Suicides and Macroeconomic Variables: Are They Related in the Long-run?

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Abstract

Background

This study investigates the cross-country long run relationship between suicides and macroeconomic variables (unemployment, per capita income, and inflation). It is hypothesized that while inflation level and unemployment level stimulate suicide and intentional self-harm in a society, per capita income level alleviates suicide and intentional self-harm in a society.

Method

A balanced annual data spanning the period 2000 to 2012 across 35 countries is used in the empirical analysis. We employ panel test and estimation approaches to reveal the long-run association among suicide, inflation, per capita income and unemployment series. The most conventional cross-sectional dependency tests, panel unit root tests, panel cointegration tests, and heterogeneous panel non-causality tests are implemented.

Results

We found a statistically significant cross-country long run association between suicides and all macroeconomic variables under study. The results of the study suggest that while 1% increase in per capita income causes 0.752% decrease in suicide rate, 1% increase in inflation and unemployment rate is associated with a rise in suicide rate by 0.088% and 0.238%, respectively. In regard to causality, there is no causality is identified between inflation and suicide. On the other hand, a statistically significant unidirectional causality running from per capita income level to suicide and a unidirectional causality running from suicide to unemployment are found. A unidirectional causality running from suicide to unemployment can be stem from the fact that rises in suicides are associated with both early indicators of economic downturns and during economic downturns when unemployment increases.

Conclusion

Having found that adverse economic conditions such as increase in unemployment or inflation or decrease in per capita income triggers suicides and suicides are also associated with early indicators of economic crises, this study suggest that social and economic policy measures and programs related to labor market, health safety, family support and debt relief should be implemented both prior to and during economic crises in order to prevent suicides and loss of human capital of the society. Economic policies that result in a high level of unemployment or inflation should be critically assessed from the human cost of these measures.

Background

Economic theory of suicide outlined by Hamermesh and Soss [1] suggests that factors which lead to decrease in the expected lifetime utility and future income stream are associated with suicide. Especially,

the suicide rate is inversely related to the permanent income while it is positively related to unemployment. When unemployment rises and permanent income decreases, the suicide rate will increase since expected lifetime utility and future expected income stream of individuals diminish under these conditions. These factors emerge especially in times of economic downturn/recession when unemployment increases and per capita income decreases. Thus, adverse macroeconomic changes can lead to increase in the suicide rate of a society.

In this framework, economic downturn causes loss of employment, reduced career progression, threat of unemployment, increased debt, and financial strain which lead to increased stress at work, loss of status, loss of personal control, increased anxiety, negative relationships, marital breakdown, reduced social support in workplace and personal relationships, reduced social integration, decreased tolerance of mental illness, reduced access to mental health care, increased drug and alcohol misuse, increased mental illness and depression which may result in suicide [2].

Numerous country level empirical studies investigated the relationship between adverse macroeconomic changes and suicides. Country-level empirical studies suggest that adverse macroeconomic changes such as a sharp increase in unemployment and negative growth rates are associated with increase in suicide in some countries (USA, England, Ireland, Spain, Italy, Australia, Greece, Russia, Latvia, Japan, Korea, Taiwan, Singapore), while suicide mortality fell in some countries (Finland and Sweden) when economic deterioration happens. Variations in the findings are attributed to the welfare system, social protection policies, culture and social structures of countries [22, 16, 23, 24].

Empirical studies also indicate that the relationship between adverse economic conditions and suicide rates varies depending on the age and gender of the population. Findings indicate that the impact of adverse macro-economic conditions on suicide mortality is strongest among males and younger age groups [25, 15, 2, 17, 16, 27, 3].

There are also number of cross-country studies investigating the association between adverse macroeconomic changes and suicides. Andres [27] scrutinized the impact of socio-economic variables on the suicide rate in the context of 15 European countries between 1970 and 1998. No statistically significant impacts of unemployment rates and GDP per capita are found on suicide rates after controlling country-specific linear trends and country and year fixed effects. Stuckler et al. [28] examined the association between changes in employment and suicides in Europe by employing multivariate regression and data set including 26 European Union countries between 1970 and 2007. They found that every 1% increase in unemployment was associated with a 0.79% rise in suicides at ages younger than 65 years. Barth et al. [29] evaluated the association between socioeconomic factors (grosss domestic product, unemployment rates, labor force participation, and divorce rates) and suicide rates for 18 countries by using panel-vector error correction models. They found that socioeconomic factors are related to suicide rates although this relationship varies by sex. Increasing unemployment is significantly associated with increasing suicides for only women. Breuer [26] analyzed the effect of unemployment on suicide mortality in Europe by using a regional panel data set of 275 regions in 29 European countries

