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The specific role of agriculture for economic vulnerability of small island spaces[1]

Stéphane Blancard[2], Maximin Bonnet[3], Jean-François Hoarau[4]

Abstract:
Small Island Spaces are confronted to large handicaps resulting in a situation of strong economic vulnerability. The recent food crises revealed that the dependency to imported food is more determinant for structural vulnerability than the weight of agriculture in the economy. We suggest a new structural vulnerability indicator by substituting into the well-known EVI the share of agriculture in GDP by a proxy of imported food dependency. For robustness considerations, this new indicator is obtained from an endogenous weighting system. Our simulations point out that taking into account food dependency strengthens dramatically the exposure of small island economies to structural vulnerability.

Keywords: Agriculture, composite indexes, DEA method, Small island Spaces, structural vulnerability.

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1. Introduction

Several decades of researches focused on the insular world stated out that Small Island Spaces [SIS] was confronted to many large handicaps. These historical, geographical, ecological and economic impediments result together in a situation of strong structural vulnerability which questions their ability to sustain a process of growth and development in the long-run (see Blancard and Hoarau for a survey). Following the consensual definition of the United Nations' Committee Development Policy [UNCDP], structural vulnerability is the risk for a country to encounter a significant decrease in its average growth rate in the long run because of unanticipated and exogenous environmental and economic shocks (Guillaumont 2004a; Guillaumont 2009a). Then, structural vulnerability consists in both the magnitude and frequency of shocks (natural and trade), and exposure to these shocks depending on several factors as smallness, remoteness, distance, and specialisation of local production and exports[5].

When identifying the potential factors of structural vulnerability, the orthodox literature states agriculture as one of the main "usual suspect" (Angeon and Bates 2015a). Considering its exposure to environmental and trade fluctuations, specialisation in primary goods is obviously presented as an important weakness for a sustained development. More generally, a widely agricultural region is more expected to suffer from external conditions. This is the conceptual view adopted by most empirical studies focusing on structural vulnerability for the developing world including SIS (see Angeon and Bates, 2015b for a survey).

However, this conventional wisdom was recently challenged by the 2007-2008 and 2010-2011 international food crises. These latter led to demonstrations and food riots in several countries principally located in Africa, Asia, the Middle East and the Caribbean (Bush and Martiniello 2017). Increase in world commodities prices is known as a major cause of these events[6]. In the same time, the commodity market gained a new interest from investors. As a consequence, the prices became more volatile, whereas they were quite stable in the earlier decades (Berazneva and Lee 2013; Berthelot 2008; FAO 2009; Mazzeo 2009)[7]. Furthermore, these episodes of spikes and instability in food prices was associated with a strong rise in poverty, and especially in urban areas of food-importing developing countries (Ivanic and Martin 2008; Ivanic, Martin and Zaman 2012) that is economies largely

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[5] More obviously, economic vulnerability includes three determinants, namely the size and likelihood of shocks, exposure to the shocks which define together the structural vulnerability, and a lack of resilience to the shocks (the capacity for reacting to them) (Guillaumont 2009a). Contrary to policy-induced vulnerability due to a lack of resilience, structural vulnerability arises from environmental and economic factors that are independent of a country's current political will. So that when trying to identify economies that need to retain the attention of the international community, structural vulnerability should be preferred.

[6] Actually, the impact of global food prices variations on well-being and poverty depends on the food prices pass through that is the extent to which changes in world food prices lead to changes in local food prices (Bekkers et al. 2017).

[7] The recent movement of higher and more volatile international food prices relies on many factors: poor harvests in major producing countries due to extreme weather events, declining food stocks to low levels, high oil and energy prices raising the cost of fertilizers, irrigation and transportation, production of bio-fuels substituting food production, speculative transactions, export restrictions leading to hoarding and panic buying, and three decades of underinvestment in agriculture (FAO 2011).

dependent on the world market to supply their domestic consumption[8].

This new international context reopened the debate about the merits and the downsides of the concept of food self-sufficiency for promoting national food security (Clapp 2017). Mainstream economists, rejecting the endogenous and self-reliant development policies implemented by most newly independent developing countries during the 1960s and 1970s, dominated the end of the 20th century. They pointed out that the food self-sufficiency approach was inefficient and prone to dramatic market distortions (Naylor and Falcon 2010). Then, trade liberalisation was presented as the better way to sustain food security. For the major part of the developing world including SIS, food security implied a trade strategy based on a specialisation on goods for which they have a comparative advantage, namely export crops, and relying essentially on imports for their food supplies, i.e. a number of developing economies gradually became net food importers.

Nevertheless, since the recent food crises and the high uncertainty on world food markets, a renewed interest in food self-sufficiency as a means to protect domestic economies from higher and more volatile world food prices, emerged amongst academics and policymakers (Clapp 2017). The context of on-going climate change and the food sovereignty social movement, initiated by La Via Campesina (Martínez-Torres and Rosset 2010), supports that an important and productive agricultural sector can also be a factor of resilience allowing to reduce the exposure to the effects of the crisis, and so the vulnerability (Dimova and Gbakou 2013; Dogru et al. 2019; Johnston and Mellor 1961; Meijerink and Roza 2007; Oluwatayo and Ojo 2016; Yang et al. 2008).

In accordance with this latter line of the literature, we claim that agricultural specialisation is not necessarily a factor of economic vulnerability. What matters is its ability to sustain the food needs of the domestic population. In short, economic vulnerability does not increase with the share of agriculture in GDP but with the degree of imported food dependency. Then, based on the assumption that dependency on global food market is a good way for measuring the role of agriculture and food production for vulnerability, this article aims at designing a new structural Economic Vulnerability Index [EVI] by introducing into the well-known EVI of the United Nations Committee for Development Policy [UNCDP] (Guillaumont 2009a; United Nations 1999) an indicator of dependency from food imports. Moreover, following the literature about the "benefit of the doubt" composite indicators (Blancard and Hoarau 2013; Blancard and Hoarau 2016), we adopt an endogenous weighting system derived from the "Data Envelopment Analysis" [DEA] framework (Charnes, Cooper and Rhodes 1978) rather than the more common equal weighting system. We especially apply the common weights approach of Hatefi and Torabi (2010). Simulations are performed on a sample of 131 developing countries including 35 small island territories[9].

The rest of the paper is organized as follows. Section 2 reviews the literature focusing

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[8] The reasons of this dependence are numerous. Some of them, especially in the Middle East, do not have the natural conditions to produce enough. Others are too small or built up countries, especially in the case of SIS. Economic choices of specialisation, supporting by international institutions (World Trade Organisation, World Bank, and International Monetary Fund), also led to the specialisation in cash crops at the expense of subsistence agriculture, as in some West African states.

[9] Appendix A.1. gives more details about the sample.

on the debate "food security versus food sovereignty" so that the role of food dependency and agriculture for vulnerability. Section 3 exposes our variable of interest measuring food dependency. Section 4 presents the EVI incorporating the new variable of food dependency. Section 5 describes the methodological design of the food dependency augmented index based on the DEA procedure developed by Hatefi and Torabi (2010), and discusses the results. Section 6 concludes and emphasizes some interesting economic policy insights.

2. Is agriculture a factor of structural vulnerability for developing countries and SIS?

How does the literature analyse the nexus between the agricultural sector and economic vulnerability? Actually it depends on the vision about the role of free trade so that how to consider the merits and the drawbacks of liberalisation and agricultural specialisation.

2.1. The liberal theory, food security and the positive role of agriculture

One strand of the literature, in line with the liberal theory or the so-called Heckscher-Ohlin-Samuelson [HOS] model, states that countries must specialize in activities for which they have a comparative advantage. Concerning the developing world and SIS, liberal economists suggest that these economies must consider the development of the agricultural sector as a priority in accordance with its factorial endowments because agriculture is a labour-intensive sector. Then, free trade gives them the opportunity to export primary goods in exchange of capital-intensive goods. Mainstream economists applied the same idea to the field of food self-sufficiency. Indeed, since the well-known Berg report (1981), within the agricultural sector, developing countries are fostered to specialize in cash crops (coffee, banana, sugar cane, tea, cotton) to make full use of their comparative advantage (Laroche Dupraz and Postolle 2010; Hassan, Faki and Byerlee 2000), and import staples foods from areas most suited to produce it that is developed countries.

This approach led to the concept of food security widely accepted by the international institutions. Accordingly, following the Food and Agriculture Organisation [FAO], "food security exists when all people, at all times, have a physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO 1996). This definition does not consider as important the origin of commodities. The only crucial thing is that people can feed themselves with a nutritious, safe and culturally relevant food. Free trade is even presented as the best way to ensure food security.

The implementation of food security by international organisations (IMF and the World Bank) through their structural adjustment programs resulted in a progressive shift from the cultivation of domestic food crops to export-oriented agriculture in developing countries and their growing dependency from imported foodstuffs. This is even truer for SIS because the promotion of cash crops for exports at the expense of other traditional agricultural sectors targeting local markets continued the trend fixed by the colonisation process (Barlagne et al. 2015).

2.2. Post-structuralist wisdom, food sovereignty, and the negative impact of food

dependency

Since the beginning of the 1990s, following the line of the structuralist wisdom (Furtado 1976; Prebisch 1950; Singer 1950), strong critics about the positive role of free trade and agricultural specialisation emerged. Post-structuralists argue in particular that the structure of agricultural exports is a main channel of exposure to price shocks then implying a strong economic vulnerability. Countries where the supply and export structures are concentrated on a few raw materials are prone to dramatic price shocks[10] leading to strong instability in export earnings and casting doubts about the possibility to sustain both a process of development and food security in the medium-long run (Easterly and Levine 2003; Guillaumont 1994; Guillaumont and Guillaumont Jeanneney 2003). Thus, it is not surprising that the composite indicators measuring economic vulnerability, based on the post-structuralist wisdom, consider agriculture as a factor of vulnerability (see Angeon & Bates, 2015b, for a survey). Especially four components are suggested to identify the vulnerability of agriculture (Angeon and Bates 2015a): (i) export concentration, (ii) the dependency from agri-exports, (iii) instability of exports and agricultural production, and (iv) the share of agriculture in GDP.

However, even if the three first sources of vulnerability are difficult to contest, according to us designing the share of agriculture in GDP as a weakness is misleading. Several works showed that a productive and efficient agriculture is a mean of development but not of insecurity (Dimova and Gbakou 2013; Johnston and Mellor 1961; Meijerink and Roza 2007; Oluwatayo and Ojo 2016; Yang et al. 2008). Moreover, other works highlighted strong links between past episodes of price spikes and worsening poverty, severe political and social unrest in particular in urban areas of food importing countries (Bellemare 2014; Ivanic et al. 2012)[11]. Actually, what is crucial is not the share of agriculture sector but rather its ability to feed the local population. Angeon and Bates (2015a) put forward that promoting the macroeconomic resilience of a country requires improving the production conditions rather that reducing the share of agriculture. In short, agricultural policy must foster a reorientation towards a strategy of diversification and food self-sufficiency. Undoubtedly, food self-sufficiency is a good means to insulate a country from higher and more volatile world food prices, then to reduce economic vulnerability.

