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COUNTRY SIZE AND EXPOSURE TO INTERNATIONAL ECONOMIC SHOCKS: NEW EVIDENCE FROM THE FINANCIAL CRISIS

Working Papers Liechtenstein Institute No. 74 (2022)

LIECHTENSTEIN-INSTITUT

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Working Papers No. 74 (2022)
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http://dx.doi.org/10.13091/li-ap-74

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ABSTRACT

The international Financial Crisis shock of 2008/09 is used as case study with a worldwide data set of 210 states to examine potential resilience factors with special focus on country size, along with other pre-crisis determinants. The cross-country analysis suggests an increasing partial effect of smaller country size on vulnerability with a larger impact magnitude of the Financial Crisis shock. States below a population of around 10 million featured a higher exposure compared to larger states and very small states suffered the most from being more vulnerable. With respect to impact persistence, significant evidence can be found that the shock persistence was prolonged by smaller state size. Also, small states were impacted earlier on average, but the faster shock transmission was mainly linked to their higher GDP per capita and lower pre-crisis GDP growth.

Keywords: Resilience; small states; Financial Crisis; cross-country regression
JEL classification: C21, E02, E32, G01

Anhand eines weltweiten Datensets mit 210 Ländern wird der internationale Finanzkrisenschock 2008/09 als Fallstudie angewendet, um potenzielle Resilienzfaktoren zu untersuchen, mit einem speziellen Fokus auf Ländergrösse. Die Länderquerschnittsanalyse legt einen verstärkenden partiellen Einfluss von kleinerer Bevölkerungsgrösse auf die Vulnerabilität mit einer grösseren Schockwirkung der Finanzkrise nahe. Länder mit einer Bevölkerung von unter 10 Millionen wiesen eine höhere Exposition auf und sehr kleine Länder litten am meisten unter der höheren Verwundbarkeit. Bezüglich der Persistenz der Schockwirkung kann signifikante Evidenz gefunden werden, dass die Dauer von Länder-Kleinheit verlängert wurde. Zudem waren kleine Länder im Durchschnitt früher betroffen, die schnellere Schockübertrag war jedoch hauptsächlich mit ihrem höheren BIP pro Kopf und dem tieferen Vorkrisenwachstum verknüpft.

Schlüsselwörter: Resilienz; Kleinstaaten; Finanzkrise; Länder-Querschnittsregression
JEL-Klassifikation: C21, E02, E32, G01

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1. INTRODUCTION[1]

The number of sovereign nations in the world has roughly tripled since World War II and as a consequence, the average country size has decreased. According to the CIA World Factbook 2020 listing 238 inhabited sovereign countries and independent territories worldwide, 147 show a population of below 10 million, 78 below 1 million and 42 below 100'000. Yet, the examination of the economic implications of state size remains a niche in the scientific literature, especially in economics (an extensive overview on small states research is given in THORHALLSSON [2018]).[2] One major finding is that small economies exhibit higher volatility for reasons that the small states literature usually relates to the general literature on state resilience (see last paragraphs of the introduction).

Higher volatility implies a larger impact magnitude of international shocks (but not necessarily a longer impact persistence). The Financial Crisis 2008/09 was – at the time – the largest international economic shock and led to the sharpest recession since World War II with its international average trough in 2009. Its sudden and strong impact and the fast worldwide propagation affecting most economic sectors may help uncover the otherwise more obscured conditions of economic resilience. In line with the findings of the small states economics literature it can be presumed that smaller economies were more heavily affected by the international Financial Crisis shock; a presumption that can be confirmed in this study.[3] But what determinants beyond state size itself were responsible for this pattern? And were those determinants directly tied to size in terms of mere fate or simply correlated with size, possibly due to common policy choice patterns of small states worldwide?

High volatility is strongly related to the shock exposure. At the same time, small state research also suggests that some small states have managed to accommodate and get used to high volatility (and recover well from shocks), since they tend to be more flexible and adapt more quickly. This is visible by the fact that many – yet by far not all – small states have attained a high level of economic prosperity.[4] Hence, the additional question arises which of the two features attributed to small states – higher exposure or higher adaptation flexibility – have dominated in the mid- and long-run of the Financial Crisis shock impact (i.e. the recovery).

1 The author is grateful to Martin Geiger and Martin Gächter for useful comments and several interns at the Liechtenstein Institute for research assistance. The paper has also benefitted from comments received at the "International Conference on Macroeconomic Analysis and International Finance" and in research seminars.

2 This partly emerges from the question of how to define size – be it area, population, economic/political power, other characteristics or a combination of them – and what size limit actually defines a small state at all.

3 As small states are associated with higher foreign trade ratios and typically low economic diversification – both increasing the responsiveness to international shocks – it is not surprising that the literature finds a negative relation between volatility and state size. This finding can also be confirmed with the data applied in this study, for the time period 1970–2019 (see Table 1) and also for the Financial Crisis (see section 3.1.).

4 According to GDP per capita figures (USD, 2019) of the UN National Accounts Main Aggregates Database, seven of the ten wealthiest states worldwide have a population of below 1 million (Bermuda, Cayman Islands, Iceland, Macao, Monaco, Liechtenstein, Luxembourg). The other three wealthiest states have a population between 1 and 10 million (Ireland, Norway, Switzerland). For 2019, the correlation between GDP per capita and the logarithm of population size of the 212 states in the UN database is negative and highly significant (correlation coefficient −0.28, p-value 0.000038). Yet, this has not much to say about the causal impact of size itself if no other covariates are taken into account.

In the paper at hand the international economic shock of the Financial Crisis 2008/09 is used as case study to investigate the shock impact's cross-country variation and to isolate and quantify the effect of state size driving the impact. With a worldwide data sample of 210 states (sovereign countries and independent territories), the broadest dataset[5] with respect to the quantity of states and the variety of variables is applied to overcome the latent data sample bias towards larger states usually neglected in the literature. This is of importance especially but not only when the focus lies on state size.[6] The combination of the multiple regression frame with the broad data set allows to thoroughly quantify the partial effect of state size (measured by population) on the impact magnitude, persistence duration and timing of the Financial Crisis shock. The state size factor needs to be separated from or potentially be fully explained by other economic, political or geographical resilience conditions. Also, potential size-thresholds and other non-linear relationships between size and the shock impact are explored. This study's goal is therefore to disentangle size itself from other resilience determinants proposed in the small states and resilience literature that are simply correlated with size. In doing so, more of the thus far unobserved conditions within size are accounted for.

The impact of the Financial Crisis shock is measured by adopting the perception of resilience as the combination of vulnerability (shock impact magnitude) and recovery (shock persistence). This definition places explicit emphasis both on the time dimension and on the impact on a given single variable.[7] In the study at hand 210 states and about 40 economic, political, and geographic pre-crisis determinant variables are included in the dataset covering the years from 2002–2013 (see data section A.2.). All 210 states can be considered for the main regression specifications as the majority of relevant variables originates from the harmonized and fairly new National Accounts Main Aggregates Database supplied by the United Nations. Some variables are gained from other international datasets, though. Each additional state is crucial to lessen a potential state sample bias, as a neglected state would most likely be a small state, which is usually not well covered by international databases. To explore the shock vulnerability, pre-crisis determinants are regressed on the initial impact magnitude measured by the real GDP percentage points growth difference of 2009 versus 2007 (section 3.1.). The shock impact persistence is examined both in ordinary multiple regressions to explain the real GDP percentage points growth difference of post-

5 At least to the author's knowledge.

6 State size is largely neglected in the literature dealing with conditions for the Financial Crisis shock's impact magnitude, but also in the general resilience literature. But even if state size is indeed included into the regression setting, then the studies usually suffer from a state sample bias, as they include about 120 states on average. The reason for not including more states merely lies in the fact that heavy data restrictions exist, even more so with granular data beyond population size or GDP: Hence, the more detailed the variables must be to satisfy the research question or estimation strategy, the narrower the state sample becomes, with an increasing bias towards larger states. This sample bias alters the findings not only regarding the impact of state size, but potentially also on other independent variables if they are interconnected with size (as demonstrated in the step-wise sample restriction by state size in Table 11). Furthermore, in the frequently used international data bases some of the very small states are included, but typically only IMF/World Bank member states and/or small states with a colonial past. This potentially adds bias, too. The data truncation problem is also thoroughly discussed in Armstrong and Read [2020], who manage to attain a data sample of 223 states, which reduces to 192–197 when variables apart from GDP are introduced into the main analysis.

7 This perception of resilience is more in the applied data setting as opposed to the well-cited and policy-oriented definition of risk and resilience by Briguglio et al. [2009], in which risk is determined both by vulnerability (exposure, which increases risk) and resilience (ability to adapt, which reduces risk).

shock years averages against pre-crisis years and in ordinal dependent variable regressions on the duration to reach pre-crisis real GDP levels again (section 3.2.). The speed of the shock propagation, i.e. the timing/earliness of the impact, is investigated in a binary dependent variable frame (section 3.3.).

The results suggest a ceteris paribus link between smaller population size and higher vulnerability expressed in a larger impact magnitude of the Financial Crisis shock. States below around 10 million inhabitants featured a size disadvantage compared to larger states, and very small states suffered the most, partly due to unobserved factors related to size and not only due to pre-crisis determinants directly attributable to or simply correlated with size. With respect to impact persistence, significant evidence can be found that the duration of the recovery to pre-crisis levels was prolonged by smaller size. Hence, the smallness disadvantage of higher exposure has dominated the advantages of flexibility and adaptation speed. Small states were also more likely to be impacted earlier and the faster shock transmission can be explained by their higher GDP per capita and lower pre-crisis GDP growth.

The mere population size itself cannot be interpreted as the sole responsible factor by any economic reasoning. However, the robust significance of the population size coefficient both for the shock impact magnitude and the impact persistence indicates that the included and frequently cited determinants such as high degree of foreign trade, low diversification level, focus on financial services, economic prosperity, remoteness/insularity, or reliance on tourism are not responsible for all volatility induced by small size, if at all. After partialling out these effects, the adverse influence of smallness still implicitly includes important uncontrolled factors tied to small size that are not fully capturable with pre-crisis determinants control variables, such as the lack or low leverage of fiscal or monetary policy in small states and the higher sensitivity to terms-of-trade shocks (both of which cannot be explored due to the lack of worldwide data). Yet, the terms-of-trade shocks not only have a direct nexus with low price setting power but also with high international trade integration. This should be reflected by significant partial effects of the trade quotas included as control variables and therefore potentially turn the population coefficient insignificant (both is not the case). This gives rise to the conclusion that the reduced scope of anticyclical policy per se or state differences in policy responses actually carried out are likely drivers behind the significance of population size.

The contribution most closely related to this study is ARMSTRONG AND READ [2020], who apply correlation and cluster analyses to a worldwide state sample (mainly building on World Bank data), with the focus on the magnitude and persistence of the Financial Crisis impact. Beside other insights, they find a negative correlation between the impact magnitude and population size, which can be confirmed in this study. The main additional contribution of the study at hand is that the impact of size on the shock vulnerability and persistence are isolated and disentangled from other determinants correlated with size to alleviate possible omitted variable bias. Additionally, nonlinear relationships and the impact timing are explored. Also, a broader, harmonized data set with more states and control variables and an alternation of shock impact and persistence measures are applied.

There exist three literature strands relevant for the subsequent data analysis: The general literature on resilience (where size can be one influential determinant), the literature on the impact drivers of the Financial Crisis (neglecting state size in most cases), and the small states literature.

Numerous potential determinants of resilience – both on the vulnerability and the recovery dimension of resilience – or growth volatility are analyzed in the literature (for a literature overview on resilience/vulnerability see FÖRTSCH ET AL. [2021] or ARMSTRONG AND READ [2020]).[8] BRIGUGLIO ET AL. [2009] identify a positive impact of wealth (GDP per capita) on resilience in general, while CRESCENZI ET AL. [2016] find a negative influence of wealth during the Financial Crisis. The empirical findings regarding the impact of the education or innovation level on resilience are mixed (FÖRTSCH ET AL. [2020], MARTIN AND GARDINER [2019], CRESCENZI ET AL. [2016]). Foreign trade integration, both with respect to international trade share and regional diversification of international trade partners, can have a strong impact on resilience: A higher international trade share (DI GIOVANNI AND LEVCHENKO [2009]) and a larger regional trade concentration (LEDERMAN AND LESNIAK [2018]) decrease resilience. A strong reliance on strategical imports or a low export variety decrease resilience (BRIGUGLIO [2016]). Likewise, the sectoral composition of the economy seems to play a role. Yet, this nexus is not as clear as it seems at first sight. While overall diversification has a smoothing effect on business cycle fluctuations, which is usually one of the key arguments for the small states' higher volatility, specialization into a very robust niche could still yield lower vulnerability (SENSIER AND ARTIS [2016]). The relevant factor is not necessarily the sectoral distribution in terms of an overall diversification measure (such as the HHI mentioned in footnote 22), but in which particular sectors the diversification appears (MARTIN AND GARDINER [2019]). EASTERLY ET AL. [2001] for instance find a non-linear relationship between financial sector development and volatility, indicating that financial deepening has stabilizing effects at first but increases risk beyond some point. Besides economic factors, also geographical, social and political characteristics affect states' resilience. On the one hand, reachability (MARTIN AND GARDINER [2019]), social development and cohesion (BRIGUGLIO ET AL. [2009]), the quality of institutions (BRIGUGLIO AND VELLA [2018]), or social peacefulness (RODRIK [1999]) have a positive influence on resilience. On the other hand, urban population share, remoteness, world regional location, a certain geographical composition within states, or the proneness to natural disasters have a negative effect (ARMSTRONG AND READ [2006]). The literature finds contradicting empirical results to some of the just mentioned conditions. While some discrepancies are explainable by varying resilience conceptions or measurements, a possible further reason could be counter-effects between determinants and that the determinants' influence may vary across certain characteristics, such as the development state of the economy (see HNATKOVSKA AND LOAYZA [2003]).

