378	0.377	0.647	0.366	0.157	0.161	0.496
Time Dummies	0.781	0.106	0.861	0.668	0.862	0.931	0.269	0.275	0.231

Notes: The dependent variable is growth rate of GDP per capita (GDP_gr). Meaning of acronyms: _L – group of Large states, _S – group of Small states, _T – Total states. t-statistics are in parenthesis. Significance level to reject the null hypothesis: *** - 1%, ** - 5% e * - 10%.

4.1.1 – Sensitivity analysis

We checked the robustness of our conclusion about the difference between the coefficients of the variables of interest across the two groups of countries by doing a sensitivity analysis of our results. First, we used other criteria to classify the countries in clusters, by considering separately total GDP, total population and total land area to define the clusters. Also, a limit of 3 million was used to define small countries (following Armstrong et al., 1998), but the results were identical to those obtained with the use of the total population variable to define the clusters, so we do not present these estimations. Second, we controlled the sample by excluding high income states, low income states and member states of the Organization of Petroleum Exporting Countries (OPEC) plus other states considered petroleum exporters by United Nations Conference on Trade and Development (UNCTAD).[14] Third, we eliminated the first and last 10 years of our database, forming two sub-periods,

[14] We followed the income classification of countries defined by the World Bank for the year 2010. We exclude 18 petroleum exporting states: Angola, Algeria, Libya, Nigeria, Venezuela, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, Kazakhstan, Russia, Norway, Ecuador, Gabon and Indonesia.

1970-2000 and 1980-2010. Finally, we eliminated some states with population and land area outliers in each group.[15] The tables with the estimation results are in the appendix (table A.4).

We present only the estimations with the Cost (% GDP) variable, since the estimations with people killed or affected by natural disasters, do not have statistical significance in both groups of countries. In all regressions, Cost (% GDP) has negative coefficients in both groups of countries and most are statistically significant. In all regressions, the difference between the coefficients of the two groups of countries is not statistically significant. Thus, the impact of environmental vulnerability in the growth rate of GDP per capita is not influenced by the country size. This finding is consistent with that obtained above. All regressions passed the specification tests of Hansen, autocorrelation and difference-in-Hansen, and the VIF test does not show the existence of multicollinearity. Hence, our findings are robust to changes in the criteria used to classify the countries, the country income level, the removal of outliers and the sample period used.

4. 2 – Channels of transmission

In this subsection we analyse empirically the main channel through which environmental vulnerability affects the growth rate of GDP per capita in both groups of countries. This exercise combines growth accounting and regression following the methodology adopted by Aisen and Veiga (2013). First, we decompose the product into its components: physical capital accumulation, human capital accumulation and Total Factor Productivity (TFP); and, then we estimate these components with the control of some variables.

4.2.1 – Equations and database

We consider the Cobb-Douglas production function presented by Hall and Jones (1999):

$$Y_i = K_i{}^{\alpha}(A_i H_i)^{(1-\alpha)} \quad (5)$$

where: K_i – physical capital stock; H_i – amount of human capital-augmented labour used in production; A_i – labour-augmenting measure of productivity; α – factor share and is assumed to be the same for all countries and equal to 1/3.[16]

Not all variables of the equation (5) are observed directly. Thus, we follow the literature to construct the series of human capital, physical capital and productivity.

1 – The amount of human capital-augmented labour used in production, H_i, is given by:

$$H_i = e^{\emptyset(E_i)} L_i \quad (6)$$

where: E_i – years of schooling;[17] $\emptyset(E_i)$ – is a piecewise linear function with return rate: 13,4% for $E_i \leq 4$; 10,1% for $4 < E_i \leq 8$; and 6,8% for $E_i > 8$;[18] L_i – labour force and is homogeneous within a country.[19]

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[15] Outlier countries: Small States (Hong Kong, Singapore, Moldavia, Lebanon, Puerto Rico, Guyana, Suriname, Iceland and Latvia); Large States (China, United States, Indonesia, Russia, Brazil, Canada and Australia).
[16] This value of factor share is assumed by Hall and Jones (1999) and most of the studies.
[17] Average years of schooling in the population over 25 years old (source: Barro and Lee, 2010).
[18] This value of return was estimated by Psacharopoulos (1994).

