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**Gordon Cordina and Nadia Farrugia**

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# **Measuring Vulnerability: A Methodological Review and a Refinement Based on Partner Country and Price Volatility Issues**

Gordon Cordina and Nadia Farrugia

**Abstract:** Indexes of vulnerability are intended to measure the proneness of countries to exogenous shocks lying outside their control, or to the increased susceptibility of such countries to the adverse effects of these shocks. The main attempts to measure vulnerability found in the literature focus mainly on openness to international trade and capital flows, export concentration and dependence on strategic imports. This paper presents a conceptual refinement to these ideas by assessing the importance of the stability of partner countries and of price volatility as important determinants in the way in which such variables impact on vulnerability. Subject to the usual measurement problems, the index proposed here generally confirms that small states, particularly if insular, tend to face heightened degrees of vulnerability.

## INTRODUCTION

The construction of a vulnerability index was first formally proposed by the Maltese Ambassador to the United Nations in 1990. It was then stated that “such an index is important because it reiterates that the per capita GDP of island developing countries is not by itself an adequate measurement of the level of development of these countries as it does not reflect the structural and institutional weaknesses and the several handicaps facing island developing countries” (Malta Government, 1990, p.7). These handicaps have recently come to be interpreted as being the proneness of such countries to exogenous shocks lying outside their control, or to the increased susceptibility of such countries to the adverse effects of these shocks (Briguglio, 2004; Cordina, 2004a,b).

Since the early 1990s, there have been several attempts at constructing vulnerability indices. These mainly focused on quantifying the special characteristics of small states using indicators such as economic openness, export concentration, dependence on imports of energy and peripherality. These may be construed to be the *causes* of and to proxy the incidence of exogenous shocks or the extent of their propagation. Other approaches attempt to measure vulnerability in terms of the *effects* of the phenomenon, namely the variability of output and similar indicators.

This paper describes the various approaches employed so far in measuring economic vulnerability. On this basis, it proposes to extend the measurement of vulnerability to consider the stability of partner countries as well as price volatilities in international business. This can be considered as a refinement to the methodologies proposed so far in attempting to measure the phenomenon of vulnerability.

## A DESCRIPTION OF VULNERABILITY INDICES

The first vulnerability index was developed by Briguglio (1993) and was composed of three variables, namely exposure to foreign economic conditions, insularity and remoteness, and proneness to natural disasters. Exposure to foreign economic conditions was measured by calculating a composite index of size made up of three variables, which are population size, size of GDP and land area, as it was argued that the degree to which an economy depends on foreign trade is closely related to size. Remoteness and insularity was measured by taking the ratio of transport and freight debits to export proceeds, and disaster proneness was proxied by an estimate of damages in relation to GDP derived from a 1990 report published by United Nations Disaster Relief Organisation, and refined to exclude disasters of a political nature. It was hypothesised that the higher the incidence of these variables in a given country, the higher the degree of vulnerability in the same country, everything else, including GDP per capita remaining constant. The assumption that Small Island Developing States (SIDS) tend to be more vulnerable than other countries was confirmed since in general SIDS registered higher vulnerability scores than other groupings of countries.

A modified index was presented in 1995, where the variable measuring exposure to foreign economic conditions was changed from a composite index of size to the ratio of

exports and imports to GDP. As argued by Briguglio (1997), this change was necessary as using size as a factor of vulnerability is methodologically incorrect because this amounts to assuming what needs to be proven. The general tendency that SIDS tend to have higher vulnerability scores was reconfirmed.

Briguglio (1997) further modified the index by including three new variables, excluding one and modifying another. The new variables were introduced to measure export concentration, dependence on strategic imports and dependence on foreign sources of finance. Briguglio also excluded the variable measuring proneness to natural disasters and changed the measure of peripherality from the ratio of transport and freight costs to export proceeds to the ratio of transport and freight costs to imports. Briguglio (1997) argued that export concentration is observed in both trade in goods as well as in trade in services. As the export concentration index devised by UNCTAD covers just merchandise, Briguglio devised a concentration index of exports of goods and services by considering tourism and financial services. Export concentration was taken to be the percentage of the three highest export categories in total exports of goods and services. Dependence on imported commercial energy was measured as imports of commercial energy as a percentage of imports plus the production of commercial energy, while dependence on foreign sources of finance was taken to be remittances, capital and financial inflows as a percentage of GDP.

An updated computation of Briguglio (1997) was presented in Briguglio and Galea (2003). The main difference was the inclusion of dependence on food imports as an additional indicator to measure the extent to which a country's livelihood depends on imports. These refinements further reaffirmed the relatively high vulnerability scores of SIDS.

Chander (1996) employed a methodology similar to that used by Briguglio. The sub-indices used attempted to measure dependence on external markets by taking the ratio of exports to GDP, while costs arising from remoteness and insularity were measured by the CIF/FOB ratio. Chander also introduced two additional variables, which were export concentration (UNCTAD index), to highlight dependence on a narrow range of products and the ratio of long term capital flows to gross domestic investment, to reflect dependence on external funds to finance development. Chander's results showed that in general, small states had larger vulnerability scores than larger countries. The study emphasised that countries with a diversified export and production base were less vulnerable.

