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Asymmetric effects of global uncertainty: the socioeconomic and environmental vulnerability of developing countries

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Abstract

Purpose – This study aims to investigate the influences of global uncertainty indicators volatility on the domestic socioeconomic and environmental vulnerability in a sample of 54 developing countries.

Design/methodology/approach – The two-step system generalized method of moments estimator is recruited to deal with autoregression and endogeneity matter in our dynamic panel data. Seven different global uncertainty indicators (US trade uncertainty; world trade uncertainty; economic policy uncertainty; world commodities and oil prices; the geopolitical risk index and the world uncertainty index) have been mobilized and compared for their empirical impact on the economic (growth and GDP), social (the misery index and income inequality) and environmental (CO_2 emissions) vulnerabilities of nations.

Findings – Our empirical estimations suggest that the socioeconomic and environmental vulnerability cannot be solved through the same pattern: all decrease of a particular aspect will necessarily have a cost and an opposite influence on at least one of the other aspects of the nations' vulnerability.

Originality/value – The originality of this article is to combine these three dimensions of vulnerability in the same investigation. To our knowledge, our research is one of the few providing a joint analysis of the influence of global uncertainty on the economic and socioenvironmental countries' vulnerabilities – given the fact social, economic and environmental aspects are at the heart of the UN sustainable goals, our study can be seen as an investigation of the nations' capabilities to work proactively on meaningful sustainable goals in an increasingly uncertain world.

Keywords Uncertainty, External shock, Economic volatility, Social vulnerability, Environmental vulnerability, Economic vulnerability

Paper type Research paper

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1. Introduction

The fight again poverty, inequality and climate, environmental degradation are among the most important objectives of the United Nations (UN) sustainable development goals (UN, 2019). These dimensions are indeed increasingly important and debated in a context of a growing internationalization (Gnangnon Sena, 2016). Many of the existing studies focus on the output volatility: Le (2020) or Barrot Araya, Calderón, and Servén (2016), for instance, examine the impacts of the shocks in demand, supply, money and commodity on the GDP fluctuations while other authors argued that this concern not only simply implies an economic weaknesses (Kerschner *et al.*, 2013) but it also generates a social vulnerability (de Loyola Hummell, Cutter, & Emrich, 2016) and an environmental problem (Nguyen & Liou, 2019).

Investigating vulnerability proxies is a tricky task given the fact that these factors are influenced by numerous aspects – furthermore, the definition and the way of measuring these proxies might also vary from a study to another. However, the matter is increasingly important given the fact that the "three major areas of macro-vulnerability (economic, social and environmental) correspond to the three dimensions generally referred to in the presentation of the countries' agenda for their sustainable development. In these three areas, vulnerability appears as the opposite of sustainability" (Guillaumont, 2017, p. 1). In a context of growing uncertainty (i.e. pandemics, war in Ukraine etc.) analyzing nations' vulnerability in relation to indicators capturing this global uncertainty is an important step for policy-makers, first to understand and second to discuss the development of potential framework for actions.

The notion of global uncertainty is also a complex concept that has generated several debates during the last decades, and new measurements of uncertainties and risk have been developed and introduced in the literature (Schinckus, 2009, 2011): economic policy uncertainty (Baker, Bloom, & Davis, 2016), geopolitical risk (Caldara & Iacoviello, 2018), world uncertainty (WU) and also world trade uncertainty (WTU) (Ahir, Bloom, & Furceri, 2018). These proxies offer a new room for further investigation on the influence of global uncertainty and risk on the domestic socioeconomic and environmental vulnerabilities.

Barrot Araya *et al.* (2016) and Gnangnon Sena (2016) noticed that a higher economic integration induces a higher vulnerability (in terms of economic outcome) of developing countries to external shocks. Some studies emphasize that global uncertainties or risk would have a stronger impact on developing countries. Colombo (2013), for instance, showed that one standard deviation shock in economic policy uncertainty of the USA has a statistical significant negative impact on the industrial production and the price in the EU countries. Carrière-Swallow and Céspedes (2013) documented that 20 emerging economies suffered more severely (with a longer downfall in investment and consumption) from an exogenous uncertainty shock between 1990 and 2011. Despite the existing literature investigating the impact of uncertainty on countries' economic dynamics, there is still no conclusive and clear trend emerging from all studies. Our research aims at contributing to this literature. Precisely, our study empirically examines a set of factors aiming at analyzing the social, economic and environmental sensitivity of countries in relation to the variation of global uncertainty and international risk. Specifically, we study the influence of global geopolitical risk, WU, world trade uncertainty, US trade uncertainty (USUT), global commodity price (GCP), oil price and global economic policy uncertainty (GEPU) on the national economic vulnerability. The latter is estimated through the estimation of several indicators including both GDP and GDP per capita and the economic vulnerability index. The social vulnerability is proxied here by the income inequality and the misery index (MI) (the sum of inflation and unemployment) while we use the CO_2 emissions per capita and CO_2 emissions per output unit to capture the environmental vulnerability. Due to the availability of data, the final sample includes 54 developing countries over the period 1991–2013 while the two-step system generalized method of moments (GMM) estimator framework is recruited to deal with our empirical estimations.

The study is structured as follows. The next section presents our literature review while Section 3 explains our methodology and data. Our results are presented and discussed in Section 4 whereas the final section concludes this research with some recommendations.

2. The literature review

The first subsection presents the works dealing with economic vulnerability in relation to prices' variations; microeconomic impact (i.e. individual welfare) and output variations. Afterward, this section, through its second subsections, provides a quick overview of the studies that investigated the economic uncertainty. Finally, the third subsection offers a quick overview of the major researches on socioenvironmental vulnerability.

2.1 Economic vulnerability

In the recent years, a growing literature has paid attention to international shocks and their effects on nations' domestic vulnerability. The existing studies mainly focus on the influences of international commodity prices on the domestic vulnerability. Studying in 18 countries in the Middle East and North Africa, Ianchovichina, Loening, and Wood (2014) found that the changes in international food prices exert pressures on domestic prices leading to policy and market distortions and vulnerability. Kalkuhl (2016) added that poor people in developing countries are severely impacted by an increase in GCPs through the rolling effect on the domestic food prices.

More recent studies integrated other kinds of international shocks and other forms of vulnerability. Lloyd, Manuel, and Panchev (2021) documented that foreign shocks are key drivers of domestic growth vulnerability in advanced economies. Almansour *et al.* (2015) showed the existence of a relationship between domestic economic growth's volatility and financial/trade openness in emerging economies. The authors concluded that economic growth in these economies is related to growth in advanced economies reflecting the dependence of their domestic growth to international shocks. Almansour *et al.* (2015) showed that a stronger economic growth in advanced economies leads to stronger growth in emerging economies in addition to the important roles of internal factors. In this context, the globalization might generate a higher economic integration leading, potentially, to a higher vulnerability of developing countries to external shocks (Barrot Araya *et al.*, 2016; Gnangnon Sena, 2016) such as global uncertainty (Carrière-Swallow & Céspedes, 2013; Strobel, 2018) or uncertainty in leading economy (*i.e.* the USA) (Colombo, 2013).

Rocha and Moreira (2010) used the sovereign spreads as a proxy of global risk shocks to investigate the vulnerability of emerging economies. Meanwhile, Canh and Thanh (2020) emphasized that economic vulnerability should be further investigated under the dynamics of economic factors such as tourism consumption.

