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Acknowledgements

The authors are grateful to the anonymous referees for their constructive comments on an earlier draft of this paper and to feedback and insights from colleagues and seminar participants. This research is part of an ongoing extensive research project by the authors on growth issues relating to small economies.

Size & Sectoral Specialisation:

The Asymmetric Cross-Country Impacts of the 2008 Crisis & its Aftermath

Abstract

This paper analyses the cross-country impacts of the 2008 Global Financial Crisis and the subsequent recovery process, with a specific focus on small economies. Key growth volatility variables highlight the critical exposure of small economies to the transmission of exogenous shocks owing to their high degrees of trade openness and inherent output and export specialisation, notably in financial services and tourism. These factors also constrain the mitigation of exogenous shocks giving rise to greater growth volatility. The paper demonstrates systematic asymmetries between countries with respect to the impact of the crisis and its persistence according to their size and patterns of sectoral specialisation. Small tourism-dependent economies and non-sovereign entities were particularly adversely affected although an offshore financial sector partly mitigated the impacts. The robustness of the findings is examined further in an appendix with regard to truncation problems arising from the use of international datasets.

Key words: Global crisis; economic shocks; growth volatility; country size; sectoral specialisation; services sector; cluster analysis.

JEL: F43; F44; F62; F63; L8; O110

Size & Sectoral Specialisation:

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The primary causes of the 2008 global financial crisis are now well-known as are its initial impacts on leading industrialised economies, notably those in Europe and North America, and its 'knock-on' effects on industrialising and developing economies The impacts of the crisis however, were not evenly distributed between countries but rather asymmetrically according to their exposure to specific sources of exogenous shocks. Small economies are particularly vulnerable to such shocks because of their narrow inherent output and trade structures along with very high degrees of openness to trade. These factors also constrain their capacity to mitigate the impacts of disturbances such that they experience greater growth volatility. This paper utilises the literature on the sources of growth volatility to inform its analysis of the impacts of the 2008 global financial crisis and its aftermath on the economic performance and subsequent recovery of small economies. In the period preceding the crisis, many of the smallest economies pursued highly successful export-led growth strategies that focused upon serving the markets for financial services and tourism in the leading industrialised economies. The acute reliance of many small economies on these sectors and export markets, coupled with their inherent exposure to exogenous shocks, may therefore have provided the mechanisms for transmitting and amplifying the effects of the crisis as well as hampering the recovery process.

The paper begins by reviewing the empirical literature on the principal sources and impacts of growth volatility – openness to trade, export and geographic concentration and sectoral specialisation – and its asymmetric country size effects with reference to key characteristics of small economies. Section 2 presents the analytical methodology, including the sources of data and, the selection of business cycle and other variables. This is followed by a

presentation of the findings regarding the differential country size impacts of the crisis for: i) the initial post-2008 recession; and ii) the subsequent recovery phase of the business cycle up until 2016. In Sections 4 and 5, both correlation and cluster analysis are used to assist in explaining the differential impact of the crisis and subsequent recovery on small economies with respect to their: i) openness to trade; ii) sectoral structures; and iii) proximity to major industrialised economies. Section 6 summarises the principal findings of the paper and offers suggestions for further research.

1. Growth volatility, country size and small economies

The volatility of national income has critical implications for economic growth, employment, investment and productivity, irrespective of country size. Further, the findings of large scale cross-country studies indicate that the longer-term impact of volatility is non-neutral in that the growth impacts of economic downturns tend to outweigh the positive effects of upturns through negative 'ratchet effects', so dampening average rates of growth. Growth volatility is primarily a function of the extent of countries' linkages with the global economy, their domestic growth strategies (including governance), developmental level and susceptibility to natural catastrophe. Its adverse effects are therefore particularly pronounced in low-income developing countries owing to their relatively undiversified export structures and poor institutional governance that lead to inferior domestic policy choices.

There is an extensive empirical literature on the sources and impacts of growth volatility (e.g., Ramey & Ramey, 1995; Acemoglu & Zilibotti, 1997; Rodrik, 1999; Easterly *et al*., 2001; Hnatkovska & Loayza, 2003). The literature focusing on developing countries in particular, distinguishes between endogenous and exogenous sources of volatility (e.g., Turnovsky & Chattopadhyay, 2003; Koren & Tenreyro, 2007; Loayza *et al*., 2007; Raddatz, 2007); domestic policy choices (e.g., governance) are viewed as quasi-independent of

external shocks. Very few studies however, focus on the relationship between size and growth volatility (e.g., Furceri & Karras, 2007; Alouini & Hubert, 2019) and, more specifically, growth volatility in small economies (e.g., Easterly & Kraay, 2000; Jansen, 2004; Hnatkovska & Kohler-Geib, 2018; Lederman & Lesniak, 2018). The structural characteristics of small economies however – narrow production and trade structures, high degrees of openness to trade, export-oriented patterns of sectoral specialisation and dependence upon a few key export markets – engender more pronounced growth volatility because they give rise to greater inherent susceptibility to exogenous shocks than for larger economies. Further, the absorption and smoothing of the effects of such shocks is particularly problematic. The focus of the discussion here is therefore on the inter-relationship between the principal structural characteristics of small economies and the sources and impacts of growth volatility.

Openness to trade and growth volatility

The limited size of the domestic market in small economies severely constrains their feasible range of productive activities, even before considering potential diseconomies associated with small-scale output. A second dimension of this constraint is that their economies are likely to be highly specialised with both relatively undiversified output and export structures. These give rise to significant asymmetries between the patterns of domestic production and consumption in small economies that can only be resolved efficiently via imports (Kuznets, 1960). The critical importance of tradeable goods and services therefore means that they necessarily pursue highly open trade regimes in broad accord with their underlying comparative advantage. The trade/GDP ratios of small economies are therefore generally well in excess of 100 per cent. In the years preceding the 2008 crisis, the global economy offered a fertile environment for export-led growth by small economies, particularly in financial

services and tourism, leading to their featuring increasingly (and disproportionately) in the World Bank's High and Upper-Middle Income classifications (Armstrong *et al*., 1998; Armstrong & Read, 2000). Openness to trade greatly increases the extent of the market for small economies by reducing the adverse scale effects of output while simultaneously increasing their exposure to growth volatility.

The general view of the empirical literature is that greater trade openness generates increased growth volatility (e.g., Mendoza, 1995; Turnovsky & Chattopadhyay, 2003; Hnatkovska & Loayza, 2003; Calderon *et al*., 2005; Cavallo, 2007; di Giovanni & Levchenko, 2007). This is also the case for small economies (Easterly & Kraay, 2000, Hnatkovska & Kohler-Geib, 2018). The destabilising effects of adverse terms of trade shocks however, are argued to be at least partly mitigated by a greater degree of international trade and financial integration (Cavallo, 2007). This also appears to have been the case for small economies prior to the onset of the crisis (Easterly *et al*., 2001; Armstrong & Read, 2002; Alesina *et al*., 2005). The greater volatility of demand for tradeable goods and services than for non-tradeables resulting from output specialisation however, is viewed as a risk hedge because it is less correlated with the domestic economy (di Giovanni & Levchenko, 2007). The applicability of this argument to small economies is debatable because of their greater openness and exposure to volatility. Further, the severity of the downturn caused by the 2008 crisis appears to have far outweighed any beneficial ameliorating effects arising from their regional and global integration. Small economies therefore may have experienced a 'triple whammy' because of the combined volatility effects of their high trade openness, patterns of sectoral specialisation and reliance upon export markets in the leading industrialised economies.

Export concentration and growth volatility

A second causal element of growth volatility in small economies is export concentration. This arises as a direct consequence of their output specialisation and so exacerbates exposure to terms of trade shocks (Briguglio, 1995; Armstrong *et al*., 1998). Undiversified export structures are usually regarded as intrinsic to developing countries, particularly their dependence upon primary commodities, although terms of trade volatility varies significantly between different goods and services.

