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"Modelling the dynamic interaction between economic uncertainty, growth, unemployment and suicide"

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Abstract

Economic uncertainty is a driver of the business cycle. In a recent study, Claveria (2022) used a fixed-effects model to assess the impact of uncertainty on suicide rates worldwide. Using that same panel, in which global economic uncertainty is linked to the evolution of the suicide rates in 183 countries between 2000 and 2019, this work evaluates the dynamic interconnections between unemployment, economic growth, uncertainty and suicide using a dynamic panel model. Overall, the analysis suggests that increases in the growth of economic uncertainty and unemployment may lead to increases in suicide rates growth worldwide. When replicating the experiment for different regions and for groups of countries classified according to their level of income, the greatest impact of increases in economic uncertainty is found in upper middle-income economies. Given the anticipatory nature of economic uncertainty with respect to the evolution of the economy, and its relationship with suicide rates, the obtained results suggest the usefulness of uncertainty indicators as tools for the early detection of periods of increased suicide risk and for the design of suicide prevention strategies.

JEL Classification: C33, C51, I15, J17, O57, Z18.

Keywords: Economic uncertainty, Suicide, Prevention, Unemployment, Economic growth, Dynamic panel model.

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1. Introduction

To this day, and despite showing a progressive decline in recent years, suicide continues to be one of the most important causes of mortality, especially in countries with higher per capita income. According to the World Health Organization (WHO), low- and middle-income countries bear most of the global suicide burden, and suicide is the fourth leading cause of death among the young population. In recent years, there has also been a rise among adults (Hempstead and Phillips, 2015). Apart from the fact that more than 700,000 people die by suicide every year, for each suicide there are more than 20 suicide attempts (WHO, 2021). Since suicide has proven to be preventable, it is crucial to make progress in research aimed at preventing it.

This has led researchers from different fields to analyse the factors that may be influencing suicidality. The existing literature has shown that mental illness (Mann et al., 2005; Qin et al., 2003), personality disorders (Gray and Otto, 2001; Rihmer et al., 2004) and dependence on alcohol and drugs (Comtois et al., 2004; Oqendo et al., 2007) are key risk factors. Morselli (1882) was the first to suggest that suicide rates could be dependent on socioeconomic factors. Since then, the effect that different economic aggregates can have on suicide has been widely studied (Fountoulakis et al., 2014; Kentikelenis et al., 2011). The variables that have been most commonly analysed are economic growth (Chang and Chen, 2017; Korhonen et al., 2017), and especially unemployment (Botha and Nguyen, 2022; Noh, 2009; Nordt et al., 2015; Phillips and Nugent, 2014).

Recently, especially in the wake of the Great Recession of 2008, there has been a renewed interest in measuring and studying economic uncertainty. There is a consensus in the literature that uncertainty drives business cycles (Bloom, 2009, 2014; Meinen and Roehe, 2017). The leading nature of economic uncertainty with respect to economic growth and the high frequency with which it can be computed, as opposed to other macroeconomic variables such as gross domestic product (GDP) that are published on a quarterly basis and are subject to subsequent corrections, make economic uncertainty a key variable to analyse the potential effect that socioeconomic factors may end up having on suicide behaviour, providing an early signal of periods of increased turmoil.

To the best of our knowledge, hitherto there are only five previous studies that analyse the relationship between economic uncertainty and suicide rates (Antonakakis and Gupta, 2017; Claveria, 2022; de Bruin et al., 2020; Vandoros et al., 2019; Vandoros and Kawachi, 2021). Antonakakis and Gupta (2017) examined the relationship between

policy-related economic uncertainty and suicide mortality in the United States (US) over the period 1950-2013. The authors found that increased uncertainty was associated with increased suicide mortality in the youngest and oldest segments of the male population. Claveria (2022) used a fixed-effects panel model to analyse the impact of economic uncertainty on suicide rates worldwide, finding a significant relationship. De Bruin et al. (2019) also estimated a fixed-effects panel model that matched economic uncertainty and other economic variables to suicide rates in 17 countries, obtaining a significant association between both variables. Likewise, Vandoros et al. (2019) used daily data for England and Wales, and found that economic uncertainty had an effect on the increased risk of suicide in the short-term. Vandoros and Kawachi (2021) further analysed this relationship by matching monthly suicide data from the US at the states' level from 2000 to 2017 with economic uncertainty and other economic indicators. The authors found a positive association and highlighted the importance of providing access to suicide prevention interventions during periods of high economic uncertainty.

One of the possible reasons why this link has not been analysed in more depth may be related to the very nature of economic uncertainty. As it is an unobservable phenomenon, there is no consensus on how to measure the level of uncertainty. An indication of the difficulty of specifying what exactly is understood by uncertainty shocks and disentangling them from other type of shocks, is the number of different strategies that are used to proxy uncertainty. These approaches can be grouped into five categories: disagreement among professional forecasters, responses from business and consumer surveys, econometrically-constructed measures, those based on financial data and text-based proxies.