Wells (1996) produced a composite index made up of six sub-indices namely: a trade openness index, measuring the ratio of exports and imports to GDP, similar to the one used in Briguglio (1995); a remoteness index, measured by the ratio of insurance and freight credits to total imports; an export diversification index as compiled by UNCTAD; a capital openness index, measured by the resource gap in the balance of payments; an index of energy dependence, measured by the net imports of commercial energy as a percentage of energy consumption; and an index of tourism dependence, measured by net tourism receipts as a percentage of GDP. The results confirmed that the highest

vulnerability scores pertained to small developing states. Wells' most important contribution to the study of vulnerability was the introduction of a sub-index measuring energy dependence.

Wells (1997) used a different approach by focusing on vulnerability as manifested in instability in economic growth and subsequently using regression analysis to identify the causes of vulnerability. The study argues that volatility is related to the terms of trade (measured by an export diversification index), instability in net capital flows (measured as the resource gap in relation to GDP) and vulnerability to natural disasters (measured by the proportion of the population affected by natural disasters during 1970-96). Economic volatility is shown to be related to these three variables, although the correlation coefficient is very low.

The Committee for Development Policy (CDP) of the United Nations developed a composite index for the purpose of identifying vulnerability of the Least Developed Countries (CDP, 2000; United Nations, 2001). In line with Wells (1997), this approach focuses on instability as the manifestation of vulnerability and makes use of five variables, namely the share of manufacturing and modern services in GDP, merchandise export concentration ratio, instability of agricultural production, instability of exports of goods and services and population size to derive a composite index. The weights were drawn from an econometric exercise reflecting the estimated impact on growth of the different components indicators.

Output volatility was also used as the basis for the index developed by Atkins et al (1998) and for determining the factors that might lead to vulnerability. The model, which was constructed for the Commonwealth Secretariat, explains output volatility and, thus vulnerability as specifically being a function of the export dependency ratio, merchandise export diversification, share of agriculture in GDP, capital openness, freight and insurance costs and vulnerability to natural disasters. A preferred model based on three variables found to be statistically significant – export dependency ratio, merchandise export diversification and vulnerability to natural disasters – was then used to predict levels of output volatility for individual countries – ‘scores’ in the composite vulnerability index. The index suggests that small states are especially prone to vulnerability as small states were reported as having relatively high index scores when compared to large states.

The variables in the index of economic vulnerability for developing countries, proposed by Crowards (2000) are freight and insurance costs for imports as a percentage of total import costs; imports net of exports of energy as a percentage of total energy consumption; export concentration index of goods and services accounted for by the major export and the top three exports, combined with information on the openness of the economy measured as total export earnings as a percentage of GDP; concentration of export destination of goods and services measured in terms of the percentage of total export receipts accounted for by the single most important destination and the top three most important destinations, combined with information on the openness of the economy measured as total export earnings as a percentage of GDP; reliance upon external finance

and capital, measured as a combination of the annual disbursement of concessionary overseas development assistance and annual foreign direct investment, as a proportion of annual gross fixed capital formation; and, susceptibility to natural disasters, measured as a combination of cumulative number of persons affected by natural disasters between 1950 and 1988 and cumulative number of deaths caused by natural disasters between 1950 and 1998, each as a proportion of total population. The index results suggested a negative non-linear relationship between economic vulnerability and country size, as measured by total population. The results indicated that small countries and islands are particularly vulnerable, while landlocked countries tend to be relatively vulnerable.

A common conclusion of all of these indices is that small states are inherently more vulnerable. This is despite pronounced differences in the parameters and methodologies employed. However, within this broad consensus, there are considerable variations and contradictions. As Gonzales (2000) points out, "A comparison of the various vulnerability classifications reveals a large amount of inconsistency. While small developing states on average emerge as being comparatively vulnerable, rankings of individual countries can differ substantially between alternative indices."

#### THE MEASUREMENT OF VULNERABILITY: SOME LESSONS

Briguglio (1992) proposed a number of desirable characteristics for a vulnerability index. The index should be a composite of a small number of variables chosen for their relevance in explaining vulnerability, simplicity, ease of comprehension and suitability for international comparisons. It should have an intuitive meaning and produce plausible results and be based on variables which are measured in a homogenous manner internationally with data being available for all or most countries of the world.

Briguglio also proposed criteria for rejecting variables from use in a vulnerability index (Briguglio, 1997). Correlation with country size is, on its own, an unsuitable criterion for the inclusion of a variable in the index as this would bias the results in favour of the hypothesis that vulnerability depends upon size. In the same spirit, it is here suggested that vulnerability should not be a direct measure of poverty or underdevelopment, or of competitiveness or the lack of it. Furthermore, for a variable to be relevant towards the measurement of vulnerability, it should reflect inherent features of an economy which render it more susceptible to exogenous shocks and which cannot be influenced by economic policy.