Similar to the general literature on resilience, also the literature on the resilience during the Financial Crisis is abundant (see DWYER AND TAN [2014] and FÖRTSCH ET AL. [2021] for a literature overview). Some studies examine the variation across regions (ANGULO ET AL. [2018], CRESCENZI ET AL. [2016], FÖRTSCH ET AL. [2021], GROOT ET AL. [2011], WEBBER ET AL. [2018], XIAO ET AL. [2018]). Others exploit the Financial Crisis shock affectedness in a cross-country setting (AIGINGER [2011],

[8] The most important determinants from the vast literature shall be mentioned here with exemplary references.

Armstrong and Read [2020], Dwyer and Tan [2014], Berg et al. [2011], Berkmen et al. [2012], Chen et al. [2019], Claessens et al. [2010], Favaro et al. [2011], Frankel and Saravelos [2012], Giannone et al. [2011], Ho [2015], Lane and Milesi-Ferreti [2010], Rose and Spiegel [2010, 2011, 2012], Verdun [2012]). Especially the latter studies typically focus on financial variables (such as credit growth, leverage, debt to GDP), GDP per capita, and international trade with goods/services. But they typically have rather small cross-section samples of about 120 states in average, mostly because of the data granularity. State size as determinant is not considered in the majority of the mentioned references, and if considered, not consistently significant.

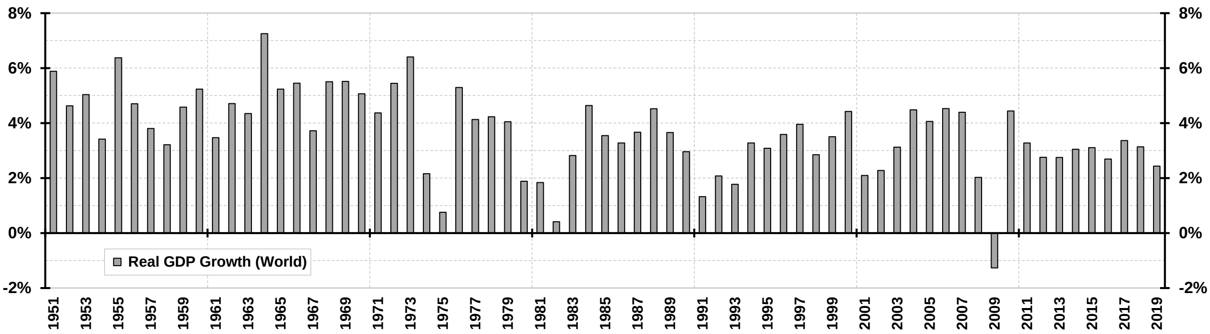
Armstrong and Read [2020, pp. 892–897] provide an excellent summary on growth volatility with a special emphasis on state size and also deliver a collection of the literature on the research question at stake in this study. They also connect the conditions of growth volatility of small states with their implications for the examination of the Financial Crisis shock. Even though their literature summary shall not be repeated or extended here, it is still worth noting a few stylized facts on small states from economic theory and empirics that are relevant for the subsequent analysis. These stylized facts are closely tied to the determinants mentioned in the general resilience literature above. The empirical literature shows that smaller states feature higher volatility and provides manifold explanations (see for instance Easterly and Kraay [2000], Furceri and Karras [2007, 2008], Hnatkovska and Koehler-Geib [2018], Alouini and Hubert [2019], Edwards and Romero [2020]). There exist various volatility increasing determinants for small states. The most important argumentation lines are: First, the high international trade share leads to a reduced domestic market buffer to international shocks and increased sensitivity to terms-of-trade shocks. Second, small states exhibit a low leverage of stabilizing fiscal policy and in most cases no autonomous monetary policy. Third, they feature a lower sectoral diversification level. Additionally, the geographic and natural/human resource constraints and other (risk) diversification restrictions of small states are amplified by niche strategies often pursued by small states (Kocher [2002, pp. 134–136]). Other frequently mentioned factors enhancing volatility in small states are lower competition in the domestic market (e.g. natural monopolies), asymmetries between local production or consumption, reliance on strategical imports, and increased exposure to natural disasters (e.g. small island states).[9]

[9] Traditional economic theory stresses the lack of economies of scale for the provision of public goods in small regional entities (Alesina and Spolaore [1997], Kuznets [1960], Tullock [1969]) and the challenge for the private sector to exploit returns to scale in face of small domestic markets (Romer [1986]). Both can be interpreted as growth obstacles. Also, the low economic and political power of small states can be seen as important prosperity burdens (Baldacchino [2008], Briguglio et al. [2006]). The small states economics literature finds inconsistent results on the nexus between size and prosperity, be it wealth levels or observed growth and discusses various advantages of small size offsetting the shortcomings (see for instance Alesina and Spolaore [2003], Alesina et al. [2005], Alouini and Hubert [2019], Armstrong and Read [2003], Briguglio et al. [2006], Easterly and Kraay [2000], Rose [2006]).

2. DATA AND DESCRIPTIVE STATISTICS

The Financial Crisis 2008/09 started with the sub-prime crisis in the US and led to a sharp world-wide economic down-turn, often referred to as the "Great Recession" in reference to the "Great Depression" in the interwar years. The Great Recession marked the deepest business cycle trough of the post-war era until the COVID-19 crisis 2020. 2009 was the first year after World War II with a negative world real GDP growth, as shown in Figure 1. Even the oil crisis years 1975 and 1982 showed positive – yet very low – growth rates.

Figure 1: Real Growth Rates of World GDP



Data source: UN (National Accounts Main Aggregates Database), Maddison Database 2010

As already outlined, small states generally feature higher economic volatility compared with larger ones. Table 1 considers the standard deviation of real GDP growth rates (1970–2019) of the 170 states[10] that are available in the National Accounts Main Aggregates Database (UN) and have continuously existed since 1970. When split into state size groups, the growth volatility group mean gradually decreases with state size. This pattern is also reflected in the correlation coefficient between the standard deviation of real GDP growth rates and population size (−0.1683, p-value 0.0283) or the logarithm of population size −0.3122 (p-value 0.0000).

Table 1: GDP growth volatility since 1970 by state size group

Annual Real GDP Growth (1970–2019)	Number of States in Group	Standard Deviation (Group Mean)
Population < 100'000	19	5.6%
100'000 < Population < 1'000'000	29	5.3%
1'000'000 < Population < 10'000'000	52	4.9%
10'000'000 < Population < 100'000'000	60	4.5%
100'000'000 < Population	10	3.3%

Data source: UN (National Accounts Main Aggregates Database)

The Financial Crisis was associated with a massive shock wave throughout the economies and societies worldwide. While only ten out of 207 states[11] featured negative real GDP growth in 2007, about half of the 207 states suffered from negative growth in 2009. The median annual real GDP

[10] Nine heavy outlier states have been excluded from Table 1, as they feature a standard deviation of the real GDP growth rate larger than 12%, mostly due to armed conflicts. These states are Afghanistan, Equatorial Guinea, Iraq, Nauru, Kiribati, Kuwait, Lebanon, Liberia, and Libya.

[11] The former Netherland Antilles, Nauru, Somalia, South Sudan, Sudan, and Zimbabwe were excluded from the sample of tables Table 2 and Table 3 (for reasons explained in footnotes 17 and 18).

growth rate in 2009 was −0.1% compared to +5.8% in 2007. The growth difference between 2009 and 2007 was −6.2 percentage points in mean (median −5.7). Yet, as shown in Table 2, the shock impact's magnitude considerably varied across states if grouped by size. While the 21 states below a population of 0.1 million experienced an average growth difference of −10.5% percentage points, the negative growth difference in mean shrinks as more and more larger states are included into the sample.

Table 2: Impact magnitude of Financial Crisis shock by state size group

Annual Real GDP Growth Difference (2009 vs. 2007, %-Points)	Number of States	Group Mean
Population < 100'000	21	−10.5
Population < 1'000'000	53	−7.6
Population < 10'000'000	130	−7.0
Population < 100'000'000	196	−6.3
All States	207	−6.2

Data source: UN (National Accounts Main Aggregates Database)

To examine what country characteristics might have affected the Financial Crisis shock impact magnitude, it is in a first step useful to compute descriptive statistics in order to draw some preliminary conclusions.[12] The data set mainly builds on data provided by United Nations, but additional variables are gathered from World Bank, IMF, CEPII (GeoDist Database), ILO, CIA (World Factbook), UCDP/PRIO Armed Conflict Dataset, and the author's own data compilations (see data section A.2.). Table 3 shows descriptive statistics and correlations and reveals that in 2007 smaller states (logarithm of population size[13]) tended to be wealthier in terms of per capita GDP and featured lower average real GDP growth before the Financial Crisis (between 2002 and 2007). They also exhibited a lower value added share in manufacturing and a higher share in other services (as proxy for financial services, see footnote 16). Additionally, they were less diversified, more remote – many small states are Caribbean or Pacific islands – and featured a higher reliance on international trade.

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12 Aiming at a worldwide data set with as many states as possible carries the drawback of a reduced number of variables available for each state. Since data availability (and quality) is an especially critical issue for small states, the trade-off between the number of considered states and the number of included variables is treated here by maximizing the number of cross-section entities rather than increasing the number of variables. Doing so will prevent a selection bias towards larger states.

13 If all the states are plotted by increasing size and their number of inhabitants, one observes a "quasi-exponential" shaped curve. By taking logarithms, the remaining graph comes much closer to a continuously increasing line. The inclusion of log[*POP*] instead of *POP* in the regressions (section 3.1.) also yields an improvement of goodness-of-fit measures such as R^2 and the information criterion by AKAIKE [1974].

Table 3: Descriptive statistics of pre-crisis determinants and Financial Crisis impact magnitude

	Descriptive Statistics				Correlation Coefficient							
	Mean/ Median	**Max/ Min**	**Std. Dev.**	**N**	***GDP-GD97***	**log [*POP*]**	***Pre-Crisis GDP Growth***	***GDP per Capita***	***VA Manufacturing***	***VA Other Services***	***VA Diversification***	***Trade Quota***
GDP Growth Difference (GDPGD97)	−6.21/ −5.70	19.34/ −32.12	7.13	207		0.18*** N=207	−0.39*** N=207	−0.31*** N=207	−0.05 N=207	−0.10 N=207	−0.09 N=207	−0.22*** N=207
Population (POP)	32.0/ 5.9	1'346/ 0.005	128.5	207	0.07 N=207	0.41*** N=207	0.13* N=207	−0.07 N=207	0.22*** N=207	−0.06 N=207	−0.12* N=207	−0.16** N=207
log[*POP*]	1.33/ 1.78	7.20/ −5.32	2.40	207	0.18*** N=207		0.19*** N=207	−0.28*** N=207	0.43*** N=207	−0.39*** N=207	−0.42*** N=207	−0.38*** N=207

GDP Growth Difference: real GDP (annual growth rate), difference (%-points) 2009 vs. 2007; *Pre-Crisis GDP Growth*: real GDP (annual growth rate), average 2002–2007; *GDP per Capita:* nominal GDP per capita (1'000 USD), 2007; *POP*: population (1'000'000 people), 2007; *VA Manufacturing*: sectoral value added share of manufacturing (%), 2007; *VA Other Services*: sectoral value added share (%), other services, 2007; *VA Diversification*: Herfindahl-Hirschman Index of sectoral value added shares, 2007 (see footnote 22); *Trade Quota*: goods and services trade (exports plus imports) in percent of GDP, 2007. See Table 14 for further explanations of variables and data sources.
Displayed are Pearson-Bravais correlation coefficients. The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01).

The highly significant positive correlation between state size and the Financial Crisis impact magnitude implies a less negative real GDP growth difference (2009 vs. 2007) in larger states and therefore points to a lower shock exposure in comparison to smaller states. Yet, this could be a spurious correlation artefact linked to the observation that many very small countries have used their sovereignty to specialize into low tax regimes combined with an attractive environment for financial services and therefore probably suffer more from an international Financial Crisis. Also, the international trade share is on average – but not necessarily – higher with smaller domestic market size. Furthermore, many small states are either very wealthy or poor, most are remote islands (in the data sample 41 of 54 states with a population below 1 million are islands), and many heavily rely on tourism. Thus, the high shock impact magnitude could be caused by certain common economic determinants or geographic characteristics of many small states and not by factors inevitably tied to smallness itself. Or mutual economic strategies, such as small states' search for economic niches or even loopholes could have an influence. Hence, the advantage of the usage of covariates along with population size in a multiple cross section regression frame is obvious.