The first two alternatives are based on dispersion metrics that vary depending on the type of survey information they are based on (Claveria, 2021; Mokinski et al., 2015; Rossi and Sekhposyan, 2015). A third way to proxy uncertainty, first proposed by Jurado et al. (2015), is based on econometric unpredictability—understood as the conditional volatility of the unforecastable components of a broad set of economic variables. The ex-post nature of this approach has recently generated a strand in the empirical research that makes use of more direct measures of uncertainty based on prospective information. As a result, a fourth strand of the literature has focused on the exploitation of financial data (e.g., bond yields, exchange rates). However, since developments in the stock market only partially reflect developments in the real economy (Girardi and Reuter, 2017), some authors have opted for collecting new data for approximating economic uncertainty.

The most popular approach is based on calculating the frequency with which concepts related to uncertainty appear in the media. Baker et al. (2016) constructed the economic policy uncertainty (EPU) index by computing a text-mining measure using ten American newspapers from the US. The degree of subjectivity entailed in the selection of newspapers and its limited scope, led Davis (2016) to calculate a global economic policy uncertainty (GEPU) index by taking a GDP weighted average of EPUs from several countries proportional to the monthly share of national articles. The countries on the GEPU index account around 80% of global output at market exchange rates.

In the present study, the GEPU index is used to evaluate the dynamic relationship between economic uncertainty and suicides worldwide. Given the geographical scope of the study, as well as the leading properties of uncertainty with respect to the business cycle (Bloom, 2009, 2014), the selection of this index seems particularly appropriate to assess the effect that economic uncertainty may have on suicide rates worldwide. Most of the existing literature linking economic variables to suicide find evidence suggesting that macro aggregates have a significant effect on suicide rates (Coope et al., 2014; Iglesias-García et al., 2017; Phillips and Nugent, 2014). However, there are divergences as to how they affect them. While there is a certain consensus regarding the effect that job loss has on suicide, the impact of the income level and the phase of the economic cycle in some cases show conflicting results. While dos Santos et al. (2016) and Luo et al. (2011) found a significant and inverse relationship between these variables and suicide rates in Portugal and the US respectively, studies carried out in other countries obtained mixed results (Chang et al. 2009, Chen et al., 2010; Wang et al., 2020).

Suicide, like uncertainty, is the result of the complex interaction of a diverse amalgam of factors. The ultimate goal of this study is to advance in the research aimed at suicide prevention. Given the anticipatory nature of economic uncertainty with respect to the business cycle, this study evaluates to what extent economic uncertainty can be used as an advanced indicator of increased suicide risk. The contribution of this research is threefold.

First, as Fountoulakis et al. (2014) noted, most existing studies on suicide are often based on samples from developed countries. The present study covers 183 countries in the world, using the suicide mortality rates published by the WHO. Second, rather than focusing on a cross-sectional analysis, the study also takes into account the temporal dimension of the annual suicide rates for the period 2000-2019. With this aim in mind, a dynamic panel framework is used to examine the relationship between the evolution of

economic uncertainty and suicide risk, controlling for unemployment and economic growth, and replicating the analysis for different geographical regions and groups of countries according to their level of income.

The work is structured as follows. First, Section 2 presents the data that were used in the study, complemented with a graphic and descriptive analysis. Next, Section 3 discusses the methodology and presents the results. Section 4, discusses the results obtained in the empirical analysis. Finally, Section 5 draws some conclusions and offers some suggestions for future research.

2. Data

2.1. Economic uncertainty

In recent years, there have been great advances in the approximation of economic uncertainty. Nevertheless, the question of what exactly is meant by economic uncertainty and how to measure it, are aspects that are still open to debate (Dibiasi and Iselin, 2021; Glas, 2020). Kozeniauskas et al. (2018) differentiated between three types of uncertainty: micro uncertainty (cross-sectional variance of firm-level outcomes); macro uncertainty (aggregate shocks); and higher-order uncertainty (disagreement). For an overview of recent developments regarding the measurement of uncertainty see Castelnuovo (2019).

An alternative taxonomy is that of Binge and Boshoff (2020), who grouped the different approaches to proxy economic uncertainty into five categories: disagreement among professional forecasters, responses from business and consumer surveys, econometrically-constructed measures, those based on financial data, and text-based proxies. Survey-based measures of economic uncertainty are usually obtained through different dispersion metrics computed from forecast surveys. Some recent works that take advantage of this type of information are, for example, those of Altig et al. (2020) and Jo and Sekkel (2019) for the US, and Rich and Tracy (2021) and Rossi and Sekhposyan (2017) for the Euro Area.

Forecast surveys have also been used to derive and assess different proxies of economic uncertainty based on the disagreement among professional forecasters (Dovern, 2015; Krüger and Nolte, 2016). Several authors have proposed alternative measures to proxy economic uncertainty based on qualitative expectations from business and consumer surveys in which respondents are asked about the expected direction of change

of a wide range of economic variables (Bachmann et al., 2013; Claveria et al., 2019; Girardi and Reuter, 2017; Glocker and Hölzl, 2021).