An extensive literature finds strong empirical support for a positive relationship between export concentration and growth volatility (Hnatkovska & Loayza, 2003; Bacchetta *et al*., 2007, 2009; Loayza *et al*., 2007; Raddatz, 2007; Haddad *et al*., 2012). A secondary factor is poor institutional governance (Hnatkovska & Loayza, 2003) owing to the 'intrinsic instability of the development process' (Raddatz, 2007). Controlling for the effects of openness, Bacchetta *et al*. (2007) still find a positive and significant relationship between terms of trade volatility and income volatility. Easterly & Kraay (2000) however, find that terms of trade volatility in small economies is primarily the outcome of their high degrees of openness rather than export concentration *per se*. Jansen (2004) finds a significant relationship between export concentration (excluding services) and terms of trade volatility for both developing and small economies although openness is insignificant for the latter. Lederman & Maloney (2012) and Lederman & Lesniak (2018) find that terms of trade volatility is positively related to export concentration but only indirectly related to size. The latter study also finds a positive and highly significant relationship between size and trade volatility when controlling for the number of export products, suggesting that the trade volatility impact of small size is the result of export concentration (Lederman & Lesniak, 2018).

Sectoral specialisation and growth volatility

Discussion of export concentration and volatility must necessarily consider the distinct patterns of sectoral output and export specialisation in small economies, notably natural resources (if present), financial services and tourism (e.g., UNCTAD, 1997). A positive and significant empirical relationship is found between this sectoral pattern and high per capita incomes in small economies (Armstrong *et al*., 1998; Armstrong & Read, 2000, 2002; Read *et al*., 2012). This pattern of specialisation is therefore a further channel through which the effects of the 2008 crisis may have been transmitted to small economies.

The analysis of the relationship between sectoral specialisation and growth volatility tends to focus on the roles of the oil and non-oil sectors, particularly in developing countries, while services are often excluded altogether. This issue with regard to small economies has received scant empirical attention. Koren & Tenreyro (2007) find little evidence of volatility arising from sectoral or product specialisation, openness and size (among other factors) for 39 relatively large economies. Studies of the Caribbean find that agriculture, notably bananas, has been a major source of shocks in small economies (Kida, 2006) and that the growth of tourism has reduced growth volatility (IMF, 2011; Thacker & Acevedo, 2011). The IMF study also finds that the positive effects of openness in the region have been outweighed by greater growth volatility. Jackman *et al*. (2009) find no significant relationship between the volatility of remittances and domestic output for 20 small island developing states (SIDS) and conclude that they smooth both investment and output.

Geographic export concentration and growth volatility

A further dimension of export specialisation and volatility relates to geographic export concentration; dependence upon a limited number of markets that exposes economies to imported volatility through partner-specific demand shocks (Ostlind, 1953). Many small

economies have strong links with high income countries within their broader global region, notably Europe and North America (Armstrong *et al*., 1998), including their former metropolitan countries (Bertram, 2004). Geographic export concentration may therefore be another transmission channel through which the crisis affected small economies.

The intensity of trade linkages between countries determines the extent of synchronisation between their business cycles (Frankel & Rose, 1998), particularly for developing countries (Calderon *et al*., 2007). An imported demand shock variable is found to be positive and significantly related to greater volatility effects in developing countries (Bacchetta *et al*., 2007). Haddad *et al*., (2012) observe a higher degree of correlation between both export and market concentration for developing countries, with the former having greater explanatory power with regard to growth volatility. Jansen *et al*. (2016) find a high correlation between export partner and growth volatility but that more synchronous business cycles (i.e., a lower covariance of volatility) result in greater stability in export markets. The empirical analysis of geographic export concentration and growth volatility in small economies is more limited. Export and market concentration are both found to be significant determinants of trade volatility in small economies with a negative and significant interaction term such that diversification in either reduces volatility (Lederman & Lesniak, 2018). Growth volatility in small economies is therefore the result of specialisation in output and exports rather than size specifically. In the Caribbean, the growth cycles of small economies have a high degree of synchronisation with key markets in the European Union and United States (Kouamé & Reyes, 2016).

Sovereignty and growth volatility

The differential impact of growth volatility on sovereign and non-sovereign entities has not previously been addressed explicitly in the empirical literature. This is probably because the

latter are presumed to be affected in an identical manner to their metropolitan patrons, which does not take into account distinct differences in their size location and economic structures, as well as a lack of comprehensive data. Empirical evidence suggests that sub-national jurisdictions (SNJs) out-perform sovereign entities in terms of growth for reasons that remain poorly understood but include their capacity to secure financial and other forms of support from as well as their strong trade links with their metropolitan powers (e.g., Armstrong & Read, 2000; Bertram, 2004). This is the first study to incorporate a test of sovereignty status as an independent variable in the analysis of growth volatility.

Additional sources of growth volatility in small economies

Several additional sources of volatility have important implications for the growth of small economies, namely; their dependence upon strategic imports (notably energy), remoteness and exposure to environmental shocks (e.g., hurricanes and typhoons as well as the effects of climate change). Given the primary focus of this paper on the impacts of the 2008 global financial crisis, these sources of volatility are not discussed further here.

Growth volatility mitigation in small economies

A critical policy challenge for small economies is to mitigate the effects of growth volatility. The implementation of standard solutions – i.e., diversification of output, exports and trade partners – however, is severely constrained by their inherent structural characteristics. Growth volatility in small economies is therefore more persistent and results in lower long-run growth, less investment, higher unemployment as well as greater than predicted external debt (Lederman & Lesniak, 2018). These effects require prescriptive domestic macroeconomic policies (see Guillaumont, 2007), including fixed exchange rates (Helleiner, 1982) or the use of third country currencies (Armstrong & Read, 1998). The vulnerability of

small economies to exogenous shocks and policies to increase their resilience are dealt with elsewhere (e.g., Briguglio, 1995, 2016; Armstrong & Read, 2006; Briguglio *et al*., 2006). Many small economies also perform very strongly on measures of institutional governance and policy-making (see Congdon Fors, 2007, 2014; Read, 2018), which are argued to be the outcomes of their greater exposure rather than a causal determinant.

Growth volatility in small economies and the impact of the global crisis

The primary focus of research into the impacts of the 2008 global financial crisis has been on industrialised countries and its implications for the international financial system. The principal transmission mechanism of the crisis to developing countries is found to be trade, particularly for more open economies, and the greatest impact was in those countries with more leveraged domestic financial systems, stronger credit growth and greater short-term debt (Berkmen *et al*., 2012). An important additional transmission mechanism in Sub-Saharan Africa was remittances but the impact of the crisis in many countries in the region was exacerbated by their low resilience (Allen & Giovannetti, 2011).

The empirical literature on the effects of the crisis on small economies is very limited. In a study of 15 small Caribbean economies prior to the crisis, asymmetries between positive demand shocks affecting prices and negative ones affecting output as a result of structural rigidities led to kinked supply curves in eight cases (Kandil, 2009). An analysis of the immediate impacts of the crisis in six small Pacific economies finds only limited direct effects on finance, tourism and remittances (Kida, 2009). The effects of the crisis and its aftermath on growth in small Caribbean economies is found to be strongly correlated with their major trading partners (the EU and US), particularly for smaller service-oriented countries (Kouamé & Reyes, 2016). Further, although this exposure does not amplify demand shocks from these partners, the effects of such cycles tend to be persistent. Armstrong &

Read (2018) find that the crisis had very distinct sector-specific effects in the Caribbean, with those small economies specialising in tourism and financial services being the worst affected.

The remainder of the paper draws upon the preceding discussion of critical sources of growth volatility and the transmission of exogenous shocks with respect to the impacts of the 2008 global financial crisis. In particular, it analyses the determinants of the asymmetric country size impacts of the crisis and its aftermath, focusing on the extent to which key characteristics of small economies – trade openness, pattern of sectoral specialisation and proximity to the major industrialised economies – were critical determinants of the magnitude of these effects.

2. Analytical methodology, dataset and caveats

This section provides a brief overview of the analytical methodology adopted in this paper, its choice of business cycle variables, its data sources and some methodological caveats.