2 – The capital stock, K_t, is calculated by the perpetual inventory equation:

$$K_t = (1-\gamma)K_{t-1} + I_t \quad (7)$$

where: I_t – real aggregate investment (PPP, I$, 2005);[20] γ – depreciation rate of the capital (we assume 6%).[21] Following the literature, the initial capital stock, K_0, is given by:

$$K_0 = \frac{I_0}{(g_I+\gamma)} \quad (8)$$

where: I_0 – the value of the investment series in the first year it's available; g_I – the average geometric growth rate of the investment series during the first ten years of available data.

3 – Following Hall and Jones (1999) and Caselli (2005) the TFP is constructed by using the equation (5) and the data of output, physical capital stock and human capital-augmented labour used. Considering the production function (5) and defining $h_i = H_i/L_i$, we have:

$$\frac{Y_i}{L_i^{(1-\alpha)}} = K_i^{\alpha}(A_i h_i)^{(1-\alpha)} \quad (9)$$

Assuming $y_i^* = Y_i/L_i$ and $k_i = K_i/Y_i$, we rewrite the equation (9) as:

$$y_i^* = k_i^{\alpha/(1-\alpha)} A_i h_i \quad (10)$$

The TFP is given by:

$$A_i = \frac{y_i^*}{h_i} k_i^{-\alpha/(1-\alpha)} \quad (11)$$

Dividing the equation (5) by population, we get a conventional equation for growth accounting (see: Hsieh and Klenow, 2010; Aisen and Veiga, 2013):

$$y_i = k_i^{\alpha}(A_i h_i)^{(1-\alpha)} \quad (12)$$

where: y_i – real GDP per capita (PPP, I$, 2005); k_i – stock of physical capital per capita; h_i – amount of human capital per capita; and, A_i – TFP.

The decomposition of equation (12) in the contributions to growth of GDP per capita from growth of physical capital accumulation, human capital accumulation and TFP is given by:

$$g(y_i) = \alpha g(k_i) + (1-\alpha)g(h_i) + (1-\alpha)g(A_i) \quad (13)$$

where: $g(.)$ – growth rate.

4.2.2 – Empirical results and analysis

Our period of analysis is 1970-2010. The data are in a 5-year "rolling window", except the initial value of human capital per capita, physical capital per capita and TFP. The basic

[19] Number of workers resulted from division of GDP (rgdpch*pop*1000) by GDP per worker (rgdpwok), source: PWT 7.1.
[20] The aggregate investment results from multiplication of investment *per capita* (ki/100*rgdpl) by population (pop*1000), source PWT 7.1.
[21] This value is assumed by Hall and Jones (1999) and most of the studies.

variables, the variables of interest and the time dummy have the same definitions and sources indicated in previous subsections.

We used the basic model defined in the previous subsection and system-GMM estimator. The growth of GDP per capita and the logarithm of initial GDP per capita were replaced by the growth of physical capital, human capital and productivity and their respective initial values, depending on the channel of transmission to be estimated. We tried to keep the same basic explanatory variables used on the estimation of growth of GDP per capita in the subsection above. However, in the physical capital estimations we excluded investment (% GDP), in the human capital estimations we did not include secondary (%) and in the TFP estimations we did not consider investment (% GDP) and secondary (%), since these variables/proxies are used in the construction of the series. In the regressions with the dependent variable growth rate of human capital per capita we included a second lag of initial human capital in order to avoid second order autocorrelation of the residuals. We used only Cost (% GDP) as a proxy for environmental vulnerability because only this proxy was statistically significant in the previous regression of GDP per capita.

Table 2: Channels of transmission

Variables	(1) HCAP_gr_L	(2) HCAP_gr_S	(3) PCAP_gr_L	(4) PCAP_gr_S	(5) TFP_gr_L	(6) TFP_gr_S
Initial Human C. pc (log)	0.0649*	0.103***				
	(1.925)	(3.192)				
Initial Human C. pc (log) (t-2)	-0.0766**	-0.105***				
	(-2.213)	(-3.051)				
Initial Physical C. pc (log)			-0.0630***	-0.101**		
			(-3.013)	(-1.985)		
Initial TFP (log)					-0.0544*	-0.0146**
					(-1.949)	(-2.455)
Secondary (%)						
POP_gr (%)	0.381	0.145	-8.071***	-0.345	-5.244*	-5.077**
	(1.287)	(0.379)	(-3.418)	(-0.159)	(-1.726)	(-2.413)
Invest. (% GDP)	0.000180	3.99e-05				
	(0.631)	(0.113)				
Cost (% GDP)	-0.341	-0.0646**	0.115	0.741*	-1.596***	-0.877*
	(-1.563)	(-2.359)	(0.175)	(1.849)	(-3.225)	(-1.699)
Nº observations	3,508	559	3,940	1,214	3,523	586
Nº Countries	111	26	125	54	108	26
Nº instruments	97	24	104	44	41	19
Hansen test (p-value)	0.120	0.143	0.439	0.612	0.604	0.939
AR1 test (p-value)	8.79e-08	0.0518	0.0191	0.947	0.239	0.106
AR2 test (p-value)	0.533	0.544	0.386	0.465	0.357	0.278
Difference-in-Hansen tests (p-value)						
Instruments level	0.996	0.125	0.424	0.539	0.341	0.887
Time Dummies	0.722	0.855	0.419	0.603	0.409	0.934