In a recent paper, Caggiano and Castelnuovo (2021) combined volatility data on the stock market, exchange rate returns and bond yields, to construct a measure of global financial uncertainty. However, given the limited scope of finance with respect to the developments in the real economy, some authors end up collecting new data for approximating economic uncertainty. The most popular approach is based on calculating the frequency with which concepts related to uncertainty appear in the media. The EPU index constructed by Baker et al. (2016) is the most widely used text-based uncertainty proxy. The index combines a text-mining measure with disagreement amongst forecasters, as well as the number of tax code previous about to expire. Since then, various authors have used this methodology to develop indicators of economic uncertainty for their respective countries: Armelius et al. (2017) for Sweden; Ghirelli et al. (2019) for Spain; Sorić and Lolić (2017) for Croatia, etc.

As was mentioned in the Introduction, the EPU is computed for the US and its construction is conditioned by the criteria used for the selection of newspapers. As a result, Davis (2016) proposed calculating the GEPU by taking a GDP weighted average of the 21 individual country EPUs (Australia, Brazil, Canada, Chile, China, Colombia, France, Germany, Greece, India, Ireland, Italy, Japan, Mexico, the Netherlands, Russia, South Korea, Spain, Sweden, the United Kingdom, and the United States).

To construct the GEPU the authors re-normalise each national EPU index to a mean of 100 from the first year to 2015, they impute missing values for certain countries using a regression-based method, which yields a balanced panel of monthly EPU index values for the 21 countries from January 1997 onwards. Finally, they compute the GEPU index value for each month as the GDP-weighted average of the 21 national EPU index values, using GDP data from the International Monetary Fund's World Economic Outlook Database. In this paper, we use the version of the GEPU based on GDP adjusted by purchasing power parity (PPP). An additional advantage of the GEPU index is that it allows establishing a comparative analysis between the different countries.

Given that the main aim of this study is to evaluate the association of uncertainty to suicide with prevention as the final objective, the anticipatory nature of the GEPU with respect to the business cycle makes it a suitable indicator for that purpose. GEPU data is freely available at the EPU index web (http://www.policyuncertainty.com/index.html).

2.2. Suicide mortality

The present study used the suicide mortality rate, understood as the number of suicide deaths in a year per 100,000 population (not age-adjusted) published by the WHO. These data are freely available at the Global Health Observatory Data Repository (http://apps.who.int/ghodata/). Table 1 contains the average and the standard deviation of annual suicide rates over the period 2000-2019 for the 183 countries included in the study.

Table 1 shows that the countries of some regions bear most of the global suicide burden, with generally higher average rates than the rest. Among these regions, Eastern Europe stands out. To examine the causes behind these high suicide rates in Eastern European economies, Kõlves et al. (2013) used a wide range of variables—from unemployment and GDP to the divorce rate and alcohol consumption—to assess their impact on changes in suicide rates in 13 countries from the former Soviet bloc between 1990 and 2008. The authors found that changes in suicide were related to socioeconomic disruptions experienced during the transition period.

With the aim of further exploring these regional differences, a graphical analysis of the distribution of average suicide rates in each continent is carried out in Figure 1. The box plots show upper-average levels in Europe. Lesotho, Eswatini, Botswana and South Africa have particularly high average rates, despite having a lower average rate than Europe and Oceania. As noted by the WHO (2021), the prevalence and characteristics of suicidal behaviour vary widely between different communities and over time. Figure 2 shows the distribution growth in suicide rates by continent during the sample period. Although the highest growth rates are obtained in America, some countries within each continent show particularly high rates of growth: Lesotho in Africa; Cyprus, Korea and Saudi Arabia in Asia; Portugal and Greece in Europe; and Papua New Guinea in Oceania.