This proposal is in line with the more and more popular concept of food sovereignty, proposed by the social movement of La Via Campesina since the 1990s, which regroups Non-Governmental Organisation and associations of farmers from several countries. Food sovereignty is defined as “the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems” (Forum for Food Sovereignty 2007). This definition gives a wider importance to the origin and to the means of production than the food security. Here,

[10] Price shocks could result from different sources as climate hazards (Heinen, Khadan and Strobl 2015; Parker 2018), political instability (Miguel, Satyanath and Sergenti 2004), and foreign trade (Guillaumont and Guillaumont Jeanneney 2003).

[11] Examining the determinants of the food prices pass through for a large sample of countries, Bekkers et al. (2017) argue that global price spikes should more adversely hurt low-income economies, especially those who are food consumers rather than producers.

agriculture sector obviously appears as a strength rather than a weakness relative to its ability to protect a country for the instability of international food prices while promoting food security. In other words, what stands out is food dependency from imports must be considered as a major source of vulnerability.

2.3. Food self-sufficiency as a continuum

Recently, Clapp (2017) drew attention to the fact that the debate about food self-sufficiency must not oppose absolute autarky, i.e. complete reliance on domestic good production to meet food needs, and absolute open borders, i.e. complete reliance on imports for food supply. A more fruitful approach is to define food self-sufficiency as a continuum stating that most countries fall somewhere between the extremes on the policy continuum, depending on their own unique circumstances. Then, "food self-sufficiency is more about a country's domestic capacity for food production than it is about a rejection of food trade. Indeed, most countries engage in at least some food trade, even if they are actively promoting food self-sufficiency" (Clapp 2017, p.95).

Then, some situations could necessitate that trade rules be enough flexible to allow the use of policy tools that enable countries to maximize the benefits of greater food self-sufficiency while minimizing the risks linked with both the restriction of trade and an over reliance on trade. Clapp (2017) identify six such situations where economies can benefit from greater self-sufficiency, that is (i) poor countries with high levels of food insecurity, (ii) countries with volatile export earnings, (iii) countries having the potential to be food self-sufficiency relative to their natural resource endowments but are paradoxically net food importers, (iv) countries whose main dietary staples are controlled by a small handful of suppliers, (v) countries with a large population whose their food purchases can disturb world food prices, and (vi) countries at risk of trade disruptions following war or political tensions. In all these cases, promoting more self-sufficiency without dropping out the possibility of trade makes economic sense (Clapp 2015).

3. Measuring food self-sufficiency : the food dependency ratio

3.1. The food dependency ratio: methodological aspects

Before introducing food dependency into an indicator of economic vulnerability, we need a proxy for it. Following Clapp (2017), this proxy must take into account the property that self-sufficiency does not exclude the possibility of foreign trade. A convenient way is to select the so-called "self-sufficiency ratio" [SSR], set up by the FAO (FAO 2012). The SSR focuses on the capacity of the domestic food production to equal to or exceed 100% of a country's food consumption. Thus, this understanding preserves the interest for a country to trade a part of its food production with outside. The FAO (2012) gives a simple formula to calculate the SSR that is:

SSR = production x 100 / (production + imports – exports)

Nevertheless, this indicator is not directly suited for an economic vulnerability analysis because the SSR measures a performance although we need on the contrary a measure of deprivation. That is why we prefer to retain a complementary version of the SSR, namely the "food dependency ratio" [FDR], which takes the following form:

FDR = (imports + food aid) x 100 / (imports + food aid + production – exports)

Thus, the closer the FDR is to 100% (to 0%) the more the country does not produce (produces) food in sufficient quantities to meet its domestic needs[12]. Note that we introduce into the FDR "food aid" taking into account the fact that most poor countries rely on international assistance for emergency food supply. Furthermore, considering that the FDR aims at reflecting the real dependency of a country to foreign food sources, it is not necessary to include every agricultural production. Only basic productions are needed. Cash crops such as sugar cane, cotton, cocoa or coffee are not considered because they are mainly export-oriented.

A country can be concerned by hunger and malnutrition while being self-sufficiency in food at the global level. Such a country might produce more than enough of some food crops, but too little of others essential for a healthy diet (Clapp, 2017). Thus, two distinct FDR have been computed, respectively on energy (cereals and starchy roots, FDR_E) and on animal proteins (meat and milk, FDR_P). The commodities used in the computation of the FDR_E are rice, wheat, maize, cassava, potatoes and sweet potatoes[13]. The commodities computed in the FDR_P are pork, beef, poultry, mutton and goat meat and milk. The total FDR [FDR_T] takes into consideration the dependency both to energy and to animal proteins. The assumption that the majority of international trade of milk is under the form of powder allows a comparison between milk and meat in the unity of mass. Then, the only unit used for FDR computation was the ton.

3.2. Simulations and results

We calculated the three FDR on a sample of 131 developing economies, including 35 SIS in the sense of the United Nations Secretariat. Data concerning import, export and production of commodities are extracted from the food balance sheet [FBS] of the FAO[14]. This sheet gathers data for each country of interest and is based on national data, information

[12] Note that some cautions must be taken when interpreting the score resulting from the FDR. Indeed, this indicator is an average so that a score largely below 100% does not mean all the time that hunger does not exist. A food self-sufficiency situation can hide strong impediments to food access for certain segments of the population. Likewise, a country may have a score close to or above 100% and in the same time has no problem to afford imported food even when world food prices are high and/or volatile (Clapp, 2015). Nevertheless, these aspects are directly connected to a country's capacity of resilience and do not question the reality of its structural vulnerability.

[13] The exclusion of non-basic commodities for the assumption of food dependence can be criticized. Even if the reject of cash crops is self-evident, the choice of commodities could be larger. For instance, oil and vegetables play an important role in some culinary traditions. However, we decided to not include them in vulnerability assessment either because they are mainly exported or because the world trade on these products is very small.

[14] http://www.fao.org/faostat/en/#data/FBS.

from trade partners and estimations. Data on the food aid are extracted from the FAO's Food aid sheet, which source is the World Food Program [WFP][15]. Data are averaged on a ten-year (2003-2012) period in order to smooth the effect of exceptional events.

First, a significant correlation exists between FDR_T, FDR_E, and FDR_P, with an especially strong coefficient between FDR_T and FDR_E: the Spearman's rho is higher than 0.96 (Table 1). Moreover, the p-value of this test is zero, so the null hypothesis is rejected at $\alpha = 0.01$. This correlation is not so surprising in the extent that commodities relative to energy account for about ¾ of all total commodities considered here. Second, Table 2 and Figure 1 put forward that in average the developing world is not particularly food dependent with a median and a mean of 31.594 and 40.385 respectively. As a general result, the dependency from energy is relatively more pronounced than dependency from animals' proteins due to their perishable nature that does not facilitate foreign trade in this latter domain (see Table 2). However, standard errors and the boxplot analysis stand out that this outcome hides a large heterogeneity. Indeed, our sample covers a large spectrum going from the least food dependent country, India (0.33%), to the most food dependent one, Oman (140%). Third, when considering the two features of insularity and development level, several interesting but not so surprising findings emerge.

Table 1. Spearman's tests for rank correlation between FDR_T, FDR_E, and FDR_P

Variables	rho	p. value
FDRT, FDRE	0.967005161134532	<0.01
FDRT, FDRP	0.746254594177639	<0.01
FDRE, FDRP	0.607485129629611	<0.01

Source: from authors.

Table 2. Standard statistics for the FDR_T, all developing groups

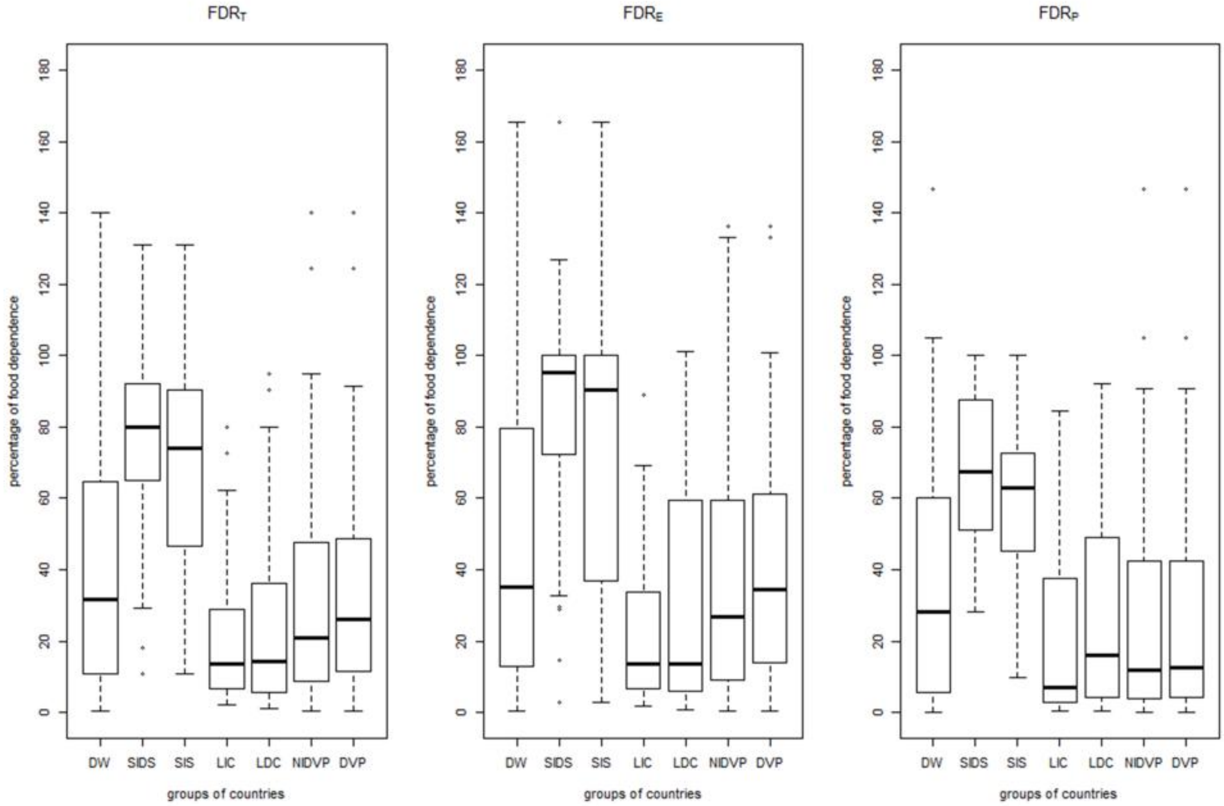
Groups	Min	1st Qu.	Med	Mean	3rd Qu.	Max	Standard error
DW	0.329	10.748	31.594	40.385	64.608	140.239	33.191
SIDS	10.961	65.872	80.029	75.137	91.649	130.989	28.120
SIS	10.961	45.077	75.347	68.753	90.487	130.989	28.792
LIC	2.165	6.591	13.645	21.223	28.968	79.949	20.580
LDC	1.174	6.033	14.466	26.675	34.827	94.866	28.049
NIDVP	0.329	8.919	21.913	30.442	47.913	140.239	28.669
DVP	0.329	12.087	26.200	35.044	49.289	140.239	29.149

Note: DW: developing world, SIDS: Small Island Developing States, SIS: Small Island Spaces (includes SIDS), LIC: Low Income Countries, LDC: Least Developed Countries, NIDVP: Non-Insular Developing Countries, DVP: Non-insular, Non-LDC Developing Countries

[15] www.fao.org/faostat/en/#data/FA . In the special case of French Overseas Regions [FOR], data are extracted from the French customs and the French Ministry of Agriculture (https://stats.agriculture.gouv.fr/disar-web/disaron/%21searchurl/searchUiid/search.disar).