Notes: HCAP_gr – Growth rate of human capital per capita ; PCAP_gr – Growth rate of physical capital per capita; TFP_gr – Growth rate of total factor productivity. Meaning of acronyms: _L – group of Large states, _S – group of Small states. t-statistics are in parenthesis. Significance level to reject the null hypothesis: *** - 1%, ** - 5% e * - 10%.

The results in the table above (table 2) of the impacts of the variables of interest (Cost) are similar to those obtained in the estimation of growth rate of GDP per capita. Cost (% GDP) has negative coefficient on growth rate of human capital per capita and TFP of large and small states (columns 1, 3, 5 and 6), and only on growth rate of human capital in large states (column 1) is it not statistically significant. On the estimation with growth rate of physical capital per capita, Cost (% GDP) has a positive coefficient in both groups of countries (columns 3 and 4), but is not statistically significant in large states (column 3). This positive impact on growth rate of physical capital can be associated with the reconstruction process that normally follows after the natural disasters.

All regressions passed the specification test of Hansen, autocorrelation and difference-in-Hansen, so the results are acceptable.

4.2.3 – Effects on the channels of transmission

We used the equation (13) to analyse the effect of the variable of interest (Cost) on growth rate of GDP per capita through the three transmission channels estimated.

The results (table 3) indicate TFP as the main transmission channel through which environmental vulnerability affects growth rate of GDP per capita in both groups of countries. In the group of small states, Cost (% GDP) has a positive impact on the accumulation of physical capital, but is outweighed by the negative impact on the accumulation of human capital and productivity. In the group of large countries, the effect of Cost (% GDP) is negative on the accumulation of human capital and positive on the accumulation of physical capital, but statistically they do not affect the growth of GDP per capita.

Table 3: Effects on the transmission channels

Variables		Large States				Small States			
		ΔGDPpc	ΔHC pc	ΔPC. pc	ΔTFP	ΔGDPpc	ΔHC pc	ΔPC. pc	ΔTFP
Cost (% GDP)	Coefficient	-1.164*	-0.341	0.115	-1.60***	-0.139**	-0.065**	0.741*	-0.877*
	Effect on GDP		0.0000	0.0000	-1.0640		-0.043	0.2470	-0.5847

Notes: The coefficients of ΔGDPpc was estimated on subsection 4.1, table 1 (columns 5 and 6). The effect on GDP is obtained by multiplying the statistically significant coefficients of each channel by $\alpha = 1/3$ in the case of growth of physical capital and by $\alpha = 2/3$ in the case of growth of human capital and growth of TFP.

5 – CONCLUSION

Some studies identify small size as a major impediment to the economic growth process. This is because small size implies higher costs per capita of various public goods and services, lower diversification of products and export markets, greater difficulty in accessing capital markets and taking advantage of economies of scale. However, following an analysis of some stylized facts we conclude that small size is not a handicap to economic growth. We also conclude that despite the significantly higher number of disasters in the group of large countries, the negative impact of environmental vulnerability is not stronger in large countries compared to small countries.

We used land area and population size to divide the countries in two groups, small and large, and we empirically analysed the impact of environmental vulnerability on the growth rate of GDP per capita of these groups of countries. The effects of environmental vulnerability were analysed using the variables people killed or affected and the estimated costs of damage caused by natural disasters. Overall, we conclude that the effect of environmental vulnerability on growth of GDP per capita is not influenced by country size. And this result is robust. In particular, in the two groups of countries, killed (% pop), affected (% pop) and Cost (% GDP) have negative effects on growth of GDP per capita, but only Cost

(% GDP) is statistically significant. TFP is the main transmission channel through which environmental vulnerability affects the growth of GDP per capita in both groups of countries.