Table 1. Suicide rates 2000-2019

country	mean	SD	Country	mean	SD
Afghanistan	4.5	0.4	Djibouti	8.3	0.9
Albania	5.9	1.6	Dominican Rep.	5.0	0.7
Algeria	3.3	0.7	Ecuador	9.0	1.2
Angola	7.3	1.0	Egypt	3.2	0.1
Antigua	0.7	0.7	El Salvador	6.7	0.9
Argentina	8.9	0.6	Equatorial Guinea	9.5	1.2
Armenia	4.8	1.6	Eritrea	12.6	1.0
Australia	11.7	0.9	Estonia	21.3	4.8
Austria	16.7	1.4	Eswatini	41.0	9.0
Azerbaijan	4.2	0.5	Ethiopia	7.1	1.5
Bahamas	3.2	0.5	Fiji	9.6	0.4
Bahrain	8.5	1.1	Finland	18.9	3.1
Bangladesh	4.4	0.8	France	17.6	2.0
Barbados	1.1	0.7	Gabon	10.1	1.2
Belarus	34.0	8.2	Gambia	5.4	0.4
Belgium	20.1	1.2	Georgia	8.3	1.5
Belize	6.2	0.7	Germany	13.3	0.7
Benin	8.4	0.3	Ghana	7.0	0.7
Bhutan	4.5	0.2	Greece	4.1	0.9
Bolivia	6.3	0.3	Grenada	1.8	1.4
Bosnia	10.4	0.6	Guatemala	8.0	2.2
Botswana	25.6	6.6	Guinea	6.4	0.7
Brazil	5.3	0.9	Guinea-Bissau	8.2	0.7
Brunei	2.1	0.6	Guyana	34.6	3.2
Bulgaria	12.7	2.7	Haiti	9.8	0.4
Burkina Faso	8.0	0.2	Honduras	2.4	0.6
Burundi	8.0	1.6	Hungary	24.1	4.5
Cabo Verde	13.6	1.0	Iceland	13.0	1.3
Cambodia	5.2	0.2	India	14.4	1.5
Cameroon	10.4	0.9	Indonesia	2.8	0.4
Canada	12.0	0.5	Iran	6.5	0.7
Central Africa	15.4	1.6	Iraq	3.9	0.2
Chad	7.4	0.5	Ireland	11.5	1.3
Chile	10.3	1.0	Israel	5.7	0.6
China	10.5	2.1	Italy	7.1	0.3
Colombia	4.2	0.4	Jamaica	2.0	0.3
Comoros	5.5	0.3	Japan	22.0	3.2
Congo	9.0	2.1	Jordan	1.8	0.4
Congo DR	7.1	0.4	Kazakhstan	30.7	7.8
Costa Rica	6.7	1.0	Kenya	6.1	0.5
Cote d'Ivoire	11.1	1.4	Kiribati	30.1	0.9
Croatia	18.1	1.5	Korea	26.8	5.5
Cuba	14.0	1.1	Korea DPR	9.5	0.4
Cyprus	3.8	1.5	Kuwait	2.6	0.2
Czechia	15.0	1.3	Kyrgyzstan	11.4	2.2
Denmark	12.9	1.6	Lao PDR	6.1	0.5

Notes: Suicide rates denote the number of suicide deaths in a year per 100,000 population (not age-adjusted). SD refers to the standard deviation. Antigua stands for Antigua and Barbuda, Bosnia for Bosnia and Herzegovina, Brunei for Brunei Darussalam, Central Africa for the Central African Republic, and Congo for the Republic of the Congo.

Table 1. (cont.) Suicide rates 2000-2019

country	mean	SD	Country	mean	SD
Latvia	24.5	4.5	Sao Tome	1.5	0.1
Lebanon	2.8	0.2	Saudi Arabia	5.0	1.3
Lesotho	59.6	23.7	Senegal	6.8	0.5
Liberia	4.8	0.2	Serbia	17.4	5.1
Libya	5.2	0.6	Seychelles	8.2	0.6
Lithuania	38.0	6.6	Sierra Leone	6.3	0.3
Luxembourg	12.8	2.1	Singapore	10.7	1.1
Madagascar	5.7	0.1	Slovak Republic	13.3	0.9
Malawi	7.4	1.4	Slovenia	23.8	4.4
Malaysia	4.7	0.4	Solomon Islands	14.9	0.7
Maldives	3.0	0.4	Somalia	8.4	0.4
Mali	4.5	0.2	South Africa	24.2	1.2
Malta	6.4	0.7	South Sudan	3.8	0.2
Mauritania	3.2	0.1	Spain	7.9	0.5
Mauritius	9.1	1.3	Sri Lanka	18.8	4.3
Mexico	4.7	0.7	St. Lucia	7.7	0.6
Micronesia FS	25.2	1.7	St. Vincent	4.3	2.6
Moldova	17.4	1.8	Sudan	4.0	0.1
Mongolia	21.8	1.9	Suriname	24.5	0.9
Montenegro	20.9	0.5	Sweden	15.1	0.5
Morocco	8.7	1.0	Switzerland	16.8	2.4
Mozambique	13.6	1.1	Syria	1.6	0.2
Myanmar	3.7	0.6	Tajikistan	3.9	0.3
Namibia	14.0	3.6	Tanzania	5.4	1.3
Nepal	8.4	0.4	Thailand	9.0	1.3
Netherlands	10.4	1.1	Timor-Leste	3.3	0.4
New Zealand	12.3	0.8	Togo	10.2	0.7
Nicaragua	4.9	0.4	Tonga	4.2	0.3
Niger	5.3	0.1	Trinidad Tobago	11.7	2.3
Nigeria	4.3	0.5	Tunisia	3.5	0.2
North Macedonia	9.4	1.1	Turkey	2.6	0.5
Norway	12.4	0.8	Turkmenistan	10.0	3.7
Oman	5.8	0.7	Uganda	7.0	2.2
Pakistan	9.0	0.1	Ukraine	27.9	6.2
Panama	4.4	1.1	Un. Arab Emirates	7.6	1.0
Papua New Guinea	2.6	0.3	United Kingdom	8.2	0.3
Paraguay	4.5	1.0	United States	13.2	1.6
Peru	2.9	0.3	Uruguay	17.3	2.4
Philippines	2.1	0.3	Uzbekistan	8.9	0.6
Poland	16.5	2.1	Vanuatu	18.8	0.5
Portugal	12.0	1.6	Venezuela RB	3.5	1.2
Qatar	7.2	0.9	Vietnam	6.9	0.6
Romania	12.0	1.2	Yemen	5.8	0.2
Russia	39.7	9.3	Zambia	10.2	1.7
Rwanda	8.1	3.1	Zimbabwe	16.6	3.1
Samoa	12.8	0.6	World	10.8	1.2

Notes: Suicide rates denote the number of suicide deaths in a year per 100,000 population (not age-adjusted). SD refers to the standard deviation. Sao Tome stands for Sao Tome and Principe, and Saint Vicente for Saint Vicente and the Grenadines.