Analytical methodology: correlation and cluster analysis

The analyses in Sections 3 and 4 use simple bivariate correlation analysis to test the significance of the correlation coefficients between the principal variables. In the first instance, the relationship between the recession and recovery variables outlined below are analysed with respect to size (population). This is followed by correlation analysis of the relationship between the recession and recovery variables and the key geographic, trade and structural variables that affect the transmission of the effects of the crisis to small economies highlighted in Section 2.

Multivariate cluster analysis is used in Section 5 to investigate the role of a further 11 GDP, geographical and trade/sector variables to identify clusters of cases, including small economies. This is a widely used statistical multivariate classificatory technique that is

particularly useful in searching systematically for patterns among many variables. A large variety of alternative methods of cluster analysis exist (see Kaufman & Rousseeuw, 1990; Everitt, 1993) of which the Ward's method is utilised here. This is a hierarchical cluster model which begins with each case (i.e., entity) being identified as a cluster in its own right. Cases are then grouped together successively in a hierarchical manner until only a single cluster remains containing all (*n*) entities. At each stage, every possible pairing of clusters is examined and fusion between pairs of clusters is undertaken in a manner that minimises the loss of information (measured using an error sum of squares – ESS – criterion across the 11 cluster variables). Squared Euclidean distance between scores on the cluster variables is employed as the similarity coefficient. Euclidean distance is defined as:

$$\sum_{k=1}^{n} \left(x_{ik} - x_{jk}\right)^2 \quad \text{(eqn 1)}$$

Where $k = 1 \ldots\ldots n$ are the cases to be clustered and $x = i \ldots\ldots\ldots j \ldots\ldots p$ are the cluster variables.

The Ward's method has the advantage of generating clearer clusters than most other methods and is the default algorithm in most statistics software packages (e.g., MINITAB – used here – and SPSS).

Cluster analysis results are typically presented in the form of a *dendrogram*. These show how the clusters have been formed since the algorithm groups cases from the start point (at the bottom of the graph) through to the final situation with only a single cluster (at the top). There is therefore no single 'correct' number of clusters; a large number is appropriate for analysing very fine variations between cases while a smaller one is more appropriate when seeking broad patterns. Extreme solutions (e.g., a single cluster or the number of clusters equal to the number of cases) however, are generally uninteresting since a single cluster hides all within-cluster variation while the maximum number equals *n*, the number of original

cases. The standard approach is used here whereby the 'best' number of clusters is identified with reference to the largest 'jump' in the similarity measure (the vertical axis of the dendrogram). Longer vertical lines show that the clustering algorithm is grouping together more dissimilar initial clusters. The intention is to allow the technique to identify the 'best' set of clusters in terms of maximising within-cluster similarity while retaining minimum between-cluster similarity.

The dataset

The World Bank *World Development Indicators* global dataset is used for the period 2008-2016 and provides a sample of between 193 and 201 countries, depending upon the measure of real GDP change. Most of these entities are sovereign states (UN definition) but several are not technically sovereign but nevertheless enjoy major economic and political policy autonomy – i.e., sub-national jurisdictions (SNJs). The SNJ category includes associated and dependent territories together with sub-national regions of larger states possessing significant autonomy, such as the Farøe Islands (Denmark) and the Åland Islands (Finland). The SNJs included in (most) of the World Bank real GDP data are American Samoa, Aruba, Bermuda, Greenland, Hong Kong (SAR), Isle of Man, Macau, Northern Marianas Islands, Puerto Rico and the US Virgin Islands. These entities however, constitute only a small part of the global set of SNJs.

The 2016 end year is chosen for two reasons. The principal justification is that it marks the end of the typical seven-year business cycle post-crisis recovery period. Nevertheless, the post-2009 recovery is notably atypical because of the sustained international and governmental responses – e.g., quantitative easing. A secondary consideration is data availability and the further truncation of the dataset, such that there is little marginal benefit to be derived from including a further year in the analysis.

Business cycle variables

There is no standard definition of an economic recession although two or three successive quarters of real GDP decline is a commonly-used indicator (e.g., Claessens & Kose, 2009). Detailed analysis however, is hampered by substantial gaps in the availability of quarterly GDP data in the main international harmonised datasets, both in terms of country coverage and over time. World Bank annual rather than quarterly GDP data for the period 2008-2016 is used here in order to maximise the sample of entities available to examine the impact of the crisis. The World Bank provides data in in local currency units (LCUs), with differing base years for deflation purposes, and in US Dollars with a common 2010 base year. In practice, these are identical when examining changes in values over time. The LCU series is adopted here to ensure consistency with the subsequent incorporation of variables drawn from national statistical series.

Two versions of real GDP change following the 2008 financial crisis are examined:

i) The percentage change in real GDP in LCUs 2008 to 2009, when the recession, averaged across all economies, was at its peak in 2008 with its trough in 2009. This variable is named CH08/09.

ii) The percentage change in real GDP in LCUs from *each individual country's* peak year to its trough year. This is generally 2008 but not in all cases. Peak years prior to 2007 are not deemed to be related to the crisis. The trough year is also country-specific. This variable is named CHPEAK/TROUGH.

For the subsequent recovery phase, two equivalent measures of real GDP change are applied: the percentage change in real GDP 2009-2016 (CH09/16) and the percentage change in real GDP from each economy's own trough year through until 2016 (CHTROUGH/16).

The preferred variables for this analysis are CHPEAK/TROUGH and CHTROUGH/16 since some countries led the way – notably in Europe and North America – while others followed. Each country therefore had its own particular peak and trough years. In order to cross-check the stability of the results for the two definitions of peak and trough years, the results of the analysis for both variables are presented. In addition, the number of successive years of negative real GDP growth is also measured for each economy. This is a measure of cycle *duration*, as distinct from cycle *amplitude* (i.e., GDP fall), and provides a means to assess whether small economies experienced a more persistent recession than larger economies. This variable is termed NEGYEARS.

Methodological caveats: Data truncation issues and measuring trade openness

A fundamental methodological shortcoming of much of the cited empirical literature on growth volatility is that it relies upon major international datasets, including those of the World Bank. These datasets suffer from systematic truncation in terms of the variables available, such that many of the smallest economies are frequently excluded. Systematic sample selection bias of this type is an inherently serious statistical issue affecting the true robustness of any cross-country findings although this problem is generally ignored in the mainstream literature. Many of the cited studies use restricted country samples, determined by the availability of comprehensive data for the widest range of critical variables, to draw broad conclusions regarding the impact of volatility on country size. In the case of small economies, this data truncation problem may therefore disguise the underlying strength of the relationship between size and volatility. There are no easy solutions to this problem however, since the standard international datasets have not, as yet, been able to resolve these issues. This paper explicitly recognises this challenge and, in the absence of harmonised statistics for

variables such as real GDP, it attempts to evaluate the likely scale of any truncation bias to better interpret the results of analysing harmonised samples (see Annex).

A further methodological issue is the inverse relationship between size and openness to trade as specified using the standard trade/GDP ratio measure. While this is perhaps self-evident from the preceding discussion and the broader literature on small economies, it is ignored in the mainstream economic growth literature although, in this case, dataset truncation dampens its distorting effects. This discussion is not intended to cast doubt on the general validity of the growth volatility literature, especially with regard to small economies, but rather to highlight methodological misgivings regarding the robustness of their empirical findings and conclusions.

3. Correlation analysis of the impact of the global crisis by country size

Simple correlation techniques are used to analyse the extent to which the impacts of the 2008 global crisis and its aftermath were distributed asymmetrically according to country size and therefore whether small economies were more adversely affected. Correlation coefficients between the selected business cycle measures and country size (measured in terms of 2016 population) are given in Table 1.

The results suggest a strong positive relationship between country size and growth performance in both the initial crisis downturn and the subsequent recovery phase. Smaller economies have performed worse than larger ones in both phases.

[Table 1 here]

The correlation coefficients are mostly less than 0.2 but all have positive signs and are significant at either the 95% or 99% levels with the exception of NEGYEARS – i.e., the length of the initial downturn. These findings have an important caveat; China and India are

extreme outlier values in terms of their absolute populations. When they are excluded from the analysis (the final three columns of the table), the coefficients again all have the appropriate signs, indicating that smaller economies perform less well, but their statistical significances fall substantially. The evidence therefore indicates that smaller economies have, as expected, performed less well than larger economies, both during the initial downturn after 2008 and also in the longer recovery phase up until 2016. These relationships are quite weak however, rarely explaining more than 20% of the variance in real GDP and with a wide dispersion of impact values between small economies. Further, the results are skewed by China and India which, when excluded, weaken these relationships. There is therefore only limited support for the view that small economies had a greater degree of exposure to the exogenous global shock caused by the 2008 financial crisis and took longer to recover.