Source: from authors.

Figure 1. Food dependencies for each group of countries: a boxplot analysis



Note: DW: developing world, SIDS: Small Island Developing States, SIS: Small Island Spaces (includes SIDS), LIC: Low Income Countries, LDC: Least Developed Countries, NIDVP: Non-Insular Developing Countries, DVP: Non-insular, Non-LDC Developing Countries.
Source: from authors.

On the one hand, insularity is clearly a constraint when talking about food independency. The two island groups, SIDS and SIS, have scores (median and mean) significantly higher than the average of the developing world as well as the mean scores of the other groups, that is LDC, LIC, NIDVP and DVP (Table 2). Moreover, the ranking analysis by quarters (Table A.6 in appendix) shows that no SIS is ranked in the first quarter, that is, the quarter of the least food dependent economies. On the contrary, 20 SIS out of 35 are located into the fourth quarter of the most food dependent countries. We can add 11 others if we consider the third quarter. Following the global trend, this relative food dependency is more intense for energy than for animals' proteins even if the two items display strong scores. In the opposite, the groups of non-island developing economies, NIDVP and DVP, appear weakly food dependent with an average about 30.442 and 35.044 respectively, supporting the fact that being an island is a serious impediment for reaching food independency. Very traditional features explain this finding. First, their small size does not allow them to have an important agricultural sector. Second, the residual agriculture concerns often cash crops or fruits and vegetables, not accounted in the food dependency ratios. Finally, some of them have an economy driven by tourism, which can even more deteriorate the food dependency because of the increasing population in some periods during the year.

On the other hand, the level of development does not appear as a discriminating factor for food independency. Thus, two sets of countries, both very poor and emerging economies, display rather low global scores. Table 2 gives an average performance of 21.223 and 26.675 for LDC and LIC and of 35.044 for DVP. Table A.6 supports this finding highlighting an over-representation in the first quarter, i.e. the least food dependent countries, of both very poor and large emerging economies (Argentina, Brazil, China, India, Vietnam and so on). Nevertheless, in spite of quite similar performances, the underlying factors are very different. Emerging economies seems to have succeeded in producing enough food for their own population. Even if they sometimes remain significant importers of commodities, they also are ones of the biggest food producers and the most productive in the world. Unsurprisingly, they appear quite independent.

Conclusions are more complex for LDC and LIC. Agriculture is a very important part of their production. We showed previously that rural regions suffer less than urban regions from economic shocks, especially when these latter affect the food global market. In this extent, countries with an important subsistence farming sector are more likely to be food independent since their population produces their own food. However, this low dependency on imported food could also be explained by their low-income status. These countries do not have the opportunity to participate to foreign trade, that is, they do not have the currencies required to buy food on the global market. Besides, most of these economies benefit from aids given by the World Food Programme [WFP][16]. The distinction between these two potential sources of low food dependency is not so evident, but probably a combination of both factors at different level for each country is at work to explain their relative food independency.

4. A new structural economic vulnerability indicator integrating food dependency

Since the 1994 United Nations conference in Barbados, adopting the SIS program of action, many works have tried to build economic vulnerability indicators, which directly focus on integrating the features of SIS (Blancard and Hoarau, 2016 for a review of the literature). Among all the formulations of the vulnerability index, that of the UNCDP appears to be the most suitable for analysing the special cases of SIDS and SIS, particularly the least developed ones (Guillaumont 2004b; Guillaumont 2009b; United Nations 1999) (Guillaumont 2004b; Guillaumont 2009b; United Nations 1999). Indeed, this indicator is designed to focus directly on structural vulnerability so that it is convenient to identify economies that need to retain the attention of the international community[17].

4.1. The methodological framework for computing the EVI

[16] Over the considered period (2003-2012), 95 countries of our dataset have benefit at least once from the World Food Programme (see FAOSTAT, Food Aid Shipment Sheet, data from the WFP, http://www.fao.org/faostat/en/#data/FA).

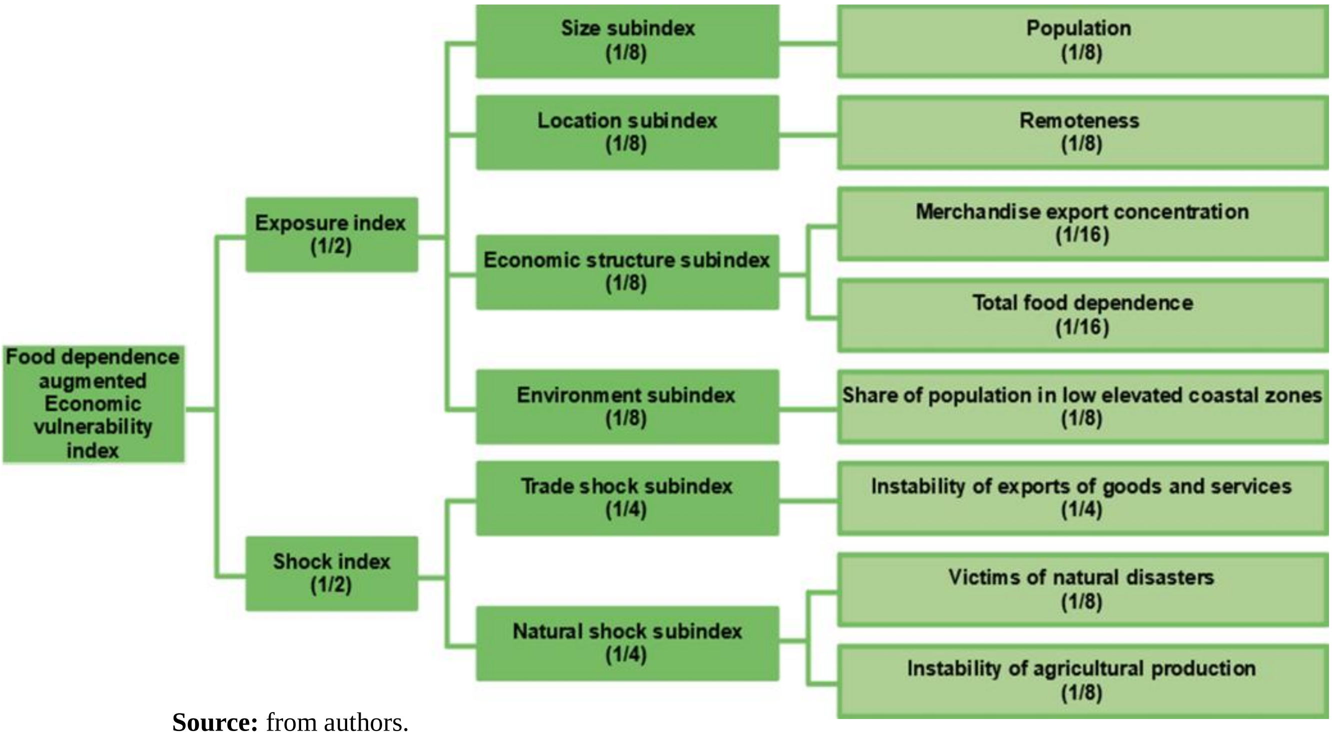
[17] As such, the UNCDP's EVI is one of the three criteria used for determining the group of LDC. The two other criteria are Gross National Income per capita and the human assets index. Therefore, to be considered as a LDC, a country must be a low-income country with a low level of human capital and high vulnerability (Guillaumont 2010) .

In its last updated version released in 2011, the UNCDP's EVI has two main blocks[18]: (i) the size and frequency of exogenous shocks (observed or anticipated) and (ii) exposure to shocks. The first block, which measures growth volatility due to exogenous shocks, has three sub-indices: (i) victims of natural disasters [VND], (ii) an agricultural production instability index [API], and (iii) an indicator of the instability of exports of goods and services [EI]. The second block, which measures the importance of structural exposure to external shocks, consists of five elements: (i) the population size [POP], (ii) an export concentration coefficient [ECC], (iii) remoteness from major world markets [REM], (iv) the share of agriculture, including fisheries and forestry in GDP [SA], and (v) the share of population in low elevated coastal areas [POPLCA]. Here, following the review of the literature about food self-sufficiency, we remove the variable "the share of agriculture, including fisheries and forestry in GDP" and introduce the new variable "the food dependency ratio". Using the FDR in our vulnerability analysis gives a more positive role for agriculture.

Three categories of countries are expected to be especially impacted by this change. First, non-agricultural countries largely dependent to the global market for their food supply should have a higher vulnerability score. Second, agricultural countries that do not import food should on the contrary have a smaller score in the extent that they are oriented towards subsistence farming and have the ability to feed a large share of their population. Third, agricultural countries importing large amount of food are expected to show a higher score. Most of these economies have cash crop oriented agriculture and consequently are not able to feed the local population by their own production. Figure 2 gives a representation of this new EVI (dimensions, variables, and associated weights) called the "Food dependency augmented EVI" (FDEVI hereafter).

[18] All relevant information about the raw data (the rationale, the methodology of construction, the time span, and data source) are given in Table A.2 figuring in Appendix.

Figure 2. Structure of the Food Dependency augmented Economic Vulnerability Index



Source: from authors.

Each raw data (sub-component) are not denominated in the same unit. Thus, before aggregating we need to transform the sub-component into sub-indices rescaled between 0 and 100. To do that, the so-called "min-max" standardisation procedure is implemented as such:

For the variables positively related to economic vulnerability: $\mathbf{I} = \mathbf{100} \times \frac{\text{observed value} - \text{Min}}{\text{Max} - \text{Min}}$

For the variables negatively related to economic vulnerability: $\mathbf{I'} = \mathbf{100} \times \frac{\text{Max} - \text{observed value}}{\text{Max} - \text{Min}}$

Note that the "Min and Max" values for each variable are given in Table A.2 (see appendix)[19]. In the second hand, we aggregate all the normalized sub-components into one overall index to obtain the FDEVI. Following the conventional way, the average approach consists in combining arithmetically with equal weights a set of three sub-components reflecting the intensity of exogenous shocks and a set of five ones reflecting exposure to these shocks[20]. So that:

$$\mathbf{FDEVI} = \frac{1}{2} \times \textbf{ Shock index} + \frac{1}{2}\textbf{ Exposure index}$$

$$\textbf{Shock index} = \frac{1}{4} \times \mathbf{API} + \frac{1}{4} \times \mathbf{VND} + \frac{1}{2} \times \mathbf{EI}$$

[19] For all conventional dimensions, official min and max values have been retained. In the absence of studies that define categories of states for food dependence, it was not easy to determine the thresholds used for the min-max method. The two bounds used here (10% and 100%) are arbitrary and can be discussed.