Even though the majority of the existing studies (Klomp & de Haan, 2009; Mathonnat & Minea, 2018) associated economic vulnerability with economic volatility or fluctuations, the concept of economic vulnerability is much broader than economic volatility (Noy & Yonson, 2018), (Gnangnon Sena, 2016). In the 1990s, pioneering studies (Briguglio, 1993, 1995, 1997) applied the concept of vulnerability to both macroeconomics and microeconomics. In the same vein, Seth and Ragab (2012) worked on macroeconomics mainly by focusing on the impact of shocks on economic growth while Gnangnon Sena (2016) provided a microeconomic analysis associating microeconomics' vulnerability with the variation in the wellbeing of individual households.

According to Gallopín (2006) and Naudé, Santos-Paulino, and McGillivray (2009), vulnerability can also be defined as the likelihood of a system to be negatively affected by a perturbation or a shock that would go beyond a normal variability so that the system reaches

a critical position. In relation to that, many studies focusing on the variability of output can be presented in three strands: the first strand deals with the mismanagement of macroeconomic policies such as exchange rate and monetary policy (Hausmann & Gavin, 1996), or fiscal policy (Fatás & Mihov, 2003), or policies and trade openness (Agénor, McDermott, & Prasad, 2000). In the second strand, the economic crises resulting from large variation on the financial markets are blamed (Orgiazzi, 2008); however, debates and empirical evidences are still mixed (*e.g.* see Wang, Wen, & Xu, 2018; Epstein & Finkelstein Shapiro, 2019; Zouaoui, Mazioud & Ellouz, 2018; Ibrahim & Alagidede, 2017). The third strand investigates the issues related to institutional frameworks and economic volatility (Malik & Temple, 2009) such as the intermediating role of governments (Jetter, 2014), or proportional electoral rules (Mathonnat & Minea, 2018).

2.2 Economic uncertainty

Bloom (2009) emphasized that a macro uncertainty shock has a strong negative influence on employment, productivity and output in the USA. Recently, internal shocks (*i.e.* shocks in demand, supply, monetary and commodity) have been documented as important drivers (Barrot Araya *et al.*, 2016), but trade openness and external shocks have been highlighted for their increasing impacts (Gnangnon Sena, 2016). New measurements of uncertainty and risk have been developed and proposed in the literature – the most common being the economic policy uncertainty (EPU) developed by Baker *et al.* (2016), which proxies the movements in policy-related economic uncertainty with three components [1]. From the EPU of 20 large economies, the global EPU is constructed by GDP-weighted average of national EPUs [2]. This new measure of EPU has been extensively investigated in the current literature (Nguyen, Le, & Su, 2020). Baker *et al.* (2016) found that an increase in EPU decreases investment, output and employment in the USA and 12 advanced economies. Other studies found that an increase in the EPU acts as a significant negative shock for investment (Drobetz *et al.*, 2018) and employment (Fontaine, Razafindravaosolonirina, & Didier, 2018). Moreover, such shock also has a significant impact on the financial system especially on the banking systems as detailed in (Lee *et al.*, 2017; Phuc Nguyen, Schinckus, & Dinh Su, 2020).

Another measure of the global uncertainty commonly used in the specialized literature is the GPR which has been developed by Caldara and Iacoviello (2016) by counting the occurrence of words related to geopolitical tensions (i.e. words mentioning explicitly a GPR and a military-related problem such as nuclear tensions and/or war threats and terrorist threats) in 11 leading international newspapers (Caldara and Iacoviello (2016). Gkillas, Gupta and Wohar (2018) found that the volatility jumps in Dow Jones Industrial Average index are directly related to GPR. In the same vein, Demir, Gozgor and Paramati (2019) concluded that GPR has a negative impact on the inbound tourism for 18 countries over the period 1995–2016.

A third common measure of the global uncertainty used in the literature refers to the WU, the WTU and the USTU – these indicators having been developed by Ahir *et al.* (2018) [3]. The WTU is a more specific index (based on the quarterly Economist Intelligence Unit (EIU) country report) related to trade from EIU country reports which measures uncertainty by using the frequency counts of the word "uncertainty" and its relation to trade for 143 individual countries (within a proximity to a word). Ahir *et al.* (2018) showed that the level of WU is positively correlated with the EPU and the stock markets' volatility. Moreover, these authors documented that WU is negatively associated with economic growth and innovations. In the same vein, an increase in the WU would decrease the domestic output significantly.

These three new indicators evoked here enlarge the epistemic scope of the investigation of different kinds of global uncertainties on the economic situation of countries. Generally speaking, the empirical studies of the three proxies introduced above offer similar trend: an

increase in all proxies related to global uncertainty tends to act as a negative shock on investment (Drobetz *et al.*, 2018), employment (Fontaine *et al.*, 2018) and output (Bloom, 2009). Some studies showed that global uncertainty, especially uncertainty related to economic fluctuations in large and leading economies, might have a stronger impact on the domestic economy of developing countries. Colombo (2013) found that one standard deviation shock in the economic policy uncertainty of the USA has a statistically significant negative impact on the industrial production and prices in the EU. Carrière-Swallow and Céspedes (2013) added that 20 emerging economies even suffer more severely and face with a longer downfall in investment and consumption due to an exogenous uncertainty shock over the period of 1990–2011.

Broadly speaking, an increase in the volatility of global uncertainty indicators exacerbates the negative shocks on the domestic output, and therefore, it would induce a higher domestic vulnerability. However, it is worth mentioning that a change in level of uncertainty indicators may not always be in line with changes in their volatility (Engle, 2004). Indeed, the volatility mainly reflects the intensity of fluctuations (up or down) in an index while the change, instead, only simply reflects the direction of fluctuations (Brooks & Persand, 2003). Thus, any change in the volatility implies a change in the uncertainty of any factor as evoked by Barrot Araya *et al.* (2016) and Gnangnon Sena (2016). In this context, the volatilities of different global uncertainty indicators directly influence the vulnerability of developing countries and therefore deserve further concerns and empirical investigations. This study uses a combination of seven indicators to capture the economic vulnerability and study its relationship with social and environmental vulnerability as presented in the following sections.

2.3 Social and environmental vulnerability

The vulnerability of a country does not only refer to economic vulnerability but it also echoes to the social vulnerability such as income inequality or the miserable situation (de Loyola Hummell *et al.*, 2016), and environmental vulnerability as emissions (Nguyen & Liou, 2019) are more important issues in sustainable development goals (UN, 2019). Income inequality is, in fact, one of the most important problems in the economic development in many centuries (Zhang & Ben Naceur, 2019). This is not the only problem for the society but also for environment (Baek & Gweisah, 2013); (Oishi, Kushlev, & Schimmack, 2018). According to The Economist (2019), although the income level is linked with happiness across countries, long-term economic growth seems not to be enough to turn the average happiness frown upside down. The Organization for Economic Cooperation and Development - OECD (2018) warned that an increasing trend in wealth inequality in OECD and emerging economies over the past 25 years, especially in advanced economies such as the USA (Amadeo, 2018). The severe income inequality is one of the major causes of social vulnerability and economic externality (OECD, 2018). Besides the income inequality, the literature also uses the MI (Welsch, 2007) (created by the economist Arthur Okun) which is the sum of unemployment and inflation, as an important index of social vulnerability (Tang & Lean, 2009). Since the variations in all kinds of indicators of global uncertainty are expected to act as a negative shock on the domestic economic activity, they usually negatively affect investment, employment and the output (Colombo, 2013; Carrière-Swallow & Céspedes, 2013) – and that situation can also worsen the social vulnerability of countries. In our empirical estimations, we use the combination of the Gini index and MI to proxy social vulnerability of a country.