3. DETERMINANTS OF THE FINANCIAL CRISIS SHOCK EXPOSURE

In this study, resilience is perceived as the combination of shock vulnerability and ability to recover. A worldwide cross-section with 210 states is applied to identify responsible pre-crisis determinants behind the state cross-section variation of the impact of the Financial Crisis shock 2008/09 and to isolate those factors from state size. The regressions follow a coherent cross-section equation frame with *i* states. Population size log[POP_i] along with other pre-crisis conditions $x_{i,1},\dots,x_{i,j}$ (referring to the year 2007 if not stated otherwise) are regressed on the shock's initial impact magnitude (vulnerability, section 3.1.), the impact persistence (recovery, section 3.2.) and the impact timing (earliness, section 3.3.):[14]

$$y_i = c + \alpha \cdot \log[POP_i] + \beta_1 \cdot x_{i,1} + \cdots + \beta_j \cdot x_{i,j} + \varepsilon_i$$

The dependent variable *y* varies across impact dimensions: The impact magnitude is proxied by the percentage point difference between real GDP growth rate in 2009 and the real GDP growth rate in 2007. The impact persistence is constructed as real GDP percentage points growth difference of the post-shock years average (2008–2013) compared with pre-crisis years (2002–2007) and as ordinal dependent variable capturing the number of years to reach the pre-crisis real GDP level again. The impact timing is examined as binary dependent variable with the value 1 for the states experiencing negative real GDP growth already in 2008 and 0 otherwise. The selection process of the *j* control variables is led by typical resilience conditions mentioned in the literature, covering a broad range of economic, geographical and political characteristics.

3.1. Vulnerability: Impact Magnitude

In the main regression exercise, the percentage point difference between real GDP growth rate in 2009 (worldwide GDP peak) and real GDP growth rate in 2007 (worldwide trough) serves as vulnerability proxy to measure the magnitude of the financial crisis' initial impact and is used as dependent variable. With the application of growth differences, a more accurate capture of the change in the business cycle dynamics can be achieved. Several pre-crisis determinants are regressed on the immediate impact magnitude, first in the main regression equation setting (Table 4) and then augmented by additional regressors (Table 5).[15] Additionally, critical state size thresholds are examined.

Since wealth determinants, international trade reliance and sectoral composition are usually identified as key economic resilience conditions, they were in the center of the data gathering and selection process. Equation [5] of Table 4 represents the main regression equation, in which population size, prosperity (GDP per capita in USD, *GDPC*), value added share of manufacturing (*VAMAN*), the value added share of other services (*VAOTH*, as a proxy for financial services

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[14] EViews and STATA (including the packages "parmest", "hetprobit", "st0208") are used for the regressions.

[15] All the regressions in section 3.1. are carried out with robust standard errors (EICKER [1967], HUBER [1967], WHITE [1980]), as conventional tests detect at least some heteroskedasticity in the data.

relevance[16]) are regressed on the percentage difference of real GDP growth 2009 in comparison to 2007 (*GDPGD97*). Also, the pre-crisis growth level is included as regressor (*GDPG27*) and defined as average real *GDP* growth during the years after the burst of the dot-com bubble until the peak before the crisis (2002 up to 2007). The variable selection in the main regression equation is based on economic a-priori reasoning, data availability and model fit measures. All the variables just mentioned are available from the harmonized National Accounts Main Aggregates Database (UN).

Table 4: Financial Crisis impact magnitude (vulnerability), main regression equation

Impact Magnitude (Vulnerability)	Dependent Variable: Real GDP Growth Difference 2009 vs. 2007, %-Points (*GDPGD97*)						
	Ordinary Least Squares						
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Constant	−6.7581***	−1.4333	0.7199	2.1903	6.6924	3.7004	5.7029**
Population (log[*POP*])	0.6487***	0.9843***	0.7261***	0.9598***	0.8231***	0.6300***	0.5462***
Real GDP Growth 2002–07 (*GDPG27*)		−1.1597***	−1.2164***	−1.2236***	−1.3448***	−1.1649***	−1.2708***
GDP per Capita (*GDPC*)			−0.0996***	−0.0902***	−0.0652***	−0.0794***	−0.0744***
Value Added Share Manufacturing (*VAMAN*)				−0.1471**	−0.1504**	−0.1161**	−0.1178**
Value Added Share Other Services (*VAOTH*)					−0.1185	−0.0603	−0.1014**
N	210	210	210	210	210	207	191
R^2	0.0334	0.2266	0.3005	0.3146	0.3329	0.3413	0.3800
Adjusted R^2	0.0288	0.2191	0.2903	0.3012	0.3165	0.3249	0.3633

The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The standard errors are computed with Eicker-/Huber-/White-correction.

When the control variables are gradually added to the regression, population size remains highly significant with a positive coefficient sign, indicating a partial ceteris paribus effect beyond sole correlation. Larger state size provided shelter against the initial shock impact magnitude: If population size increases by one percent, the model estimates the usually negative growth difference to improve by 0.0082 percentage points (equation [5] of Table 4). Also pre-crisis GDP growth, GDP per capita, and the value added sector share of manufacturing are significant, all with negative sign, indicating an amplifying effect to the impact magnitude. The value added sector share of other services (including financial services) turns out insignificant, at least in this equation specification.

No convex or concave relation of the partial effect of population size on the impact magnitude could be detected, log[*POP*]^2 is insignificant and does not alter the sign and high significance of log[*POP*], if both are included simultaneously. Multiplicative terms of log[*POP*] with other

[16] "Other services" include the following ISIC 3.1 sectors (see Table 15): Financial intermediation (J); real estate, renting and business activities (K); public administration and defense, compulsory social security (L); education (M); health and social work (N); other community, social and personal service activities (O); activities of private households as employers and undifferentiated production activities of private households (P); extraterritorial organizations and bodies (Q). Other services cover financial services well, also indicated by the highly significant correlation of *VAOTH* with the other financial variables such as financial employment share (*EMPFIN*), the correlation coefficient is 0.6891 (p-value 0.0000). "Financial intermediation" is a highly profitable sector in comparison to, say, education or public administration (in which wages are the lion share of value added). Also, "real estate, renting and business activities", "education" and "health and social work" are most likely highly correlated with the financial sector development level. To control for the public sector share, public consumption to GDP (*PUBCONS*) is used as additional covariate (see Table 5).

variables of equation [5] show no significant interaction, except for log[*POP*]∗*VAOTH* (which will be discussed below).

Instead of the entire state cross-section with 210 states[17], regressions without three heavy outlier states[18] and additionally without states that suffered from an armed conflict between 2002 and 2010 (intensity 2 in the UCDP/PRIO-database) are conducted. The conclusions from the main regression remain unchanged as visible in equations [6] and [7] of Table 4, except for *VAOTH* turning significant in [7] with an expected negative sign.[19]

The goods and services trade quota ($TRADEGS$) as an important proxy for international trade integration and potentially associated with vulnerability are considered as well, but subsequently dropped from the main regression equation. It is nonetheless listed as additional regressor in the augmented regressions in Table 5. If *TRADEGS* is included in a regression with *GDPG27* and log[*POP*] alone, then *TRADEGS* is weakly significant with the expected negative coefficient sign (the other two regressors are highly significant). Yet, as soon as *VAMAN*, *VAOTH* and *GDPC* are added, *TRADEGS* reveals no additional explanation power.

To extend the analysis to other potentially important pre-crisis determinants of the Financial Crisis shock impact magnitude, the main regression equation is augmented by other additional relevant pre-crisis variables (always only one additional variable at a time). *GDPG27* is included in all the equation specifications as pre-crisis growth adjustment. All the regression results are shown in the summary Table 5, which comprises about 90 regressions in the following three regression specifications, along with correlation coefficients.

[8] $$GDPGD97 = c + \beta_1 \cdot GDPG27 + \beta_2 \cdot x_2 + \varepsilon$$

[9] $$GDPGD97 = c + \beta_1 \cdot GDPG27 + \beta_2 \cdot GDPC + \beta_3 \cdot VAMAN + \beta_4 \cdot VAOTH + \beta_5 \cdot x_5 + \varepsilon$$

[10] $$GDPGD97 = c + \alpha \cdot \log[POP] + \beta_1 \cdot GDPG27 + \beta_2 \cdot GDPC + \beta_3 \cdot VAMAN + \beta_4 \cdot VAOTH + \beta_5 \cdot x_5 + \varepsilon$$

Specification [8] represents the regression with only the additional control variable *x* to show the mere correlation with the impact magnitude. Equation [9] with the additional regressor *x* but without log[*POP*] potentially exposes interaction with population size. And regression equation [10] is the main regression equation [5] augmented by *x*. As a starting point in the search for

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17 The former Netherland Antilles are dropped from the sample, due to its 2010 break up as independent common territory of then five insular entities. Two of those entities (Curaçao and Sint Maarten) are included in the sample. Sudan and South Sudan are as well excluded, since South Sudan gained independence from Sudan in 2011, which also falls into the inspected data period of 2002–2013.

18 Following a thorough visual outlier inspection, three states have been identified as outliers in the inspected data period 2002–2013: Nauru, Somalia, and Zimbabwe. The extreme variation in real GDP growth of Nauru in the inspected data period could be due to the revival of phosphate mining and the establishment of an offshore immigration center for Australia. Somalia features almost no variation of the real GDP growth rate in the years 2007–2013, most probably an artefact of linear interpolation for data gaps in the applied UN database. In Zimbabwe, there was a hyperinflation with extreme inflation rate values in the years before, during and after the Financial Crisis. This likely had a distorting effect on economic activity and presumably caused problems deflating nominal into real GDP and converting it to US Dollars in the database.

19 The main results are also unaltered if the dummy *WAR210* for the states with armed conflict is introduced, instead of removing them from the sample (*VAOTH* and the dummy itself insignificant).

further variables with additional explanatory power, the UN dataset is consulted, before other databases come into play.

Table 5: Financial Crisis impact magnitude (vulnerability), augmented regressions

Dependent Variable (Impact Magnitude): *GDPGD97* (OLS)		None	*TRADE-GS*	*TRADEG*	*TRADES*	*EXPGS*	*EXPG*	*EXPS*	*IMPGS*
Additional Regressor	Correlation with *GDPGD97*		−0.1931***	−0.1937**	−0.1498*	−0.1851***	−0.1499*	−0.2108***	−0.1702**
	Equ. [8]: All vars. excl., *GDPG27 incl.*		−0.0282***	−0.0241***	−0.0509***	−0.0395***	−0.0269*	−0.0928***	−0.0597***
	Equ. [9]: All vars. incl., log[*POP*] excl.		−0.0095	−0.0160*	−0.0131	0.0005	−0.0188	−0.0284	−0.0362**
	Equ. [10]: All variables included		0.0033	−0.0094	0.0158	0.0169	0.0131	0.0122	−0.0083
log[*POP*]	Equ. [10]: All variables included	0.8231***	0.8571***	0.6543***	0.7984***	0.8874***	0.6928***	0.7536***	0.7622***
N	Equ. [10]: All variables included	210	210	171	171	210	171	171	210
R^2	Equ. [10]: All variables included	0.3329	0.3332	0.3453	0.3437	0.3357	0.3441	0.3402	0.3335
Adj. R^2	Equ. [10]: All variables included	0.3165	0.3135	0.3214	0.3197	0.3161	0.3201	0.3180	0.3138
Dependent Variable (Impact Magnitude): *GDPGD97* (OLS)		***IMPG***	***IMPS***	***TRADE-CAGS***	***VADIV***	***VAAGFI***	***VACON***	***VA-MINEUT***	***VASA-REHO***
Additional Regressor	Correlation with *GDPGD97*	−0.2065***	−0.0329	−0.0159	−0.1005	0.2366***	−0.3106***	0.0785	−0.0857
	Equ. [8]: All vars. excl., *GDPG27 incl.*	−0.0565***	−0.0592*	0.0242	−19.6318*	0.1900***	−0.5707***	0.1163*	−0.2112**
	Equ. [9]: All vars. incl., log[*POP*] excl.	−0.0402**	−0.0079	0.0688**	0.8517	0.0537	−0.5088***	0.0682	−0.2405***
	Equ. [10]: All variables included	−0.0217	0.0405	0.0471*	3.7869	0.0461	−0.4462***	0.0560	−0.1915**
log[*POP*]	Equ. [10]: All variables included	0.6110**	0.8036***	0.6919***	0.8356***	0.7897***	0.7088***	0.7784***	0.7037***
N	Equ. [10]: All variables included	171	171	210	210	208	210	207	209
R^2	Equ. [10]: All variables included	0.3462	0.3454	0.3423	0.3336	0.3281	0.3626	0.3219	0.3478
Adj. R^2	Equ. [10]: All variables included	0.3223	0.3214	0.3228	0.3139	0.3080	0.3438	0.3015	0.3285
Dependent Variable (Impact Magnitude): *GDPGD97* (OLS)		***VATR-STCOM***	***PUB-CONS***	***PRIV-CONS***	***INV***	***PUB-DEBT***	***EMPFIN***	***EMP-FIN_AF***	***FIN-OPEN***
Additional Regressor	Correlation with *GDPGD97*	−0.0480	−0.0772	0.1960***	−0.2665***	0.2556***	−0.2221***	−0.2775***	−0.2346***
	Equ. [8]: All vars. excl., *GDPG27 incl.*	−0.1013	−0.2144**	0.0556*	−0.1891*	0.0297*	−1.8925***	−1.8612***	−6.6073***
	Equ. [9]: All vars. incl., log[*POP*] excl.	−0.0857	−0.1712**	−0.0107	−0.1605*	0.0226	−1.6214***	−1.4127***	−3.5266*
	Equ. [10]: All variables included	−0.0984	−0.1177	−0.0003	−0.1358	0.0208	−0.8906	−0.6627	−3.8396*
log[*POP*]	Equ. [10]: All variables included	0.8278***	0.6916***	0.8234***	0.7411***	0.8297***	0.4190*	0.8131***	0.7102***
N	Equ. [10]: All variables included	209	209	209	209	182	181	210	165
R^2	Equ. [10]: All variables included	0.3326	0.3409	0.3312	0.3486	0.4343	0.3464	0.3366	0.3798
Adj. R^2	Equ. [10]: All variables included	0.3128	0.3213	0.3113	0.3292	0.4149	0.3239	0.3170	0.3562
Dependent Variable (Impact Magnitude): *GDPGD97* (OLS)		***BANK-DEP***	***TOUR***	***GOV-EFF***	***URB-POP***	***SOV***	***ISL***	***REM***	***EAST-EUR***
Additional Regressor	Correlation with *GDPGD97*	−0.2488***	−0.0377	−0.2960***	−0.2423***	−0.0288	−0.0325	0.0831	−0.2743***
	Equ. [8]: All vars. excl., *GDPG27 incl.*	−0.0354***	−0.0900	−3.0353***	−0.1018***	1.6257	−2.9767**	0.0052	−6.1577***
	Equ. [9]: All vars. incl., log[*POP*] excl.	−0.0236	0.0403	−1.8614***	−0.0393	−2.5314	−2.0568*	−0.1380	−6.2787***
	Equ. [10]: All variables included	−0.0230	0.4246	−2.0175***	−0.0506**	−4.4583**	−0.3335	0.0880	−6.1419***
log[*POP*]	Equ. [10]: All variables included	0.6561***	0.7208**	0.9561***	0.8795***	0.9714***	0.7933***	0.7756***	0.7998***
N	Equ. [10]: All variables included	179	176	194	204	210	210	202	210
R^2	Equ. [10]: All variables included	0.3304	0.3954	0.3534	0.3380	0.3493	0.3330	0.3267	0.3770
Adj. R^2	Equ. [10]: All variables included	0.3070	0.3740	0.3327	0.3179	0.3300	0.3133	0.3059	0.3586