A clearer picture of the overall weak nature of the relationship between country size and business cycle impact is provided in Figure 1. The scatterplot shows the preferred recession downturn indicator (percentage change in real GDP between each economy's peak trough year – CHPEAK/TROUGH) and the log of population size, including China and India. Those entities lying below the zero CHPEAK/TROUGH line experienced absolute falls in real GDP. The vertical line at 1.5m population is a rough and ready indicator of small size using the World Bank's 'small state' definition.

[Figure 1 here]

Correlation analysis of key determinants of the impact of the global crisis

The 2008 crisis is noteworthy primarily because of the magnitude of its global impact. It also had severe consequences for small economies for several reasons; their high degree of openness to trade, their close trade links with the principal financial epicentres of the crisis and its sector-specific effects. Highly open economies with close trade links with Europe and

North America are likely to have been more severely affected than other economies. Financial services, tourism and several other service sectors were hardest hit initially while agricultural products, natural resources and manufacturing were less affected. As noted above, most small economies are highly dependent upon a limited range of exports, including services, and often rely upon a limited number of export markets (Armstrong *et al*., 1998). Their initial pattern of specialisation is therefore likely to have been an important determinant of the domestic impact of the crisis. This analysis therefore follows Kouamé & Reyes (2016) and Armstrong & Read (2018) by investigating the extent to which the impact of the 2008 financial crisis can be explained by country size, openness to trade, pattern of sectoral specialisation and trade links. Simple correlation analysis is again used as a first step in examining the role of geographic and structural variables along with trade openness in determining the magnitude of the effects of the crisis and their persistence.

Geographic determinants of the impact of the crisis

Four geographic characteristics, drawn from empirical studies of the growth performance of small economies, are analysed as potential determinants of the impact of the crisis.

Population size**:** This is a continuous variable, measured as population size in 2008. It is the most commonly used country size measure and is generally acknowledged to be superior to other measures, e.g., geographic area, in economic analyses since it captures additional dimensions of size (labour force, market size etc.). A positive relationship is hypothesised between size and GDP performance since larger entities tend to be less open and therefore less adversely affected by the transmission of exogenous demand shocks via trade flows.

Distance from Europe & the United States**:** This is a continuous variable measuring the great circle distance in km from each entity to whichever is the nearer of either the EU (i.e., Brussels) or the United States (the nearest of either Washington DC or Los Angeles), as

developed by Armstrong & Read (2000). It is hypothesised that a positive relationship exists between this distance and changes in real GDP since entities that are more distant from the crisis epicentres can be expected to have less economic interaction (i.e., potential trade flows with iceberg costs) and are therefore likely to have been less adversely affected.

***Islandness*:** This is a simple binary variable (1 = island and 0 = non-island). Its inclusion reflects the case made by an extensive literature that island economies face a range of unique challenges (over and above those of small size) that affect their growth performance and reaction to external shocks (e.g., Dommen & Hein, 1985; Briguglio, 1995; Armstrong & Read, 2003; Guillaumont, 2007). Major international organisations recognise these unique challenges in special programmes and policies, notably UNCTAD (small island developing states - SIDS), the United Nations (Alliance of Small Island States – AOSIS) and The Commonwealth. A negative relationship is hypothesised between islandness and real GDP performance during the recession since most islands in the World Bank dataset are small open economies and can therefore be expected to have had greater exposure to the impacts of the recession.

***Sovereignty*:** The World Bank dataset comprises both sovereign states (i.e., recognised by the UN) and non-sovereign SNJs. This is a simple binary variable (1 = sovereign, 0 = non-sovereign). Although empirical evidence suggests that SNJs out-perform sovereign entities in terms of growth, the principal metropolitan powers (Europe and the United States) were the epicentres of the 2008 crisis such that SNJs may therefore have been more adversely affected than sovereign states. The hypothesised relationship between sovereignty and changes in GDP is therefore ambiguous.

Trade openness and sectoral determinants of the impact of the crisis

The premise of this paper is that the recession post-2008 had distinct trade and sectoral dimensions. In spite a lack of data for many key variables, it is possible to analyse seven variables of likely relevance for the large sample of small economies of interest.

***Trade openness*:** This is a continuous variable measuring the value of exports of goods and services as a percentage of GDP (World Bank, 2008) and therefore exposure to the post-2008 recession. It is hypothesised that there is a negative relationship between openness and GDP changes. Ideally, trade direction data would also have been used, particularly with Europe and North America, but this does not exist for a large enough sample of entities.

***Primary activity, manufacturing and services*:** These three variables measure the percentage shares of the principal sectors of economic activity in GDP. This provides the means to investigate any broad post-2008 differences in the cross-sectoral performance of each entity; natural resources, agriculture and manufacturing were less adversely affected than services. These sectoral variables are far from ideal in that they measure aggregate outputs and lack finer definition but the use of more highly defined sectoral variables would greatly reduce the number of entities in the analysis and exacerbate the serious dataset truncation problem.

***Finance*:** There exists no comprehensive harmonised data on financial services so a binary variable is utilised to indicate the presence of an Offshore Financial Centre (OFC) (1 = OFC, 0 = no OFC) derived from the OECD OFC list in 2000. This variable is expected to have a negative relationship with GDP change since the 2008 crisis was triggered by a financial sector collapse.

***Tourism*:** This continuous variable measures the relative importance of the tourism sector in terms of international arrivals per one thousand population (UN WTO data, 2008). Disaggregated tourism data by type (e.g. cruise, overnight stays, day trips etc.) would have

been useful since they are known to have been affected differently by the post-2008 recession. Further, tourism expenditure data by principal origin market (especially Europe and the United States) rather than visitor numbers alone would have been desirable. The need to maximise the sample of small entities however, necessitates reliance upon the broader measure of arrivals. The hypothesis is that there is a negative relationship between international tourism and real GDP changes as tourism was one of the sectors most severely affected by the recession.

***Resources*:** This is a continuous variable measuring natural resource rents as a percentage of GDP (WTO *Trade Profiles* data, 2008). A positive relationship with GDP changes is hypothesised given that trade in natural resources continued strongly in the aftermath of the 2008 crisis. This variable includes forestry, minerals and energy resources but not fisheries.

4. Correlation analysis of the cross-country impacts of the crisis and post-crisis performance

The correlation coefficients between each of the geographic, trade and structural variables and GDP changes during the recession and subsequent recovery are shown in Table 2. These results broadly confirm the initial hypothesis that larger economies were less adversely affected than smaller ones. As expected, entities located further from Europe and North America were also less adversely affected. Island economies appear to have been more adversely affected than non-islands although it should be noted that most islands are also very small economies; i.e., there is multicollinearity between (small) Size and Islandness. Sovereign states also appear to have been less adversely affected than SNJs, although this may simply reflect the fact that they are, on average, larger entities; i.e., there is multicollinearity between (large) Size and Sovereignty. More open economies were, as expected, more adversely impacted. A greater dependence upon Primary Activity led to less

adverse effects while greater dependence upon Services led to more adverse effects. The correlation coefficients with Manufacturing are not significant. Those economies with OFCs and/or reliant on Tourism were more adversely affected while those with substantial Resources were less adversely affected.

[Table 2 here]

The correlation coefficients for these variables in the recovery phase following the trough of the recession are shown in Table 3 and broadly mirror those for the initial downturn. Not only did smaller economies do less well in the initial downturn but they also struggled more to recover subsequently. These results offer reasonably strong support for the view that larger economies were less adversely affected than smaller ones during both the initial crisis downturn and subsequent recovery phases. The analytical challenge however, is a multivariate one and not simply a series of bivariate relationships, as implied by the simple correlation coefficients.