Briguglio (1997) also suggested that correlated variables and variables which do not measure economic vulnerability or a facet of it should also be excluded from the index. Moreover, variables measuring the effects rather than the causes of vulnerability should not be included in a composite vulnerability index. It is here suggested that the reason for this is the fact that output volatility, which is often taken as the manifestation of vulnerability, may be the result of other factors, such as short term fluctuations in aggregate demand. The latter in turn, can be managed by economic policy, and hence are

inconsistent with the definition of vulnerability which emanates out of inherent features in the economy.

Building on these premises, the variables employed in the construction of various vulnerability indexes can be assessed and some refinements suggested.

Most authors associate a relatively high dependence on international trade with the undesirable effect that it renders the country in question too much exposed to what happens in the rest of the world, rendering it economically vulnerable to external shocks. However, it can be argued that trade openness may imply that a country can easily switch from one type of export to another, thereby attenuating vulnerability. Thus, it is here argued that it is not so much trade openness per se that is the source of vulnerability, as much as the concentration of such openness into relatively few products traded in potentially volatile markets. Thus, it is important to consider trade openness in relation to the degree of export concentration, ideally not only in goods but also in the increasingly important service activities. A further refinement may be suggested in terms of the consideration of the type and nature of the export commodities and markets in which a country is trading. Indeed, a country may be very open to trade and specialized in a narrow range of commodities without being vulnerable if it is trading in products with very stable markets and selling to stable economies. Conversely, a relatively wide diversification in exports may still imply vulnerability if exports are traded in inherently unstable market conditions which result in high price volatility, and consequently frequent terms of trade shocks.

These considerations in no way endorse the exclusion of trade openness from a vulnerability index. While trade openness may indeed be a competitive strength for a country, it will also invariably lead to exposure to shocks over which a country can have no control and hence it should be rightly included in a vulnerability index. What is here being suggested is to refine the role of trade openness in a vulnerability index, to account not only for export concentration but also for the nature of the markets in which such exports are being traded.

Many researchers contend that economies that are heavily reliant on imports of energy and foodstuffs are vulnerable to external shocks. Indeed, these indicators have been incorporated in a number of vulnerability indices, namely Wells (1996), Briguglio (1997), Crowards (2000) and Briguglio and Galea (2003). It is correct to include a measure of dependence on strategic imports such as energy, as the impact of shifts in this market has devastating effects. The same applies to other essential imports which cannot be foregone and for which there are no substitutes. This measure can however be further refined by considering the degree of stability of the country of origin of imports, as this would impact on the likelihood of shocks emanating from this source, as well as the degree of volatility of prices which would have to be paid for such imports.

Some indexes include an indicator measuring tourism receipts as a percentage of GDP. Dependence on tourism receipts can be a source of vulnerability only to the extent that such activity is subject to larger shocks than other activities. It is true that tourist

receipts can be volatile, as they are sensitive to the business cycle and to the behaviour of real personal disposable income in the countries of origin. However, there are other types of volatile exports, such as primary commodities. Furthermore, vulnerability emanating from export activity is likely to be better captured through an export concentration index of services considering the destination of exports. For example, if the tourist market is diversified enough and if tourists originate from stable countries, then shocks from tourism activity are likely to be limited.

Openness to capital flows is also considered as a source of additional vulnerability by many researchers. However, as in the case of openness to international trade, foreign direct investment flows can help mitigate, rather than accentuate, the effects of shocks. Those states with access to world capital markets can in principle turn to them to smooth out consumption over time to compensate for adverse shocks to domestic production. On the other hand, it is also true that countries that rely on external sources of funding will be susceptible to withdrawal of such injections of funds in some cases. Uncertainties in this respect can be viewed to emanate primarily from the stability of the country from which the flow of capital or assistance originates. If the country of origin is competitive and has a sound macroeconomic performance, then capital is less likely to be suddenly withdrawn from the recipient country. On the other hand, if the country of origin is unstable, this will lead to increased vulnerability in the recipient country. Therefore including an indicator to measure vulnerability from external finance makes sense from an economics perspective. However, just relying on total capital flows or similar measures is insufficient. Rather, once again, it is the stability of the countries of origin of such capital which plays a determining role in vulnerability.

Disaster proneness is included in economic vulnerability indices because disasters represent shocks over which a country has little control. The indicators researchers used to measure disaster proneness are namely the money damage in relation to GDP (Briguglio, 1993), the percent of population affected by natural disasters (Wells, 1997; Atkins et al., 1999; Crowards, 2000) and the number of deaths caused by natural disasters as a proportion of total population. It can however be contended that the inclusion of disaster proneness in a vulnerability index may bias results because they are based on past events which need not be repeated in future. Moreover, the measurements used typically relate to the effects of disasters, which are significantly affected by policy responses which reflect the resilience of a country to such disasters. Thus, the available measures do not reflect the vulnerability per se.

Remoteness and insularity are related to vulnerability by some researchers because they might introduce uncertainties associated with the availability, timeliness and cost of undertaking external trade. However, it can be argued that peripherality is more of an economic disadvantage leading to economic backwardness than a source of economic vulnerability. The extent of shocks introduced by remoteness and insularity per se however, is unlikely to be significant. Hence, it is not considered appropriate to include this variable in an index of vulnerability.