[20] Note that the arithmetic average procedure is prone to the inconsistent property of perfect substitutability between the different components. See Guillaumont (2009a) for alternative methods.

$$\textbf{Exposure index} = \frac{1}{4} \times \text{POP} + \frac{1}{4} \times \text{REM} + \frac{1}{4} \times \text{POPLECA} + \frac{1}{8} \times \text{ECC} + \frac{1}{8} \times \text{FDR}$$

In short, relative to the normalisation procedure, the range for the FDEVI is 0-100 and the closer the score is to 100 the more the country is economically vulnerable. Its structure is similar to the EVI with the share of agriculture in GDP replaced by the total food dependency in the exposure index. The food dependency dimension therefore only accounts for 6.25% of the total FDEVI.

4.2. Results and comments

As previously, our simulations are made on the sample of 131 countries for the year 2015. The raw data required to build the EVI are easily available from the official dataset of the United Nations' Department of Economic and Social Affairs [UNDESA][21].

Before analysing the findings relative to our new index, note that Spearman's rank correlation coefficient (0.9545) highlights a strong similarity between the rankings from FDEVI and the standard EVI (see Appendix, Table A.3). Moreover, the p-value of this test is zero, so the null hypothesis is rejected at $\alpha = 0.01$. Then, due to its weak weight in the global index (6.25% of the total score of the FDEVI), substituting "the share of agriculture in GDP" by "the food dependency ratio" does not upset so much the world state in the field of economic vulnerability. However, this strong correlation should not obscure the presence of large rank variations. Indeed, Table A.6 display that many countries are associated with important gains or losses : Ethiopia (-28), Togo (-26), Central African Republic (-23), Myanmar (-22), Mali (-21), Brunei Darussalam (+22), Trinidad and Tobago (+23), Kuwait (+24), Barbados (+25), Mauritius (+26), Singapore (+27), Oman (+28), and United Arab Emirates (+28). Table A.3 also states the correlation between the two composite indices (EVI and FDEVI) and the eight sub-indicators. No major difference exists. Both indices are quite structurally balanced even if the FDEVI is more closely correlated with population and instability of agricultural production and less correlated with export instability. The correlation coefficient between FDEVI and "Total food dependency" is surprisingly weak and non-significant. This latter outcome emphasizes that many LDC countries highly vulnerable relative to most of dimensions, are in the same time food independent as presented earlier.

Otherwise, our new assessment of structural economic vulnerability gives strong support to earlier works in the field. In spite of some heterogeneity (see Appendix, Table A.5), Table 3 states especially high FDEVI scores for the insular groups (SIDS, 45.453 and SIS, 44.340), both relative to the sample's mean (33.989) and to non-insular groups (NIDVP, 34.699 and DVP 27.325)[22]. However, what is the most striking is that small islands appear most economically vulnerable than the groups usually considered as the most fragile in the specialized literature, that is LDC (39.402) and LIC (37.735). The main reason is due to the

[21] https://www.un.org/development/desa/dpad/least-developed-country-category/evi-indicators-ldc.html. For Guadeloupe, Guyane, Martinique, and La Reunion, data are extracted from the seminal work of (Goujon, Hoarau and Rivière 2015) and are available for the year 2012.

[22] To take into account the strong heterogeneity within each group, we test for the significance of the difference between groups by implementing the Wilcoxon procedure. The results are given in Appendix (Table A.5).

introduction of the new component “FDR”. As shown earlier, islands are largely more prone to food dependency than most of LDC: the FDEVI performance is significantly above than the EVI one for SIDS and SIS. Table A.7 gives the same conclusion putting forward an over-representation of SIS in the third and fourth quarters characterizing the most economically vulnerable economies: 8 and 20 out of 35 small islands are in the third and the fourth quarters respectively. Moreover, most countries downgraded with the new index are SIS (see Table A.7).

Table 3. Standard statistics for the standard EVI and FDEVI, all developing groups, 2015

EVI

Groups	min	1st Qu.	med	mean	3rd Qu.	max	sd	nb
DW	11.783	25.341	31.811	33.641	39.892	71.526	11.432	131
SIDS	25.575	33.610	40.468	41.817	47.238	71.526	11.246	26
SIS	16.762	31.965	40.430	40.716	48.821	71.526	11.797	35
LIC	24.859	32.865	36.067	39.212	42.276	70.663	10.583	28
LDC	24.859	33.460	38.162	40.424	45.873	71.526	10.761	40
NIDVP	11.783	24.242	30.263	31.062	36.903	70.663	10.191	96
DVP	11.783	20.671	26.418	27.377	31.551	58.950	8.699	65

FDEVI

Groups	min	1st Qu.	med	mean	3rd Qu.	max	sd	nb
DW	10.964	25.410	32.832	34.225	41.955	74.448	11.635	131
SIDS	29.869	39.053	44.054	45.338	50.108	74.448	10.645	26
SIS	20.120	35.092	42.891	43.695	49.891	74.448	11.158	35
LIC	22.583	29.135	34.694	36.754	39.777	72.632	11.181	28
LDC	22.583	30.105	35.870	38.672	43.804	74.448	11.644	40
NIDVP	10.964	23.603	29.187	30.773	35.700	72.632	9.778	96
DVP	10.964	21.590	27.409	28.077	32.768	59.124	8.662	65

Note: DW: developing world, SIDS: Small Island Developing States, SIS: Small Island Spaces (includes SIDS, LIC: Low Income Countries, LDC: Least Developed Countries, NIDVP: Non-Insular Developing Countries, DVP: Non-insular, Non-LDC Developing Countries.
Source: from authors.

5. The determination of an endogenous weighting system for the FDEVI

The “official” exogenous weighting system method raises important concerns. It largely depends on the state of the art and on the choices of the operator. The decision to allocate the same weight to exposure and intensity is purely arbitrary. Moreover, the hierarchy between groups of variables is questionable since every variable carries several aspects of vulnerability. It is also impossible to know precisely the real weight of the variables in the constructed index. In the literature, more convenient ways exist to determine the weights (see OECD 2008 for a survey). Among these, the methodology from DEA initially proposed by

(Charnes et al. 1978) and known as the "benefit of the doubt" in the field of composite indicators, gives good perspectives of robustness.

5.1. An efficient weighting method for the construction of composite indicators: Hatefi and Torabi's DEA-based approach

First, assume that we have information for *m* countries about *n* sub-indicators, which allows the calculation of a composite indicator (CI). Let I_{ij} denote the value of country *i* with respect to sub-indicator j. Let also w_{ij} be the weight associated to sub-indicator *j* for the country *i*. We seek to aggregate $I_{ij}\left(j=1,2,\ldots,n\right)$ into a CI for each country as follows:

$$\mathrm{CI}_i = \sum_{j=1}^{n} w_{ij} I_{ij}, \quad i=1,2,\ldots,m \tag{1}$$

At this level, the topic is on the determination of the weights (w_{ij}) required to construct the composite indicator from a DEA programming. DEA is a method to evaluate relative efficiency of units with multiple inputs and outputs using mathematical programming. It focuses on each unit to select the weights assigned to the inputs and outputs. These weights correspond to the most favourable and are specific for each unit (Zhou, Ang and Poh 2007).

In DEA literature, we find several adaptations of this methodology used to generate common set of weights (Hatefi & Torabi, 2010; Kao & Hung, 2005; E. E. Karsak & Ahiska, 2005; E. Ertugrul Karsak & Ahiska, 2007; Li & Reeves, 1999; Roll, Cook, & Golany, 1991; among others). Beyond the advantage of DEA, which is to avoid the arbitrary attribution of weight, the common weight method allows a fair assessment since all entities share the same set of weights. In nutshell, all entities are compared on one only scale. Moreover, this kind of models presents a high discriminating power in particular among efficient units compared to DEA-like models with best weights. In this paper, we propose to exploit the recent approach of Hatefi and Torabi (2010) that is herself derived from Karsak and Ahiska (2005, 2007).

To understand this model, we start from the following DEA formulation, which computed the efficiency (or value of CI), for the entity (e.g. country) *o*:

$$\begin{aligned}
&\max_{w}\ E_o = \sum_{j=1}^{n} w_{oj} I_{oj} \\
&\text{subject to:} \\
&\sum_{j=1}^{n} w_{oj} I_{ij} \leq 1 \qquad i=1,2,\ldots,m \\
&w_{oj} \geq \pounds, \qquad i=1,2,\ldots,m,\ j=1,2,\ldots,n
\end{aligned} \tag{2}$$

where E_o is the efficiency of the evaluated entity *o*. w_{oj} is the weight assigned to sub-indicator *j* for evaluated entity *o*. I_{ij} is the value of sub-indicator *j* of entity *i*. In order to assure that none of the weights will take a zero value, we introduce the constraint $w_j \geq £$ with £ a non-Archimedean small number (here. 0.001). $E_o \in [0,1]$. If $E_o = 1$, then the entity is deemed efficient.

For each entity *o*, this model (2) seeks the best set of weights, which are used to aggregate the sub-indicators into a performance score. In essence, model (2) is an output maximizing multiplier DEA model with multiple outputs and constant inputs (Charnes et al. 1978) in which the sub-indicators represent the different outputs and a single dummy input with value unity is assigned to each country.

Next, consider d_o as the deviation of the efficiency of the entity *o* (E_o) from the ideal efficiency equal to unity (i.e. $d_o = 1 - E_o$). Maximize E_o is equivalent to minimize d_o. Consequently, from the model (2), we can deduce the maximisation model (3) which can also be solved *m* times in order to provide a set of best weights for each entity.

$$
(3) \quad
\begin{aligned}
& \min_{d,w} \; d_o \\
& \text{subject to:} \\
& \sum_{j=1}^{n} w_{oj} I_{ij} + d_i = 1 \qquad i = 1, 2, \ldots, m \\
& w_{oj} \geq 0,\; d_i \geq 0, \qquad i = 1, 2, \ldots, m,\; j = 1, 2, \ldots, n
\end{aligned}
$$

The model (3) is solved for each entity, so different weights are obtained. Thus, this program does not permit to deal with the problem of different systems of weights and the weak discrimination power of DEA in which each entity is evaluated by using different weight systems. Thus, Hatefi and Torabi (2010) proposed to reformulate this program as a new multi-criteria decision making (MCDM) model using a set of common weights which maximizes simultaneously the efficiency scores of all entities. More precisely, they used *minimax* approach consisting on minimizing the maximum deviation among all entities (M). The program is:

$$
(4) \quad
\begin{aligned}
& \min_{M,d,w} \; M \\
& \text{subject to:} \\
& M - d_i \geq 0 \qquad i = 1, 2, \ldots, m \\
& \sum_{j=1}^{n} w_j I_{ij} + d_i = 1 \qquad i = 1, 2, \ldots, m \\
& w_j \geq £,\; d_i \geq 0, \qquad i = 1, 2, \ldots, m,\; j = 1, 2, \ldots, n
\end{aligned}
$$

where w_j is the weights of each sub-indicator *j* shared by all countries. £ is a small positive scalar considered as a lower bound of the weights. The constraint $M - d_i \geq 0, \forall i$ assures that $M = \max\{d_i = 1, 2, \ldots, m\}$. By using the model (4), we can compute the composite indicator of country i i.e. $\text{CI} = 1 - d_i$. In this model, all entities are evaluated with the same set of weights. As noted by Karsak and Ahiska (2005), minimax efficiency measure has a higher discriminating power than the classical efficiency measure, since it considers the favour of all entities simultaneously. Thus, this method restricts the freedom of a particular entity to choose the factor weights in its own favour[23].