Many studies consider small countries more vulnerable to natural disasters than large countries (Briguglio, 1995; Armstrong and Read, 2003) but we conclude that, on average, large countries suffer more natural disasters than small countries and in terms of the effect of environmental vulnerability on growth rate of GDP per capita, there is no difference between small countries and large countries.

Environmental vulnerability contributes significantly, mainly through the channel of productivity, to the reduction in growth rate of GDP per capita in small states. We therefore suggest some policies and strategies to mitigate this negative effect of environmental vulnerability: prepare an appropriate map of the major risks areas; define and implement safer building codes; promote mechanisms for reporting disaster; and, establish fiscal integration at the regional level which facilitates the transfer of resources to face the damage caused by natural disasters.

This work contributes to the empirical literature on small states and the effects of country size on some determinants of economic growth, especially those related to environmental vulnerability. The analysis of transmission channels contributes to understanding the main channels through which environmental vulnerability affects the growth of GDP per capita in both groups of countries. Furthermore, from the literature review, we understand that the lack of consensus about the empirical effects of country size on economic growth arise from the use of different models, variables, methods and databases to compare the economic behaviour of small and large states. In this study we filled this gap by analysing the two groups of states simultaneously.

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APPENDIX

Table A.1 – Groups of countries

Small States

Albania	Curacao	Iceland	Mayotte	Solomon Islands
American Samoa	Cyprus	Isle of Man	Micronesia, Fed. Sts.	St. Kitts and Nevis
Andorra	Djibouti	Jamaica	Moldova	St. Lucia
Antigua & Barbuda	Dominica	Kiribati	Monaco	St. Martin
Armenia	Equatorial Guinea	Kosovo	Montenegro	St. Vincent & the Grenadines
Aruba	Estonia	Kuwait	New Caledonia	Suriname
Bahamas, The	Faeroe Islands	Latvia	Northern Mariana	Swaziland
Bahrain	Fiji	Lebanon	Palau	Timor-Leste
Barbados	French Polynesia	Lesotho	Puerto Rico	Tonga
Belize	Gambia, The	Liechtenstein	Qatar	Trinidad &Tobago
Bermuda	Gibraltar	Luxembourg	Samoa	Turks & Caicos Islands
Bhutan	Greenland	Macao	San Marino	Tuvalu
Brunei Darussalam	Grenada	Macedonia, FYR	S. T. & Principe	Vanuatu
Cape Verde	Guam	Maldives	Seychelles	Virgin Islands (U.S.)
Cayman Islands	Guinea-Bissau	Malta	Singapore	West Bank & Gaza
Channel Islands	Guyana	Marshall Islands	Sint Maarten	
Comoros	Hong Kong	Mauritius	Slovenia	

Large States

Afghanistan	Congo, Rep.	Iran	Nepal	Sri Lanka
Algeria	Costa Rica	Iraq	Netherlands	Sudan
Angola	Cote d'Ivoire	Ireland	New Zealand	Sweden
Argentina	Croatia	Israel	Nicaragua	Switzerland
Australia	Cuba	Italy	Niger	Syrian Arab Republic
Austria	Czech Republic	Japan	Nigeria	Tajikistan
Azerbaijan	Denmark	Jordan	Norway	Tanzania
Bangladesh	Dominican Republic	Kazakhstan	Oman	Thailand
Belarus	Ecuador	Kenya	Pakistan	Togo
Belgium	Egypt	Korea, Dem. Rep.	Panama	Tunisia
Benin	El Salvador	Korea, Rep.	Papua New Guinea	Turkey
Bolivia	Eritrea	Kyrgyz Republic	Paraguay	Turkmenistan
Bosnia & Herzegovina	Ethiopia	Lao PDR	Peru	Uganda
Botswana	Finland	Liberia	Philippines	Ukraine
Brazil	France	Libya	Poland	United Arab Emirates
Bulgaria	Gabon	Lithuania	Portugal	United Kingdom
Burkina Faso	Georgia	Madagascar	Romania	United States
Burundi	Germany	Malawi	Russian Federation	Uruguay
Cambodia	Ghana	Malaysia	Rwanda	Uzbekistan
Cameroon	Greece	Mali	Saudi Arabia	Venezuela, RB
Canada	Guatemala	Mauritania	Senegal	Vietnam
Central African Rep.	Guinea	Mexico	Serbia	Yemen, Rep.
Chad	Haiti	Mongolia	Sierra Leone	Zambia
Chile	Honduras	Morocco	Slovak Republic	Zimbabwe
China	Hungary	Mozambique	Somalia	
Colombia	India	Myanmar	South Africa	
Congo, Dem. Rep.	Indonesia	Namibia	Spain	