Vulnerability is at times gauged by the share of manufacturing and services in GDP. The structure of an economy, or the extent to which it is based on the production of primary products, on manufacturing, or on the provision of services, could influence its susceptibility to external shocks. A fundamental concern with this categorisation, however, is determining which type of structure is more vulnerable. Each category suffers forms of instability, and such generalisations obscure vast differences in the types of products within each category, such as whether they are high technological products or not, whether the services are knowledge based or labour intensive, whether the agricultural sector is competitive or not, etc. Moreover, it is not clear that alternative structures are an inherent feature rather than the result of past development performance and policy actions.

Instability of agricultural production and of exports of goods and services are also used in some measures of vulnerability. However, volatility or instability is a manifestation of vulnerability and not one of its sources. Moreover, it may be the result of other factors which have no association with vulnerability, such as short term fluctuations in domestic demand. Instability in agricultural production that is the fluctuations of agriculture output around the trend may be a result of natural shocks, which affect agriculture production but may also be a result of many other factors that have nothing to do with inherent features of the economy. The same can be said of the instability of exports of goods and services. The volatility in export receipts is a result of vulnerability. It does not cause vulnerability. Its causes may lie in the structural features of small states, namely, their greater concentration of their commodity exports, concentration of export destination, their inability to influence terms of trade, etc., which all serve to make them more vulnerable to external shocks originating in the international economy over which they have no control.

### THE IMPORTANCE OF PARTNER COUNTRIES AND PRICE VOLATILITY IN INTERNATIONAL BUSINESS

The analysis carried out in the previous section suggests that the primary source of vulnerability is the concentration on unstable markets in exports, imports and international capital flows. Concentration of exports on a small number of partner countries can be a source of economic vulnerability, as this makes the economy reliant on a small number of countries and their demand, especially when the partner countries are themselves unstable or vulnerable. Similarly, export concentration in products with volatile prices can be an important source of vulnerability.

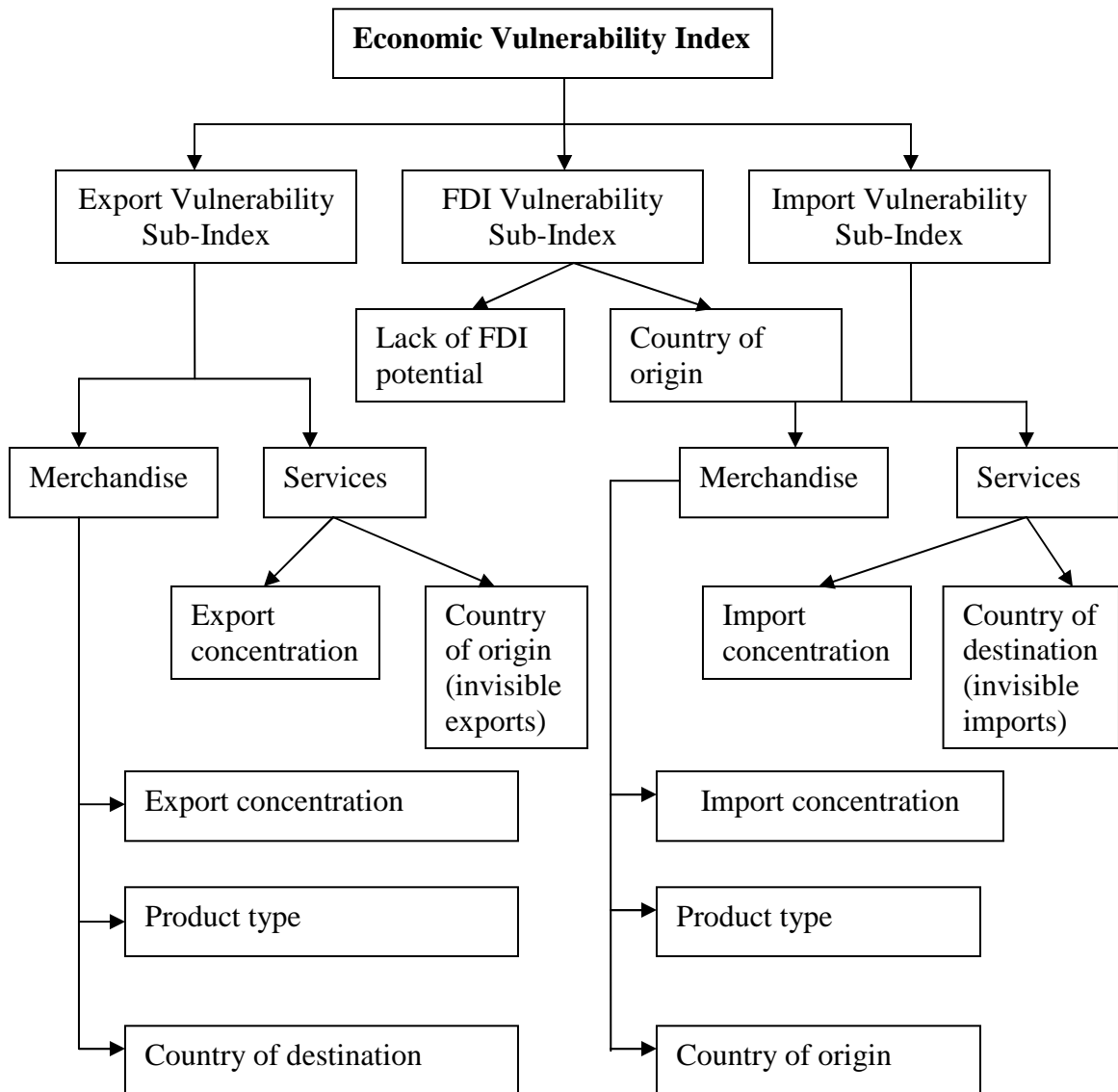
These concepts can also be applied to imports of goods and services. A high import concentration, especially of essential imports such as raw materials, energy and food, and for which no substitutes exist in the domestic market make the economy susceptible to changes in the supply of these products and to changing patterns of trade. Vulnerability is exacerbated in the case of reliance on a limited number of countries, as disruption in price and supply arises when the producer countries are or become politically and/or economically unstable. Furthermore, if the imported products exhibit high price