When model (4) results in more than one efficient entity, and thus does not enable the determination of the best entity, the use of the following common weight MCDM model is proposed by Karsak and Ahiska (2005, 2007) :

$$\begin{aligned}
&\min_{M,d,w} M - K \sum_{e \in EF} d_e \\
&\text{subject to:} \\
&M - d_i \geq 0 \qquad i = 1, 2, \ldots, m \qquad (5) \\
&\sum_{j=1}^{n} w_j I_{ij} + d_i = 1 \qquad i = 1, 2, \ldots, m \\
&w_j \geq 0,\ d_i \geq 0, \qquad i = 1, 2, \ldots, m,\ j = 1, 2, \ldots, n
\end{aligned}$$

where *EF* is the minimax efficient countries that are determined using model (7). *K* is a discriminating parameter assigned values ranging from zero to one with a predetermined step size. In other words, the value of *K* is found by trial and error. Therefore, increasing the value of *K* decreases the number of efficient DMUs, and the step-by-step procedure is interrupted when a single DMU remains efficient. The solutions obtained in the formulation (8) minimize the maximum deviation from efficiency while simultaneously maximizing the sum of the deviations from the efficiency of minimax efficient entities. This allows us to obtain the best entity with a CI value of one by augmenting the value of *K*. In the next section, models (4) and (5) are applied to construct FDEVI.

5.2. Results and comments

In order to cope with the arbitrary determination of the weighting scheme, we compare the standard FDEVI (m-score) with the FDEVI calculated from the multi-criteria DEA models in the spirit of Hatefi and Torabi (2010)[24]. Note that our DEA-FDEVI results only from the model (4) in the extent that this latter allows us to have only one efficient unit. Several interesting findings must be discussed.

First, we observe that the new method has good discrimination performance, i.e. reduces the number of efficient countries to one. Only one best performer is revealed, thanks to model 4, namely Turkey.

[23] The variables of the FDEVI are vulnerability variables. In order to remain in the scope of the “benefit of the doubt” approach, which is by definition favourable to the countries, we transform the variables into performance sub-indexes calculated as the complementary variables of the vulnerability values (that is, performance variable = 1 – vulnerability variable). We subtract the obtained value from one to get the DEA vulnerability indicator. In this case, the optimisation program is equivalent to a minimisation of the vulnerability index. Note that the performance index equals E_o and the vulnerability index equals d_o.

[24] The standard FDEVI (m-score) has been normalized to ensure the comparability with the FDEVI resulting from the DEA-like models. Therefore, a value of zero is assigned to the least vulnerable country and a value between 0 and 100 to all relatively more vulnerable countries according to a scale factor.

Second, in accordance to Table A.3, Spearman's rank correlation coefficient relative to the standard FDEVI resulting from the DEA model is 0.9246, thus giving some robustness to the standard analysis based on equal weighting. Moreover, the p-value of this test is zero, so the null hypothesis is rejected at α = 0.01. However, Table 7 shows the presence of large rank variations that is Uzbekistan (-25), Vietnam (-32), Uganda (-26), Madagascar (-28), Saudi Arabia (+39), Algeria (+42), Tunisia (+44), Jordan (+25), Sudan (-29), Kazakhstan (+38), Oman (+27), Kuwait (+27), Senegal (+28), Brunei Darussalam (+31), Singapore (+38), and UAE (+41). One potential explanation is the structural effect about the relative importance of each dimension. Indeed, Table A.3 points out that, contrary to standard FDEVI, the structure of correlation between DEA-FDEVI and the eight sub-indicators is not balanced. The dimensions of population, export concentration and agricultural production instability notably drive the global index. Note that this structural effect should be detrimental (benefit) to small (large) entities.

Third, according to Table 4, the multi-criteria DEA simulations lead to an endogenous weighting scheme highly different from that given by the standard FDEVI[25]. The new weighting structure is less homogenous than the one resulting from the *ad hoc* system. Indeed, five dimensions (population, remoteness, population in low coastal zone, numbers of victims of natural disasters, and export instability) now have lower weights what benefits to the three other (Export concentration, total food dependency, and mainly agricultural instability). This last finding gives support to the structural effect displayed earlier.

Table 4. The simulated and traditional weighting schemes for FDEVI

Dimensions	**FDEVI**		
	DEA	**DEAm**	**Standard**
Population	0.0010	0.0900	0.1250
Remoteness	0.0010	0.0900	0.1250
Population in low coastal zone	0.0010	0.0900	0.1250
Export concentration	0.0017	0.1499	0.0625
Total food dependency	0.0010	0.0900	0.0625
Numbers of victims of natural disasters	0.0010	0.0900	0.1250
Agricultural instability	0.0032	0.2856	0.1250
Export instability	0.0013	0.1146	0.2500

Source: Authors' calculations.

Finally, the analysis done by developing groupings wholly supports the traditional wisdom already exposed with the standard EVI and FDEVI. Table 5 indicates that the insular economies (SIS and SIDS) and LDC groups stay much more vulnerable than the other groups (DW, LIC, NIDVP, and DVP) in spite of certain heterogeneity (see Appendix, Table A.5)[26].

[25] For the purpose of comparison with the conventional approach, the values of the endogenous weighting schemes have been reduced to unity.

[26] See footnote 21.

Note that the structural vulnerability is especially high for insular groupings. Substituting the *ad hoc* weighting system by a DEA simulated one still widen the gap between the average scores to the detriment of small islands, confirming the fact that insularity is a main factor increasing economic vulnerability. Moreover, as previously, the third and fourth quarters giving the most economically vulnerable countries are largely dominated by SIS (Table A.8).

Table 5. Standard statistics for the DEA-FDEVI, all developing groups, 2015

Groups	min	1st Qu.	med	mean	3rd Qu.	max	sd	nb
DW	0.000	14.658	24.653	25.734	34.942	64.323	13.225	131
SIDS	17.441	30.275	37.003	38.749	45.451	64.323	11.604	26
SIS	13.286	28.174	36.709	36.930	45.398	64.323	12.095	35
LIC	8.754	16.936	25.764	26.340	33.403	64.323	11.678	28
LDC	8.754	17.828	27.758	28.452	36.053	64.323	12.517	40
NIDVP	0.000	13.131	20.105	21.653	28.699	64.323	11.134	96
DVP	0.000	12.397	17.835	19.531	26.145	46.859	10.566	65

Note: DW: developing world, SIDS: Small Island Developing States, SIS: Small Island Spaces (includes SIDS), LIC: Low Income Countries, LDC: Least Developed Countries, NIDVP: Non-Insular Developing Countries, DVP: Non-insular, Non-LDC Developing Countries.
Source: from authors.

6. Conclusion

In this paper, we revisited the literature about structural economic vulnerability for the insular developing world by suggesting an innovative measurement approach. The new suggested economic vulnerability indicator included two main contributions. The first one is conceptual with the introduction into the official composite index of the positive role of domestic agriculture through a measure of (in)dependency from food imports in accordance with the so-called “food sovereignty” wisdom. The second one is methodological, substituting the common equal weighting system by a more robust endogenous scheme obtained from DEA modelling. Our simulations set out that small islands, as a group, are the most structurally economic vulnerable entities amongst the developing world, even more than LDC.

Obviously, their proneness to food dependency from outside inherited from both their smallness and their colonial past highly contributes to this state of vulnerability. In short, food dependency can be considered as a constraint for growth and development for small islands. The transmission channel mainly works through higher and more volatile food prices in international markets, and we have good reasons to anticipate that this situation will persist for a long time[27]. More and more academic works argue that soaring prices of staples food during the 2000s and the 2010s are the signal of a persistent shortage in agricultural markets (Brown 2011; Daviron 2012; International Monetary Fund 2011). Our current agricultural model based on the massive consumption of natural resources (oil, water, biodiversity, land,

[27] Animal-sourced foods, indirectly affected by the cost and availability of feed, are also expected to see price increases, but the range of projected price changes are about half those of cereals (IPCC, 2019).

phosphate …), which led to an unprecedented production growth, comes to an end (IPCC, 2019). This prodigious growth is now threatened by the depletion of a major part of these resources, and by the pollution of both local and global "commons" (rivers, groundwater, atmosphere …) due to industrial production. In the same time, with the new context of climate change and the need of a carbon-free development model, the demand of agricultural crops for non-food uses strongly increased and will continue to rise in the medium/long run.

Consequently, it is very important for small islands to be aware of the potential worsening of their structural economic vulnerability in the future. Accordingly, a clear structural strategy and some bold political reforms must be taken urgently. Although most of the more efficient solutions against permanent rises in foodstuff prices are on the international side (limiting food demand for developed and emerging countries, building buffer food stocks, designing international trade rules in favour of food security, …), some relevant possibilities exist locally. We claim that the most promising challenge is to reduce significantly the dependency on imported foods by increasing internal agricultural capacity, i.e. promoting self-sufficiency without removing the possibility of foreign trade. In contrast with the contemporaneous dominant position extolling unbridled liberalisation of trade in foodstuffs, we call for an intervention of political authorities in favour of domestic farmers giving them facilities to sustain local produce and improve local cereal yields. Insofar as global warming is likely to push up energy and food prices sustainably, reducing dependency on imported food is a relevant option for SIS to face the consequences of climate change (Dogru et al. 2019) and in the same time to create locally opportunities for additional revenues (Golay 2010). This is in line with the observation of the last "alarming" report of IPCC (2019): "Given the likelihood that extreme weather will increase, in both frequency and magnitude, and the current state of global and cross-sectoral interconnectedness, the food system is at increasing risk of disruption (medium evidence, medium agreement), with large uncertainty about how this could manifest. There is therefore a need to build resilience into international trade as well as local supplies" (IPCC, 2019, chap. 5, p. 116).