[Table 3 here]

5. Multivariate analysis of the cross-country impacts of the crisis and post-crisis performance

The use of a multivariate approach is likely to provide greater insight than a bivariate one into the transmission processes of the financial crisis. This section uses cluster analysis to examine the relationship between the real GDP change variable and the geographic characteristics and trade/sector variables identified earlier, taking each of the recession and recovery variables in turn.

Cluster analysis of the initial cross-country impact of the crisis

The results of the cluster analysis using the preferred CHPEAK/TROUGH changes in real GDP as the initial recession impact variable are shown in a dendrogram (Figure 2), together with the characteristics of each cluster (Table 4). The entities in each cluster are given in Appendix Table A1. From the figure, a 6-cluster solution appears to be the best in terms of differences between within-cluster and between-cluster variance. The discussion is therefore based upon this solution.

[Figure 2 & Table 4 here]

In order to interpret the solution, the characteristics of the economies within each cluster are estimated with respect to the mean values of the original variables. These cluster means are then compared with the mean variable values for the full set of 192 observations (i.e., all six clusters). These values are shown in Table 4 for each cluster in turn. The values for the Island, Sovereignty and OFC variables refer to the percentage of entities in the cluster. Small economies are almost completely confined to Clusters 2 and 4.

Clusters 2 & 4: Cluster 2, tentatively labelled 'Small Open Financial Centres & Tourism', and Cluster 4, 'Small Open Tourism SNJs', have several important similarities: they have by far the smallest mean populations (0.8m and 1.3m respectively); they are predominantly islands; and are heavily reliant upon tourism (1,800 and 5,863 mean arrivals per 1,000 population respectively). Nevertheless, there are also some important differences between them. Cluster 2 has a substantially greater reliance upon OFCs than Cluster 4 (95% versus 22.2% of entities) but is much less dependent on tourism. In the immediate aftermath of the crisis recession however, Cluster 2 performed less badly than Cluster 4, with a mean fall in real GDP of -2.3% compared to -7.0%. This suggests that the presence of an offshore financial centre was not as detrimental as might have been expected *a priori*, at least during

the initial crisis downturn. A final difference of note is that all twenty entities in Cluster 2 are sovereign states while all nine of those in Cluster 4 are SNJs. This suggests that dependent entities may not have enjoyed the types of advantage during the initial post-2008 downturn suggested by previous studies of longer term economic growth (Armstrong & Read, 2000; Bertram, 2004). Many of these SNJs are dependencies or associated territories of the United States and European metropolitan powers and were therefore closely tied to the epicentres of the 2008 financial crisis. It is also important to note that data for many SNJs, particularly in Europe, are not available, resulting in a truncation of the available dataset which may affect the robustness of these results (see Section 2).

Cluster 3: designated 'Larger Island States', comprises island economies (mean population 27.1m) which performed quite badly during the initial downturn period (a fall of -2.7% in real GDP by the trough year). This was in spite of their being, with the exception of Ireland and the UK, very distant from the European and North American epicentres of the recession (mean of 6,288 km). The explanation for this poor performance appears to be their greater than average reliance on services (66.6% of GDP). Perhaps more importantly, with the exception of Australia and possibly Indonesia, they lacked a valuable natural resource base (2.0% versus the global mean of 10.0%) while tourism was close to the global average (701 versus 774 arrivals per 1,000 population).

Cluster 6: 'China & India', unsurprisingly comprises just these two entities, since they are not only very large – and therefore less exposed to outside forces – but were also major drivers of global growth throughout the post-2008 downturn and subsequent recovery. In the initial post-crisis period, they recorded 9% real GDP growth while much of the rest of the global economy was in recession. China and India also had the additional advantages of being distant from both Europe and North America, relatively low trade openness because of their size (mean exports were 28.2% of GDP) and being less dependent on the service sectors

most badly affected by the recession (i.e., finance and tourism). Their performance does not appear to have been greatly hindered by a relative lack of resources (8.7% of GDP); China's buoyant demand for natural resources was primarily responsible for the sustained performance of this sector and continued growth in many resource-exporting economies.

***Clusters 1 &* 5**: Cluster 1, tentatively designated 'Europe/US Orbit', and Cluster 5, 'Globally Insulated/Resource Rich', are both big clusters (58 and 80 members respectively) of large (mean populations 25.7m and 25.1m respectively) sovereign states. The major difference between them is their performance during the immediate post-2008 period; Cluster 1 performed badly (a mean real GDP change of -3.9%) while Cluster 5 did well (real GDP change of +2.7%). The data in Table 4 and their cluster membership (Appendix Table 1) demonstrate why they differ so greatly. Cluster 1 comprises many of the countries close to the epicentres of the 2008 financial crisis in Europe and North America, including Central America, parts of Central Asia and the Middle East/North Africa. Its members are also more heavily reliant on manufacturing and services while lacking in natural resources that might have insulated them (mean 3.5% of GDP). It is therefore unsurprising that these countries were drawn into recession. In contrast, entities in Cluster 5 are more distant from Europe and North America (mean 6,344 km), more reliant upon agriculture, fisheries and forestry (20.4% of GDP compared to 6.9% for Cluster 1) and have the largest natural resource endowments of all clusters (20.5% of GDP). This cluster is therefore both further from the recession epicentres – and, hence, closer to China and India – and less reliant upon the service sectors most adversely affected by the recession.

These findings provide more detailed support for the principal argument of this paper that the impacts of the initial recession caused by the 2008 crisis were asymmetric between countries and determined by key geographic and structural variables, including size.

Cluster analysis of the post-crisis economic recovery

The recovery phase after the crisis trough years through to 2016 is analysed for the real GDP change variable CHTROUGH/2016 using the same geographical characteristics and sector and trade variables. The cluster findings are presented in Figure 3 and Table 5. Comparing Tables 4 and 5, the multivariate analysis produces remarkably similar types and sizes of clusters for the recovery phase of the crisis to those for the initial recession phase. The colour coding of the clusters is the same in Figure 3 as in Figure 2 to facilitate comparison,

There are two principal differences between the initial crisis impact and recovery phases. First, all six clusters exhibited positive real GDP growth during the recovery phase. Clusters 5 and 6, which were less adversely affected during the initial downturn, also recovered strongly (mean 42.8% and 83.3% real GDP growth respectively). GDP growth in the two predominantly small economy clusters (Clusters 2 and 4) however, was of a lower order of magnitude than all but one of the other clusters. Second, the relative importance of OFCs in Cluster 2 does not seem to have been a disadvantage, as was also the case during the initial downturn. The SNJs in Cluster 4 again performed least well of all, although with the same important critical caveat regarding dataset truncation.

[Figure 3 & Table 5 here]

The findings for the post-crisis recovery phase generally reinforce those for the impacts of the initial recession regarding the critical geographic and structural determinants of the asymmetric cross-country effects. It is also interesting to note that, while there are some changes in cluster membership between the two periods (see Appendix Tables A1 and A2), this is primarily between Clusters 1 and 3 while the membership of Clusters 2 and 4, featuring most small economies, is relatively stable.

6. Summary and conclusions

This paper demonstrates that exposure to demand shocks and growth volatility differs between economies, not only because of openness to trade, export and market concentration and trade links but also because of country size and pattern of sectoral activity. The salient characteristics of small economies induce their sectoral specialisation, notably in financial services and tourism, so intensifying their inherent exposure to exogenous shocks. Drawing upon the growth volatility and small economy literatures, this study examines the differential cross-country impacts of the 2008 global financial crisis and subsequent recovery with respect to the key structural and geographic characteristics of economies, including size.

The analysis of the relationship between country size and the selected recession and recovery variables reveals a positive and generally significant correlation for both the initial downturn and subsequent recovery phases of the crisis. These relationships are considerably weakened however, when China and India are excluded. Openness to trade, patterns of sectoral specialisation, population size and proximity to the crisis epicentres are shown to be important determinants of the magnitude and persistence of the crisis. Entities more heavily dependent upon international trade – and especially financial services and tourism in small economies – were more adversely affected by the downturn and also slower to recover. Those more dependent upon primary activity and natural resources were both less adversely affected and faster to recover. Larger entities were therefore less adversely affected than smaller ones.