Table A.2 – Statistics data

Large states

Variables	Obs	Mean	St. Dev.	Min	Max
GDP per capita (log)	4978	8.222086	1.32276	5.080144	11.09557
GDP per capita (growth)	4830	0.0144257	0.0318562	-0.2979097	0.2464264
Population (growth)	5412	0.0147749	0.0113374	-0.0532828	0.1194897
Investment (% GDP)	4978	21.56081	9.525715	0.6920165	66.37524
Secondary school enrolment (%)	4498	55.1768	34.97741	0.18163	156.5211
Killed (% population)	4135	0.000046	0.000321	0	0.0071621
Affected (% population)	4135	0.0289256	0.0861738	0	1.151946
Cost (%GDP)	4089	0.0031047	0.0130644	0	.3423149
TFP (growth)	5274	0.0028537	0.0398351	-0.4675579	0.3636466
TFP (log)	5716	8.26341	.9484005	4.647868	10.57974
Human Capital (growth)	5348	0.0090861	0.0109102	-0.0379078	0.0651661
Human Capital per capita (log)	5800	-.3427445	0.4689464	-1.543521	0.6504265
Physical Capital (growth)	5906	0.0240277	0.0364251	-0.0845323	0.7195717
Physical Capital per capita (log)	6423	8.800752	1.608962	3.217362	12.70484

Notes: Data in 5 year period, rolling Windows, from 1970 to 2010, for 127 large states.

Small states

Variables	Obs	Mean	St. Dev.	Min	Max
GDP per capita (log)	2168	8.785968	1.153771	6.118179	11.82269
GDP per capita (growth)	2008	0.0176938	0.0381922	-0.2398716	0.3633565
Population (growth)	2378	0.0124913	0.0135348	-0.1391962	0.1140619
Investment (% GDP)	2168	26.92532	12.52897	2.14892	75.86247
Secondary school enrolment (%)	1825	63.79278	31.38732	1.88067	164.5947
Killed (% population)	1268	0.0000446	0.0001449	0	0.0015563
Affected (% population)	1268	0.0763198	0.1911857	0	1.586869
Cost (%GDP)	1263	0.0283401	0.1032278	0	1.524193
TFP (growth)	1079	0.0030298	0.0443354	-0.1904459	0.1613677
TFP (log)	1194	8.74524	1.028299	6.281762	12.53713
Human Capital (growth)	1079	0.0126139	0.0117807	-0.0175195	0.0646177
Human Capital per capita (log)	1194	-0.1213982	0.3710991	-1.088073	0.7908052
Physical Capital (growth)	2168	0.0314269	0.0400493	-0.0620972	0.3917897
Physical Capital per capita (log)	2396	9.591817	1.392971	2.980491	12.43568

Notes: Data in 5 year period, rolling Windows, from 1970 to 2010, for 54 small states.