Equation [8]: $GDPGD97 = c + \beta_1 \cdot GDPG27 + \beta_2 \cdot x_2 + \varepsilon$
Equation [9]: $GDPGD97 = c + \beta_1 \cdot GDPG27 + \beta_2 \cdot GDPC + \beta_3 \cdot VAMAN + \beta_4 \cdot VAOTH + \beta_5 \cdot x_5 + \varepsilon$
Equation [10]: $GDPGD97 = c + \alpha \cdot \log[POP] + \beta_1 \cdot GDPG27 + \beta_2 \cdot GDPC + \beta_3 \cdot VAMAN + \beta_4 \cdot VAOTH + \beta_5 \cdot x_5 + \varepsilon$

The augmented regressions [8]–[10] include additional regressors *x*. See Table 14 for explanations to variable abbreviations and data sources. The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The regression coefficients' standard errors are Eicker-/Huber-/White-corrected. In the correlation rows (pairwise samples) Pearson-Bravais correlation coefficients are displayed, except for the binary dummy variables *SOV*, *ISL*, *EASTEUR*, for which point-biserial correlation coefficients are listed.

As an important shock transmission channel, trade determinants from the UN database are included. While the goods and services trade quota (quota in relation to GDP, *TRADEGS*), goods and services exports quota (*EXPGS*), and goods and services imports quota (*IMPGS*) are significantly and negatively correlated with the impact magnitude, they show no significance or additional explanatory power respectively when the other main equation variables are added to the regression. But, the coefficient of the current account balance (*TRADECAGS*) displays some significance, indicating that current account surplus has reduced the exposure to the shock. As the UN figures do not differentiate between goods and services trade – they are derived from a national accounting logic – additional trade variables from the balance of payments[20] perspective (World Bank data)

[20] Balance of payment figures in general and especially for small states appear to be less reliable and their inclusion causes a large reduction of available states.

are compiled and included into the regression analysis. These variables are goods trade quota (*TRADEG*), services trade quota (*TRADES*), goods export quota (*EXPG*), services export quota (*EXPS*), goods import quota (*IMPG*), and services import quota (*IMPS*). The inclusion of these variables leads to a dataset truncation from 210 to 171 states. Albeit some of these variables are highly negatively correlated with the growth difference, meaning that states with high levels of trade tended to be affected more severely by the crisis, no ceteris paribus effect can be detected in the main regression equation [10] and the high significance and coefficient sign of the population size (log[*POP*]) remains in place.[21]

As the UN database contains national aggregate figures both from the production and the expenditure side, additional variables regarding the sectoral structure of the states' economy can be gathered for the analysis. Building on the value added shares of the seven sectors listed in the database, a sectoral gross value diversification measure is computed[22] (*VADIV*). With respect to sectoral value added, only the construction sector share (*VACON*) and the share of the sector comprising of sales, retail, repair, hotels, and restaurants (*VASAREHO*) show a significant partial effect in equation [10]. The negative coefficient signs do not surprise, as construction but also sales and hospitality are business cycle sensitive activities. Indeed surprising is that sectoral diversification does not seem to have provided a significant buffer for the vulnerability to the Financial Crisis shock. Natural resource abundance, i.e. value added share of mining and utilities (*VAMINEUT*), did not amplify the Financial Crisis impact nor did it serve as mitigating factor.[23] Even though the GDP shares of the expenditure side variables investments (*INV*), private consumption (*PRIVCONS*), and public consumption (*PUBCONS*) are significantly correlated with the impact magnitude (*GDPGD97*), they show no significance when added to the main regression equation. The coefficient sign and significance of log[*POP*] is unaffected if any of the expenditure and production side variables are incorporated into the regression.

The nature of the Financial Crisis with its large impact on the financial sector but also on the tourism industry[24], as well as the fact that many small states heavily rely on finance and/or tourism require focused attention on these two sectors.

The coefficient's insignificance of the employment share of finance and insurance (*EMPFIN*) signals additional explanation power at first sight. This appears to emerge from the high correlation with *GDPC* and *VAOTH*, both of which become insignificant as well, indicating multicollinearity issues (underlined by severe centered variance inflation factors). If *VAOTH* is removed from the regression, *EMPFIN* becomes highly significant with the expected negative sign, with *GDPC* still

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21 This is in line with Furceri and Karras [2007] who find that the higher business cycle volatility of smaller states cannot be explained by their higher trade openness.

22 The diversification measure is derived by computing the Herfindahl-Hirschman-Index (Herfindahl [1964]) of the sectoral gross value added shares. The HHI ranges from 1 and approximately 0. A HHI value of 1 indicates complete concentration (no diversification) with only one sector responsible for the total value added. By contrast, an HHI close to 0 reflects a broadly diversified economy with sectors of comparable importance.

23 This result is also confirmed if a binary dummy variable (*OIL*) is included, with 1 for states with oil rents above 10% of GDP and 0 otherwise.

24 According to TCdata360 (World Bank) covers value added of travel and tourism of states worldwide since 1995. The years 2003 (−0.6%), 2008 (−1.5%), and 2009 (−2.8%) were the only three years until 2019 featuring negative growth. The sharp declines in comparison to the average annual growth of +3.2% highlights how challenging the Financial Crisis years 2008 and 2009 were for tourism.

being insignificant at the same time (with no variance inflation factors warranty anymore). In the latter regression, the significance of log[*POP*] is considerably weakened (p-value of 0.0800), possibly due to the reduced sample size of 181 states. To avoid a potential states sample bias, a new variable (*EMPFIN_AF*) is estimated[25] for the missing 29 states to generate a hybrid cross-section series consisting of 181 actual and 29 fitted values. If *EMPFIN_AF* is used instead of *EMPFIN*, then the state sample size increases to 210 and log[*POP*] turns from weakly to highly significant again. While the coefficient of *EMPFIN_AF* is as well insignificant if simultaneously included with *VAOTH*, it has the expected negative sign and a p-value of 0.0104 if *VAOTH* is excluded (see Table 5 and Table 9).

The financial openness indicator (*FINOPEN*) by CHINN AND ITO [2008] and the bank deposits' worth in relation to GDP (*BANKDEP*) are also considered to obtain alternative measures for the financial sector's importance. Albeit *BANKDEP* is highly correlated with the Financial Crisis impact magnitude, it yields no additional ceteris paribus explanation if incorporated into the main regression, and population size is still highly significant with positive sign. *BANKDEP* only shows additional significance if *VAOTH* is left out from the equation. In contrast, *FINOPEN*, also highly correlated with the shock, shows some partial effect significance and a negative sign indicating a shock amplifying influence of the degree of inclusion into international financial markets. However, all the financial variables point to the conclusion that the wealth malus indicated by the negative coefficient of *GDPC* could be driven by the financial services' relevance in the respective states, as *GDPC* turns insignificant, when the financial variables *EMPFIN*, *EMPFIN_AF*, *BANKDEP* or *FINOPEN* are included into the regression (multiplicative interaction with population size and quadratic trends of financial variables are displayed in Table 9). It appears that the partial effect of the financial sector on the impact magnitude has the u-shape of a negative influence with increasing financial sector share (see Figure 3). Also, the positive influence of population size decreases with the importance of the financial sector (both for *VAOTH* and *EMPFIN_AF* interacted with log[*POP*]). Sign and significance of the population size coefficient remain firmly in place if *BANKDEP* and *FINOPEN* are included.

Regarding the states' reliance on tourism. i.e. the contribution of travel and tourism to GDP (*TOUR*), no significant additional explanation power can be found. Once again, coefficient sign and significance of population size are unaltered.

Further resilience determinants frequently mentioned in the literature are also regarded as additional regressors: Public debt to GDP (*PUBDEBT*) as a measure for degrees of freedom to policy reaction, the urban population ratio (*URBPOP*) and a quality of policy institutions indicator (*GOVEFF*). While *PUBDEBT* is not significant, *GOVEFF* and *URBPOP* are, yet with unexpected negative sign. *GDPC* turns insignificant if combined with either of the latter two variables, as they are

[25] First, the variables other services (*VAOTH*), GDP share of public consumption (*PUBCONS*), GDP per capita (*GDPC*), and the insularity dummy (*ISL*) are regressed on the financial sector's employment share (*EMPFIN*). All the predicting variables are highly significant with expected signs. For the 181 states with *EMPFIN* observations, the correlation coefficient between the actuals *EMPFIN* and the fitted values is 0.8505. As the mentioned regressors are available for all the 210 states, a predicted value for *EMPFIN* can be obtained for the 29 missing states. Then, the 181 actuals of *EMPFIN* and the 29 forecasted values are combined to the hybrid series *EMPFIN_AF*. The regression output is: $EMPFIN = -0.1237 + 0.0531^{***} \cdot VAOTH - 0.0444^{***} \cdot PUBCONS + 0.0446^{***} \cdot GDPC + 0.3453^{**} \cdot ISL + \hat{\varepsilon}$.

highly correlated with GDP per capita. Note that the resilience literature stresses the importance of the mentioned three variables particularly in the recovery phase, not during the initial impact measured in the dependent variable. All three variables have no effect on the significance of the population size coefficient.

Additionally, geographical properties are incorporated into the regression analysis, namely a remoteness measure (average distance to all other states, *REM*), an island dummy (*ISL*), and a sovereignty dummy (*SOV*). Also a regional dummy for Eastern European countries (*EASTEUR*) is considered, as many East European states faced a tremendous financial sector growth before the Financial Crisis and were then subject to major corrections (BLANCHARD ET AL. [2010, p. 265]). *REM* and *ISL* do not show significant partial effects when added to the main regression. The coefficient of *SOV* is significant with negative sign, meaning that non-sovereign territories performed better than independent countries (ceteris paribus). This is perhaps because sub-national territories might enjoy stabilizing ties with their patron state (ARMSTRONG AND READ [2020, pp. 893–894]). The coefficient of *EASTEUR* is significant in the main equation, with a negative sign confirming the notion of higher shock exposure due to the financial boom in Eastern Europe before the crisis. The inclusion of the geographical conditions has no decisive effect on the results with respect to population size.

Comparing the findings of this section with ARMSTRONG AND READ [2020], the significance and sign of the correlation coefficients between the following pre-crisis determinants and the initial impact magnitude can be confirmed (see Table 3 and Table 5): Population size (positive correlation), export quota (negative correlation), primary sector GDP share (positive correlation), value added share of manufacturing (no correlation), value added share of services[26] (negative correlation), and importance of financial activity (negative correlation). In contrast to ARMSTRONG AND READ [2020], no correlation of insularity (only correlating if pre-crisis growth level is controlled for), sovereignty, tourism, and resource abundance with the shock impact magnitude could be found in the applied data set. As already outlined, the mere correlations do not fully reveal partial effects if confounding variables are not included as controls, potentially leading to omitted variable bias. Of the mentioned determinants, only population size, manufacturing value added share, services value added share and sovereignty provide ceteris paribus explanation in the regression setting of equation [5] and [10]. Additionally, a highly significant negative partial effects of pre-crisis growth and GDP per capita level can be found. Also, significant negative effects of financial services variables are detected (with a u-curve relationship). Other notable identified significant ceteris paribus effects are identified for current account surplus (negative coefficient), value added share of the construction sector (negative), and value added share of sales, retail, repair, hotels/restaurants (negative).