Multivariate cluster analysis is used to side-step multicollinearity between the geographic, trade and sectoral variables. Most small economies are found in just two of the six distinct clusters, which have the smallest populations and greatest reliance upon tourism. The relative importance of financial services (and sovereignty) however, differs substantially between these two clusters of small economies; the presence of an OFC appears to have at least partly mitigated the effects of the initial downturn. The close economic and geographic links

between SNJs and the epicentres of the financial crisis in Europe and the United States also appear to have been particularly detrimental. The results for the recovery phase are very similar, albeit with two distinct elements: growth in these two clusters was of a lower order of magnitude; and resource-rich countries along with China and India were less affected by the initial crisis downturn as well as recovering more strongly.

Nevertheless, the relationship between the impact of the crisis and small size *per se* appears weaker than might have been expected *a priori*. A compelling explanation for this finding might be effect of truncation bias owing to the omission of many small entities from the principal international datasets. This caveat is addressed in the Annex, where further empirical analysis suggests that this dataset truncation results in a systematic *underestimation* of the impacts of the crisis on small economies.

The findings of this study generate several important policy issues. The first relates to the truncation of the principal international datasets, which provide incomplete data for many small economies and omit others. Many large scale cross-country empirical studies of economic growth and volatility therefore suffer from a size bias owing to the systematic omission of smaller economies from their analyses, with critical implications for the robustness of their findings and policy recommendations. The core analysis here is based upon the full World Bank harmonised dataset of 198 entities but is extended up to 223 out of a possible 240 entities in the Appendix by incorporating non-harmonised data. A second issue relates to the high degree of similarity in the patterns of specialisation in many small economies, notably in financial services and tourism. This appears to be a case of the 'fallacy of composition', whereby small economies have similar sectoral growth strategies and so are exposed to the same exogenous shocks as well as competing directly with each other during any recovery. Even in the wake of the crisis, the IMF and World Bank continue to advocate tourism as a growth panacea for small economies over and above its environmental

implications. Finally, the strength of the links retained by many small economies with their (former) metropolitan countries, often an epicentre of the crisis, were a mechanism by which the crisis contagion was transmitted and amplified. This emphasises the need for small economies to diversify their geographic markets as well as their sectoral structures.

Appendix: Dataset truncation problems and robustness analysis

The empirical analysis in this paper is based upon a sample dataset drawn from the full set of states and SNJs in the World Bank's *World Development Indicators*. An important caveat to the robustness of the findings in the paper is the problem of truncation in standard harmonised international datasets to which there is no easy solution. For example, a common approach in the growth volatility literature cited in Section 1 is to include only those countries for which all of the desired explanatory variables are available, so further embedding sample bias.

It is possible however, to approximate roughly the severity of specific truncation issues and therefore whether findings using international datasets are likely to be invalidated. The analysis here follows the two-step method developed by Armstrong & Read (2000, 2002, 2004) to try to deal with dataset truncation problems for small economies. First, the continuous (ratio) data for variables (e.g., real GDP changes) are converted into a cruder broad-brush ordinal scale. Second, where harmonised data from international datasets are not available, *non-harmonised* data are obtained for entities from other sources, most often from national statistics but also other international organisations (e.g., Eurostat). Judgements are then made regarding the broad GDP change category into which each omitted entity is most likely to fall. If the case is not unequivocal, then that entity is omitted from the ordinal dataset.

The conversion of a continuous variable into an ordinal dataset leads to a detrimental loss of information and such a dataset is not the ideal main focus of any analysis. This method has its advantages however, in that it can be used to examine the robustness of findings using the truncated dataset by *cross-checking* the interpretation of the results rather than replacing them.

Dataset truncation and robustness analysis of the initial impact of the crisis

This method is used to deal with the dataset truncation in the analysis of the initial impact of the crisis using the following procedure regarding GDP changes.

i) The continuous variable (in percentages) CHPEAK/TROUGH is converted into an ordinal variable TROUGH. The original 198 entities for which harmonised continuous World Bank GDP data were available are re-classified into one of four ordinal classes and, to circumvent issues with outlier values, the four classes are based on the median, lower and upper quartile values for CHPEAK/TROUGH. A value of '1' is applied to entities with declining real GDP between peak and trough years in excess of -4.735% (the lower quartile value); '2' to entities with changes between peak and trough of between -4.735% and -0.65% (the median); '3' to cases of -0.65% to +3.3% (the upper quartile) changes in GDP; and '4' for any cases with changes of over +3.3%.

ii) Non-harmonised GDP data are found for those entities originally omitted. Using the best available non-harmonised real GDP data, they are then categorised using the authors' judgement into the most likely (i.e., 'best guess') TROUGH group. Fortunately, most but not all entities omitted from the standard international datasets appear to fall very clearly into one ordinal category or another.

iii) If any significant doubt remains concerning the ordinal class into which a particular entity falls, it is simply excluded from TROUGH altogether.

This procedure produces a new variable, TROUGH(SUPP), comprising 223 entities while 17 further entities are still omitted because of either very poor or non-existent data. This variable therefore still has a truncated dataset with systematic bias but its degree of truncation has been substantially reduced.

The likely extent to which the degree of truncation in the World Bank dataset poses significant robustness issues for the original results for CHPEAK/TROUGH (Table 1) can now be examined. Two chi-square tests are conducted to find any significant differences between small and large entities. For simplicity the World Bank definition of small (under 1.5 million) is adopted. The results for the ordinal variable TROUGH for the *original dataset* are shown in Appendix Table A1 and those for the extended dataset in Appendix Table A2.

[Appendix Tables A3 & A4 here]

Three main findings stand out. First, there are significant differences in real GDP changes between the peak and trough years for the ordinal TROUGH variable between small and large economies, with a chi-square value of 11.677 (significant at the 90% and 95% levels). The differences between observed and expected (O-E) values indicate that small economies are *over*-represented in the lower quartile categories while large economies are *over*-represented in the higher quartile categories. This therefore suggests that small economies were significantly more adversely affected by the downturn than larger ones.

Second, the chi square findings for the ordinal TROUGH(SUPP) variable in Appendix Table 2 increase in strength for the extended dataset, with the differences between the peak and trough years for small and large entities significant at the 99% level as well as at the 90% and 95% levels (chi-square = 21.299 and p = 0.000). The O-E values show that these results are

the consequence of many previously-omitted small entities, including SNJs, appearing in the lower quartile GDP change categories and many previously-omitted larger entities appearing in the upper quartile categories. The truncation of the World Bank harmonised dataset is therefore very likely affecting the perception of the strength of the relationship between size and the fall in GDP post-2008. Reliance on the harmonised dataset alone therefore appears to systematically *understate* the adverse effects of the post-2008 global downturn on small economies.

Finally, 17 entities are still omitted from TROUGH(SUPP), all of which are small economies and SNJs. It is distinctly possible therefore that the degree of underestimation of the adverse effects of the recession on these entities may be even greater than that indicated by Tables A2 and A3; that is, the robustness analysis has itself not completely eliminated bias from the inherent data truncation problem.

Dataset truncation and robustness analysis of the post-crisis economic performance

A similar procedure is performed on the truncated World Bank datasets for the robustness analysis of the post-crisis performance. The ordinal variable RECOVERY is also created by estimating quartile values for the continuous CHTROUGH/2016 variable and allocating the entities into one of four groups. These take the value of '1' for real GDP changes less than 15.08% (the first quartile value), '2' for values 15.08-28.05% (the second quartile), '3' for values 28.05-42.78% (the upper middle quartile) and '4' for values over 42.78%. Again, non-harmonised data were retrieved for as many of the initially omitted entities as possible so as to allocate them to one of the four ordinal classes. The extended variable RECOVERY(SUPP) contains 221 states and SNJs compared to 194 entities in the original RECOVERY.

The results of chi-square tests for significant differences between small and large entities for the RECOVERY and RECOVERY(SUPP) datasets are shown in Appendix Table A3 and A4. It can be seen that small economies perform less well during the post-crisis phase than larger ones, as was the case in the initial downturn. Moreover, the extension of the dataset to include more of the initially omitted entities again strengthens the significance of the findings. This result provides further support for the view that the truncation of the World Bank dataset appears to disguise the full extent of the differences in the impact of the crisis between small and large economies.