Table A.3 – VIF test

Variables	Cost (% GDP)			Affected (% pop)			Killed (% pop)		
	VIF_L	VIF_S	VIF_T	VIF_L	VIF_S	VIF_T	VIF_L	VIF_S	VIF_T
Initial GDPpc (log)	3.92	2.09	3.29	3.95	2.16	3.32	3.92	2.09	3.29
Secondary (%)	5.11	3.41	4.67	5.12	3.45	4.67	5.13	3.40	4.69
POP_gr (%)	1.99	1.71	1.85	1.99	1.73	1.85	1.99	1.72	1.85
Invest. (% GDP)	1.15	1.04	1.10	1.15	1.03	1.09	1.15	1.03	1.10
Cost (% GDP)	1.01	1.03							
Cost_L (% GDP)			1.01						
Cost_S (% GDP)			1.02						
Affected (% pop)				1.07	1.11				
Affected_L (% pop)						1.07			
Affected_S(% pop)						1.02			
Killed (% pop)							1.03	1.08	
Killed_L (% pop)									1.03
Killed_S(% pop)									1.02
Dummy (1976-1980)	2.16	2.86	2.25	2.16	2.87	2.26	2.16	2.88	2.26
Dummy (1981-1985)	2.33	3.56	2.49	2.33	3.62	2.50	2.33	3.58	2.50
Dummy (1986-1990)	2.41	3.71	2.58	2.41	3.71	2.57	2.42	3.71	2.59
Dummy (1991-1995)	2.51	3.74	2.67	2.50	3.73	2.65	2.52	3.73	2.67
Dummy (1996-2000)	2.66	4.01	2.82	2.66	4.01	2.82	2.67	4.01	2.84
Dummy (2001-2005)	2.89	5.02	3.17	2.88	5.02	3.15	2.90	5.03	3.17
Dummy (2006-2010)	2.96	5.09	3.25	2.95	5.08	3.23	2.96	5.09	3.25
Mean VIF	2.59	3.11	2.48	2.60	3.13	2.48	2.60	3.11	2.48

Note: Meaning of acronyms: _L – group of Large states, _S – group of Small states, _T – Total states

Table A.4: Sensitivity analysis

Variables	(1) *Cluster* GDP GDPgr_T	(2) *Cluster* POP GDPgr_T	(3) *Cluster* Area GDPgr_T	(4) Period (1970-2000) GDPgr_T	(5) Period (1980-2010) GDPgr_T	(6) Excludes low income GDPgr_T	(7) Excludes high income GDPgr_T	(8) Excludes petroleum exporting GDPgr_T	(9) Excludes outliers GDPgr_T
Initial GDPpc (log)	-0.0178*	-0.0189*	-0.0181*	-0.0239**	-0.0402***	-0.0260***	-0.0255*	-0.0200*	-0.0228**
	(-1.834)	(-1.891)	(-1.950)	(-2.003)	(-5.953)	(-2.623)	(-1.856)	(-1.717)	(-2.178)
Secondary (%)	0.000475*	0.000507	0.000487*	0.000669*	0.0015***	0.000479	0.000761	0.000484	0.000484
	(1.665)	(1.630)	(1.767)	(1.795)	(5.651)	(1.641)	(1.286)	(1.463)	(1.420)
POP_gr (%)	-1.512**	-1.522**	-1.469**	-1.339**	-1.009**	-1.402*	-1.538**	-2.322***	-1.018
	(-2.465)	(-2.488)	(-2.460)	(-2.397)	(-2.132)	(-1.848)	(-2.426)	(-3.999)	(-1.160)
Invest. (% GDP)	0.00119**	0.00113**	0.00115**	0.0015***	0.000593	0.0013***	0.00091**	0.00103**	0.00138**
	(2.395)	(2.252)	(2.323)	(2.955)	(1.331)	(2.925)	(2.008)	(2.410)	(2.080)
Cost_L (% GDP)	-0.870*	-0.932*	-0.757*	-0.578	-0.434	-0.667*	-0.912	-1.054*	-0.776*
	(-1.701)	(-1.716)	(-1.729)	(-1.380)	(-1.584)	(-1.697)	(-1.482)	(-1.741)	(-1.723)
Cost_S (% GDP)	-0.149*	-0.149*	-0.156*	-0.0418	0.0316	-0.148*	-0.101	-0.143*	-0.173*
	(-1.790)	(-1.782)	(-1.836)	(-1.005)	(0.638)	(-1.746)	(-1.211)	(-1.787)	(-1.685)
Nº observations	4,688	4,688	4,688	3,166	4,019	3,778	3,508	4,316	4,292
Nº Countries	181	181	181	170	181	148	133	166	165
Nº instruments	134	134	134	132	145	116	116	116	110
Hansen test (p-value)	0.242	0.158	0.191	0.168	0.219	0.288	0.337	0.241	0.202
AR1 test (p-value)	0.0262	0.0324	0.0384	0.253	0.205	0.0104	0.142	0.0178	0.145
AR2 test (p-value)	0.611	0.648	0.422	0.857	0.290	0.322	0.700	0.887	0.395
Difference-in-Hansen tests (p-value)									
Instruments level	0.225	0.169	0.139	0.809	0.403	0.535	0.130	0.101	0.177
Time Dummies	0.273	0.170	0.236	0.769	0.579	0.701	0.709	0.637	0.891