The central finding is that the partial effect of population size is robustly significant throughout all the applied regression specifications, indicating that larger state size was associated with a

[26] To meet the sector share definition of ARMSTRONG AND READ [2020], the value added share of all services *VASERV* has been computed as the sum of *VASAREHO*, *VATRSTCOM*, and *VAOTH* (see Table 14 and Table 15). If *VASERV* is used in the regression [5] in Table 4, its coefficient of −0.1230 is weakly significant (p-value 0.0658). All other coefficients remain unchanged regarding sign and significance level.

smaller exposure with respect to the immediate impact magnitude of the Financial Crisis. This is on the one hand in line with the small states economics literature that postulates a higher shock exposure of smaller states. But on the other hand it is not, as most of the explanatory factors behind the lower resilience of small states proposed in the literature were explicitly modelled in the regressions with the significance of the population size coefficient remaining firmly in place. Hence, those factors do not tell the whole story behind the inherent nexus between small size and high volatility. Whether this finding is an artefact of unobserved state characteristics correlated with size or directly tied to size itself remains an open question. But the causal partial effect of the mere state size itself cannot be justified by reasonable economic arguments.

One possible explanation for the robust significance of population size presumably lies in the fact that only pre-crisis conditions were regarded in this study. While this approach mitigates endogeneity issues, it does not cover developments during the crisis. This leaves out two important influences on volatility and the shock transmission mechanism, which are not assessable due to the lack of worldwide data: The economic policy response and terms-of-trade shocks, both of which are especially relevant in this context. Small states have lower fiscal policy leverage, as the larger share of their demand is abroad, and only limited monetary tools at their disposal, if at all. Furthermore, the sensitivity to price or exchange rate shocks is relatively higher in small states exhibiting high international trade integration and low price setting power. But the reduced price setting power relates to many medium-sized states as well and the international trade quota shows no significant partial effect (the opposite should be the case if terms-of-trade sensitivity were the main driving force behind the significant population size coefficient). Thus, state differences in the actually occurred economic policy response, such as monetary and/or fiscal policy, can be seen as a likely explanation for the significance of population size.[27]

Several robustness checks are run to explore the robustness of the results on the impact magnitude of the Financial Crisis shock. Sign and significance of population size are robust across alternative choices of proxies for the impact magnitude, control variables or size measures and are insensitive to outlier removal (see robustness section A.1.2.).

There is a trade-off between the number of state cross-section observations and the granularity of available variables.[28] A selection bias towards larger states should be avoided in the analytical

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[27] If the scope of monetary policy, proxied by the exchange rate arrangement classification (Ilzetzki et al. [2019], available for 192 states in the year 2007), is included into equation [10], then log[*POP*] remains highly significant and the additional regressor *EXCHRA* is insignificant. However, beyond availability and efficiency of fiscal or monetary policy, the actually conducted interventions are as well relevant but not investigable due to the lack of extensive worldwide data.

[28] For instance, no information on the regional diversification of trade partners could be obtained without a substantial loss in the number of included states, while the regional diversification might be especially crucial for small states (and other economic ties to their patron states). Especially trade linkages with USA, EU with weak growth in the Financial Crisis or China with fairly stable growth could be an additional explaining factor. Uncertainty unquestionably also has an influence on shock transmission, which could be of particular relevance in small states usually facing higher volatility. Reliance on strategic imports is as well a relevant issue for small states, even more so for less developed ones, and they are more exposed to protectionist measures possibly imposed by larger states in times of economic emergency. A detailed composition of exports and imports into product categories or trade partners was not achievable without significant shrinkage of states quantity. This also holds for data on cross-border

context of this study, since especially very small states face certain resilience disadvantages. To prevent such bias, the number of states was considered more important than the granularity in terms of variables. The risks of a state sample bias and the advantage of an extensive inclusion of small states, as applied in the data set of this study, can be demonstrated if the sample is restricted to states above 0.1 or 0.2 million inhabitants, as shown in Table 11. The coefficient significance of population size falls considerably if the sample is restricted to states with a population of above 0.1 million (188 states instead of 210 states included) and in the further sample restriction to states above 0.2 million (179 stated included). The coefficient eventually exceeds a p-value of 0.1, if only states with a population of 0.4 million are included (170 states), and gets highly insignificant for much larger population thresholds, with only very few exceptions in size restrictions (see the automated regressions with step-wise sample restrictions in Figure 4).

Smallness tends to make states more vulnerable, which could also be observed during the Financial Crisis shock as previously outlined. To obtain a better isolation of the population size partial effect and to account for a potential non-linear relation with the Financial Crisis impact magnitude, a sequence of regressions with the following specification is executed:

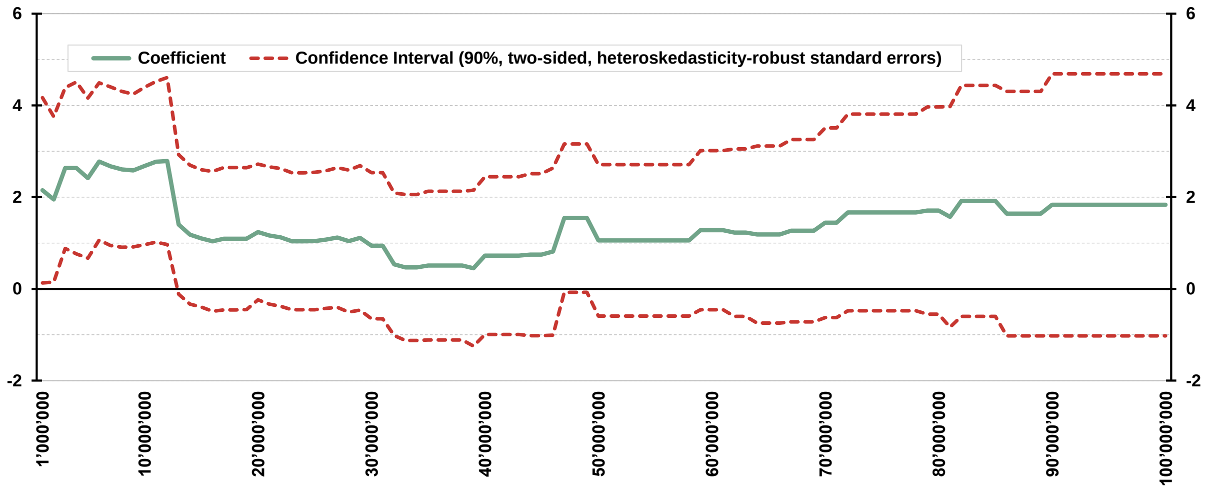
$$[11] \quad GDPGD97 = c + \alpha \cdot POPTD + \beta_1 \cdot GDPG27 + \beta_2 \cdot GDPC + \beta_3 \cdot VAMAN + \beta_4 \cdot VAOTH + \varepsilon$$

Equation [11] is essentially the main regression equation [6] listed in Table 4. But instead of log[*POP*], a population size threshold is applied and constructed as binary dummy (*POPTD*) with 1 for the states with a population above the threshold and 0 otherwise. For each individual regression, the population threshold is increased step-wise (1’000’000, 2’000’000,…, 100’000’000). The regression loops aim at uncovering critical population limits in the small-size disadvantage unveiled above. As shown in Figure 2, the regression loop sequences suggest a critical size level of around 12–13 million.

The population size level of 13 million does not represent a sharp frontier in the sense of a binary 0 or 1 choice in the between-group comparison of small and large states. Size also seems to matter within the group of the 141 states below a population of 12 million, as visible in equation [12] of Table 6. The significant coefficient of log[*POP*] indicates that very small states were more severely hit due to their population size (or other unexplained factors attributable to population size); not only compared to very large states but also to states with, say, only slightly below 12 million inhabitants.

direct investments or credit availability. Furthermore, the applied HHI diversification indicator might not be detailed enough, as value added data comprises only of seven sectors. If ever feasible, unmitigated international goods and services trade data could shed more light on the matter and explain more of the unexplained significance of population size. In a similar vein, a broader availability of worldwide financial data (especially on small states) would be desirable.

Figure 2: Financial Crisis impact magnitude (vulnerability), population size thresholds



When the sample of states below 12 million inhabitants is simply split into thirds, generating three groups of 47 states (equations [13]–[15] of Table 6), an increased within-group disadvantage of smaller size in the group of the 47 smallest states (below 0.62 million inhabitants) is identifiable. A within-group disadvantage is not visible in the other two groups of states between 0.62 and 4.4 million inhabitants or between 4.4 and 12 million. This finding does not mean, though, that the states of the latter two do not experience a general (between-group) disadvantage if compared to large states well above 12 million inhabitants.

Table 6: Financial Crisis impact magnitude (vulnerability), main regression equation, restricted samples

Impact Magnitude (Vulnerability within Size Groups)	**Dependent Variable: Real GDP Growth Difference 2009 vs. 2007, %-Points (*GDPGD97*)**			
	Ordinary Least Squares			
	[12]	[13]	[14]	[15]
Sample Restrictions	*Population < 12M*	*Population < 0.62M*	*Population > 0.62M and < 4.4M*	*Population > 4.4M and < 12M*
Constant (*C*)	1.1246	−8.5687	11.2044	2.1059
Population (log[*POP*])	0.9731***	1.8875**	−3.5775	0.1701
Real GDP Growth 2002–07 (*GDPG27*)	−1.1485***	−0.9925*	−1.8522***	−0.8058***
GDP per Capita (*GDPC*)	−0.0704***	−0.1060***	0.0317	−0.0724**
Value Added Share Manufacturing (*VAMAN*)	−0.0901	0.1706	−0.1641	−0.1664**
Value Added Share Other Services (*VAOTH*)	−0.0113	0.2146**	−0.1025	−0.0200
N	141	47	47	47
R^2	0.3261	0.4663	0.4063	0.4412
Adjusted R^2	0.3011	0.4013	0.3339	0.3731

The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The standard errors are computed with Eicker-/Huber-/White-correction.

The regression sequences and the sample splits corroborate the positive partial effect of population size on the impact magnitude of the Financial Crisis unexplained by the control variables. Even though the cut-off is not especially sharp, it is evident that the small-size disadvantage unfolds for a population size of below around 10 million and that very small states with populations of well below 1 million suffered the most from this disadvantage (see section A.1.3. for a re-run of the regression loops for the restricted sample of states with a population of below 12 million).

3.2. Recovery: Impact Persistence

The fact that smaller countries feature higher GDP volatility would imply that not only the decline but also the recovery is more pronounced across an entire business cycle. Can such a bounce-back also be observed after the Financial Crisis 2008/09?

To capture the shock persistence, two different dependent variables are inspected: The real GDP growth percentage point difference between the average of the years 2008–2013 and the average of the pre-crisis years 2002–2007 (*GDPGD81327*), and an ordinal dependent variable capturing the number of consecutive years below the pre-crisis real GDP peak level in either 2007 or 2008, depending on the year of the peak (*GDPLEVEL78*).

In the OLS estimations below, heteroskedasticity-robust standard errors (EICKER [1967], HUBER [1967], WHITE [1980]) are again applied to treat potentially inefficient estimates. In a limited dependent variable setting with probit or logit models, however, dealing with heteroskedasticity is less straightforward, as the parameter estimates might also be biased and inconsistent. For the shock persistence analysis, the ordinal generalized linear model with heteroskedasticity correction is executed in addition to OLS.[29]

Table 7: Financial Crisis impact persistence (recovery), main regression equation

Impact Persistence (Recovery)	Dependent Variable			
	GDPGD81327		*GDPLEVEL78*	
	OLS		OGLM	
	[16]	[17]	[18]	[19]
Constant (*C*)	2.0883**	6.7229***		
Population (log[*POP*])	0.3529***	0.2141	−0.3181***	−0.2961***
Real GDP Growth 2002–07 (*GDPG27*)	−0.8737***	−0.9864***		−0.0764
GDP per Capita (*GDPC*)		−0.0296**		0.0613***
Value Added Share Manufacturing (*VAMAN*)		−0.0542		0.0108
Value Added Share Other Services (*VAOTH*)		−0.0800**		0.0316*
N	210	210	210	210
R^2	0.3847	0.4841		
Pseudo R^2 (MCFADDEN [1974])			0.0512	0.1396

GDPGD81337: real GDP growth difference (%-points, average 2002–2007 vs. 2008–2013). *GDPLEVEL78*: ordinal dummy (0–6) for 0 up to 5+ consecutive years below pre-crisis real GDP peak (2007 or 08). OLS: ordinary least squares with Eicker-/Huber-/White-correction; OGLM: ordinal generalized linear model with heteroskedasticity correction (STATA package "st0208").
The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01).

The coefficient of population size is significant in the regressions of Table 7, with the exception of equation [17], where it is slightly insignificant (p-value of 0.1277). The change in coefficient sign between regressions [16]–[17] and regressions [18]–[19] is plausible, as the capability to recover comes with a less negative sign of the pre-/post-crisis growth difference (*GDPGD81327*), while a faster recovery is associated with a lower value of *GDPLEVEL78*. The regressions indicate a slower recovery of smaller states, with respect to both growth difference and recovery duration. A significant partial effect of population size prolonging the shock persistence is detectable, as the population size coefficient remains significant with the control variables in equation [19].

[29] The stepwise likelihood ratio test procedure by WILLIAMS [2010, pp. 562–563] for the heteroskedasticity specification is applied. The testing procedure is applicable to binary and ordinal dependent variable settings.