Figure 1. Box-plot of average suicide rates by continent – 2000-2019

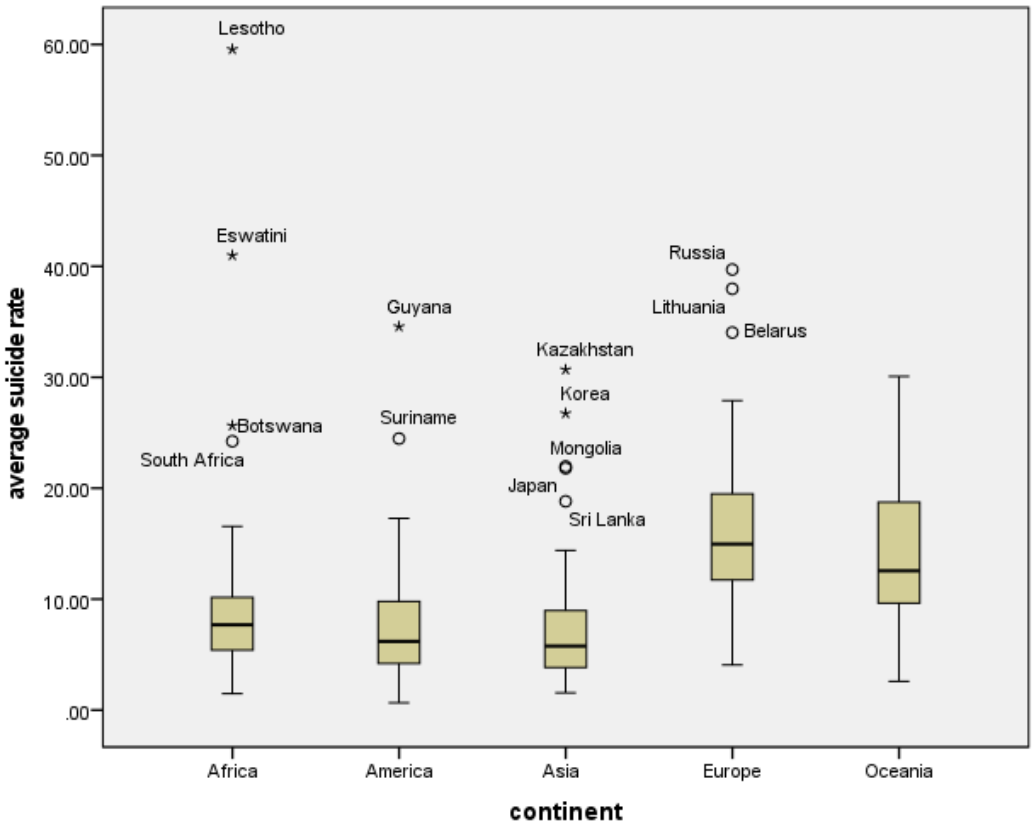
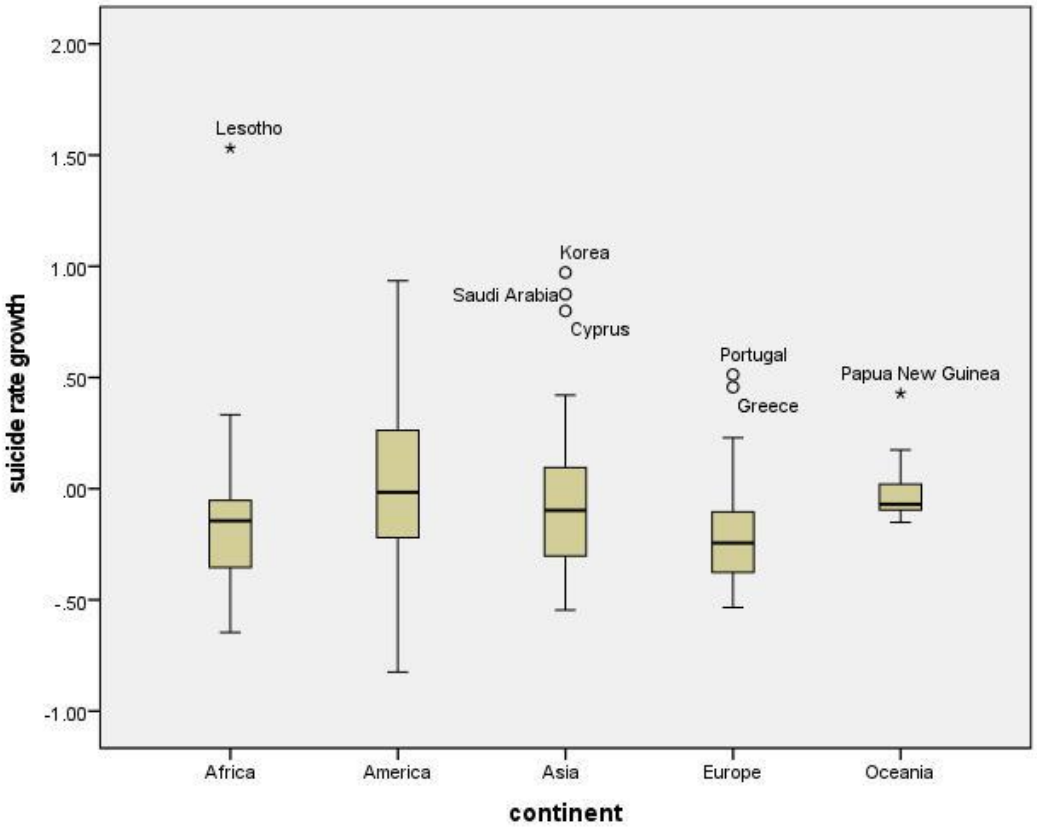