during the period 1999 to 2010. The results suggest that 1% increase in unemployment is associated with a 1% increase in suicides among individuals aged younger than 65 years old by controlling region-specific trends. Gajewski and Zhukovska [24] estimated the short and long run relationship between unemployment and suicide for a panel of 10 high-income countries. Only a long-run impact of unemployment on suicides was found to be significant for the liberal group of countries (Canada, United States, Australia, New Zealand, and United Kingdom) while there is no significant association for the social-democratic countries (Norway, Sweden, Denmark, Finland, and the Netherlands). Chang et al. [25] investigated the impact of Asian economic crises in 1997–1998 on suicide in Japan, Hong Kong, South Korea, Taiwan, Singapore and Thailand. Their finding suggests an association of the Asian economic crisis with a sharp increase in suicide in some but not all East/Southeast Asian countries. These increases are most closely associated with rises in unemployment.

Different from previous studies, this study investigates the long run relationship between suicides and selected macroeconomic variables (unemployment, per capita income, and inflation) which are potentially related with suicide behavior in a panel data context by using the most conventional economic techniques and sensitive robustness tests. This study also provides causality analysis which is lack of the previous studies. Previous studies have found strong associations between adverse economic conditions and suicide rates, but they fail to provide causality analysis which reduces the policy relevance of their study. Moreover, causality analysis which is put forth in this study reconciles the conflicting results of previous studies.

Next section provides research hypothesis of the study, data and methodology. Estimation results are given in Sect. 3 while Sect. 4 concludes.

Methods

Research Hypotheses

Based on the theoretical foundations outlined in the introduction and previous empirical studies on the subject, the following three hypotheses are tested in the empirical analysis section:

Hypothesis 1

Inflation level stimulates suicide and intentional self-harm in a society.

Hypothesis 2

Per capita income level alleviates suicide and intentional self-harm in a society.

Hypothesis 3

Unemployment level stimulates suicide and intentional self-harm in a society.

Data

A balanced annual data spanning the period 2000 to 2012 across 35 countries is used in the empirical analysis. The sample period and number of countries utilized in the analysis is determined by the availability of balanced data on suicide and intentional self-harm rate. Data on suicide and intentional self-harm rate are gathered from UNECE Statistical Database of UNECE while data on unemployment rate are collected from ILOSTAT made available by ILO. On the other hand, data on inflation rate and GDP per capita are obtained from the World Development Indicators (WDI) database published by the World Bank.

Suicide and intentional self-harm (SUICIDE): SUICIDE variable measures death rate per 100,000 population as a result of cause of death by suicide and intentional self-harm. This figure covers both sexes at all ages.

Inflation rate (INFLATION): Inflation rate is measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services.

GDP per capita (GDPPERCAP): GDPPERCAP variable represents GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. It is measured in terms of current international dollars.

Unemployment rate (UNEMPLOYMENT): UNEMPLOYMENT variable reflects the unemployment rate in an economy and is calculated by expressing the number of unemployed persons as a percentage of the total number of persons in the labor force. The labor force is imputed by the sum of the number of persons employed and the number of persons unemployed. It covers 15 + ages and both sexes.

Since our variables are measured in different units, we take the natural logarithmic transformation of each variable in order to normalize the variables so that each variable is expressed in a uniform unit. Another advantage of this transformation is that the coefficient of each variable now displays the elasticity of the relevant variable.

Estimation Methodology

We employ proper panel test and estimation approaches to reveal the long-run association among suicide, inflation, per capita income and unemployment series. In accordance with this purpose, we first test whether the series are cross-sectionally dependent. Secondly, given the existence of cross-sectional dependency, a panel unit root test accounting for cross-sectional dependency is applied to each variable. Upon identifying that each variable are I(1), we thirdly conduct panel cointegration test explicitly counting in cross-sectional dependency in order to disclose the long-run equilibrium relationship among the variables. In addition to panel cointegration test, we apply test of parameter constancy to see if we have heterogeneous parameters across panels. Once a panel cointegration relation and heterogeneous parameters are detected for relevant series, then long-run elasticities are obtained by using a convenient panel estimation approach taking both cross-sectional dependency and heterogeneous parameters into

account. Lastly, heterogeneous panel non-causality test is implemented to find out the direction of causality among the series.

In accordance with the objective of the study, we construct the following equations as the benchmark models:

$SUICIDE_{it} = f(INFLATION_{it}, \mu_i)$ (1)

$SUICIDE_{it} = f(GDPPERCAP_{it}, \square_i)$ (2)

$SUICIDE_{it} = f(UNEMPLOYMENT_{it}, \square_i)$ (3)

where μ_i, $\square_i$ and $\square_i$ stands for country specific fixed effects and *it* subscript represents *i-th* country's observation at time *t*.