The fact that smallness increased the initial impact of the Financial Crisis shock – as shown in section 3.1 – is not surprising and in line with the observation that small states have a higher business cycle volatility and the related arguments proposed in the small states literature. Yet, against the notion of small states research, small states were not able to adapt and recover faster/stronger in the aftermath of the Financial Crisis and could therefore not profit from their higher political flexibility and their habituation to high volatility. Surely, an important obstacle to the recovery was the enduring international pressure on "tax haven" states, most of them small and highly reliant on financial services[30], which cannot be fully captured by the control variables. Even though there is evidence that the recovery lasted longer in states reliant on financial services, as the *VAOTH* coefficient is significant in equations [17] and [19], the coefficient of log[*POP*] remains significant.

The correlation coefficients between *GDPLEVEL78* and pre-crisis determinants cannot be fully compared with the results of ARMSTRONG AND READ [2020], since they apply the number of negative GDP growth years as measure of the Financial Crisis impact length instead of the number of years until pre-crisis peak is met again. Yet, the intuition behind both measures is of similar nature. All their bivariate correlation results can be confirmed with the data applied in this study: Export quota is positively correlated with shock persistence length, primary sector GDP share negatively, manufacturing GDP either positively nor negatively, insularity positively, sovereignty negatively, services sector GDP share positively, financial activity positively, tourism share positively, and resource abundance negatively.

With regard to population size, ARMSTRONG AND READ [2020] can also be confirmed as the recovery duration is not significantly correlated with size. But, if the logarithm of population size is considered, as consistently applied in this study, then there appears a negative and highly significant coefficient. This means that larger states actually featured a shorter persistence of the Financial Crisis shock. When control variables are included to tackle possible omitted variable bias, population size, pre-crisis growth and primary activity share show a shock duration reducing partial effect. On the other hand, GDP per capita, services and financial services reliance featured a prolonging ceteris paribus effect on the shock impact length (see Table 10). Resource abundance, goods/services export quota, reliance on tourism, insularity, and sovereignty show no significant influence, while the positive partial effect of population size is highly significant across the main and augmented regressions.[31]

3.3. Timing: Impact Earliness

Section 3.1. and 3.2. have shown that small states were hit harder in the initial Financial Crisis impact, that they suffered longer and that both observations cannot be fully explained by the control variables. So, if they were hit harder, did they also experience the shock earlier? At first sight, small states could be seen as business cycle ''importers'' from bigger neighboring states implying

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[30] The high reliance of small states on financial services is also visible in the applied data set. The correlation coefficient of log[*POP*] with the financial variables available for all the 210 states is negative and highly significant: *VAOTH* −0.3975 (p-value 0.0000), *EMPFIN_AF* −0.2845 (p-value 0.0000).

[31] If Nauru, Somalia, Zimbabwe (see footnote 18) are dropped from the sample, the positive coefficient of log[*POP*] in equation [17] turns highly significant (p-value reduces from 0.1277 to 0.0018).

a business cycle lag. But if smaller states are more volatile and have a higher sensitivity to international economic fluctuations, then they might also show an earlier – rather than a lagging – response (in line with the business cycle lead of the small state Liechtenstein against its neighbor Switzerland found in BRUNHART [2017]).

The timing of the shock transmission is investigated by two dependent variables. In the first regression setting, the independent variables are regressed on the real GDP percentage points growth difference of 2008 versus 2007 (*GDPGD87*) instead of 2009 versus 2007 (*GDPGD97*, as applied in section 3.1.), applying OLS with robust standard errors. The second setting employs a heteroskedastic probit model[32] with a binary dependent variable (*GDPEARLY8*), that assigns the value 1 to the 34 states that experienced negative GDP growth already in 2008 and 0 otherwise.

Table 8: Financial Crisis impact earliness (timing), main regression equation

Impact Earliness (Timing)	Dependent Variable			
	GDPGD87		*GDPEARLY8*	
	OLS		HETPROBIT	
	[20]	[21]	[22]	[23]
Constant (*C*)	3.5856	7.4010	−0.8563**	−0.8070
Population (log[*POP*])	−0.0466	−0.3031	−0.1418***	0.1487**
Real GDP Growth 2002–07 (*GDPG27*)	−1.0533**	−1.1528**		−0.2447***
GDP per Capita (*GDPC*)		−0.0711***		0.0136*
Value Added Share Manufacturing (*VAMAN*)		−0.0114		−0.0131
Value Added Share Other Services (*VAOTH*)		−0.0509		−0.0063
N	210	210	210	210
R^2	0.1656	0.2185		
Pseudo R^2 (MCFADDEN [1974])			0.0613	0.1858

GDPGD87: real GDP growth difference (%-points, 2009 vs. 2007); *GDPEARLY8*: binary dummy (0, 1) for states with negative real GDP growth already in 2008; OLS: ordinary least squares with Eicker-/Huber-/White-correction; HETPROBIT: heteroskedastic probit model (STATA package "hetprobit").
The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01).

The regressions indicate that smaller states were not hit harder in 2008 in terms of the GDP growth difference against the pre-crisis peak in 2007 (equation [20] in Table 8), while this was the case for the growth difference 2009 versus 2007 (see section 3.1.). But they tended to react sooner when it comes to the earliness of negative GDP growth appearance, as indicated by equation [22].[33] However, the earlier shock reaction of smaller states can be explained by control variables correlated with size, as the significant negative sign of the population size coefficient vanishes and even turns positive in equation [23]. Higher wealthiness (*GDPC*) led to an increased likelihood of being hit earlier and harder in 2008. In addition, faster pre-crisis growth worsened the GDP growth percentage point difference between 2008 and 2007, but made states less likely to already experience negative growth in 2008 because of the higher drop height. The observable business cycle lead of small states in the Financial Crisis can be explained by those two variables, as smaller states were wealthier on average and with lower pre-crisis growth (see Table 3).[34]

32 Again, the procedure by WILLIAMS [2010] is used for the heteroskedasticity specification (see footnote 29).

33 Note that the interpretation of the coefficient signs in regressions [20]–[21] is of opposite direction compared to [22]–[23]: Higher affectedness already in 2008 comes with a lower dependent variable *GDPGD87* and an earlier shock response is coded with 1 whereas a later response is assigned a 0 (*GDPEARLY8*).

34 It should be mentioned that a business cycle lead is generally easier to detect with sub-annual data, which is not feasible for an extensive worldwide data set. Also, the Financial Crisis was not a conventional shock impulse with a gradual transmission, which also complicates the identification of leading properties.

4. CONCLUSIONS

In this study on the Financial Crisis 2008/09 various pre-crisis determinants are examined as potential resilience factors from a worldwide cross-section of 210 states. This is done with a special focus on population size to explain the cross-country variation of vulnerability, with the initial shock impact magnitude in focus. Additionally, the impact persistence and the earliness of the shock manifestation are also investigated.

Smaller population size is associated with higher vulnerability during the Financial Crisis 2008/09 in terms of the initial impact magnitude, which is well in line with the small states literature. The ceteris paribus disadvantage of small size is driven by unobserved factors and cannot be fully explained by pre-crisis determinants usually proposed in the literature on the reduced resilience of small states (e.g. high foreign trade share, low sectoral diversification, remoteness, insularity, reliance on tourism and/or financial services).

From the pre-crisis determinants, highly significant partial effects of pre-crisis growth and GDP per capita level can be detected (both with negative coefficient indicating an amplifying effect on the impact magnitude). The trade variables are all insignificant, with the exception of current account surplus (positive sign indicating a stabilizing effect). Among the sectoral value added shares, only the shares of manufacturing (negative sign), other services (u-shaped negative influence and interaction with population size), sales/retail/repair/hotels/restaurants (negative sign), and construction (negative sign) show significant ceteris paribus effects, while also the sectoral diversification measure turns out insignificant. The GDP expenditure variables are all found to be insignificant. From the considered additional financial sector variables, the financial sector employment share (u-shaped negative influence and interaction with population size) and the financial openness indicator (negative sign) are significant, while bank deposit to GDP is insignificant. Additionally, government effectiveness (negative sign, probably due to multicollinearity with GDP per capita), urban population (negative sign), sovereignty (negative sign) and the Eastern European dummy (negative sign) show significant effects, while GDP share of tourism, public debt to GDP, remoteness, and insularity do not. Population size remains significant with positive coefficient sign throughout the inclusion of additional pre-crisis determinant variables.

The small-size disadvantage is relevant for states below around 10 million inhabitants and very small states suffered the most from the Financial Crisis impact. There is also significant evidence that smaller state size prolonged the recovery from the Financial Crisis shock, which implies that the disadvantage of small states with respect to higher exposure was not outweighed by the ability of faster adaption. Also, small states were more likely to experience an earlier impact, which can be explained by their higher GDP per capita and lower pre-crisis GDP growth.

One possible explanation for the robust significance of population size is arguably the fact that only pre-crisis conditions were considered in this study to overcome endogeneity problems and also to adapt to the heavy restrictions in the compilation of worldwide data covering small states well. Hence, developments during the crisis are not captured. As discussed, the limited scope of the economic policy response, such as fiscal or monetary policy, represents the most likely source for the small size disadvantage.[35]

Data limitations are a severe restriction for small states research. Hence, it will be an ongoing task for both the data supply side (national and international data providers) and the analysis side (researchers, policy makers) to make more of the unobservable features of state size observable. And even if it will ever become feasible to obtain enough previously unobserved confounding factors for a dataset including at least almost all of the small states worldwide such that small size effect can perhaps be fully explained (turning insignificant): It will remain the important question whether the identified explanatory variables are inevitably tied to smallness or simply a consequence of the states' choices and therefore not only mere fate of smallness.

[35] Yet, this is not explorable by statistical means due to the lack of comprehensive worldwide data, as it is also the case for other conceivable but unobservable drivers behind the population size significance.

APPENDIX

A.1. Additional Results

A.1.1. Regression Tables and Figures

Table 9: Financial Crisis impact magnitude (vulnerability), additional augmented regressions

Impact Magnitude (Vulnerability)	Dependent Variable: Real GDP Growth Difference 2009 vs. 2007, %-Points (*GDPGD97*)						
	Ordinary Least Squares						
	[24]	[25]	[26]	[27]	[28]	[29]	[30]
Constant (*C*)	9.4006*	5.8756*	3.4023	14.3486*	4.7279*	4.7089	3.2264
Population (log[*POP*])	0.4190*	0.4684*	0.8860***	0.7911***	0.8347***	2.2524***	1.3409***
Real GDP Growth 2002–07 (*GDPG27*)	−1.4458***	−1.3679***	−1.2626***	−1.4022***	−1.2914***	−1.3646***	−1.3117***
GDP per Capita (*GDPC*)	−0.0193	−0.0269	−0.0279	−0.0846***	−0.0476	−0.0639***	−0.0472
Value Added Share Manufacturing (*VAMAN*)	−0.1562**	−0.1673**	−0.1401**	−0.0734	−0.1167**	−0.1267**	−0.1430**
Value Added Share Other Services (*VAOTH*)	−0.1291			−0.6395**		−0.0862	
VAOTH ^{2}				0.0074**			
Employment Share Fin. Services (*EMPFIN*)	−0.8906	−1.4693***					
Fitted EMPFIN (*EMPFIN_AF*)			−1.1249**		−2.5370***		−0.9049*
EMPFIN_AF ^{2}					0.2306***		
***VAOTH**log[*POP*]**						−0.0372***	
***EMPFIN_AF**log[*POP*]**							−0.2232**
N	181	181	210	210	210	210	210
R^2	0.3464	0.3309	0.3285	0.3637	0.3462	0.3496	0.3401
Adjusted R^2	0.3239	0.3118	0.3121	0.3449	0.3269	0.3304	0.3206

The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The standard errors are computed with Eicker-/Huber-/White-correction.

Table 10: Financial Crisis impact persistence (recovery), additional augmented regressions

Impact Persistence (Recovery)	Dependent Variable: *Duration to Pre-Crisis Real GDP Level (GDPLEVEL78)*						
	OGLM						
	[31]	[32]	[33]	[34]	[35]	[36]	[37]
Constant (*C*)							
Population (log[*POP*])	−0.2599***	−0.2471***	−0.2379***	−0.2807***	−0.3233***	−0.2308**	−0.3237***
Real GDP Growth 2002–07 (*GDPG27*)	−0.0781	−0.0802*	−0.0984*	−0.1297**	−0.0638	−0.0657	−0.0668
GDP per Capita (*GDPC*)	0.0587***	0.0366***	0.0231**	0.0351***	0.0684***	0.0605***	0.0663***
Value Added Share Manufacturing (*VAMAN*)	0.0134	0.0135	−0.0029	0.0246	0.0160	0.0128	0.0079
Value Added Share Other Services (*VAOTH*)		0.0293	0.0171	0.0354**	0.0296*	0.0281	0.0376**
Value Added Share Services (*VASERV*)	0.0370***						
Val. Add. Share Mining/Utilities (*VAMINEUT*)		−0.0017					
Val. Add. Share Agr./Fishing (*VAAGFI*)			−0.0649***				
GDP Share Travel/Tourism (*TOUR*)				0.0023			
Goods and services exports/GDP (*EXPGS*)					−0.0061		
Insularity Dummy (*ISL*)						0.6569	
Sovereignty Dummy (*SOV*)							1.1362
N	210	210	210	210	210	210	210
Pseudo R^2 (McFadden [1974])	0.1470	0.1318	0.1625	0.1404	0.1408	0.1428	0.1433

GDPLEVEL78: ordinal (0–6) for 0 up to 5+ consecutive years below pre-crisis real GDP peak (2007 or 08). OGLM: ordinal generalized linear model with heteroskedasticity correction (STATA package “st0208”).
The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The standard errors are computed with Eicker-/Huber-/White-correction.