instability, potential for future shocks lies in rising international prices, which increases pressure on export performance.

Those countries that rely on external sources of funding in the form of foreign direct investment are susceptible to withdrawal of such injections of funds. This makes the economy vulnerable to changes in external conditions, especially those prevailing in the countries from which the resources originate.

Thus, this paper proposes to measure vulnerability by considering the likely shocks to exports, imports and foreign capital flows as would be represented by the openness of a country to such transactions, the degree of concentration in each of the three areas of international business, the nature of the partner countries with which such business is being conducted, and the price volatility of the goods and services being transacted. This model is schematically represented in Figure 1, which shows that the composite vulnerability index is made up of three sub-indices: an export vulnerability sub-index, an import vulnerability sub-index and an FDI (foreign direct investment) sub-index. The sub-indices, which comprise a number of variables, will be discussed thoroughly below.

**Figure 1**



## THE COMPONENTS OF A REFINED INDEX OF VULNERABILITY

The choice of variables for inclusion in the composite vulnerability index was based on the three criteria proposed by Briguglio (1993), which are simplicity, ease of comprehension and suitability for international comparisons. Also, as Briguglio (1997) proposed, variables which beg the question, are not relevant, are redundant, which measure the effect and not the cause of vulnerability, and which represent transitory features, were not included in the composite vulnerability index.

A feature which distinguishes the vulnerability index developed in this study from existing vulnerability indices is the consideration of trading partners by means of a weights which may be termed as 'lack of competitiveness' scores. Competitiveness is defined by the OECD as 'the degree to which a country can, under free and fair market conditions, produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding the real incomes of its people over the long term'.

The competitiveness measure adopted in this study was that issued by the International Institute for Management Development (IMD), which analyses the overall competitiveness of 60 countries. The most competitive country is assigned a competitiveness score of 100, and this score decreases the lower the countries' competitiveness becomes. As the IMD chooses countries on the basis of their impact on the global economy and the availability of comparable international statistics, this means that no failed states are considered, and thus, in the IMD scoreboard no economy has a competitiveness score of 0. In the 2003-2004 ranking, the lowest competitiveness score awarded was 24.748. For this reason, the competitiveness scores were normalised and multiplied by 100, in order to yield values on a scale between 0 and 100.

The competitiveness scores were then transformed into 'lack of competitiveness' scores by the following formula:

$$\text{Lack of competitiveness score} = 100 - \text{competitiveness score.}$$

The closer the 'lack of competitiveness' is to 100 the more uncompetitive the country is and thus any country which trades with it is increasing its vulnerability. Therefore the scores measure how much a country's vulnerability is increased (or decreased) by trading with another country, be it through exports, imports or FDI flows. It is assumed that the higher the 'lack of competitiveness' score for a particular country is, the more vulnerable the country which trades with becomes.

As was stated above, the IMD only calculates competitiveness profiles for economies which matter in the world economy. This means that if a country's competitiveness standing is not calculated, then it is either a small economy or else it is a failed or undeveloped state, which does not even have reliable statistics. If a country trades with such a non-listed country, then it is not helping its vulnerability. We thus assign the maximum 'lack of competitiveness' score of 100 to non-listed countries.

### *Export Vulnerability*

The export vulnerability sub-index considers possible sources of vulnerability in the export of both merchandise and services. These two factors were considered separately rather than in conjunction in order to enable a more accurate analysis of their composition.

The merchandise sub-index is made up of three variables: export concentration, which measures a country's lack of diversification of exports of goods; product type, which measures the price instability of the products exported and country of destination, which measures the concentration of trading partners and the reliability of these trading partners.

The export concentration index is that obtained from UNCTAD, which measures the export concentration index of goods only. The UNCTAD concentration index, which is sensitive to large shares of individual commodities in total merchandise exports, is computed by means of the Herfindahl-Hirschmann index (HHI), a widely used measure of the degree of market concentration.

The type of product exported brings with it a different level of vulnerability, due to differences in price stability, ex: food items, fuels and manufacturing goods exhibit different levels of price stability and consequently, producing more or less of one item rather than another yields different levels of vulnerability. This indicator assumes that all economies are price takers, as no distinction is made between small and large economies.