[Appendix Tables A5 & A6 here]

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Table 1: Correlation coefficients between business cycle variables and country size (population, 2016)

	Including China & India			Excluding China & India		
	Correlation coefficients	*p*	*n*	*Correlation coefficients*	*p*	*n*
(a) Initial downturn						
'CH08/09'	+0.174	0.013**	201	+0.069	0.336	199
'CHPEAK/TROUGH'	+0.169	0.018**	198	+0.110	0.126	196
'NEGYEARS'	-0.090	0.205	199	-0.069	0.332	197
(b) Recovery phase						
'CH09/16'	+0.213	0.003***	193	+0.084	0.247	191
'CHTROUGH/16'	+0.243	0.001***	193	+0.083	0.254	191

Notes: 1. *, significant at 90%, **; significant at 95%; ***, significant at 99%.
2. Nauru is excluded from the CH09/16 and CHTROUGH/16 correlations because it is an extreme outlier value. For CH09/16, its real GDP growth was +190.4% while for CHTROUGH/16 its GDP increased +215.4%, some 7 standard deviations from the mean. These extreme outlier values appear to be related to growth from a very low base; the re-start of phosphate mining and changes related to support for the accommodation for Australian asylum seekers.

Table 2: Correlation coefficients of recession variables with geographic characteristics and trade/sectoral variables

	'CHPEAK/TROUGH'	*n*	*'NEGYEARS'*	*n*
1. Geographic Characteristics				
Size (population)	+0.169 (p=0.018*)	198	-0.090 (p=0.205)	199
Distance EU or US	+0.333 (p=0.000**)	198	-0.296 (p=0.000**)	199
Islandness	-0.173 (p=0.015*)	198	+0.201 (p=0.004**)	199
Sovereignty	+0.179 (p=0.012*)	198	-0.134 (p=0.060)	199
2. Trade & Sectoral Variables				
Openness (Exports/GDP)	-0.179 (p=0.013*)	192	0.124 (p=0.087)	192
Primary Activity	+0.430 (p=0.000**)	193	-0.382 (p=0.000**)	193
Manufacturing	-0.058 (p=0.422)	193	+0.070 (p=0.331)	193
Services	-0.370 (p=0.000**)	193	+0.301 (p=0.000**)	193
Finance Centre	-0.166 (p=0.020*)	198	+0.207 (p=0.003**)	199
Tourism	-0.340 (p=0.000**)	197	+0.300 (p=0.000**)	197
Resources	+0.267 (p=0.000**)	197	-0.231 (p=0.001**)	197

Notes: 1. *, significant at 90%, **; significant at 95%; ***, significant at 99%.
2. Nauru is again excluded from CH09/16 and CHTROUGH/16.
3. Islandness is a binary variable (1 = island, 0 = non-island) so that Pearson correlation is not strictly an appropriate technique. Results using more appropriate 2-sample t-tests (islands and non-islands) bear out the simple correlation results and are set out in Appendix1.

Table 3: Correlation coefficients of recovery variables with geographic characteristics and trade/sectoral variables

	'CHTROUGH/16' Excluding Nauru	*n*
(a) Geographic Characteristics		
Size (population)	+0.202 (p=0.000**)	193
Distance EU or USA	+0.390 (p=0.000**)	193
Islandness	-0.194 (p=0.007**)	193
Sovereignty	+0.159 (p=0.027*)	193
(b) Trade & Sectoral Variables		
Openness (Exports/GDP)	-0.171 (p=0.019*)	188
Primary Activity	+0.299 (p=0.000**)	189
Manufacturing	+0.009 (p=0.898)	189
Services	-0.309 (p=0.000**)	189
Finance Centre	-0.184 (p=0.010*)	193
Tourism	-0.163 (p=0.025*)	193
Resources	+0.253 (p=0.000**)	193

Note: 1. *, significant at 90%, **; significant at 95%; ***, significant at 99%.

Table 4: Cluster characteristics in the initial downturn (CHPEAK/TROUGH)

Cluster	***1***	***2***	***3***	***4***	***5***	***6***	***All***
CHPEAK/TROUGH: % change in real GDP	-3.9	-2.3	-2.7	-7.0	+2.7	+9.0	-0.9
Islandnesss (% cluster entities)	0	80.0	100.0	77.8	6.3	0.0	26.6
Size (m. population)	25.7	0.8	27.1	1.3	25.1	1,260.9	34.7
Distance EU/US (km)	2,055	4,538	6,268	5,923	6,344	7,186	4,840
Sovereignty (% cluster)	100.0	100.0	100.0	0.0	100.0	100.0	95.3
Agriculture (% GDP)	6.9	5.6	11.4	4.8	20.4	14.4	12.9
Manufacturing (% GDP)	15.8	8.0	11.4	12.5	11.8	25.2	12.7
Services (% GDP)	63.9	73.4	66.6	72.1	44.0	45.3	57.1
Tourism (per 1000 pop.)	547	1,800	701	5,863	150	22	774
Finance centre (% cluster)	0.0	95.0	0.0	22.2	1.3	0.0	11.5
Resources (rent % GDP)	3.5	0.7	2.0	0.1	20.5	8.7	10.0
Exports goods & services (% GDP)	39.4	70.1	34.0	119.4	41.3	28.2	46.3
n	***58***	***20***	***23***	***9***	***80***	***2***	***192***

Note: Cells with shaded backgrounds have values in excess of the variable overall mean (or percentage of entities as appropriate).

Table 5: Cluster characteristics in the recovery phase (CHTROUGH/2016)

Cluster	***1***	***2***	***3***	***4***	***5***	***6***	***All***
CHTROUGH/2016: Percentage change in real GDP trough to 2016	19.1	22.0	28.4	11.8	42.9	83.3	31.3
Islandnesss (% cluster entities)	0.0	90.7	85.7	71.4	6.3	0.0	26.1
Size (m. population)	25.1	0.5	27.6	1.1	25.2	1,260.9	35.3
Distance EU/USA (km)	1,786	4,221	6,854	6,826	6,104	7,186	4,869
Sovereignty (% cluster)	100.0	100.0	100.0	0.0	100.0	100.0	96.3
Agriculture (% GDP)	6.0	5.9	10.5	6.1	20.8	14.4	13.0
Manufacturing (% GDP)	16.8	7.3	14.4	9.4	10.6	25.2	12.6
Services (% GDP)	65.2	73.5	64.7	79.9	44.2	45.3	57.3
Tourism (no. per 1000 pop.)	596	1,810	699	6,231	136	22	742
Finance centre (% cluster)	0.0	100.0	0.0	14.3	1.3	0.0	11.2
Resources (rent % GDP)	2.9	0.8	2.4	0.2	20.7	8.7	10.1
Exports goods and services (% GDP)	42.5	61.6	46.0	132.3	38.3	28.2	46.4
n	***52***	***19***	***28***	***7***	***80***	***2***	***188***

Note: Cells with shaded backgrounds have values in excess of the variable overall mean (or percentage of entities as appropriate).