As can be seen from Table 1, based on the results of Farrar-Glauber Multicollinearity Chi-square and F tests, there is a multicollinearity problem among INFLATION, GDPPERCAP, and UNEMPLOYMENT variables. Therefore, in that sense it will be better to separately check the long-run association of each variable with SUICIDE variable.

Table 1
Multicollinearity Test

Farrar-Glauber Multicollinearity Chi-square Test (H0: No Multicollinearity)		
	Test statistic	**P-value**
Farrar-Glauber Multicollinearity F Test (H0: No Multicollinearity)		
	Test statistic	P-value
INFLATION	76.673	0.013
GDPPERCAP	153.158	0.007
UNEMPLOYMENT	73.945	0.013

Results

As recently discussed in the literature, the conventional unit root tests are inappropriate to test the stationarity of series in the case of presence of cross-sectional dependence in series since they assume cross-sectional independence. Hence, instead of conventional unit root tests, it will be better to conduct second-generation unit root test, which accounts for cross-sectional dependence. Thus, we started our empirical analysis firstly by implementing various cross-sectional dependence tests. Table 2 displays cross-sectional dependence test results for four distinct tests, namely Breusch-Pagan [30] LM test, Pesaran [31] scaled LM test, Baltagi, Feng, and Kao [32] Bias-corrected Scaled LM test, Pesaran [31] CD test. The entire test results depicted in Table 2 strongly rejects the null hypothesis of "No cross-section dependence" at the 1% significance level in the data.

Table 2
Cross-Section Dependence Test (H0: No cross-section dependence (correlation))

INFLATION	**Test-statistic**	**P-value**
Breusch-Pagan [30] LM	1434.992	0.000
Pesaran [31] scaled LM	26.092	0.000
Baltagi, Feng, and Kao [32] Bias-corrected Scaled LM	24.676	0.000
Pesaran [31] CD	27.964	0.000
GDPPERCAP	**Test-statistic**	**P-value**
Breusch-Pagan [30] LM	7130.548	0.000
Pesaran [31] scaled LM	189.456	0.000
Baltagi, Feng, and Kao [32] Bias-corrected Scaled LM	187.998	0.000
Pesaran [31] CD	84.287	0.000
UNEMPLOYMENT	**Test-statistic**	**P-value**
Breusch-Pagan [30] LM	1921.121	0.000
Pesaran [31] scaled LM	38.442	0.000
Baltagi, Feng, and Kao [32] Bias-corrected Scaled LM	36.984	0.000
Pesaran [31] CD	16.124	0.000
SUICIDE	**Test-statistic**	**P-value**
Breusch-Pagan [30] LM	2801.451	0.000
Pesaran [31] scaled LM	63.962	0.000
Baltagi, Feng, and Kao [32] Bias-corrected Scaled LM	62.503	0.000
Pesaran [31] CD	41.771	0.000

We also conducted residual cross-section independence test for the error terms of the models in Eqs. 1, 2 and 3. As indicated by the results in Table 3, null hypothesis of cross-section independence is rejected for each equation.

Table 3
Residual Cross-Section Independence Test (H0:Cross-section independence)

Eq. 1 (SUICIDE-INFLATION)	**Test-statistic**	**P-value**
Breusch-Pagan [30] LM	1932	0.000
Pesaran, Ullah and Yamagata [34] bias-adjusted LM	76.590	0.000
Pesaran [31] CD	32.500	0.000
Eq. 2 (SUICIDE-GDPPERCAP)	**Test-statistic**	**P-value**
Breusch-Pagan [30] LM	1072	0.000
Pesaran, Ullah and Yamagata [34] bias-adjusted LM	20.360	0.000
Pesaran [31] CD	0.943	0.346
Eq. 3 (SUICIDE-UNEMPLOYMENT)	**Test-statistic**	**P-value**
Breusch-Pagan [30] LM	1377	0.000
Pesaran, Ullah and Yamagata [34] bias-adjusted LM	40.580	0.000
Pesaran [31] CD	19.710	0.000

Given the detection of cross-sectional dependence in the data suggested by the test results in Tables 2 and 3, we apply the CIPS test for unit roots in heterogeneous panels developed by Pesaran [35] accounting for cross-sectional dependence. The CIPS test results are displayed in Table 4 below. According to the indications of the test, all series are not stationary in levels but they are stationary in first differences at 1% significance level. In other words, the CIPS unit root test findings hint that variables of SUICIDE, INFLATION, GDPPERCAP, and UNEMPLOYMENT are integrated of order one (i.e. I (1)).