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Appendix

A.1. The whole sample by groupings

Table A.1. The different groups of developing countries

Groups	**Countries**
Developing World (DW)	Afghanistan, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahamas, Bangladesh, Barbados, Belize, Benin, Bolivia, Botswana, Brazil, Brunei Darussalam, Burkina Faso, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo, Costa Rica, Cote d'Ivoire, Cuba, Cyprus, Democratic People's Republic of Korea, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Fiji, Gabon, Gambia, Georgia, Ghana, Grenada, Guadeloupe, Guatemala, Guinea, Guinea-Bissau, Guyana, Guyane, Haiti, Honduras, India, Indonesia, Iran, Iraq, Israel, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Lebanon, Lesotho, Liberia, Madagascar, Malawi, Malaysia, Maldives, Mali, Martinique, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Republic of Korea, Reunion, Rwanda, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Solomon Islands, South Africa, Sri Lanka, Sudan, Suriname, Eswatini, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, United Arab Emirates, Uruguay, Uzbekistan, Vanuatu, Venezuela, Viet Nam, Yemen, Zambia, Zimbabwe.
Small Island Developing States (SIDS) according to the United Nations Conference on Trade and Development	Antigua and Barbuda, Bahamas, Barbados, Cabo Verde, Comoros, Dominica, Fiji, Grenada, Guadeloupe, Guyane, Jamaica, Kiribati, Maldives, Martinique, Mauritius, Reunion, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Seychelles, Solomon Islands, Timor-Leste, Trinidad and Tobago, Vanuatu.
Small Island Spaces (SIS) according to the United Nations Secretariat	SIDS + Belize, Cuba, Cyprus, Dominican Republic, Guinea-Bissau, Guyana, Haiti, Singapore, Suriname.
Low Income Countries (LIC) according to the World Bank	Afghanistan, Benin, Burkina Faso, Central African Republic, Chad, Comoros, Democratic People's Republic of Korea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Liberia, Madagascar, Malawi, Mali, Mozambique, Nepal, Niger, Rwanda, Senegal, Sierra Leone, Tajikistan, Togo, Uganda, United Republic of Tanzania, Yemen, Zimbabwe.

Least Developed Countries (LDC) according to the United Nations Conference on Trade and Development	Afghanistan, Angola, Bangladesh, Benin, Burkina Faso, Cambodia, Central African Republic, Chad, Comoros, Djibouti, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Sudan, Timor-Leste, Togo, Uganda, United Republic of Tanzania, Vanuatu, Yemen, Zambia.
Non-Island Developing Countries (NIDVP)	DW – SIS
Non-Island, Non-LDC Developing Countries (DVP)	DW - SIS – LDC

Note: Micronesia, Marshall Islands, Palau and Tuvalu also belong to the list of SIE established by the United Nations. However, we do not include them due to the lack of data.

A.2. Description of the database

Table A.2. Description of the database (unit, thresholds, sources, and time coverage)

Variable	**Unit**	**Bounds for min-max Transformation**	**Sources**	**Time coverage**
Population	logarithm of inhabitants	ln(150,000) – ln(100,000,000)	UN World Population Prospects 2017	2017
Remoteness	logarithm of km adjusted by landlockness	10 – 90	Centre d'Études Prospectives et d'Informations Internationales, UN National Accounts Main Aggregates Database	2014-2016 average
Merchandise export Concentration	Herfindahl-Hirschmann index	0.5 – 0.95	UN Conference on Trade and Development	2014-2016 average
Share of agriculture, fisheries and forestry in GDP	%	1% – 60%	UN National Accounts Main Aggregates Database	2014-2016 average
Food dependency	%	10% – 100%	FAOSTAT, World Food Program, French Ministry of Agriculture, French Customs	2003-2012 Average
Share of population in low elevated coastal zones	%	0% – 35%	Center for International Earth Science Information Network at Columbia University	2010

Instability of exports of goods and services	adjusted deviation to a 20-years trend	5 – 35	UN National Accounts Main Aggregates Database	1996-2016 trend
Victims of natural disasters	‰ inhabitants	0.005‰ – 10‰	Emergency Disasters Database (EM-DAT), UN World Population Prospects	1997-2016 average
Instability of agricultural production	adjusted deviation to a 20-years trend	1.5 – 20	FAOSTATS	1994-2014 trend

Source: UN Committee for Development Policy, https://www.un.org/development/desa/dpad/least-developed-country-category/evi-indicators.html (consulted Nov. 13, 2018)

A.3. Spearman's rank correlation tests

Table A.3. Spearman's rank correlation rho and p-values

	Dimensions	EVI		
		Standard EVI	FDEVI	DEA FDEVI
Dimensions	**Population**	0.5434***	0.6720***	0.7172***
	Remoteness	0.3306***	0.3173***	0.2019**
	Population in Low Coastal Zone	0.0839	0.1527*	0.2062**
	Export Concentration index	0.5210***	0.5293***	0.6041***
	Share of Agriculture in GDP	0.2909***	..	..
	Total Food Dependency	..	0.0495	-0.1387
	Number of Victims of Natural Disasters	0.3020***	0.1919**	0.0371
	Instability of Agricultural Production	0.4328***	0.5093***	0.6864***
	Instability of Exports	0.6779***	0.5893***	0.4142***
EVI	**Standard EVI**	1		
	FDEVI	0.9545***	1	
	DEA FDEVI	0.8228***	0.9246***	1

Note: *, ** and *** indicates that the null hypothesis is rejected at α = 0.1, 0.05 and 0.01.
Source: from authors.

A.4. Testing the significance of gaps between the different developing groupings

Table A.4. Pairwise Wilcoxon rank sum tests with Bonferroni corrections

EVI

	DVP	LDC	LDCSIS
LDC	1.78 e-06 ***		
LDCSIS	2.01 e-04 ***	2.54 e-02 **	
SIS	1.17 e-04 ***	1	6.29 e-02 *

FDEVI

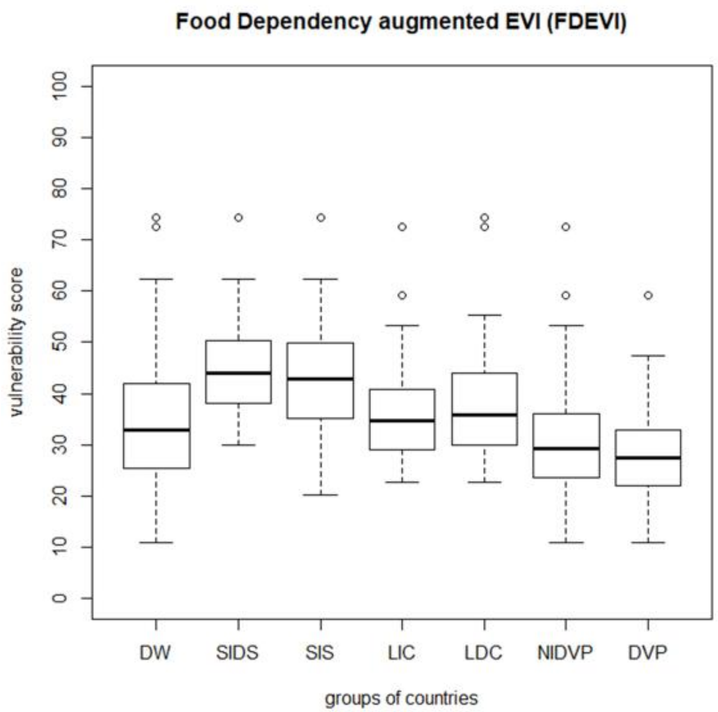
	DVP	LDC	LDCSIS
LDC	7.28 e-04 ***		
LDCSIS	2.35 e-04 ***	9.87 e-03 ***	
SIS	1.44 e-06 ***	6.94 e-02 *	9.98 e-01

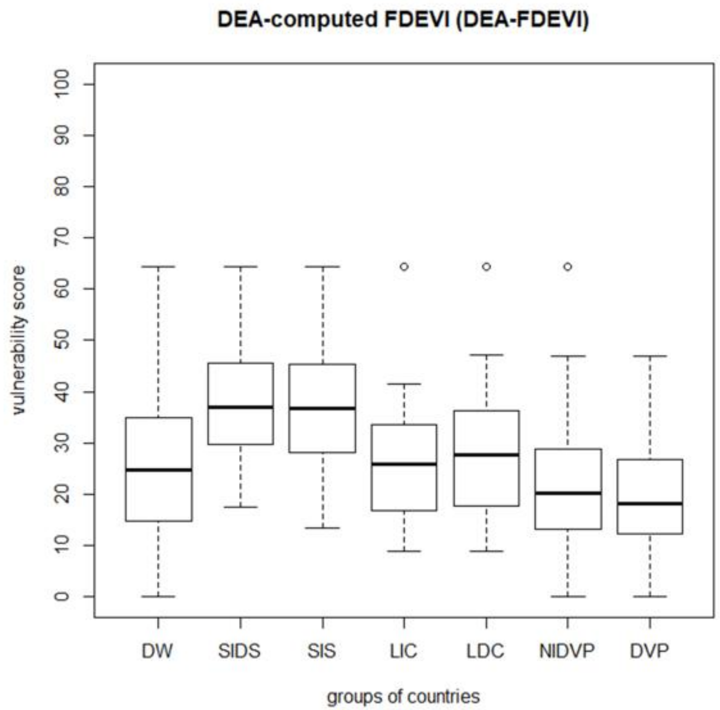
DEA-FDEVI

	DVP	LDC	LDCSIS
LDC	4.15 e-02 **		
LDCSIS	1.39 e-03 ***	2.18 e-02 **	
SIS	1.14 e-06 ***	5.77 e-03 ***	1

Note: *, ** and *** indicates that the null hypothesis is rejected at α = 0.1, 0.05 and 0.01. Because of the entanglement of the categories of SIS and LDC, the comparison of the groups is not possible. For that reason, we tested the significance of the difference between the groups 'LDC not SIS', 'SIS not LDC', 'LDC and SIS' and 'not LDC nor SIS'.
Source: from authors.

A.5. A dispersion analysis of FDEVI and DEA-FDEVI





Note: DW: developing world, SIDS: Small Island Developing States, SIS: Small Island Spaces (includes SIDS), LIC: Low Income Countries, LDC: Least Developed Countries, NIDVP: Non-Insular Developing Countries, DVP: Non-insular, Non-LDC Developing Countries.
Source: from authors.

A.6.