Appendix Table A1: Cluster membership – initial impact of the crisis

Cluster Number & Suggested Name	***Member States & SNJs***		
Cluster 1(58) ‘Europe/US Orbit’	Albania Armenia Austria Belgium Bosnia & Herzegovina Bulgaria Cameroun Canada Colombia Costa Rica Croatia Czech Republic Denmark Ecuador Egypt El Salvador Eritrea Estonia Finland France	Georgia Germany Greece Guatemala Honduras Hungary Israel Italy Jordan Kosovo Latvia Lebanon Lithuania Macedonia, FYR Mexico Moldova Montenegro Morocco Netherlands Nicaragua	Norway Peru Poland Portugal Romania Russian Federation Senegal Serbia Slovakia Slovenia Spain Sweden Switzerland Tunisia Turkey Ukraine USA West Bank & Gaza
Cluster 2(20) ‘Tourism/Financial Centres’	Antigua & Barbuda Bahamas Bahrain Belize Cyprus Djibouti Dominica	Grenada Luxembourg Malta Marshall Islands Mauritius Panama Samoa	Seychelles St Kitts & Nevis St Lucia St Vincent & Gren Singapore Vanuatu
Cluster 3 (23) ‘Larger Island States’	Australia Barbados Cabo Verde Comoros Cuba Dominican Rep. Fiji Iceland	Jamaica Kiribati Maldives Micronesia, FS Palau Haiti Indonesia Ireland	Japan Madagascar New Zealand Philippines Sri Lanka Tonga United Kingdom
Cluster 4 (9) ‘Small Open Tourism SNJs’	American Samoa (US) Aruba (NL) Greenland (DK)	Guam (US) Hong Kong (China) Macau (China)	Puerto Rico (US) N Marianas Is (US) US Virgin Is (US)
Cluster 5 (80) ‘Globally Insulated/ Resource Rich’	Afghanistan Algeria Angola	Guinea Guinea-Bissau Guyana	Paraguay Qatar Rwanda

	Argentina Azerbaijan Bangladesh Belarus Benin Bhutan Bolivia Botswana Brazil Brunei Darussalam Burkina Faso Burundi Cambodia Central African Rep Chad Chile Congo Dem Rep Congo, Rep Cote d'Ivoire Equatorial Guinea Ethiopia Gabon Gambia Ghana	Iran Iraq Kazakhstan Kenya Korea, Rep Kuwait Kyrgyzstan Lao, PDR Lesotho Liberia Malawi Malaysia Mali Mauritania Mongolia Mozambique Myanmar Namibia Nepal Niger Nigeria Oman Pakistan Papua New Guinea	Saudi Arabia Sierra Leone Solomon Islands South Africa Sudan Suriname Swaziland Tajikistan Tanzania Thailand Timor-Leste Togo Trinidad & Tobago Turkmenistan Uganda UAE Uruguay Uzbekistan Venezuela Viet Nam Yemen Zambia Zimbabwe
Cluster 6 (2) 'China & India'	China	India	

Appendix Table A2: Cluster membership – recovery phase

Cluster Number & Suggested Name	***Member States & SNJs***		
Cluster 1 (52) 'Europe/US Orbit'	Austria Belarus Belgium Bosnia & Herzegovina Bulgaria Canada Costa Rica Croatia Czech Republic Denmark El Salvador Eritrea Estonia Finland France Georgia Germany Greece	Guatemala Honduras Hungary Israel Italy Jordan Kosovo Latvia Lebanon Lithuania Macedonia, FYR Mexico Moldova Montenegro Morocco Netherlands Nicaragua Norway	Poland Portugal Romania Russian Federation Senegal Serbia Slovakia Slovenia Spain Sweden Switzerland Tunisia Turkey Ukraine USA West Bank & Gaza
Cluster 2 (19) 'Tourism/Financial Centres	Antigua & Barbuda Bahamas Bahrain Belize Cyprus Djibouti Dominica	Grenada Luxembourg Malta Marshall Islands Mauritius Panama Samoa	Seychelles St Kitts & Nevis St Lucia St Vincent & Gren Vanuatu
Cluster 3 (28) 'Larger Island States'	Australia Barbados Cabo Verde Comoros Cuba Dominican Rep. Fiji Iceland Jamaica Kiribati	Maldives. Micronesia, FS Palau Haiti Indonesia Ireland Japan Korea, Rep Madagascar Malaysia	New Zealand Philippines Singapore Sri Lanka Thailand Swaziland Tonga United Kingdom
Cluster 4 (7) 'Small Open Tourism SNJs'	American Samoa (US) Greenland (DK) Guam (US)	Hong Kong (China) Macau (China) N Marianas Is (US)	US Virgin Is (US)
Cluster 5 (82) 'Globally Insulated/ & Resource Rich'	Afghanistan Albania Algeria	Ethiopia Gabon Gambia	Papua New Guinea Paraguay Peru

	Angola Argentina Armenia Azerbaijan Bangladesh Benin Bhutan Bolivia Botswana Brazil Brunei Darussalam Burkina Faso Burundi Cambodia Cameroun Central African Rep Chad Chile Colombia Congo Dem. Rep Congo, Rep. Cote d'Ivoire Equatorial Guinea Ecuador Egypt	Ghana Guinea Guinea-Bissau Guyana Iran Iraq Kazakhstan Kenya Kuwait Kyrgyzstan Lao, PDR Lesotho Liberia Malawi Mali Mauritania Mongolia Mozambique Myanmar Namibia Nepal Niger Nigeria Oman Pakistan	Qatar Rwanda Saudi Arabia Sierra Leone Solomon Islands South Africa Sudan Swaziland Tajikistan Tanzania Thailand Timor-Leste Togo Trinidad & Tobago Turkmenistan Uganda UAE Uruguay Uzbekistan Viet Nam Yemen Zambia Zimbabwe
Cluster 6 (2) 'China & India'	China	India	

Appendix Table A3: Chi-square test of differences between small and large entities: Changes in real GDP peak year to trough year (TROUGH)

	Small (<1.5m)	*Large (>1.5m)*
Lower quartile	O = 20 O-E = +7	O = 29 O-E = -7
Lower-middle quartile	O = 14 O-E = +1	O = 36 O-E = -1
Upper-middle quartile	O = 13 O-E = 0	O = 38 O-E = 0
Upper quartile	O = 5 O-E = -9	O = 43 O-E = +8
n	52	146

Chi-square =11.677, DF = 3, p = 0.009.

Notes: 1. Quartile ranges are Q1 >-4.735%; Q2=-0.65%:-4.535%; Q3=-0.65%:+3.30%; Q4 > 3.30%.
2. O = observed value, E = expected value.
3. n = 198.

Appendix Table A4: Chi-squared test of differences between small and large entities: Changes in real GDP peak year to trough year (TROUGH(SUPP)), extended dataset

	Small	*Large*
Lower quartile	O = 32 O-E = +11	O = 29 O-E = -11
Lower-middle quartile	O = 19 O-E = +1	O = 39 O-E = -1
Upper-middle quartile	O = 19 O-E = 0	O = 37 O-E = 0
Upper quartile	O = 5 O-E = -11	O = 43 O-E = +11
n	75	148

Chi-squared = 21.299, DF = 3, p=0.000.

Notes: 1. Quartile ranges are Q1 >-4.735%; Q2=-0.65%:-4.535%; Q3=-0.65%:+3.30%; Q4 > 3.30%.
2. O = observed value, E = expected value.
3. n = 223.

Appendix Table A5: Chi-squared test of differences between small and large entities: Changes in real GDP trough year to 2016 (RECOVERY)

	Small	*Large*
Lower quartile	O = 18 O-E = +5	O = 30 O-E = -5
Lower-middle quartile	O = 18 O-E = +5	O = 31 O-E = -5
Upper-middle quartile	O = 10 O-E = -3	O = 39 O-E = +3
+Upper quartile	O = 5 O-E = -8	O = 43 O-E = +8
n	51	143

Chi-squared = 12.987, DF = 3, p = 0.005.

Notes: 1. Quartile ranges are Q1 > +15.08%; Q2 = +15.08% - +28.05%; Q3 = +28.05% - +42.78%; Q4 > +42.78%.

2. O = observed value, E= expected value.

3. n = 194.

Appendix Table A6: Chi-squared test of differences between small and large entities: Changes in real GDP from the trough year to 2016 (RECOVERY(SUPP))

	Small	*Large*
Lower quartile	O = 37 O-E = +14	O = 31 O-E = -14
Lower-middle quartile	O = 20 O-E = +2	O = 31 O-E = -2
Upper-middle quartile	O = 14 O-E = -5	O = 40 O-E = +5
Upper quartile	O = 5 O-E = -12	O = 43 O-E = +12
n	76	145

Chi-squared = 26.549, DF = 3, p = 0.000.

Notes: 1. Quartile ranges are Q1 > +15.08%; Q2 = +15.08% - +28.05%; Q3 = +28.05% - +42.78%; Q4 > +42.78%.

2. O = observed value, E= expected value.

3. n = 221.