Product type vulnerability was measured by analysing the distribution of revenue by product and their respective price instability. Exports were sub-divided into: all food items (SITC 0 + 1 + 22 + 4), agricultural raw materials (SITC 2 – 22 – 27 – 28), fuels (SITC 3), ores and metals (SITC 27 + 28 + 68) and manufactured goods (SITC 5 to 8 less 68). A small percentage of exports were unallocated. This information was obtained from the UNCTAD handbook of statistics. Price instability indices for the various product sub-divisions, except manufactured goods and the unallocated portion were also obtained from the same source. The total price instability index as given by UNCTAD was assigned to the unallocated portion of exports, while in the case of manufactured goods, price instability was taken to be the standard deviation in the unit value index of manufactured goods exports for the period 1990 to 1999. This index was also obtained from the UNCTAD handbook of statistics.

Analysing the country of destination of exports is important to assess a country's vulnerability, as vulnerability can be increased if a country is exporting its goods to an unstable economy or to a number of unstable economies. This means that although an economy may be vulnerable to changing patterns of trade if a large proportion of its exports are linked to a limited number of trading partners, a country is less vulnerable if it exports all its goods to a stable economy than to a number of unstable economies. Thus it can be postulated that the nature of the country of destination is more important than the diversification of country destinations.

Destination of export vulnerability was measured by constructing a matrix of exports by reporting countries and partner countries, obtained from the International Monetary Fund's Direction of Trade Statistics (DOTS). The export share composition for each of the reporting countries was calculated for each partner country. Then partner countries were assigned a 'lack of competitiveness' score, and each export share was multiplied by the 'lack of competitiveness' score and summed up. The scores were then standardised to values between 0 and 1, where 1 refers to maximum vulnerability and 0 to the minimum vulnerability.

The services export vulnerability sub-index is made up of two variables: an export concentration variable and a country of origin variable.

The export concentration index for services was not available. The UNCTAD's export concentration index considers merchandise only, while the concentration index developed by Briguglio (1997) considers goods and services together and not separately as required in this case. Thus an export concentration index of services was computed using the HHI method of market concentration. This was obtained by taking the sum of squares of the shares of each sector of service exports. Data were obtained from the UNCTAD handbook of statistics on total services for each country, subdivided into transport, travel and other services.

A convergence of export destination of services was also computed. Although the services sector is divided into transport, travel and other services, export of services by destination was only available for the tourism industry. Thus, using data from the World Tourism Organisation, a matrix of visitors from abroad by country of origin was constructed, the shares computed and correspondingly weighted by the 'lack of competitiveness score' and then finally standardised. As with the convergence of export destination of goods, a heavy reliance upon just a few trading partners will not necessarily make an economy vulnerable if the partner countries are competitive.

#### *Import Vulnerability*

As in the case of exports, the import vulnerability sub-index is divided into the import vulnerability of goods and the import vulnerability of services. The methodologies and data sources used in this case run parallel to those for the export vulnerability sub-index.

#### *Foreign Direct Investment Vulnerability*

The FDI vulnerability sub-index was made up of two parameters, country of origin of FDI inflows and lack of FDI potential.

Although FDI is an important source of external investment financing and supports economic growth, it can also be unreliable, as it is affected by conditions in donor countries. Thus, any measure of FDI vulnerability should consider the reliability of donor countries. The vulnerability index developed in this study attempted to quantify the dependence of FDI inflows on countries which are economically unstable.

The FDI database compiled by UNCTAD was used to observe the structure of each country's FDI by country of origin and note was taken of the three most important countries. In some cases, the FDI was so concentrated that a country had only one country of origin of FDI inflows. Then these FDI shares plus the share of the remainder were weighted by 'lack of competitiveness' scores. The maximum 'lack of competitiveness' score, i.e., 100, was assigned to the share of the remainder countries. The values were then standardised and the country with the greatest vulnerability was assigned a value of 1 and the one with the lowest vulnerability a value of 0.

Statistics for use in this sub-component, which measures the stability of FDI inflows, were available for 88 countries. In cases where statistics were not available, an average was taken the country's income classification and geographical location, as given by the World Bank. For example, the value for St. Vincent and the Grenadines, which was not available, was taken to be the average of the category – Latin America and the Caribbean (Lower Middle Income). Where even this was not available, the maximum vulnerability weight was assigned – 100.

The FDI potential index, computed by UNCTAD and available for 138 countries, captures several factors (apart from market size) expected to affect an economy's attractiveness to foreign investors. It is an average of the values of the following 12 variables:

1. GDP per capita: an indicator of the sophistication and breadth of local demand (and of several other factors), with the expectation that higher income economies attract relatively more FDI geared to innovative and differentiated products and services.
2. The rate of GDP growth over the previous 10 years: a proxy for expected economic growth.
3. The share of exports in GDP: to capture openness and competitiveness.
4. As an indicator of modern information and communication infrastructure, the average number of telephone lines per 1,000 inhabitants and mobile telephones per 1,000 inhabitants.
5. Commercial energy use per capita: for the availability of traditional infrastructure.
6. The share of R&D spending in GDP: to capture local technological capabilities.
7. The share of tertiary students in the population: indicating the availability of high-level skills.
8. Country risk: a composite indicator capturing some macroeconomic and other factors that affect the risk perception of investors. The variable is measured in such a way that high values indicate less risk.