The environmental sustainability is another key aspect of the socioeconomic vulnerability of nations, and this aspect is becoming more and more important due the global warming and climate change (Adom & Adams, 2018). Greenhouse emissions, mostly CO_2 emissions generated by human economic activities have been identified as one of the main causes – consequently, the reduction of emissions is set to be the first priority for global action

(Seshadri, 2017). The determinants of CO_2 emissions have been intensively studied in the recent literature (Phuc Nguyen *et al.*, 2020). The well-known Environmental Kuznets Curve (EKC) hypothesis proposes an inverted U-shaped relationship between the income level and the environmental quality (Rashid Gill, Viswanathan, & Hassan, 2018), while the Influence, Population, Affluence, and Technology model (the IPAT model) developed by Ehrlich and Holdren (1971) offers a specific relationship between human aspects and activities including population (P), affluence (A) and technology (T) to the environment (I). Based on the IPAT model, Dietz and Rosa (1997) developed the Stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT) model which is a methodological extension of the IPAT framework.

In relation to the influence of economic activities on CO_2 emissions, Andersson (2018) documented that trade liberalization, weak environmental institutions, exchange rate policy as well as legal and property rights are the major contributors to a rapid increase of emissions in China between 1995 and 2008. In contrast to this study, Mutascu (2018) did not find any non comovement between trade openness and CO_2 emissions in France over the period 1960–2013, a finding that confirmed the 'neutral hypothesis' of international trade in the short term. Even though the influence of economic activities on the CO_2 emissions has been identified, the impact of a higher global uncertainty on these emissions is not clear – indeed, an increase of the volatility of all indicators of global uncertainty have a negative impact on the economic activities (Colombo, 2013), but this context might then reduce CO_2 emissions. However, this negative impact could also lead to another environmental problem: the decreases in investment and output could slow down all initiatives aiming at promoting renewable energy consumption (Conti *et al.*, 2018; Sonnenschein, 2016) or all technological upgrades to reduce energy intensity and emissions intensity. In other words, the negative impact of a higher global uncertainty on the environment is not clear – the aim of this article is to investigate further this matter. With this purpose, the following section presents our methodology and the way we collect/use our data.

From the existing literature, there is no conclusive framework to describe the integrated impact of uncertainty on economic, social and environmental vulnerability of a country. The aim of this article is to investigate further this matter and to offer a holistic empirical analysis of the impact of global uncertainty on socioenvironmental and economic indicators of nations' vulnerability. The originality of this article is to combine these three dimensions of vulnerability in the same investigation. To our knowledge, our research is one of the few providing a joint analysis of the influence of global uncertainty on the economic and socioenvironmental countries' vulnerabilities – given the fact social, economic and environmental aspects are at the heart of the UN sustainable goals (Guillaumont, 2017), our study can be seen as an investigation of the nations' capabilities to work proactively on meaningful sustainable goals in an increasingly uncertain world.

3. Methodology and data

This study aims at investigating the influence of the volatility of global uncertainty indicators on the domestic socioeconomic and environmental vulnerability (*VUL*) of nations. Based on the theoretical framework developed by Malik and Temple (2009) combined with important studies from the existing literature (Mathonnat & Minea, 2018; Duncan, 2014), we identified the following parameters as control variables of domestic vulnerability: income level, trade openness and populations. The existing works (Mathonnat & Minea, 2018; Duncan, 2014) showed that a higher trade openness (expressed in % to GDP – *Trade*) generates a higher vulnerability to external shocks; however, this trade openness may act as the buffer for attenuating the domestic shocks (Malik & Temple, 2009). The GDP per capita (in its log form – *Income*) is usually captured to proxy the income level or the economic

development level which, to some extent, can also capture the institutional levels and financial development of countries (Malik & Temple, 2009). Finally, the population (in its log form – *Pop*) refers to the size of a country, and a larger country might be less dependent to external shocks. Given all these aspects, the empirical equation for dynamic panel data is given hereafter as follows:

$$VUL_{it} = \beta_0 + \beta_1 VUL_{it-1} + \beta_2 Income_{it} + \beta_3 Pop_{it} + \beta_4 Trade_{it} + \varepsilon_{it} \quad (1)$$

in which *i and t* denote country *i* at year *t*; β is the coefficient; ε is the residual term. To this Equation (1) summarizing the existing empirical works on the topic, we add the volatility of international uncertainty (*EVOL*) as additional augmented external shock to the domestic vulnerability.

$$VUL_{it} = \beta_0 + \beta_1 VUL_{it-1} + \beta_2 Income_{it} + \beta_3 Pop_{it} + \beta_4 Trade_{it} + \beta_5 EVOL_{it} + \varepsilon_{it} \quad (2)$$

To capture the international uncertainty, we use seven indicators including the GPR index (monthly data), the WU index (quarterly data), the WTU index (quarterly data), the USTU index (monthly data), the GCP index (quarterly data), the West Texas Intermediate (WTI) spot oil price (monthly data) and the GEPU (monthly data) index. These indicators are quite common and widely used in the literature – to remind, the GPR index presents the geopolitical risk (*GRP*); the WU index captures the global uncertainty (*WU*); the WTU and USTU indexes refer to the uncertainty in global (*WTU*) and US trade (*USTU*). The *GCP* and oil price (*OilVo*) capture the commodity prices while the GEPU stands for the uncertainty in economic policy. The GCP index is collected from the database of Federal Reserve Bank of St Louis; the oil price is collected from the database of Thomson Reuters. All remained uncertainty indicators (GRP, WU, WTU, USTU and GEPU) are collected from the existing website www.policyuncertainty.com. After collecting these indicators, their volatility has been estimated by using the percentage of their yearly standard deviation to their yearly mean.

Regarding our dependent variables, this study recruits seven proxies referring to three dimensions of vulnerability. First, the three-year standard deviation of real GDP growth rate (*GDPvo*), the real GDP per capita growth rate (*GDPpcvo*) and the log of the economic vulnerability (*EVI*) are used to capture the economic dimension of a country's vulnerability. According to Guillaumont (2009), economic vulnerability is defined as "the likelihood that a country's economic development process is hindered by the occurrence of exogenous unforeseen events". Following this definition, Sosso and Goujon (2016) developed an economic vulnerability index at www.ferdi.fr as a simple arithmetic average of the exposure subindexes and the shocks subindexes in which, two subindexes represent the exposure to shocks and the magnitude of shocks. The log of the Gini index (*GINI*) as well as the MI (sum of inflation and unemployment – *MI*) proxy the social vulnerability whereas the log of CO_2 emissions per capita (*CO2pc*) and the CO_2 emissions per one unit of output (*CO2GDP*) are used to proxy the environmental aspect of the national vulnerability. Any increase of one of these variables implies a higher vulnerability in relation to its economics, society and environment.

The economic vulnerability index has been collected from the database of Ferdi [4] while the Gini index came from the Standardized World Income Inequality Database. All remained variables were collected from the World Development Indicators database (World Bank, version Apr/2019). All these variables and their definitions, calculations and sources are presented in Table 1 below.