Figure 2. Box-plot of suicide rates growth by continent – 2000-2019



3. Empirical analysis

In this section, the relationship between economic uncertainty and suicide rates worldwide is examined by means of a dynamic panel model. While there exists empirical evidence that uncertainty shocks are an important exogenous source of economic fluctuations (Ahiadorme, 2022; Basile and Girardi, 2018; Caldara et al., 2016; Istiak and Serletis, 2018; Yıldırım-Karaman, 2017), there are only a few recent studies that have analysed the link between economic uncertainty and suicide (Antonakakis and Gupta, 2017; Claveria, 2022; de Bruin et al., 2020; Vandoros et al., 2019; Vandoros and Kawachi, 2021).

To evaluate the short-run relationship between both variables, we use a dynamic panel model. In contrast to the standard panel data model, a dynamic panel model also includes lagged values of the dependent variable as regressors. Our model can be specified as follows:

$$y_{it} = \alpha + \beta X_{t-1} + \gamma Z_{it} + \rho(y_{it-1}) + \varepsilon_{it} \quad (1)$$

Where y_{it} is the suicide rate of country *i* in year *t*, *t*=2000,…,2019. Variable X_t is the natural logarithm of the GEPU index. Given the anticipatory nature of economic uncertainty with respect to the business cycle, the index is included in the model with a one-period lag in order to evaluate its role as a potential advanced indicator of increases in suicidal behaviour. Vector Z_{it} includes other relevant country-specific socioeconomic factors (unemployment and economic growth). The first lag of the dependent variable is included to account for dynamic effects. Variables have been transformed for stationarity. Following Antonakakis and Collins (2018), in order to guarantee the consistency of the estimates due to the inclusion of the lagged dependent variable, the estimation of the coefficients is done by means of the system generalised method of moments (System-GMM), using a two-step approach. This procedure has been found to yield estimators with better finite sample properties in terms of bias (Blundell and Blond, 1998). To that effect, serial correlation tests AR(1) and AR(2), as well as the Wald test for join significance are reported in Table 2 and Table 3.

As a robustness check, and to examine regional differences, the analysis was replicated for: (i) the groupings of countries according to their income level (low, lower middle, upper middle, high), and (ii) five different regions of the world (East Asia and

the Pacific, Europe and Central Asia, Latin and the Caribbean, the Middle East and North Africa, and Sub-Saharan Africa). Due to the low number of cross-sectional units, North America and South Asia were not included. We have followed the World Bank classification (https://datahelpdesk.worldbank.org/knowledgebase/articles/378834-how-does-the-world-bank-classify-countries).

For the current 2022 fiscal year, low-income economies are defined as those with a gross national income (GNI) per capita, calculated using the World Bank Atlas method, of $1,045 or less in 2020; lower middle-income economies are those with a GNI per capita between $1,046 and $4,095; upper middle-income economies are those with a GNI per capita between $4,096 and $12,695; high-income economies are those with a GNI per capita of $12,696 or more.

Table 2. Regression results—Global and by level of income

	World	Low-income economies	Lower middle income economies	Upper middle income economies	High-income economies
GEPU(*t-1*)	0.089***	0.068***	0.060***	0.199***	-0.152***
	(0.002)	(0.019)	(0.011)	(0.014)	(0.022)
Unemployment	0.072***	0.143***	-0.007***	0.050	0.115***
	(0.001)	(0.005)	(0.003)	(0.004)	(0.009)
Economic growth	-0.006***	-0.007***	0.000	-0.005***	-0.004
	(0.000)	(0.003)	(0.001)	(0.001)	(0.003)
Lag of dependent	-0.032***	-0.046***	0.281***	-0.176***	-0.318***
	(0.000)	(0.008)	(0.001)	(0.004)	(0.002)
Constant	-0.084***	-0.158***	-0.052***	-0.078***	-0.087***
	(0.001)	(0.023)	(0.004)	(0.006)	(0.010)
AR(1) test *p*-value	0.000	0.025	0.001	0.002	0.041
AR(2) test *p*-value	0.054	0.290	0.058	0.354	0.334
Wald test *p*-value	0.000	0.000	0.000	0.000	0.000
Cross-sectional units	183	27	54	51	51
Observations	3294	486	972	918	918

Notes: Asymptotic standard errors between brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 2 presents the results for the whole sample of countries, as well as those obtained for the different groups of countries according to their income level. Table 3 presents the results for the five world regions previously mentioned. Results for the

Middle East and North Africa should be taken with caution, as the number of cross-sectional units is only 20.