Table 11: Financial Crisis impact magnitude, state sample bias (sample restrictions by state size)

Impact Magnitude (Vulnerability)	Dependent Variable: Real GDP Growth Difference 2009 vs. 2007, %-Points (*GDPGD97*)						
	Ordinary Least Squares						
	[38]	[39]	[40]	[41]	[42]	[43]	[44]
Sample Restrictions	*None*	*Population > 0.1M*	*Population > 0.2M*	*Population > 0.5M*	*Population > 1M*	*Population > 5M*	*Population > 10M*
Constant (*C*)	6.6924	9.7202*	9.9198*	10.1696*	9.7875	12.3827	19.0767
Population (log[*POP*])	0.8231***	0.5065**	0.4504*	0.4210	0.7841**	0.6711	0.4425
Real GDP Growth 2002–07 (*GDPG27*)	−1.3448***	−1.4372***	−1.4467***	−1.4256***	−1.4818***	−1.4897**	−1.8287**
GDP per Capita (*GDPC*)	−0.0652***	−0.0590**	−0.0591**	−0.0664**	−0.0562	−0.0845**	−0.0600
Value Added Share Manufacturing (*VAMAN*)	−0.1504**	−0.1593**	−0.1594**	−0.1879**	−0.1545**	−0.2348***	−0.2215**
Value Added Share Other Services (*VAOTH*)	−0.1185	−0.1725*	−0.1723*	−0.1643	−0.1991*	−0.2172	−0.3575
N	210	188	179	166	156	111	79
R^2	0.3329	0.3380	0.3385	0.3335	0.3323	0.3766	0.4109
Adjusted R^2	0.3165	0.3199	0.3194	0.3127	0.3100	0.3470	0.3705

The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The standard errors are computed with Eicker-/Huber-/White-correction.

Figure 3: Partial effect of financial variables (equations [28] and [30] of Table 9, range min/max in sample)

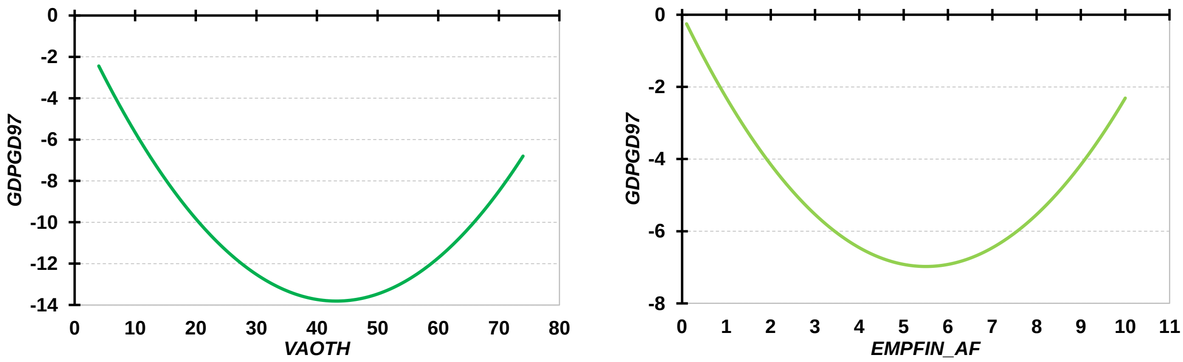
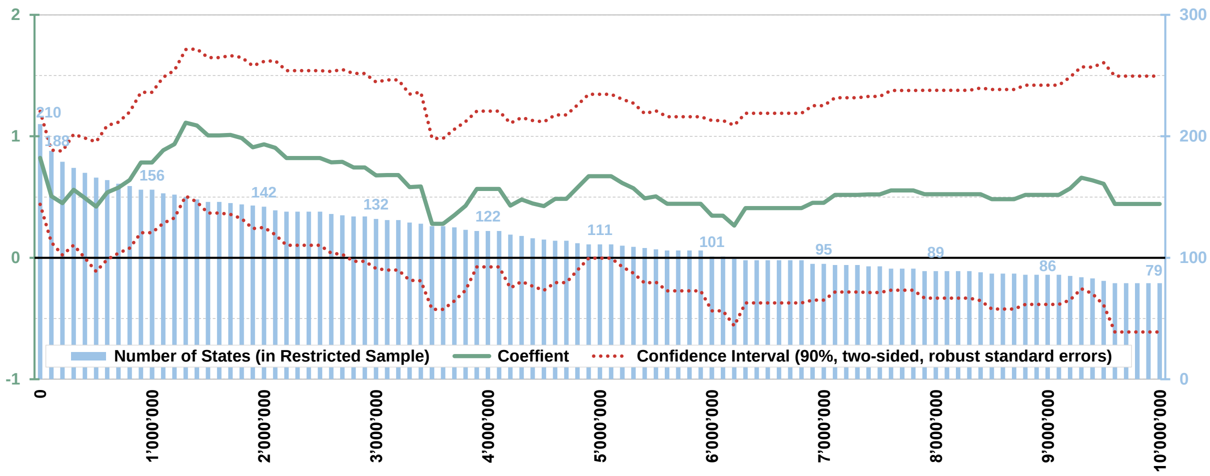


Figure 4: Financial Crisis impact magnitude, state sample bias (step-wise sample decrease by state size)



A.1.2. Robustness Checks

The results regarding the variable of main interest (population size) turn out to be very robust across the various selections of dependent and independent variables and across methodical variations. The robustness tests are executed based on equation [6] in Table 4.

The regressions in Table 4 and Table 5 show the robustness of the high significance and coefficient sign of population size against the inclusion of control variables. Furthermore, the findings on population size can also be confirmed by choice variations of the dependent variables as vulnerability proxies for the Financial Crisis impact on GDP.[36]

The regression results also turn out to be fairly insensitive to the chosen size proxy (see Table 12): If *POP* instead of log[*POP*] is applied, the size coefficient is still highly significant. This is also true if the ordinal dummy variable *POPCAT*, where the states are grouped into six population size categories[37], is applied to deal with potential non-linearity issues regarding population size. Also, if an additional quadratic term of the population size (log[*POP*]^2) is included, log[*POP*] remains significant below the 1%-level, whereas the quadratic term's coefficient is clearly insignificant. If land area (log[*AREA*]) instead of population is used as size indicator, the coefficient is significant. Using the nominal GDP level of 2007 as (economic) size proxy, yields a p-value of 0.0599 for *GDP* and a p-value of 0.1241 for log[*GDP*].

Table 12: Financial Crisis impact magnitude (vulnerability), robustness tests state size measures

Impact Magnitude (Vulnerability)	Dependent Variable: Real GDP Growth Difference 2009 vs. 2007, %-Points (*GDPGD97*)						
	Ordinary Least Squares						
	[45]	[46]	[47]	[48]	[49]	[50]	[51]
Constant	3.7004	4.9040*	1.0408	3.7142	2.4215	4.4712	4.6147*
Population (log[*POP*])	0.6300***			0.6708***			
log[*POP*]^2				−0.0217			
Population (*POP*)		0.0068***					
Population Size Category (*POPCAT*)			1.0900***				
Area (log[*AREA*])					0.3668**		
Economic Size (log[*GDP*])						0.2569	
Economic Size (*GDP*)							0.0003*
Real GDP Growth 2002–07 (*GDPG27*)	−1.1649***	−1.1757***	−1.1435***	−1.1639***	−1.1400	−1.1601***	−1.1344***
GDP per Capita (*GDPC*)	−0.0794***	−0.0872***	−0.0807***	−0.0790***	−0.0822	−0.0959***	−0.0917***
Value Added Share Manufacturing (*VAMAN*)	−0.1161**	−0.0623	−0.0971**	−0.1171**	−0.0783	−0.0734	−0.0419
Value Added Share Other Services (*VAOTH*)	−0.0603	−0.0924*	−0.0673	−0.0574	−0.0572	−0.0897*	−0.0915*
N	207	207	207	207	207	207	207
R^2	0.3413	0.3253	0.3320	0.3418	0.3273	0.3168	0.3128
Adjusted R^2	0.3249	0.3085	0.3154	0.3220	0.3106	0.2998	0.2957
The p-values are indicated by asterisks (*: p-value ≤ 0.10 and > 0.05; **: p-value ≤ 0.05 and > 0.01; ***: p-value ≤ 0.01). The standard errors are computed with Eicker-/Huber-/White-correction.							

If only GDP growth in 2007 (*GDPG*) is applied instead of the average GDP growth between 2002 and 2007 (*GDPG27*), then R^2 heavily increases from 0.3413 to 0.5061 and the coefficient of other

[36] Alternative proxies for the shock vulnerability applied instead of real GDP growth difference (2009 vs. 07) were real GDP growth difference (2009 vs. 08), real GDP growth 2009, real GDP growth (level of 2009 versus 07), average growth 2008–09, average real GDP growth difference (average growth 2008–09 versus 2006–07), and cumulated percentage real GDP loss between state specific peak and trough (2007–10).

[37] Five population size categories: < 0.1M, 0.1M–1M, 1M–10M, 10M–100M, > 100M.

services value added share (*VAOTH*) becomes significant, with negative coefficient sign (population size is still highly significant). Yet, the wider variable intuition of average pre-crisis growth speed (2002–2007) as determinant is lost and the pre-crisis growth variable interpretation reduces to an individual growth level adjustment intercept, as the dependent variable is the percentage point real GDP growth difference between 2009 and 2007. Yet. the high significance of population size is independent of the choice of the individual growth level adjustment intercept (*GDPG* or *GDPG27* or none of the two).

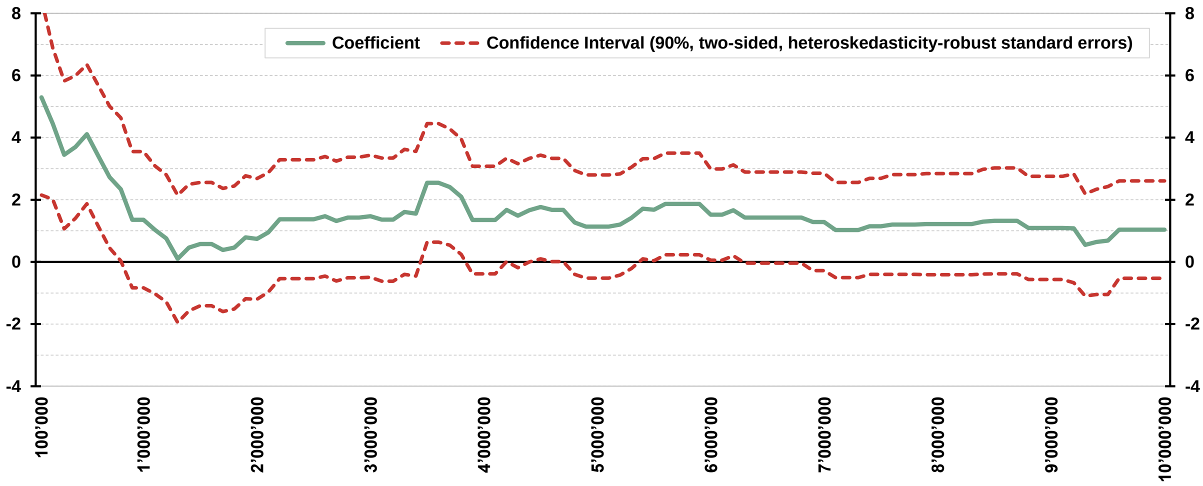
As a kind of placebo test, the main regression can be re-run, for instance using the GDP growth difference between 2007 and 2006 instead of 2009 and 2007. The population size coefficient becomes clearly insignificant, as expected. The observation is also made for the GDP growth percentage point difference of 2008 and 2007 (see equation [17] in Table 8).

The results are also robust to methodical aspects and data aspects. The population size coefficient is still significant below a p-value of 0.01 when the main regression equations [1]–[7] of Table 4 are executed without the Eicker/Huber/White-correction of the standard errors. The other variables' coefficients remain significant, as well. As shown in equations [6] and [7] of Table 4, in which outliers and war states are excluded from the sample, the relevant regression results remain. Additionally, if the data set is sliced into halves (alphabetical order), the p-value of log[*POP*] has a p-value below 0.05 for both subsets.

A.1.3. Regression Loops for States with Population below 12 Million

To obtain more insights on the comparison of vulnerability within the group of smaller states (see the paragraphs at the end of section 3.1.), the step-wise estimation loops are now executed with a restricted sample only including the 141 states with a population of below 12 million. The sequences are now carried out with a step-wise threshold increase of 100'000 inhabitants instead of 1'000'000.

Figure 5: Financial Crisis impact magnitude, population size thresholds (sample restriction: *POP* < 12M)



Looking at Figure 5, two critical population size thresholds are detectable, the first well below 1 million and the second between 3 and 4 million (yet, the latter is potentially driven by influential outliers). Figure 5 corresponds well with Table 6, where the sub-samples of states with a population of below 12 million are applied and confirms that – albeit the disadvantage of small population size comes into effect for a population size of below around 10 million – very small states with populations of well below 1 million suffered the most from the small-size disadvantage with respect to impact magnitude vulnerability measured by the initial shock impact magnitude.