Due to the availability of data, our final sample includes 54 developing countries [5] (see Table A1, Appendix, for the list of countries) over the period 1991–2013. In fact, some countries in this sample are not developing countries anymore (*i.e.* Singapore, Israel or Korea). However, the index of economic vulnerability still includes these nations because, back in

Table 1. Variables, definitions, calculations, sources and data description

Variable	Definitions	Calculations	Sources	Obs	Mean	SD	Min	Max
GDPvo	Economic Growth Volatility 1	3-year standard deviation of real GDP growth rate (%)	WDIs	1,288	2.30	2.33	0.01	20.89
GDPpcvo	Economic Growth Volatility 2	3-year standard deviation of real GDP per capita growth rate (%)	WDIs	1,288	2.27	2.29	0.04	21.05
MI	Misery index	Sum of inflations and unemployment (%)	WDIs	1,288	36.4	222.5	−24.0	4820.6
GINI	Income inequality	Log of estimate of the Gini index of inequality in equivalized (square root scale) household, disposable (posttax and post-transfer) income	SWIID	1,198	3.75	0.14	3.28	4.08
CO2pc	Environmental Vulnerability 1	Log of CO_2 emissions (metric tons per capita)	WDIs	1,288	0.21	1.29	−2.93	3.59
CO2GDP	Environmental Vulnerability 2	Log of CO_2 emissions (kg per 2010 US$ of GDP)	WDIs	1,288	−0.77	0.64	−2.62	1.30
EVI	Economic vulnerability	Log of economic vulnerability index	Ferdi	1,288	28.77	9.30	11.21	61.24
Income	Income level	Log of real GDP per capita	WDIs	1,288	7.89	1.09	5.09	10.84
Pop	Population	Log of total populations	WDIs	1,288	16.79	1.40	14.02	21.03
Trade	Trade openness	Trade (% GDP)	WDIs	1,230	74.61	51.75	13.75	441.6
GPR	Geopolitical risk	The percentage of yearly standard deviation to yearly mean of the geopolitical risk index	PU	1,288	36.6	25.5	16.0	107.2
WU	World uncertainty	The percentage of yearly standard deviation to yearly mean of world uncertainty index	PU	1,008	24.87	9.37	6.47	44.29
WTU	World trade uncertainty	The percentage of yearly standard deviation to yearly mean of world trade uncertainty index	PU	1,008	118.2	43.5	60.7	191.8
USTU	US trade uncertainty	The percentage of yearly standard deviation to the yearly mean of the US trade uncertainty index	PU	1,288	53.12	13.85	30.47	95.77
GCP	Global commodity price	The percentage of yearly standard deviation to yearly mean of global commodity price	Fred	1,232	5.68	4.14	1.08	19.83
GEPU	Global economic policy uncertainty	The percentage of the yearly standard deviation to the yearly mean of global economic policy uncertainty index	PU	952	19.97	7.45	10.36	33.40
OilVo	Oil price volatility	The percentage of the yearly standard deviation to the yearly mean of crude oil-WTI spot cushing (US$/barrel)	Reuters	1,288	11.95	5.85	4.49	28.51

Note(s): WDIs is the World Development Indicators database (World Bank, Apr/2019); SWIID is the Standardized World Income Inequality Database (link: https://fsolt.org/swiid/); Ferdi is Economic Vulnerability index in a retrospective Economic Vulnerability Index database (link: https://ferdi.fr/en/indicators/a-retrospective-economic-vulnerability-index); PU is the database of uncertainty from www.policyuncertainty.com; Fred is the economic database of Federal Reserve bank of St. Louis; Reuter is data from Eikon Thomson Reuters

1991, they were still developing countries. Due to the data availability from www.policyuncertainty.com and the Federal Reserve board database, some indicators of uncertainty have shorter time periods: the WU and WTU indexes, for instance, have data from 1996. The GEPU started to be collected from 1997 while the global price commodity has data from 1992.

Table 2 above reports the unconditional correlations between our variables and shows that negative correlations between CO_2 emissions (*CO2pc* and *CO2GDP*) and *EVI*, *MI* and income inequality (*GINI*) – all other dependent variables having positive correlations. This first observation suggests that the economic volatility (*GDPvo* and *GDPpcvo*), social vulnerability and environmental vulnerability are related to justifying our empirical investigations. Interestingly, a lower social vulnerability and economic vulnerability (*MI, GINI and EVI*) appear to have an environmental price since they induce a higher environmental vulnerability. Most of the international volatility indicators have a positive correlation with the economic growth volatility (*GDPvo* and *GDPpcvo*) – except for the case of WU. In the same vein, the international indicators' volatilities have a negative correlation with the MI but a positive correlation with income inequality. These first observations clearly exhibit links between all these indicators – this article aims at clarifying these potential links and influence through the estimations of dynamic panel data with the inclusion of one-year lag of dependent variable as regressor to deal with the endogeneity (Roodman, 2006). More importantly, for our major explanatory variable referring to the existence of international shocks is properly exogenous with regards to countries' domestic vulnerability of countries in our sample [6].

We use the Arellano and Bover (1995) system GMM estimator which has been extended by Blundell and Bond (1998) and Blundell and Bond (1998) to deal with endogeneity issue (Roodman, 2009) [7]. It is worth mentioning that, we also check the robustness of our analysis by adding the year in the instrument variable to control potential year effects. The AR(1) test has been performed to check the suitability of using dynamic panel data while the first-stage *F* test was used to check the relevance of first-stage estimates in a two step-system GMM model. The AR(2) test and Hansen test have been double checked for each estimation to ensure their consistency and that our GMM estimators are unbiased. All AR(2) and Hansen tests are statistically insignificant implying the robustness and consistency of results. Following previous studies (e.g. Kraay (2015) and Berg *et al.* (2018)), we also used the difference-in-Hansen tests of exogeneity of instrument subsets for GMM instruments with instrumental variables (IVs) to check for the strength of the instrument in our two-step system GMM. In terms of robustness checks, we reran all models with a smaller sample by dropping countries with high-income levels (Argentina, Chile, Israel, Panama, Korea, Singapore, Trinidad and Tobago, and Uruguay) and China (the second largest economy). All results are properly consistent and robust. The detail results can be provided upon requests. The following section presents and discusses our empirical results.

4. Results and discussion

4.1 Economic volatility and economic vulnerability

Table 3 hereafter shows the impacts of global uncertainty indicators' volatility on the volatility of the real GDP growth (*GDPvo*).

These results suggest that an increase in the volatility of geopolitical risk (*GRP*) and *WU* have a significant negative impact on the GDP growth volatility while the five other indicators' volatility (i.e. *USTU*, *WTU*, *GEPU*, *OilVo* and world commodity (*GCP*)) exhibits a significant positive influence. Table 4 below presents the same influence on the volatility of the GDP per capita growth (*GDPpcvo*).

The results confirm the same aforementioned observations. Overall, these findings imply that an increase in the indices of GEPU and trade uncertainty as well as the prices of oil and