Table 3. Regression results by region

	East Asia and Pacific	Europe and Central Asia	Latin America and Caribbean	Middle East and North Africa	Sub-Saharan Africa
GEPU(*t-1*)	-0.052* (0.027)	0.066*** (0.020)	0.011 (0.035)	0.021 (0.043)	0.027*** (0.018)
Unemployment	0.138*** (0.007)	0.144*** (0.008)	0.014*** (0.005)	0.013** (0.006)	0.054*** (0.004)
Economic growth	-0.014*** (0.003)	-0.007*** (0.002)	-0.013*** (0.002)	0.001* (0.001)	0.003 (0.001)
Lag of dependent	-0.134*** (0.008)	-0.274*** (0.002)	-0.131*** (0.007)	0.021 (0.043)	0.172*** (0.003)
Constant	-0.067*** (0.017)	-0.020* (0.011)	-0.065*** (0.020)	-0.066*** (0.009)	-0.134*** (0.008)
AR(1) test	0.037	0.037	0.010	0.015	0.003
AR(2) test	0.299	0.148	0.513	0.570	0.028
Wald test	0.000	0.000	0.000	0.000	0.000
Cross-sectional units	26	48	31	20	48
Observations	468	864	558	360	864

Notes: Asymptotic standard errors between brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Overall, it is found that increases in uncertainty growth are associated with increases in the growth of suicide mortality. This result is in line with recent research by Antonakakis and Gupta (2017), Claveria (2022), de Bruin et al. (2020), Vandoros et al. (2019) and Vandoros and Kawachi (2021). A similar result is found for increases in unemployment growth, with the only exception of lower middle-income economies. This finding corroborates previous research by Botha and Nguyen (2022) and Phillips and Nugent (2014), *inter alia*. The concomitances between unemployment and economic uncertainty can often be channelled by intermediate variables that have an impact on mental health. Examples of this may be drug or alcohol abuse (Kõlves et al., 2013), divorce (de Bruin et al., 2020), or sleep disruption caused by anxiety generated by job loss. In this sense, Blanchflower and Bryson (2021) have recently found evidence that the unemployed are more likely to suffer from disturbed sleep.

Economic growth and uncertainty are also highly intertwined, and have been proved to be strongly and negatively connected (Bachmann et al., 2013; Basu and Bundick, 2017; Jurado et al., 2015). As a result, one would expect that the effect that both variables may end up having on suicide risk will be different, given that while economic growth relates to first moment changes in economic conditions, uncertainty refers to the variance of these changes. Thus, increases in uncertainty reflect increases in the probability of change, being the outcome of this change dependent on the existent conditions prior to the shock in economic uncertainty. Proof of that is that, as opposed to uncertainty, we find that increases in the rhythm of GDP growth tend to be negatively associated with increases in the risk of suicide, the only exception being African countries. Somehow, these results connect with the previously mentioned mixed evidence regarding the relationship between income level and suicide mortality See Chen et al. (2012) for a review of empirical studies on the socio-economic aspects of suicide. In this sense, some authors point to a non-linear relationship between income and suicide mortality (Fountoulakis et al., 2014). Antonakakis and Collins (2018), found that for high-income countries, further income increases seemed to be associated with net negative mental health spillover effects.

4. Discussion

The obtained results show that increases in global economic uncertainty are associated with increased suicide risk. Notwithstanding, punctual differences were found for some groups of countries. Therefore, this Section discusses in more detail some of these findings, and the possible explanation for these divergent results. First of all, we want to note that the obtained results may be in part conditioned by several factors. On the one hand, since suicide is stigmatised or illegal in many countries, the availability and quality of information is often limited, especially in countries with small populations (WHO, 2021). On the other hand, as previously mentioned, for some regions there is a low number of cross-sectional units, which leads to take the results with caution. Finally, the high heterogeneity between the countries within each of the different groupings of countries should not be overlooked.

Taking all the above into account, the fact that in Sub-Saharan and North African countries increases in economic growth were associated to increased growth in suicide mortality, could to some degree be explained by the accentuated inequalities in the distribution of income consubstantial to economic growth. In a recent paper, Pak and Choung (2020) showed the impact that relative deprivation had on suicide risk in South Korea. In addition, countries with lower incomes tend to show greater resilience in the face of adverse situations. To this, once could add the fact that in countries with lower incomes, the informal economy tends to have a greater weight, thus facilitating the process of finding new occupations regardless of whether they are registered or not. This fact is often compounded by the existence of family support networks and social ties that tend to play a lesser role in higher income countries, which can also be a mitigating factor of economic downturns.