9. The world market share in exports of natural resources: to proxy for the availability of resources for extractive FDI.
10. The world market share of imports of parts and components for automobiles and electronic products: to capture participation in the leading TNC integrated production systems (WIR02).
11. The world market share of exports of services: to seize the importance of FDI in the services sector that accounts for some two thirds of world FDI.
12. The share of world FDI inward stock: a broad indicator of the attractiveness and absorptive capacity for FDI, and the investment climate.

Although the values for the FDI potential index were available from 0 to 1, they were standardized using the formula quoted above, as before standardization the maximum value obtained was 0.689, while the lowest value was 0.044. With standardisation, the values were normalized to yield a score of zero, for the lowest scoring country, to one, for the highest. In order to transform these scores into 'lack of FDI potential' scores, the values were subtracted from 1.

#### *Deriving the Aggregate Index Values*

The standardised method used throughout this study to render each and every variable used in the compilation of the vulnerability index insensitive to the scale of measurement is the following:

$$V_{ij} = \frac{(X_{ij} - \text{Min}X_i)}{(\text{Max}X_i - \text{Min}X_i)}$$

where:

- $V_{ij}$  stands for the degree of vulnerability in country j, arising from X, which is one of the variables in the index.
- $X_{ij}$  stands for the value of the ith vulnerability variable, for country j.
- $\text{Max } X_i$  and  $\text{Min } X_i$  stand for the maximum and minimum values of the ith vulnerability variable for all countries in the index.

Thus if a given country has a value of  $X_{ij}$  equal to the Minimum, its value for  $V_{ij}$  would be zero, and this would correspond to minimum vulnerability arising from variable  $X_i$ . On the other hand, the greater the gap between the reading of  $X_i$  in a particular country and the minimum of  $X_i$ , the higher will be the value of  $V_{ij}$ , so that the country with the maximum value of  $X_i$  would have a vulnerability value of 1. In this manner, the index of  $V_{ij}$  would take a value of between 0 and 1.



A composite index, is, as its name implies, some sort of average of a number of sub-indices. The vulnerability index developed in this study requires some sort of aggregation in eight different points, so that the different dimensions of vulnerability are represented by a single value indicator.

The simplest method of combining variables into a sub-index is by taking a simple average and this would result in an equally weighted index. In fact, the sub-indices of merchandise export vulnerability, services export vulnerability, merchandise import vulnerability, services import vulnerability and the FDI vulnerability were aggregated using this method.

An alternative is to use different weights for each variable, on the assumption that the different variables have a different impact on vulnerability. This approach was used in order to aggregate the merchandise export vulnerability sub-index and the services export vulnerability sub-index into a single export vulnerability sub-index and also to aggregate the merchandise import vulnerability sub-index and the services import vulnerability sub-index into a single import vulnerability sub-index. The weights, which were different for each country, were derived from the respective ratios of merchandise and services in total exports or imports, depending on the sub-index aggregated. In this way a better representation of a country's vulnerability was derived.

As detailed in the previous section before any variables were aggregated they were standardised beforehand, so that no component would have a dominating effect.

Different weights were also used to aggregate the three sub-indices, of export vulnerability, import vulnerability and FDI vulnerability, into the economic vulnerability index. This approach was preferred to a system of equal weights as it was recognised that if two countries have the same composition of exports and imports but one country is more open to international trade than the other, then the former is more vulnerable to exogenous shocks. The same applies to the composition of FDI inflows. Basically, if two countries have the same composition of FDI inflows but one country relies more on FDI inflows than the other, the former will be more prone to harm than the latter if the donor country decides to withdraw its funds.

In order to cater for the above dimension of vulnerability, the export vulnerability sub-index was weighted by the percentage of exports of goods and services to GDP, the import vulnerability sub-index was weighted by the percentage of imports of goods and services to GDP and the FDI vulnerability sub-index was weighted by the ratio of FDI inflows to gross fixed capital formation. Again, the result was standardised to yield values between 0 and 1, and these values provided the scores for the economic vulnerability index.

## RESULTS: PRESENTATION AND ANALYSIS

The economic vulnerability index was constructed for 180 countries<sup>1</sup>, of which 30 are small island developing states. The definition of a small island developing state was taken from the Alliance of Small Island States (AOSIS), which is a coalition of small island and low coastal countries that share similar development challenges and concerns. Although data limitations meant that the vulnerability index was computed for 30 AOSIS countries, the AOSIS has a membership of 43 states and observers, drawn from all oceans and regions of the world: Africa, Caribbean, Indian Ocean, Mediterranean, Pacific and South China Sea.

The ranking of countries according to the economic vulnerability index are given in Appendix 1A, which lists the countries in alphabetical order and in Appendix 1B, which lists the countries in vulnerability rank order. Table 1 summarises the results by country category.