Correlation	GDPvo	GDPpcvo	MI	GINI	CO2pc	CO2GDP	EVI	Income	Pop	Trade	GPR	WU	WTU	USTU	GCP	GEPU	OilVo
GDPvo	1.00																
GDPpcvo	1.00	1.00															
p-value	0.00																
MI	0.07	0.07	1.00														
p-value	0.01	0.01															
GINI	0.04	0.03	0.10	1.00													
p-value	0.19	0.25	0.00														
CO2pc	0.10	0.11	−0.04	−0.10	1.00												
p-value	0.00	0.00	0.18	0.00													
CO2GDP	0.01	0.02	−0.06	−0.22	0.54	1.00											
p-value	0.64	0.58	0.02	0.00	0.00												
EVI	0.08	0.08	0.04	0.08	−0.50	−0.18	1.00										
p-value	0.00	0.01	0.12	0.00	0.00	0.00											
Income	0.11	0.12	−0.01	0.01	0.87	0.04	−0.48	1.00									
p-value	0.00	0.00	0.80	0.80	0.00	0.11	0.00										
Pop	−0.12	−0.12	0.00	−0.01	−0.04	0.18	−0.35	−0.15	1.00								
p-value	0.00	0.00	0.93	0.84	0.14	0.00	0.00	0.00									
Trade	0.08	0.10	−0.05	−0.12	0.29	0.05	0.08	0.30	−0.36	1.00							
p-value	0.00	0.00	0.11	0.00	0.00	0.09	0.01	0.00	0.00								
GPR	0.01	0.01	0.03	0.03	−0.03	0.00	0.03	−0.04	−0.02	−0.04	1.00						
p-value	0.71	0.70	0.35	0.39	0.26	0.90	0.31	0.16	0.45	0.21							
WU	−0.09	−0.10	−0.06	0.01	0.01	0.00	−0.02	0.01	0.01	0.00	0.27	1.00					
p-value	0.00	0.00	0.05	0.77	0.81	1.00	0.59	0.78	0.79	0.93	0.00						
WTU	0.07	0.07	−0.03	0.01	−0.01	0.00	0.01	−0.01	−0.01	0.01	−0.02	0.03	1.00				
p-value	0.02	0.02	0.36	0.65	0.73	0.93	0.70	0.65	0.81	0.66	0.63	0.27					
USTU	0.01	0.01	0.05	0.00	−0.03	0.01	0.03	−0.05	−0.03	−0.03	−0.04	0.35	0.08	1.00			
p-value	0.67	0.76	0.09	0.99	0.21	0.63	0.26	0.08	0.29	0.30	0.18	0.00	0.01				
GCP	0.10	0.10	−0.07	0.01	0.03	−0.02	−0.03	0.05	0.03	0.06	0.03	−0.17	0.16	−0.31	1.00		
p-value	0.00	0.00	0.02	0.76	0.30	0.44	0.33	0.10	0.31	0.03	0.35	0.00	0.00	0.00			
GEPU	0.10	0.10	−0.01	0.00	0.00	−0.01	0.00	0.00	0.00	0.01	0.50	0.21	0.20	0.43	0.33	1.00	
p-value	0.00	0.00	0.78	0.93	0.92	0.87	0.93	0.98	0.98	0.74	0.00	0.00	0.00	0.00	0.00		
OilVo	0.11	0.11	−0.04	0.01	0.01	−0.01	−0.01	0.02	0.02	0.04	−0.15	−0.26	0.10	−0.25	0.87	0.25	1.00
p-value	0.00	0.00	0.21	0.67	0.61	0.65	0.65	0.38	0.57	0.22	0.00	0.00	0.00	0.00	0.00	0.00	

Table 2.
Correlation matrix

Table 3.
External shocks and domestic vulnerability: growth volatility (GDP growth)

Dep. var: *GDPvo*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.GDPvo	0.6877*** [0.0077]	0.6906*** [0.0078]	0.7040*** [0.0105]	0.6325*** [0.0099]	0.7063*** [0.0100]	0.6814*** [0.0057]	0.6775*** [0.0072]
Income	0.0975*** [0.0159]	0.0942*** [0.0153]	0.0994*** [0.0155]	0.1194*** [0.0186]	0.0884*** [0.0161]	0.0854*** [0.0156]	0.0821*** [0.0149]
Pop	−0.0419*** [0.0127]	−0.0450*** [0.0131]	−0.0311** [0.0141]	−0.0479** [0.0202]	−0.0273* [0.0145]	−0.0457*** [0.0152]	−0.0408*** [0.0134]
Trade	0.0002 [0.0003]	0.0003 [0.0003]	0.0009** [0.0003]	0.0007* [0.0003]	0.0014*** [0.0003]	0.0002 [0.0003]	0.0003 [0.0003]
GPR	*−0.0022*** [0.0003]						
USTU		*0.0026*** [0.0007]					
WTU			*0.0033*** [0.0003]				
GEPU				*0.0066*** [0.0018]			
WU					*−0.0049*** [0.0020]		
OilVo						*0.0321*** [0.0022]	
GCP							*0.0266*** [0.0028]
Cons	0.6055** [0.2446]	0.4633* [0.2509]	−0.1654 [0.2843]	0.3675 [0.3571]	0.3156 [0.2975]	0.3291 [0.3046]	0.5099* [0.2867]
N	1,178	1,178	967	915	968	1,178	1,178
No. of countries	54	54	54	54	54	54	54
No. of IVs	47	47	40	38	40	47	47
The first-stage *F*-statistic	1863	1731	1372	1050	1126	6460	2499
p-value of *F*-test	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(1) test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test (*p*-value)	0.598	0.625	0.323	0.242	0.452	0.580	0.712
Hansen test of overid. restrictions	0.234	0.241	0.101	0.112	0.143	0.153	0.153
Difference-in-Hansen tests of exogeneity of instrument subsets							
GMM instruments for levels (*p*-value)	0.184	0.164	0.081	0.100	0.081	0.101	0.065
for IVs (*p*-value)	0.412	0.275	0.262	0.101	0.237	0.284	0.271

Note(s): standard errors are in [ ]; *, ** and *** are significant levels at 10%, 5% and 1%, respectively

Table 4.
External shocks and domestic vulnerability: growth volatility (GDP per capita growth)

Dep. var: *GDPpcvo*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.GDPpcvo	0.6898*** [0.0069]	0.6917*** [0.0065]	0.6984*** [0.0085]	0.6318*** [0.0095]	0.7008*** [0.0085]	0.6784*** [0.0063]	0.6774*** [0.0065]
Income	0.1027*** [0.0170]	0.1000*** [0.0167]	0.1049*** [0.0159]	0.1260*** [0.0177]	0.0948*** [0.0170]	0.0904*** [0.0169]	0.0901*** [0.0153]
Pop	−0.0328*** [0.0123]	−0.0375*** [0.0135]	−0.0291** [0.0135]	−0.0418** [0.0195]	−0.0276* [0.0138]	−0.0401*** [0.0148]	−0.0385** [0.0145]
Trade	0.0004 [0.0003]	0.0004 [0.0003]	0.0010*** [0.0003]	0.0010** [0.0004]	0.0016*** [0.0004]	0.0004 [0.0003]	0.0004 [0.0003]
GPR	*−0.0015*** [0.0003]						
USTU		*0.0020*** [0.0006]					
WTU			*0.0033*** [0.0003]				
GEPU				*0.0066*** [0.0017]			
WU					*−0.0062*** [0.0018]		
OilVo						*0.0341*** [0.0017]	
GCP							*0.0293*** [0.0027]
Cons	0.3636 [0.2354]	0.3053 [0.2595]	−0.2415 [0.2785]	0.1804 [0.3434]	0.2946 [0.2732]	0.1551 [0.2869]	0.3788 [0.2921]
N	1,178	1,178	967	915	968	1,178	1,178
No. of countries	54	54	54	54	54	54	54
No. of IVs	47	47	40	38	40	47	47
The first-stage *F*-statistic	3306	3192	1728	1006	1540	6380	3697
p-value of *F*-test	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(1) test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test (*p*-value)	0.618	0.639	0.382	0.274	0.499	0.584	0.727
Hansen test of overid. restrictions	0.184	0.201	0.100	0.153	0.162	0.157	0.149
Difference-in-Hansen tests of exogeneity of instrument subsets							
GMM instruments for levels (*p*-value)	0.188	0.182	0.079	0.071	0.078	0.102	0.094
for IVs (*p*-value)	0.361	0.247	0.259	0.115	0.230	0.247	0.231

Note(s): standard errors are in [ ]; *, ** and *** are significant levels at 10%, 5% and 1%, respectively

commodity induce a higher volatility in developing countries. Surprisingly, the volatility of two uncertainty indices (geopolitical risk and WU) has a negative impact on the on volatility of the GDP growth.

Table 5 hereafter reports the influence of the global uncertainty indicators' volatility on economic vulnerability index (EVI).