A.2. Data Set

Table 13 lists the 210 states included in the regression analysis. The state sample follows the National Accounts Main Aggregates Database (UN). The applied variables of the (partly unbalanced) data set are described in Table 14 with the respective data sources and the number of state observations. The data set is available from the author upon request.

Table 13: States in the applied data set

Countries/Independent Territories in the Data Set (with their Population Size 2007, in Millions)
Afghanistan (27.1), Albania (3.0), Algeria (34.2), Andorra (0.083), Angola (20.9), Anguilla (0.013), Antigua and Barbuda (0.084), Argentina (39.7), Armenia (2.9), Aruba (0.101), Australia (20.9), Austria (8.3), Azerbaijan (8.7), Bahamas (0.337), Bahrain (1.0), Bangladesh (142.7), Barbados (0.279), Belarus (9.5), Belgium (10.7), Belize (0.299), Benin (8.5), Bermuda (0.066), Bhutan (0.665), Bolivia (9.6), Bosnia and Herzegovina (3.8), Botswana (1.9), Brazil (190.1), British Virgin Islands (0.025), Brunei (0.375), Bulgaria (7.6), Burkina Faso (14.3), Burundi (7.9), Cabo Verde (0.475), Cambodia (13.7), Cameroon (18.7), Canada (32.9), Cayman Islands (0.052), Central African Republic (4.2), Chad (10.8), Chile (16.5), China (1'346.0), Colombia (43.7), Comoros (0.642), Congo-Brazzaville (3.9), Congo-Kinshasa (58.5), Cook Islands (0.019), Costa Rica (4.4), Côte d'Ivoire (19.2), Croatia (4.4), Cuba (11.3), Curaçao (0.137), Cyprus (0.767), Czechia (10.4), Denmark (5.5), Djibouti (0.805), Dominica (0.071), Dominican Republic (9.3), Ecuador (14.3), Egypt (78.2), El Salvador (6.1), Equatorial Guinea (0.822), Eritrea (3.0), Estonia (1.3), Eswatini (1.0), Ethiopia (80.7), Fiji (0.836), Finland (5.3), France (63.9), French Polynesia (0.263), Gabon (1.5), Gambia (1.6), Georgia (4.2), Germany (81.3), Ghana (23.0), Greece (11.1), Greenland (0.057), Grenada (0.105), Guatemala (13.7), Guinea (9.5), Guinea-Bissau (1.4), Guyana (0.746), Haiti (9.5), Honduras (7.8), Hong Kong (6.8), Hungary (10.0), Iceland (0.305), India (1'183.2), Indonesia (232.4), Iran (71.3), Iraq (27.9), Ireland (4.3), Israel (6.8), Italy (58.7), Jamaica (2.8), Japan (128.5), Jordan (6.3), Kazakhstan (15.7), Kenya (38.7), Kiribati (0.097), Kosovo (1.7), Kuwait (2.5), Kyrgyzstan (5.2), Laos (5.9), Latvia (2.2), Lebanon (4.8), Lesotho (1.9), Liberia (3.5), Libya (6.0), Liechtenstein (0.035), Lithuania (3.3), Luxembourg (0.475), Macao (0.505), Madagascar (19.4), Malawi (13.3), Malaysia (26.7), Maldives (0.335), Mali (13.7), Malta (0.408), Marshall Islands (0.056), Mauritania (3.2), Mauritius (1.2), Mexico (109.2), Micronesia (Federated States, 0.104), Moldova (4.1), Monaco (0.035), Mongolia (2.6), Montenegro (0.620), Montserrat (0.005), Morocco (31.2), Mozambique (21.7), Myanmar (49.6), Namibia (2.0), Nauru (0.010), Nepal (26.4), Netherlands (16.5), New Caledonia (0.243), New Zealand (4.2), Nicaragua (5.6), Niger (14.7), Nigeria (146.3), North Korea (24.1), North Macedonia (2.1), Norway (4.7), Oman (2.7), Pakistan (167.8), Palau (0.019), Palestine (3.8), Panama (3.5), Papua New Guinea (6.8), Paraguay (6.0), Peru (28.3), Philippines (89.4), Poland (38.4), Portugal (10.6), Puerto Rico (3.6), Qatar (1.2), Romania (21.0), Russia (143.3), Rwanda (9.3), Saint Kitts and Nevis (0.048), Saint Lucia (0.168), Saint Vincent and the Grenadines (0.109), Samoa (0.182), San Marino (0.030), Sao Tome and Principe (0.166), Saudi Arabia (25.2), Senegal (11.7), Serbia (7.4), Seychelles (0.090), Sierra Leone (6.0), Singapore (4.6), Sint Maarten (0.033), Slovakia (5.4), Slovenia (2.0), Solomon Islands (0.492), Somalia (11.1), South Africa (49.1), South Korea (49.0), Spain (45.4), Sri Lanka (19.8), Suriname (0.511), Sweden (9.2), Switzerland (7.5), Syria (19.9), Tajikistan (7.1), Tanzania (Mainland, 39.5), Tanzania (Zanzibar, 1.1), Thailand (66.2), Timor-Leste (1.0), Togo (5.9), Tonga (0.103), Trinidad and Tobago (1.3), Tunisia (10.3), Turkey (69.6), Turkmenistan (4.9), Turks and Caicos Islands (0.030), Tuvalu (0.010), Uganda (29.5), Ukraine (46.4), United Arab Emirates (6.2), United Kingdom (61.5), United States (300.6), Uruguay (3.3), Uzbekistan (27.2), Vanuatu (0.219), Venezuela (27.2), Vietnam (85.4), Yemen (21.3), Zambia (12.5), Zimbabwe (12.3).

Table 14: List of applied variables with description, sources and number of states available

Variable Name	Description	Data Source	N
AREA	Land Area (1'000 km^2), 2007	WDI	210
BANKDEP	Bank deposits in relation to GDP (%), 2007	GFD	179
EASTEUR	Dummy (0, 1) for Eastern European states	Author's own compilation	210
EMPFIN	Employment share finance and insurance (%), 2007	ILOSTAT	181
EMPFIN_AF	Actual values from *EMPFIN* plus fitted values for missing states, 2007	ILOSTAT and author's own estimates	210
EXCHRA	Exchange rate arrangement classification (ordinal scale 1–15), 2007	ILZETZKI ET AL.[2019]	192
EXPG	Goods exports to GDP (%), 2007	WITS	171
EXPGS	Goods and services exports to GDP (%), 2007	NAMAD	210
EXPS	Services exports to GDP (%), 2007	WITS	171
FINOPEN	Financial openness indicator (0–1), 2007	CHINN AND ITO [2008]	165
GDP	Nominal GDP (1'000'000'000 USD), 2007	NAMAD	210
GDPC	Nominal GDP per capita (1'000 USD), 2007	NAMAD	210
GDPEARLY8	Binary dummy (0, 1) for states with negative GDP growth already in 2008	Calculations based on NAMAD	210
GDPG	Real GDP (annual growth rate), 2007	Calculations based on NAMAD	210
GDPG27	Real GDP (annual growth rate), average 2002–2007	Calculations based on NAMAD	210
GDPG8	Real GDP (annual growth rate), 2008	Calculations based on NAMAD	210
GDPG89	Real GDP (annual growth rate), average 2008–2009	Calculations based on NAMAD	210
GDPG9	Real GDP (annual growth rate), 2009	Calculations based on NAMAD	210
GDPG97	Real GDP (annual growth rate), 2009 vs. 2007	Calculations based on NAMAD	210
GDPGD76	Real GDP (annual growth rate), difference (%-points) 2007 vs. 2006	Calculations based on NAMAD	210
GDPGD81327	Real GDP (annual gr. rate), difference (%-points) average 2008–13 vs. 2002–07	Calculations based on NAMAD	210
GDPGD87	Real GDP (annual growth rate), difference (%-points) 2008 vs. 2007	Calculations based on NAMAD	210
GDPGD8967	Real GDP (ann. gr. rate), difference (%-points) average 2008–09 vs. 2006–07	Calculations based on NAMAD	210
GDPGD97	Real GDP (annual growth rate), difference (%-points) 2009 vs. 2007	Calculations based on NAMAD	210
GDPGD98	Real GDP (annual growth rate), difference (%-points) 2009 vs. 2008	Calculations based on NAMAD	210
GDPLEVEL78	Dummy (0–6), 0–5+ consecutive years below pre-crisis GDP peak (2007 vs. 08)	Calculations based on NAMAD	210
GDPPTC79	Cumulated real GDP loss (%, state specific peak and trough (2007–2010)	Calculations based on NAMAD	210
GNIC	GNI per capita (1'000 USD), 2007	NAMAD	210
GOVEFF	Indicator for government effectiveness (−2.5–2.5), 2007	World Bank	194
IMPG	Goods imports to GDP (%), 2007	WITS	171
IMPGS	Goods and services imports to GDP (%), 2007	NAMAD	211
IMPS	Services imports to GDP (%), 2007	WITS	171
ISL	Dummy (0, 1) for island states, 2007	Compilation based on Google Maps	210
OIL	Dummy (0, 1) for states with oil rents of more than 10% of GDP, 2007	Compilation based on WDI	210
POP	Population (1'000'000 people), 2007	NAMAD	210
POPCAT	Dummy (1–5), 2007 (further explanation in footnote 37)	Calculations based on NAMAD	210
PUBCONS	General government final consumption expenditure to GDP (%), 2007	Calculations based on NAMAD	209
POPTD	Dummy (0, 1) for states with a population larger than threshold, 2007	Compilation based on NAMAD	210
PUBDEBT	Public debt to GDP (%), 2007	HPDD	182
REM	Average distance between capital and all other states' capitals (1'000 km), 2011	GeoDist	202
SD7019	Real GDP (annual growth rate), standard deviation 1971–2019	Calculations based on NAMAD	179
SOV	Dummy (0, 1) for sovereignty, 2007	Compilation based on CIA Factbook	210
TOUR	Direct contribution of travel and tourism to GDP (%), 2007	TCdata360	176
TRADECAGS	Goods and services trade surplus (exports minus imports) to GDP (%), 2007	NAMAD	210
TRADEG	Goods trade (exports plus imports) to GDP (%), 2007	WITS	171
TRADEGS	Goods and services trade (exports plus imports) to GDP (%), 2007	NAMAD	211
TRADES	Services trade (exports plus imports) to GDP (%), 2007	WITS	171
URBPOP	Urban population ratio (%), 2007	WDI	204
VAAGFI	Agriculture, hunting/fishing, forestry: Sectoral value added share (%), 2007	NAMAD	208
VACON	Construction: Sectoral value added share (%), 2007	NAMAD	210
VADIV	Concentration index of sectoral value added (HHI, 7 ISIC 3.1 sectors), 2007	Calculations based on NAMAD	210
VAMAN	Manufacturing: Sectoral value added share (%), 2007	NAMAD	210
VAMINEUT	Mining, Utilities: Sectoral value added share (%), 2007	NAMAD	207
VAOTH	Other services: Sectoral value added share (%), 2007	NAMAD	210
VASAREHO	Wholesale/retail, repair, hospitality: Sectoral value added share (%), 2007	NAMAD	209
VASERV	Services: Sectoral value added share (%), 2007	NAMAD	209
VATRSTCOM	Transport, storage, communications: Sectoral value added share (%), 2007	NAMAD	209
WAR210	Dummy (0, 1) for conflict/war ("intensity 2") within the years 2002 to 2010	UCDP/PRIO	210

GeoDist: GeoDist database (Centre d'Etudes Prospectives et d'Informations Internationales); GDP: gross domestic product; GFD: Global Financial Development Database (World Bank); GNI: gross national income; HHI: Herfindahl-Hirschman Index (see footnote 22); HPDD: Historical Public Debt Database (International Monetary Fund); ILOSTAT: International Labour Organization data portal; NAMAD: National Accounts Main Aggregates Database (United Nations); TCdata360: Open Trade and Competitiveness Data (World Bank); UCDP/PRIO: Uppsala Conflict Data Program; WDI: World Development Indicators (World Bank); WITS: World Integrated Trade Solution (World Bank).

The value added data in the National Accounts Main Aggregates Database is based on the ISIC 3.1 code (see Table 15). The UN database also provides sectoral value added figures for each state, broken down into seven sectors summing up ISIC 3.1-sections as follows: A–B, C–E (including D), D, F, G–H, I, and J–Q. For the data set applied the sectors were recompiled in the following manner (variable name in brackets): A–B (*VAAGFI*), C+E (*VAMINEUT*), D (*VAMAN*), F (*VACON*), G–H (*VASAREHO*), I (*VATRSTCOM*), J–Q (*VAOTH*), G–Q (*VASERV*).

Table 15: Economic Activity Sections (ISIC 3.1)

Economic Activity Sections (ISIC 3.1)	
A	Agriculture, hunting and forestry
B	Fishing
C	Mining and quarrying
D	Manufacturing
E	Electricity, gas and water supply
F	Construction
G	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods
H	Hotels and restaurants
I	Transport, storage and communications
J	Financial intermediation
K	Real estate, renting and business activities
L	Public administration and defense; compulsory social security
M	Education
N	Health and social work
O	Other community, social and personal service activities
P	Activities of private households as employers and undifferentiated production activities of private households
Q	Extraterritorial organizations and bodies

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