**Table 1**

<b>Economic Vulnerability Index for Different Categories of Countries</b>		
<i>Category</i>	<i>Number</i>	<i>Index (Different Weights)</i>
All Countries	180	0.346
AOSIS	30	0.453
LDCs	46	0.356
Low Income	60	0.338
Middle Income	77	0.349
High Income	38	0.333
EMU	11	0.306

It can be seen from the appendices and from Table 1 that the hypothesis that SIDS tends to be more vulnerable than other countries is confirmed since in general SIDS registered higher vulnerability scores than the other country categories. Note that in this index, zero signifies minimum vulnerability and one is equal to maximum vulnerability.

In fact, the Table indicates that vulnerability is not at all related to the level of development. Although the lowest vulnerability score is that of EMU members, vulnerability is higher in middle income countries than in low income countries. Furthermore, the difference in vulnerability scores in high and low income countries is minimal.

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<sup>1</sup> In actual fact, statistics were collected for 220 countries. However, the vulnerability index was not computed for those countries which lacked one or more the component sub-indices.

It is interesting to note that the results seem to confirm that small states are relatively more vulnerable than larger ones, especially if they are islands. As Table 2 shows, there is a tendency for the vulnerability score to fall with country size, save for the case of countries with a population of less than one million, which register a relatively low vulnerability score on average, but in which category the island states have high vulnerability scores.

**Table 2**

<b>Economic Vulnerability Index by Population Size</b>		
<i>Size Interval</i>	<i>Number</i>	<i>Index (Different Weights)</i>
$0 < N \leq 1 * 10^6$	152	0.345
$1 * 10^6 < N \leq 2 * 10^6$	11	0.437
$2 * 10^6 < N \leq 5 * 10^6$	25	0.363
$5 * 10^6 < N \leq 10 * 10^6$	32	0.338
$10 * 10^6 < N \leq 20 * 10^6$	27	0.316
$1 * 20^6 < N \leq 2 * 50^6$	25	0.270
$1 * 50^6 < N$	23	0.202

Further analysis of this interesting phenomenon, that is, whether vulnerability is strictly related to smallness was performed by performing correlations between the indicators used as components in the vulnerability index and the natural logarithm of population. The hypothesis tested was that the indicators constituting the economic vulnerability index are negatively related to population size, in other words, that vulnerability falls with population size. The main results are summarised below. This hypothesis was not rejected in six of the sub-indexes cases but was rejected in another six.

It can be stated however, that vulnerability from exports is generally negatively correlated with population size, that is, the susceptibility of shocks from exports is higher in small economies. In imports, the opposite is true; however, the results are not as strong (three 'no' as opposed to four 'yes' in the case of exports). On the other hand, the results clearly show that vulnerability from FDI inflows is not at all related to country size. Note that in all cases, the coefficient of determination,  $R^2$ , is rather weak.

**Table 3**

<b>Indicator</b>	<b>Hypothesis Supported?</b>	<b>X Variable</b>	<b>R<sup>2</sup></b>
<b>EXPORT VULNERABILITY</b>			
<i>Merchandise</i>			
Export Concentration	Yes	-0.0397	0.1048
Product Type	Yes	-0.0042	0.0017
Country of Destination	Yes	-0.0007	0.0001
<i>Services</i>			
Export Concentration	Yes	-0.0236	0.0366
Country of Origin	No	0.0023	0.0598
<b>IMPORT VULNERABILITY</b>			
<i>Merchandise</i>			
Import Concentration	Yes	-0.0027	0.0015
Product Type	No	0.0168	0.0630
Country of Origin	No	0.0102	0.0152
<i>Services</i>			
Import Concentration	Yes	-0.0084	0.0046
Country of Destination	No	0.0846	0.0335
<b>FDI VULNERABILITY</b>			
FDI Lack of Potential	No	0.0037	0.0010
Country of Origin	No	0.0156	0.0118

It is further noted that in the case of export and import concentration, the hypothesis that vulnerability decrease with size is supported. Consideration of price volatility, that is product type and partner countries reaffirms this trend in the case of exports but not of imports.

### CONCLUSION

This study reviews the principal approaches employed in the measurement of economic vulnerability and proposes a refinement based on the consideration of partner countries and price volatility in international business.

In reviewing the methodologies employed in the measurement of economic vulnerability, it is found that openness to international trade and investment is a widely used variable in vulnerability indexes. Considering the conceptual nature of vulnerability, which relates to the presence of effects of exogenous shocks over which the country has no control, this paper concludes that openness has more value as an indicator of vulnerability if adjusted

for the degree of concentration in import, export and investment activities, for the stability of trading partners and for the degree of price volatility.

On these premises, a refined vulnerability index is computed, using standard mathematical approaches and utilizing the best practices developed in the literature so far. The index developed in this paper in general confirms that larger countries tend to be less vulnerable, and re-affirms the heightened vulnerability of small island states. It is furthermore observed that the heightened vulnerability of small states emanates from their export activities – imports and foreign direct investment are relatively unimportant sources of vulnerability for these countries. Furthermore, in this case, concentration appears to have a relatively stronger correlation with population size than price volatility or partner country considerations.

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