Table A.6. Global ranking by quarters, FDR_T

	Country	FDRT	Rank		Country	FDRT	Rank
First quarter	India	0.329	1	**Third quarter**	Cote d'Ivoire	31.765	67
	Argentina	0.741	2		Egypt	32.663	68
	Myanmar	1.174	3		Solomon Islands*	33.599	69
	Cambodia	1.507	4		Guyana*	33.792	70
	Pakistan	1.625	5		Morocco	36.471	71
	Paraguay	1.707	6		Haiti*	38.509	72
	Malawi	2.165	7		Honduras	39.139	73
	Lao People's DR	2.235	8		Venezuela	39.201	74
	Nepal	3.210	9		Sri Lanka	39.793	75
	Rwanda	3.272	10		Belize*	41.172	76
	Zambia	4.346	11		Guatemala	41.185	77
	Madagascar	4.454	12		Georgia	43.084	78
	Uganda	4.852	13		Suriname*	43.618	79
	Central African Republic	5.188	14		Tunisia	45.568	80
	China	5.246	15		Gabon	47.299	81
	Kazakhstan	5.353	16		Costa Rica	47.913	82
	Turkmenistan	5.624	17		Panama	48.459	83
	United Republic of Tanzania	6.315	18		Namibia	49.289	84
	Brazil	6.660	19		Dominican Republic*	49.452	85
	Sierra Leone	6.683	20		El Salvador	51.489	86
	Uzbekistan	7.870	21		Reunion*	51.602	87
	Ghana	8.238	22		Cuba*	52.172	88
	Turkey	8.313	23		Mauritania	53.105	89
	Nigeria	8.761	24		Israel	56.998	90

	Bangladesh	8.919	25		Algeria	57.828	91
	Chad	9.664	26		Lesotho	57.915	92
	Viet Nam	9.730	27		Martinique*	57.945	93
	Mozambique	9.751	28		Iraq	58.713	94
	Mali	9.917	29		Cyprus*	60.551	95
	Ethiopia	9.990	30		Senegal	62.156	96
	Angola	10.156	31		Lebanon	63.325	97
	Uruguay	10.265	32		Republic of Korea	64.091	98
	Kyrgyzstan	10.534	33		Jamaica*	65.126	99
Second quarter	Guyane*	10.961	34	**Fourth quarter**	Saudi Arabia	65.906	100
	Kenya	11.055	35		Eswatini	66.739	101
	Thailand	12.087	36		Fiji*	68.109	102
	Indonesia	12.262	37		Botswana	68.801	103
	Bolivia	12.904	38		Dominica*	68.876	104
	Guinea	13.115	39		Gambia	72.675	105
	Togo	13.338	40		Guadeloupe*	74.204	106
	DPR of Korea	13.951	41		Sao Tome and Principe*	76.491	107
	Cameroon	14.686	42		Vanuatu*	76.802	108
	South Africa	15.333	43		Malaysia	77.460	109
	Benin	15.594	44		Cabo Verde*	79.684	110
	Sudan	15.895	45		Yemen	79.949	111
	Ecuador	17.346	46		Antigua and Barbuda*	80.374	112
	Afghanistan	17.674	47		Jordan	81.106	113
	Timor-Leste*	18.102	48		Brunei Darussalam	81.516	114
	Iran	18.765	49		Samoa*	81.598	115
	Burkina Faso	20.095	50		Barbados*	89.351	116
	Congo	21.913	51		Saint Lucia*	90.444	117
	Mongolia	22.695	52		Kiribati*	90.476	118
	Niger	23.214	53		Seychelles*	90.490	119

	Philippines	23.290	54		Kuwait	91.380	120
	Colombia	23.394	55		Bahamas*	92.035	121
	Nicaragua	23.501	56		Trinidad and Tobago*	93.505	122
	Peru	24.849	57		Mauritius*	94.531	123
	Chile	25.836	58		Djibouti	94.866	124
	Azerbaijan	25.979	59		Singapore*	96.412	125
	Armenia	26.200	60		Maldives*	100	126
	Tajikistan	28.521	61		Saint Kitts and Nevis*	100	126
	Guinea-Bissau*	28.920	62		Grenada*	109.157	128
	Comoros*	29.113	63		United Arab Emirates	124.310	129
	Mexico	29.632	64		Saint Vincent and the Grenadines*	130.989	130
	Zimbabwe	30.368	65		Oman	140.239	131
	Liberia	31.594	66				

Note: a * indicates that the country is a SIS.

Source: from authors.

A.7.

Table A.7. Global ranking by quarters for standard EVI and FDEVI, 2015

	Country	EVI		FDEVI				Country	EVI		FDEVI		
		Score	Rank	Score	Rank	Diff. Rank			Score	Rank	Score	Rank	Diff. Rank
First quarter	Turkey	11.7827	1	10.9639	1	0	Third quarter	Ghana	35.2159	78	32.8317	66	-12
	Cote d'Ivoire	17.9880	8	16.3742	2	-6		Georgia	31.4131	61	32.8847	67	6
	Morocco	16.3545	5	16.7354	3	-2		Afghanistan	35.1099	77	32.8985	68	-9
	Republic of Korea	13.2485	2	16.8523	4	2		Barbados*	27.8164	44	33.2829	69	25
	Cameroon	18.9553	13	16.9423	5	-8		Lao PDR	36.2388	81	33.6212	70	-11
	Algeria	14.7486	3	17.1992	6	3		Madagascar	36.7079	83	33.9590	71	-12
	Egypt	18.6973	10	18.9071	7	-3		Djibouti	30.2871	56	34.0061	72	16
	Saudi Arabia	15.1202	4	18.9120	8	4		Haiti*	34.1217	76	34.2059	73	-3
	China	20.6711	17	19.7008	9	-8		Niger	37.6251	88	34.3290	74	-14
	Tunisia	18.2280	9	19.8506	10	1		Cambodia	38.2674	90	34.6380	75	-15
	Brazil	20.3394	15	19.8630	11	-4		Jamaica*	31.5495	62	34.7878	76	14
	Mexico	18.8454	11	19.9678	12	1		Mozambique	38.0565	89	35.0593	77	-12
	Cyprus*	16.7617	6	20.1204	13	7		Senegal	32.9922	71	35.0791	78	7
	Lebanon	16.8892	7	20.2622	14	7		Nigeria	37.2814	85	35.0802	79	-6
	India	22.2693	20	20.4830	15	-5		Armenia	36.2634	82	35.2224	80	-2
	Pakistan	23.1598	22	20.5904	16	-6		Cuba*	32.8917	70	35.3962	81	11
	Iran	21.7564	18	21.5903	17	-1		Tajikistan	36.7767	84	35.4375	82	-2
	Guinea	24.8594	29	22.5829	18	-11		United Arab Emirates	30.2387	55	36.4887	83	28
	Malaysia	18.9109	12	22.5892	19	7		Burkina Faso	39.4576	95	36.6609	84	-11
	Israel	19.8233	14	23.0307	20	6		Singapore*	30.6957	58	36.6966	85	27
	Thailand	23.9838	25	23.0904	21	-4		Brunei Darussalam	31.7557	64	36.7221	86	22

	Nepal	26.7989	39	23.1152	22	-17		Mongolia	37.5450	87	36.8647	87	0
	Argentina	23.8017	23	23.1422	23	0		Rwanda	40.7297	102	37.1508	88	-14
	Colombia	22.8876	21	23.2454	24	3		Malawi	41.0852	103	37.7682	89	-14
	Bangladesh	25.1071	33	23.4093	25	-8		Namibia	36.2028	80	38.1472	90	10
	Indonesia	24.9456	30	23.6675	26	-4		Trinidad and Tobago*	32.3811	68	38.1801	91	23
	Dominican Republic*	22.0503	19	24.2793	27	8		Yemen	35.4268	79	38.8371	92	13
	South Africa	24.0760	26	24.2973	28	2		Angola	39.7343	98	38.8517	93	-5
	Kenya	27.1579	42	24.3157	29	-13		Azerbaijan	39.5132	96	40.1473	94	-2
	Philippines	25.0113	32	24.7763	30	-2		Fiji*	38.8224	92	41.6709	95	3
	Peru	24.6922	28	25.0300	31	3		Paraguay	43.8120	109	41.7514	96	-13
	Jordan	20.5105	16	25.2244	32	16		Sao Tome and Principe*	39.2437	94	41.7607	97	3
Second quarter	Guatemala	24.2978	27	25.3928	33	6	**Fourth quarter**	Dominica*	39.5220	97	42.0419	99	2
	Tanzania	28.7723	47	25.4280	34	-13		Turkmenistan	43.7924	108	42.3571	100	-8
	Venezuela	23.9544	24	25.5242	35	11		Eswatini	39.0869	93	42.3604	101	8
	Sri Lanka	24.9875	31	25.9647	36	5		Comoros*	45.8475	115	42.5951	102	-13
	Chile	26.1459	35	26.9841	37	2		Cabo Verde*	38.7960	91	42.7630	103	12
	Ethiopia	31.8106	66	27.0061	38	-28		St Vincent and the Grenadines*	37.2965	86	42.8908	104	18
	Uzbekistan	29.3694	52	27.4089	39	-13		Iraq	40.0494	99	43.0924	105	6
	Ecuador	27.8451	45	27.4335	40	-5		Sierra Leone	48.9306	118	43.4918	106	-12
	Nicaragua	28.4492	46	27.5706	41	-5		Zambia	45.6120	114	43.7497	107	-7
	Kyrgyzstan	29.6266	54	27.8757	42	-12		Chad	45.9502	116	43.9679	108	-8
	Benin	31.1896	60	27.8896	43	-17		Antigua and Barbuda*	40.4297	100	45.2170	109	9
	Congo	27.5105	43	28.0171	44	1		Lesotho	42.9104	105	45.4887	110	5
	Kazakhstan	29.1704	50	28.7441	45	-5		Sudan	49.9397	119	45.9466	111	-8
	Panama	26.4179	38	28.8012	46	8		Belize*	45.1885	112	45.9901	112	0
	Uganda	31.7725	65	28.9682	47	-18		Bahamas*	40.5067	101	46.0936	113	12
	Togo	33.5503	74	28.9818	48	-26		Botswana	43.4411	107	47.3381	114	7
	Viet Nam	31.1203	59	29.1737	49	-10		Samoa*	43.9973	110	48.0511	115	5

	Central African Republic	33.5170	73	29.1858	50	-23		Saint Lucia*	43.0890	106	48.4753	116	10
	Mali	33.2895	72	29.1886	51	-21		Solomon Islands*	50.7926	122	49.5457	117	-5
	Reunion*	27.0225	40	29.8692	52	12		Vanuatu*	47.7012	117	49.7876	118	1
	Myanmar	33.7010	75	30.4107	53	-22		Guyana	49.9414	120	49.8222	119	-1
	DPR of Korea	32.4854	69	30.4346	54	-15		Guinea-Bissau*	53.5544	125	49.9605	120	-5
	Guadeloupe*	26.3477	37	30.6474	55	18		Grenada*	44.4337	111	50.2143	121	10
	Uruguay	31.5515	63	30.6529	56	-7		Seychelles*	45.3518	113	50.7547	122	9
	El Salvador	29.1007	49	30.8909	57	8		Liberia	57.9153	127	53.1649	123	-4
	Bolivia	32.0665	67	31.0689	58	-9		Suriname*	52.6012	123	54.0754	124	1
	Honduras	30.5057	57	31.1859	59	2		Timor-Leste*	54.9756	126	55.2360	125	-1
	Mauritius*	25.5753	34	31.1867	60	26		Maldives*	49.9420	121	55.8773	126	5
	Gabon	29.2470	51	31.5497	61	10		Saint Kitts and Nevis*	52.7135	124	58.8981	127	3
	Costa Rica	29.4460	53	31.5767	62	9		Zimbabwe	58.9504	128	59.1245	128	0
	Martinique*	28.9568	48	32.1486	63	15		Guyane*	62.6059	129	62.3549	129	0
	Oman	26.1684	36	32.4009	64	28		Gambia	70.6627	130	72.6315	130	0
	Kuwait	27.1167	41	32.7681	65	24		Kiribati*	71.5262	131	74.4481	131	0

Note: Countries are ordered by FDEVI. The sample is split into quarters to facilitate the interpretation. Variations of ranks (Diff. Rank) are calculated as $rank_{EVI}$ - $rank_{FDEVI}$, so that a positive variation consists in a loss of vulnerability and a negative variation in a gain of vulnerability. * indicates a SIS.
Source: from DESA, Goujon et al. (2015) and authors.