The results show that an increase in volatilities of geopolitical risk, oil price and commodity prices has significant a positive impact on the EVI, while an increase in the volatility of USTU, WTU, GEPU and WU have a significant negative impact. These observations imply that the volatility of oil and commodity price and the geopolitical risk induce a higher economic vulnerability in developing countries while the volatility of the other uncertainty indicators reduces it. At first sight, the aforementioned findings might appear surprising – however, it is important to read by them by taking into account the way the uncertainty indices are constructed. Precisely, the EVI, for instance, is "a synthetic index of the structural vulnerability" (Sosso and Goujon (2016) which tends to be focused on the national situation decomposed into two categories of shocks: i) domestic shocks including natural shocks (*i.e.* natural disasters and climatic shocks) and other domestic shocks (*i.e.* civil wars, and political and social instability) and ii) external shocks (*i.e.* international commodity price volatility or slumps in external demand). In other terms, the EVI does not really take into consideration the international situation since it mainly values the national interest and only two specific aspects related to the international scene. This methodological choice explains why an increase in the geopolitical risk and the commodity/oil prices' volatility induce a higher economic vulnerability for the developing countries. Other indicators such as the USTU, WU and the GEPU instead provide an international benchmark integrating the political aspects of the largest countries – this can explain the reason for why a higher volatility in these indexes creates a favorable condition for developing countries in stabilizing their domestic capabilities. Indeed, all kinds of political uncertainty and change in these largest countries tend to offer an opportunity for developing countries to increase their influence and become more important on the international scene.

4.2 Social vulnerability

The following vulnerability we want to investigate is the social vulnerability which refers to two indicators: the MI and the income inequality. The impact of uncertainty indicators' volatility on the MI is presented in Table 6 below.

This table shows that the volatility of the geopolitical risk, one of the GEPU, of the WU as well as the oil and world commodity prices have a negative impact on the MI. In contrast, the volatility of the USTU and one of the WU have a positive impact on this index – these observations suggest that an increase in the uncertainty related to the largest economies tends to increase unemployment and inflation in developing countries while an increase of a more economic-related uncertainty tends to transform these nations into a safe place to invest and proceed with economic activities (explaining, therefore, the decrease of the MI).

The results for the sensitivity of the income inequality to global uncertainty indicators are presented in Table 7 hereafter.

The figures show that an increase in the geopolitical risk, trade uncertainty (world and US) and WU volatilities has a positive impact on the Gini index whereas an increase in the GEPU volatility and the oil/world commodity prices has a negative impact. These facts imply that an increase in the volatility related to political uncertainty would induce a higher income inequality. In combination with the results estimated for the MI, these identify that the volatility in the trade uncertainty (US and world) are the two major determinants of the social vulnerability (higher MI and income inequality) while a higher volatility in geopolitical risk might profile emerging nations as more attractive for economic activities (lower

Table 5.
External shocks and domestic vulnerability: economic vulnerability index

Dep. var: *EVI*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.*EVI*	1.04769*** [0.01286]	1.04306*** [0.01069]	1.06192*** [0.01605]	1.06190*** [0.01815]	1.06215*** [0.01601]	1.04754*** [0.01239]	1.05116*** [0.01262]
Income	0.00756*** [0.00226]	0.00659*** [0.00202]	0.01103*** [0.00302]	0.01094*** [0.00335]	0.01107*** [0.00294]	0.00719*** [0.00225]	0.00726*** [0.00229]
Pop	0.00397** [0.00159]	0.00349*** [0.00122]	0.00540*** [0.00183]	0.00515** [0.00209]	0.00543*** [0.00185]	0.00368** [0.00150]	0.00411*** [0.00151]
Trade	−0.00003 [0.00002]	−0.00001 [0.00002]	−0.00007*** [0.00002]	−0.00007*** [0.00002]	−0.00007*** [0.00002]	−0.00003* [0.00002]	−0.00002 [0.00002]
GPR	*0.00004** [0.00003]						
USTU		*−0.00012**** [0.00002]					
WTU			*−0.00001* [0.00001]				
GEPU				*−0.00022*** [0.00009]			
WU					*−0.00026**** [0.00004]		
OilVo						*0.00038**** [0.00005]	
GCP							*0.00039**** [0.00007]
Cons	−0.2901*** [0.0840]	−0.2520*** [0.0678]	−0.3819*** [0.10206]	−0.3736*** [0.11708]	−0.3795*** [0.10215]	−0.2850*** [0.07994]	−0.3024*** [0.08104]
N	1,178	1,178	968	915	968	1,178	1,178
No. of countries	54	54	54	54	54	54	54
No. of IVs	47	47	40	38	40	47	47
The first-stage *F*-statistic	12507	14590	7732	7392	8802	15732	20681
p-value of *F*-test	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(1) test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test (*p*-value)	0.679	0.569	0.907	0.844	0.924	0.733	0.662
Hansen test of overid. restrictions	0.218	0.214	0.192	0.147	0.278	0.254	0.277
Difference-in-Hansen tests of exogeneity of instrument subsets							
GMM instruments for levels (*p*-value)	0.278	0.193	0.078	0.076	0.298	0.317	0.199
for IVs (*p*-value)	0.269	0.183	0.147	0.103	0.208	0.223	0.202

Note(s): standard errors are in [ ]; *, ** and *** are significant levels at 10%, 5% and 1%, respectively

Table 6.
External shocks and domestic vulnerability: the MI

Dep. var: *MI*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.MI	0.5032*** [0.0003]	0.5043*** [0.0003]	0.5746*** [0.0005]	0.5764*** [0.0013]	0.5711*** [0.0010]	0.5034*** [0.0003]	0.5029*** [0.0002]
Income	4.3790*** [0.3842]	4.3759*** [0.2875]	0.5610*** [0.1544]	0.1138 [0.2139]	0.4959*** [0.1536]	4.2299*** [0.2547]	4.5038*** [0.2929]
Pop	3.3938*** [0.2417]	3.3771*** [0.1984]	−0.6108*** [0.1597]	−0.5659*** [0.1456]	−0.4450*** [0.1280]	3.4817*** [0.2253]	3.3667*** [0.1917]
Trade	−0.0480*** [0.0048]	−0.0503*** [0.0040]	−0.0215*** [0.0024]	−0.0197*** [0.0040]	−0.0232*** [0.0033]	−0.0476*** [0.0046]	−0.0474*** [0.0044]
GPR	*−0.0013* [0.0031]						
USTU		*0.0073* [0.0056]					
WTU			*0.0173*** [0.0015]				
GEPU				*−0.0373*** [0.0051]			
WU					*0.0019* [0.0082]		
OilVo						*0.0347*** [0.0081]	
GCP							*−0.2622*** [0.0116]
Cons	−79.712*** [2.5702]	−79.642*** [2.5281]	11.546*** [3.2681]	16.759*** [3.2017]	11.459*** [2.4356]	−80.477*** [2.9540]	−78.754*** [2.9085]
N	1,178	1,178	968	915	968	1,178	1,178
No. of countries	54	54	54	54	54	54	54
No. of IVs	45	45	40	38	40	45	45
The first-stage *F*-statistic	2.83e + 06	2.24e + 06	428027	107375	174313	2.46e + 06	4.02e + 06
p-value of *F*-test	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(1) test (*p*-value)	0.299	0.299	0.049	0.055	0.049	0.300	0.300
AR(2) test (*p*-value)	0.257	0.257	0.234	0.188	0.226	0.257	0.257
Hansen test (*p*-value)	0.215	0.206	0.140	0.074	0.154	0.212	0.133
Hansen test of overid. restrictions							
Difference-in-Hansen tests of exogeneity of instrument subsets							
GMM instruments for levels (*p*-value)	0.130	0.124	0.081	0.181	0.189	0.181	0.203
for IVs (*p*-value)	0.130	0.140	0.216	0.074	0.122	0.143	0.123