When replicating the analysis for different groups of countries according to their level of income, a negative sign between growth in economic uncertainty and growth in suicide rates is obtained for high-income countries (Table 2). Analogously, a negative sign is also obtained for the economies of East Asia and the Pacific when the analysis is replicated by region (Table 3). To a certain extent, this result could be explained by the existence of developed social welfare systems in most higher-income countries. In this regard, easier access to government aid, as well as to prevention programs and quality public medical care, would mitigate the economic strain caused by the initial impact of economic uncertainty shocks. In this regard, using US state data, Minoiu and Andrés (2008) found evidence that increases in the proportion of public health expenditure led to a reduction in total suicide rates. Additionally, we want to note that in certain circumstances, higher uncertainty may also be associated with new opportunities for improvement, and therefore with a lower risk of suicide behaviour.

Therefore, the obtained results show that overall, indicators of economic uncertainty can provide an early signal for the advanced detection of periods of higher suicidal risk. These findings are in line with recent evidence obtained for the US by Antonakakis and Gupta (2017) and Vandoros and Kawachi (2021), and for 17 countries of the Organisation for Economic Co-operation and Development (OECD) by de Bruin et al. (2020). Likewise, Claveria (2022) recently found that that economic uncertainty shocks have a more immediate reflection in suicide rates in Europe and Central Asia, while in the rest of the regions the bulk of the impact of a global uncertainty shock does not occur until a year after. Vandoros et al. (2019) found that daily economic uncertainty

led to increases in the risk of suicide in the short-run. Antonakakis and Collins (2014, 2015) showed that the uncertainty arising from fiscal adjustment measures has a significant impact on the increase in suicidality, especially among men of retiring age. Similarly, Abdou et al. (2020) recently found that economic insecurity, as measured by a volatility index, had an adverse impact on suicide incidences for males aged 15–24, and females aged 55–64.

When analysing the relationship between economic indicators and suicide rates in England and Wales before and after the 2008 recession, Coope et al. (2014) suggested that indicators of economic strain other than unemployment may contribute to increased suicide rates. Linked to this, Kõlves et al. (2013) showed that changes in suicide are related to a wide spectrum of socioeconomic disruptions. As noted by Vandoros et al. (2019), all this evidence reveals that suicide is the end result of an interaction between a wide-range of factors, and that economic uncertainty may act in some cases as trigger. Given that there is solid evidence that the risk factors linked to suicide, both from the community point of view and at the individual level, are very diverse, and that suicide can be prevented, it is imperative to design country-specific plans that allow improving the effectiveness of prevention strategies.

For this reason, in addition to providing evidence regarding the potential preventive role that indicators of economic uncertainty can have in generating an early signal of periods of greater risk, this paper also wants to point out the importance of collecting quality data related to deaths from suicide in the design of national response plans and in the implementation of preventive measures.

5. Conclusion

The present study has analysed the effect of economic factors, and more specifically of global economic uncertainty on suicide rates in 183 countries. Since economic uncertainty has been proven to be a driver of the business cycle, it is a suitable indicator to assess the impact that socioeconomic factors may end up having on suicide. Given the geographical scope of this study, uncertainty is gauged by a global index of economic policy uncertainty that is constructed by combining news-based text-mining measures of uncertainty in a set of countries.

First, when comparing the average and the growth in suicide rates during the first two decades of the present century across continents, upper-average levels are observed in Europe. Lesotho, Eswatini, Botswana and South Africa have particularly high average rates, despite having a lower average rate than Europe and Oceania. The distribution of the growth in suicide rates during the sample period by continent shows that some countries within each continent show particularly high rates of growth (e.g., Lesotho in Africa; Cyprus, Korea and Saudi Arabia in Asia; Portugal and Greece in Europe; and Papua New Guinea in Oceania).

Second, the short-run relationship between increases in economic uncertainty and increased suicide risk is assessed by estimating a dynamic panel model, controlling for unemployment and economic growth. Overall, it is found that increases in the growth of economic uncertainty and unemployment are associated with increased growth in suicide mortality, as opposed to economic growth. When replicating the experiment in different regions and in different groups of countries classified according to income level, the greatest impact of growth in economic uncertainty is found in upper middle-income economies. Given the anticipatory nature of economic uncertainty with respect to the evolution of the economy, and its relationship with suicide rates, the obtained results suggest the usefulness of uncertainty indicators as tools for the early detection of increases in suicide risk and for the design of suicide prevention programs.

Finally, we want to note some of the limitations of the present study. On the one hand, it should be highlighted that the findings may be conditioned by several biases derived from the measurement of suicide and uncertainty. In connection with this, the aggregate nature of the data did not allow us to analyse potential discrepancies between different socioeconomic groups. In addition, given the complex interplay between the very diverse factors that affect suicidal behaviour—some of which have not been considered in the present study due to the non-availability of data for the entire sample—, additional potential biases may have arisen. Regarding future lines of research, the use of alternative proxies of economic uncertainty, including different measures of specific dimensions of uncertainty, as well as the application of alternative techniques to model potential non-linear relationships between data, are aspects left for further analysis.

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