A.8.

Table A.8. Global ranking by quarters for standard FDEVI and DEA-FDEVI, 2015

		FDEVI			DEA-FDEVI		
	Country	**Value**	**m-score**	**Rank**	**Value**	**Rank**	**Diff. Rank**
First quarter	Turkey	10.9639	0.0000	1	0	1	0
	China	19.7008	9.8128	9	4.3292	2	-7
	Brazil	19.8630	9.9949	11	6.4366	3	-8
	Mexico	19.9678	10.1127	12	6.7403	4	-8
	Republic of Korea	16.8523	6.6135	4	7.2284	5	1
	Egypt	18.9071	8.9213	7	7.2611	6	-1
	India	20.4830	10.6913	15	8.2608	7	-8
	Cameroon	16.9423	6.7145	5	8.5081	8	3
	Nepal	23.1152	13.6476	22	8.7540	9	-13
	Cote d'Ivoire	16.3742	6.0765	2	8.7932	10	8
	Thailand	23.0904	13.6198	21	8.8295	11	-10
	Indonesia	23.6675	14.2679	26	8.8759	12	-14
	Pakistan	20.5904	10.8119	16	10.0002	13	-3
	Uzbekistan	27.4089	18.4700	39	10.5936	14	-25
	Lebanon	20.2622	10.4433	14	11.4773	15	1
	Philippines	24.7763	15.5133	30	11.9856	16	-14
	Viet Nam	29.1737	20.4521	49	12.2224	17	-32
	Argentina	23.1422	13.6779	23	12.3970	18	-5
	Guinea	22.5829	13.0498	18	12.4526	19	1
	Kenya	24.3157	14.9959	29	12.5073	20	-9
	Uganda	28.9682	20.2213	47	12.5943	21	-26
	Bangladesh	23.4093	13.9779	25	12.7891	22	-3
	Guatemala	25.3928	16.2057	33	12.9701	23	-10

		FDEVI			DEA-FDEVI		
	Country	**Value**	**m-score**	**Rank**	**Value**	**Rank**	**Diff. Rank**
Third quarter	Cambodia	34.6380	26.5893	75	24.6530	66	-9
	Djibouti	34.0061	25.8796	72	25.1122	67	-5
	Mozambique	35.0593	27.0625	77	25.3791	68	-9
	Gabon	31.5497	23.1208	61	25.5587	69	8
	Jamaica*	34.7878	26.7576	76	25.8626	70	-6
	Nigeria	35.0802	27.0859	79	26.1451	71	-8
	Rwanda	37.1508	29.4116	88	26.1496	72	-16
	Mauritius*	31.1867	22.7130	60	26.6024	73	13
	Guadeloupe*	30.6474	22.1073	55	27.1345	74	19
	Tajikistan	35.4375	27.4872	82	27.3871	75	-7
	Yemen	38.8371	31.3055	92	27.6094	76	-16
	Georgia	32.8847	24.6201	67	27.6151	77	10
	Cuba*	35.3962	27.4408	81	27.8544	78	-3
	Niger	34.3290	26.2423	74	27.9065	79	5
	Martinique*	32.1486	23.7934	63	28.4936	80	17
	Eswatini	42.3604	35.2627	101	28.6493	81	-20
	Sudan	45.9466	39.2904	111	28.6616	82	-29
	Kazakhstan	28.7441	19.9696	45	28.8130	83	38
	Mauritania	41.8672	34.7087	98	28.8341	84	-14
	Burkina Faso	36.6609	28.8613	84	29.5718	85	1
	Comoros*	42.5951	35.5263	102	29.6240	86	-16
	Paraguay	41.7514	34.5787	96	30.9150	87	-9
	Azerbaijan	40.1473	32.7771	94	30.9531	88	-6

	Peru	25.0300	15.7982	31	12.9881	24	-7
	South Africa	24.2973	14.9752	28	13.1780	25	-3
	Morocco	16.7354	6.4822	3	13.2154	26	23
	Dominican Republic*	24.2793	14.9551	27	13.2859	27	0
	Malaysia	22.5892	13.0568	19	13.3148	28	9
	Israel	23.0307	13.5527	20	13.6215	29	9
	Colombia	23.2454	13.7938	24	13.7997	30	6
	Kyrgyzstan	27.8757	18.9943	42	14.0725	31	-11
	Cyprus*	20.1204	10.2841	13	14.3433	32	19
Second quarter	Panama	28.8012	20.0338	46	14.5985	33	-13
	Tanzania	25.4280	16.2452	34	14.7175	34	0
	Iran	21.5903	11.9350	17	15.0818	35	18
	Chile	26.9841	17.9930	37	15.5766	36	-1
	Ethiopia	27.0061	18.0176	38	15.6687	37	-1
	Central African Rep.	29.1858	20.4657	50	15.9714	38	-12
	Sri Lanka	25.9647	16.8480	36	16.2863	39	3
	Nicaragua	27.5706	18.6517	41	16.3316	40	-1
	Togo	28.9818	20.2367	48	16.6072	41	-7
	Myanmar	30.4107	21.8415	53	16.9254	42	-11
	Madagascar	33.9590	25.8267	71	17.0456	43	-28
	Reunion*	29.8692	21.2333	52	17.4405	44	-8
	Ghana	32.8317	24.5606	66	17.8353	45	-21
	Benin	27.8896	19.0099	43	18.0884	46	3
	Saudi Arabia	18.9120	8.9268	8	18.3367	47	39
	Algeria	17.1992	7.0031	6	18.5613	48	42
	Bolivia	31.0689	22.5808	58	19.1512	49	-9
	El Salvador	30.8909	22.3808	57	19.5527	50	-7
	Uruguay	30.6529	22.1135	56	19.8365	51	-5

	Turkmenistan	42.3571	35.2590	100	31.1500	89	-11
	Trinidad and Tobago*	38.1801	30.5676	91	32.2287	90	-1
	Oman	32.4009	24.0767	64	33.0065	91	27
	Kuwait	32.7681	24.4891	65	33.1572	92	27
	Fiji*	41.6709	34.4882	95	33.1798	93	-2
	Malawi	37.7682	30.1050	89	33.3232	94	5
	Sierra Leone	43.4918	36.5334	106	33.6438	95	-11
	Namibia	38.1472	30.5307	90	33.7110	96	6
	Sao Tome and Principe*	41.7607	34.5891	97	34.0846	97	0
Fourth quarter	Dominica*	42.0419	34.9050	99	34.9470	99	0
	Mongolia	36.8647	29.0902	87	35.7536	100	13
	Chad	43.9679	37.0681	108	35.8912	101	-7
	Belize*	45.9901	39.3393	112	35.8951	102	-10
	St Vincent and the Gr.*	42.8908	35.8584	104	36.4091	103	-1
	Angola	38.8517	31.3219	93	36.5392	104	11
	Samoa*	48.0511	41.6541	115	36.7094	105	-10
	Senegal	35.0791	27.0847	78	37.0056	106	28
	Solomon Islands*	49.5457	43.3328	117	37.2966	107	-10
	Lesotho	45.4887	38.7762	110	37.3407	108	-2
	Antigua and Barbuda*	45.2170	38.4710	109	38.4193	109	0
	Guinea-Bissau*	49.9605	43.7987	120	38.4458	110	-10
	Liberia	53.1649	47.3976	123	39.1271	111	-12
	Guyana	49.8222	43.6433	119	39.2876	112	-7
	Iraq	43.0924	36.0848	105	40.3135	113	8
	Timor-Leste*	55.2360	49.7237	125	40.4555	114	-11
	Cabo Verde*	42.7630	35.7148	103	40.7867	115	12
	Zimbabwe	59.1245	54.0911	128	41.3769	116	-12
	Brunei Darussalam	36.7221	28.9301	86	42.9877	117	31

	Ecuador	27.4335	18.4977	40	20.3744	52	12		Botswana	47.3381	40.8533	114	44.0207	118	4
	DPR of Korea	30.4346	21.8683	54	20.6985	53	-1		Seychelles*	50.7547	44.6906	122	45.1919	119	-3
	Tunisia	19.8506	9.9811	10	20.8428	54	44		Grenada*	50.2143	44.0837	121	45.2911	120	-1
	Lao PDR	33.6212	25.4474	70	21.0464	55	-15		Bahamas*	46.0936	39.4556	113	45.5044	121	8
	Honduras	31.1859	22.7121	59	21.1765	56	-3		Suriname*	54.0754	48.4203	124	46.0157	122	-2
	Jordan	25.2244	16.0165	32	21.1943	57	25		Singapore*	36.6966	28.9014	85	46.5998	123	38
	Venezuela	25.5242	16.3532	35	21.2331	58	23		United Arab Emirates	36.4887	28.6679	83	46.8589	124	41
	Costa Rica	31.5767	23.1511	62	21.8336	59	-3		Vanuatu*	49.7876	43.6045	118	47.0444	125	7
	Afghanistan	32.8985	24.6356	68	21.9678	60	-8		Saint Lucia*	48.4753	42.1306	116	47.4408	126	10
	Congo	28.0171	19.1531	44	22.0411	61	17		Guyane*	62.3549	57.7192	129	50.0229	127	-2
	Armenia	35.2224	27.2456	80	22.6423	62	-18		Maldives*	55.8773	50.4441	126	54.1053	128	2
	Mali	29.1886	20.4689	51	22.8447	63	12		Saint Kitts and Nevis*	58.8981	53.8368	127	64.3231	131	4
	Haiti*	34.2059	26.1041	73	23.3330	64	-9		Gambia	72.6315	69.2614	130	64.3231	129	-1
	Barbados*	33.2829	25.0673	69	24.5598	65	-4		Kiribati*	74.4481	71.3017	131	64.3231	130	-1

Note: Countries are ordered by DEA-FDEVI. The sample is split into quarters to facilitate the interpretation. Variations in ranks (Diff. Rank) are calculated as $rank_{DEA\text{-}FDEVI}$ - $rank_{\text{-}FDEVI}$. A * indicates a SIS.

Source: from DESA, Goujon et al. (2015) and authors.

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