Note(s): standard errors are in [ ]; *, ** and *** are significant levels at 10%, 5% and 1%, respectively

Table 7. External shocks and domestic vulnerability: income inequality

Dep. var: *GINI*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.*GINI*	0.88954*** [0.00923]	0.89761*** [0.00946]	0.90103*** [0.00831]	0.90790*** [0.00966]	0.90659*** [0.00876]	0.89515*** [0.00868]	0.89658*** [0.00816]
Income	0.00044 [0.00070]	−0.00015 [0.00072]	−0.00001 [0.00085]	−0.00017 [0.00105]	0.00027 [0.00089]	0.00024 [0.00069]	−0.00003 [0.00068]
Pop	0.00010 [0.00035]	0.00002 [0.00034]	0.00031 [0.00049]	0.00050 [0.00051]	0.00032 [0.00050]	0.00022 [0.00034]	0.00032 [0.00035]
Trade	−0.00004*** [0.00001]	−0.00004*** [0.00001]	−0.00003*** [0.00001]	−0.00003*** [0.00001]	−0.00003*** [0.00001]	−0.00004*** [0.00001]	−0.00004*** [0.00001]
GPR	*0.00003*** [2.70e−06]						
USTU		*0.00003*** [4.64e−06]					
WTU			*0.00001*** [1.46e−06]				
GEPU				*−0.00001*** [5.11e−06]			
WU					*0.00002*** [5.51e−06]		
OilVo						*−0.00004*** [0.00001]	
GCP							*−0.00013*** [0.00002]
Cons	0.41029*** [0.03976]	0.38476*** [0.04081]	0.36622*** [0.03773]	0.33961*** [0.04367]	0.34324*** [0.04128]	0.39012*** [0.03826]	0.38516*** [0.03589]
N	1,127	1,127	941	890	941	1,127	1,127
No. of countries	54	54	54	54	54	54	54
No. of IVs	47	47	40	38	40	47	47
The first-stage *F*-statistic	3856	4652	3215	2214	3609	4508	5105
p-value of *F*-test	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(1) test (*p*-value)	0.009	0.012	0.023	0.028	0.024	0.019	0.017
AR(2) test (*p*-value)	0.590	0.387	0.331	0.357	0.357	0.387	0.347
Hansen test of overid. restrictions	0.302	0.452	0.364	0.290	0.362	0.399	0.423
Difference-in-Hansen tests of exogeneity of instrument subsets							
GMM instruments for levels (*p*-value)	0.100	0.193	0.063	0.096	0.049	0.101	0.116
for IVs (*p*-value)	0.272	0.368	0.217	0.153	0.216	0.319	0.336

Note(s): standard errors are in [ ]; *, ** and *** are significant levels at 10%, 5% and 1%, respectively

unemployment and inflation rate), but this situation must be nuanced by the fact that such increased volatilities tend to increase the income inequality.

4.3 Environmental vulnerability

The last indicator we plan to investigate is related to the environmental dimension. Table 8 below summarizes the influence of the global uncertainty indicators' volatility on the environmental vulnerability captured by the CO_2 emissions per capita and the CO_2 emissions per output unit. The first proxy of CO_2 is likely presented for the emissions intensity from population, while the second proxy is likely presented for the emissions intensity relating to technology and economic facilities. Our major findings are exhibited in Table 8 below.

The results in this table, Table 8 show that an increase in the volatility of WTU has a positive influence on the CO_2 emissions per capita while an increase in all other uncertainty indicators have a negative impact. This situation means that an increase in the volatility in most of the global uncertainty indicators reduce the CO_2 emissions – such observation can be explained by the fact that a rise in uncertainty usually reduces the domestic output explaining therefore the reduction of CO_2 emissions per capita. In term of CO_2 emissions per output unit, Table 9 hereafter shows that an increase in the geopolitical risk, WU, oil price and world commodity prices reduce these emissions probably due to the reduction of the economic activities usually associated with a higher uncertainty.

However, an increase of the US trade, of the world trade uncertainties as well as the GEPU has a positive impact on this level of emissions. These findings suggest that a rise in uncertainty indicators tends to reduce the creation of new economic activities generating CO_2 emissions (explaining the reduction of the CO_2 emissions per capita), but this reduction of economic activities comes along with the closure of economic productive units leading to an increase of the CO_2 emissions per output unit. In other words, in a context of a higher uncertainty, developing nations either reduce the number of units produced or they produce the same number of units with less economic facilities leading an increase of the CO_2 emissions per unit.

5. Conclusion

This study investigates the influences of the major global uncertainty indicators on economic, social and environmental vulnerabilities of nations. Our findings can be summarized in Table 10 below. Some main findings are as follows.

In terms of economic vulnerability, external shocks (i.e. an increase in five of our uncertainty indicators) mostly increase the domestic growth volatility except for two indicators (geopolitical risk and WU). In contrast, most external shocks appear to reduce domestic growth volatility except geopolitical risk and commodity prices (overall commodity price and oil price). Social vulnerability seems to be affected in a different manner since trade uncertainties and WU appear to increase social vulnerability through the MI and income inequality. In contrast, global EPU and geopolitical risk seem to reduce these factors. Finally, with regards to the environmental vulnerability (CO_2 emissions), most external shocks appear to reduce emissions meaning that uncertainty homogeneously creates a context in which nations produce less CO_2 emissions.

Several implications can be drawn from these findings. The three aspects (economic, social and environmental) of the nations' vulnerability never move all together in relation to the variation of all uncertainty indicators. This observation suggests that the socioeconomic and environmental vulnerability cannot be solved through the same pattern: any decrease in a particular aspect will necessarily have a cost and an opposite influence on at least one of the other aspects of the nations' vulnerability. From their relation to global uncertainty

Table 8. External shocks and domestic vulnerability: environmental vulnerability (CO_2 per capita)

Dep. var: *CO2pc*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.*CO2pc*	0.8432*** [0.0120]	0.8432*** [0.0114]	0.8294*** [0.0159]	0.8118*** [0.0179]	0.8318*** [0.0161]	0.8459*** [0.0119]	0.8493*** [0.0118]
Income	0.1452*** [0.0119]	0.1433*** [0.0114]	0.1570*** [0.0165]	0.1695*** [0.0178]	0.1538*** [0.0166]	0.1400*** [0.0124]	0.1372*** [0.0121]
Pop	0.0264*** [0.0060]	0.0249*** [0.0066]	0.0320*** [0.0070]	0.0347*** [0.0074]	0.0311*** [0.0073]	0.0262*** [0.0059]	0.0258*** [0.0058]
Trade	0.0005*** [0.0001]	0.0005*** [0.0001]	0.0005*** [0.0001]	0.0007*** [0.0001]	0.0005*** [0.0001]	0.0005*** [0.0001]	0.0005*** [0.0001]
GPR	*−0.0001*** [0.00003]						
USTU		*−0.0006*** [0.0001]					
WTU			*0.00005** [0.00003]				
GEPU				*−0.0004* [0.0003]			
WU					*−0.0003** [0.0002]		
OilVo						*−0.0009*** [0.0002]	
GCP							*−0.0011*** [0.0003]
Cons	−1.5650*** [0.1580]	−1.4998*** [0.1685]	−1.7795*** [0.2129]	−1.9183*** [0.2269]	−1.7233*** [0.2170]	−1.5154*** [0.1607]	−1.4919*** [0.1575]
N	1,178	1,178	968	915	968	1,178	1,178
No. of countries	54	54	54	54	54	54	54
No. of IVs	47	47	40	38	40	47	47
The first-stage *F*-statistic	45,472	41,683	20,344	17,728	22,034	33,795	40,108
p-value of *F*-test	00	0	0	0	0	0	0
AR(1) test (*p*-value)	0	0	0	0	0	0	0
AR(2) test (*p*-value)	0.451	0.422	0.588	0.584	0.578	0.470	0.476
Hansen test of overid. restrictions	0.278	0.325	0.278	0.388	0.283	0.333	0.322
Difference-in-Hansen tests of exogeneity of instrument subsets							
GMM instruments for levels (*p*-value)	0.082	0.075	0.210	0.541	0.195	0.080	0.090
for IVs (*p*-value)	0.169	0.284	0.208	0.502	0.162	0.194	0.188

Note(s): standard errors are in [ ]; *, ** and *** are significant levels at 10%, 5% and 1%, respectively

Table 9.
External shocks and domestic vulnerability: environmental vulnerability (CO_2 per output unit)

Dep. var: *CO2GDP*	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.*CO2GDP*	0.8305*** [0.0098]	0.8405*** [0.0146]	0.8588*** [0.0178]	0.8655*** [0.0177]	0.8621*** [0.0172]	0.8294*** [0.0142]	0.8286*** [0.0125]
Income	−0.0094** [0.0037]	−0.0073* [0.0037]	−0.0057 [0.0046]	−0.0068 [0.0050]	−0.0057 [0.0046]	−0.0098** [0.0040]	−0.0091** [0.0042]
Pop	0.0251*** [0.0043]	0.0256*** [0.0043]	0.0265*** [0.0051]	0.0225*** [0.0055]	0.0235*** [0.0049]	0.0241*** [0.0043]	0.0246*** [0.0046]
Trade	0.0003*** [0.0001]	0.0003*** [0.0001]	0.0003*** [0.0001]	0.0003*** [0.0001]	0.0003*** [0.0001]	0.0003*** [0.0001]	0.0003*** [0.0001]
GPR	*−0.00006*** [0.00003]						
USTU		*0.0005*** [0.0001]					
WTU			*0.00002* [0.00003]				
GEPU				*0.0004** [0.0002]			
WU					*−0.0001* [0.0001]		
OilVo						*−0.0007*** [0.0001]	
GCP							*−0.0016*** [0.0003]
Cons	−0.5025*** [0.0805]	−0.5451*** [0.0809]	−0.5428*** [0.1085]	−0.4709*** [0.1167]	−0.4871*** [0.1054]	−0.4786*** [0.0815]	−0.4924*** [0.0914]
N	1,178	1,178	968	915	968	1,178	1,178
No. of countries	54	54	54	54	54	54	54
No. of IVs	47	47	40	38	40	47	47
The first-stage *F*-statistic	2,085	1,470	650.1	654.4	629.0	1,440	1,331
p-value of *F*-test	0	0	0	0	0	0	0
AR(1) test (*p*-value)	0	0	0	0	0	0	0
AR(2) test (*p*-value)	0.355	0.399	0.397	0.428	0.398	0.358	0.351
Hansen test of overid. restrictions	0.158	0.241	0.302	0.271	0.183	0.139	0.130
Difference-in-Hansen tests of exogeneity of instrument subsets							
GMM instruments for levels (*p*-value)	0.024	0.029	0.264	0.324	0.255	0.022	0.019
for IVs (*p*-value)	0.105	0.145	0.192	0.199	0.182	0.107	0.115

Note(s): standard errors are in [ ]; *, ** and *** are significant levels at 10%, 5% and 1%, respectively

An increase in the horizontal indicators generates to a + or – in the vertical ones	Volatility US trade uncertainty	Volatility world trade uncertainty	Volatility EPU	Volatility world commodity Price	Volatility oil price	Volatility geopolitical risk	Volatility world uncertainty
Volatility of economic growth	+	+	+	+	+	−	−
Economic vulnerability	−	−	−	+	+	+	−
Misery index	+	+	−	−	+	−	+
Income inequality	+	+	−	+	−	−	+
Environmental vulnerability	−	+	−	−	−	−	−

Table 10.
Summarizing table

indicators, we can conclude that that there is always a price to pay for the improvement of one of the aforementioned dimensions.

Given the fact social, economic and environmental aspects are at the heart of the UN sustainable goals, our study can be seen as an investigation of the nations' capabilities to work proactively on meaningful sustainable goals in an increasingly uncertain world. However, our recommendations for policy-makers depend on the uncertainty indicator used as a benchmark by a nation. However, one indicator (volatility of EPU) appear to offer a room for a consistent and coherent strategy since almost all indicators of economic, social and environmental vulnerabilities seem to move in the same directly (except for one indicator) – this finding might suggest that this uncertainty benchmark could be appropriate for policy-makers willing to implement policies that are consistent to a particular macroindicator.

It is worth mentioning that tour study has some limitations. First, the study did not deal with the long-run effects of external shocks on domestic vulnerability as the limitation of our data. External shocks might exert long-run effects on domestic vulnerability, which may last for several generations. Second, tour study did not consider how domestic economies can absorb external shocks basing on their fundamentals. Future studies with longer dataset can focus on this aspect – furthermore, future studies may concern how domestic economy can absorb external shocks through their economic strategies such as globalization or production upgrading. This could provide more details policy implication for policy-makers. This study can be seen as a first step for research on these matters.

Notes

1. These components include: (1) newspaper coverage of policy-related economic uncertainty, (2) the number of federal tax code provisions set to expire in future years and (3) disagreement among economic forecasters – for more details: https://www.policyuncertainty.com/methodology.html
2. See https://www.policyuncertainty.com/global_monthly.html
3. The EIU country reports focus on major political and economic developments in each country along with analysis and forecasts of political, policy and economic conditions (see https://www.policyuncertainty.com/wui_quarterly.html)
4. Database is provided here: https://ferdi.fr/en/indicators/a-retrospective-economic-vulnerability-index
5. This is defined in the EV index database (see https://ferdi.fr/en/indicators/a-retrospective-economic-vulnerability-index)
6. Most countries in our sample are small ones, which do not have huge impacts on international shocks when they face with variations in their domestic vulnerability.
7. To check the stationary of our main variables, we ran the cross-sectional dependence test of Pesaran (2021) and CIPS test of Pesaran (2007). The results show that most of our variables have cross-sectional dependence and stationary at levels.

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Appendix

Algeria	Côte D'Ivoire	Jordan	Nicaragua	Sri Lanka
Angola	Dominican Republic	Kenya	Nigeria	Thailand
Argentina	Ecuador	Laos	Pakistan	Tunisia
Bangladesh	Egypt	Lebanon	Panama	Turkey
Bolivia	El Salvador	Madagascar	Paraguay	Tanzania
Brazil	Ghana	Malaysia	Peru	Uruguay
Cameroon	Guatemala	Mauritania	Philippines	Venezuela
Chile	Guinea	Mexico	Korea	Vietnam
China	Honduras	Mongolia	Senegal	Zambia
Colombia	India	Morocco	Singapore	Zimbabwe
Costa Rica	Israel	Mozambique	South Africa	

Table A1. List of countries (54 developing countries)

Variable	CD-test	CIPS-test
GDPvo	16.51***	−2.861***
GDPpcvo	16.63***	−2.855***
MI	34.72***	−3.985***
GINI	7.776***	n/a
CO2pc	64.79***	−2.076*
CO2GDP	8.087***	−2.183**
EVI	18.36***	−1.836

Table A2. Cross-sectional dependence test and stationary tests

Note(s): Under the null hypothesis of cross-section independence, CD ~ $N(0,1)$, the significance of test indicates data are correlated across panel groups; in the Pesaran Panel Unit Root Test in the Presence of Cross-section Dependence (CIPS test): H0 (homogeneous nonstationary): bi = 0 for all i

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