Table 4
CIPS test (H0: homogeneous non-stationary)

	Levels	**First Differences**
SUICIDE	-2.502	-3.446***
UNEMPLOYMENT	-1.744	-3.113***
INFLATION	-2.715	-3.672***
GDPPERCAP	-2.053	-3.180***
Notes: *** indicates statistical significance at 1% level. The model used in CIPS unit root test contains a constant term and time trend.		

Upon identifying that our series are I(1), we check the cointegration relation among variables by utilizing two different panel cointegration test paying regard to cross-sectional dependence across panels. First, we apply Persyn and Westerlund [36] error-correction-based panel cointegration tests with robust P-

values, which is obtained through bootstrapping. The findings are reported in Table 5 and the last column shows the robust P-values in the sense of cross-sectional dependence. Gτ and Gα, which allow error correction terms to be heterogeneous across panels, stand for group-mean test results while Pτ and Pα, which assume error correction terms to be homogeneous across panels, stand for panel test results. Besides, group-mean test looks for cointegration in some panels whereas panel test seeks for cointegration in all panels. Robust P-values in Table 5 reveals that SUICIDE and GDPPERCAP variables are cointegrated with regard to the both test findings while there is a cointegration association between SUICIDE and INFLATION variables and between SUICIDE and UNEMPLOYMENT variables based on just panel test results not for group-mean test results.

Table 5
Persyn and Westerlund [37] ECM panel cointegration tests (H0: No cointegration)

SUICIDE-INFLATION	**Test Statistic**	**P-value**	**Robust P-Value**
Gτ	-1.810	0.416	0.220
Gα	-4.763	0.995	0.400
Pτ	-12.361	0.000	0.010
Pα	-5.294	0.081	0.040
SUICIDE-GDPPERCAP	**Test Statistic**	**P-value**	**Robust P-Value**
Gτ	-2.416	0.000	0.000
Gα	-6.860	0.621	0.000
Pτ	-16.531	0.000	0.000
Pα	-8.522	0.000	0.000
SUICIDE-UNEMPLOYMENT	**Test Statistic**	**P-value**	**Robust P-Value**
Gτ	-1.922	0.171	0.120
Gα	-5.189	0.983	0.160
Pτ	-12.627	0.000	0.040
Pα	-5.499	0.045	0.030

Next, we carried out heterogeneous ECM panel cointegration test of Gengenbach, Urbain and Westerlund [34] in which cross-sectional dependence is explicitly taken into consideration. Table 6 reports the findings of the test. The results imply that there is no cointegrating relation between SUICIDE and INFLATION variables whereas there exists a cointegrating relation between SUICIDE and GDPPERCAP variables and between SUICIDE and UNEMPLOYMENT variables at 1% significance level. In overall the findings of two distinct cointegration tests in Tables 5 and 6 strongly support the presence of cointegration for the models in Eqs. 2 and 3 while weakly support the existence of cointegration for the

model in Eq. 1. Even though there is a weak evidence for the existence of cointegration in the model of Eq. 1, we will assume cointegrating relation for that equation too and therefore we will estimate long-run elasticities for the model in Eq. 1 as well in addition to the models Eqs. 2 and 3.

Table 6
Gengenbach, Urbain and Westerlund [33] heterogeneous ECM panel cointegration test (H0: No cointegration)

	EC-coefficient	T-bar Statistic	Significance
SUICIDE-INFLATION	-0.834	-2.399	not significant at 1%
SUICIDE-GDPPERCAP	-1.397	-3.830	significant at 1%
SUICIDE-UNEMPLOYMENT	-1.149	-3.602	significant at 1%

Before proceeding to estimations of long-run elasticities we implement Swamy test of parameter constancy to find out whether parameters across panels are heterogeneous. Reported results in Table 7 show that parameters do not remain constant across panels for all three models. Therefore, the estimation model that will be chosen to estimate long-run elasticities should allow for heterogeneous slope coefficients across panel members and also account for correlation across panel members (i.e., cross-section dependence). For that reason, we preferred to use the Augmented Mean Group (AMG) estimator developed in Eberhardt and Teal [37] as an alternative to the Common Correlated Effects Mean Group (CCEMG) estimator.

Table 7
Swamy parameter constancy test

	Test statistic	P-value
SUICIDE-INFLATION	18948.090	0.000
SUICIDE-GDPPERCAP	25828.270	0.000
SUICIDE-UNEMPLOYMENT	35218.480	0.000

Table 8 below depicts the long-run elasticities for the model in Eq. 1. As seen from the mean group estimation results, coefficient of error correction term, as expected, is negative and statistically significant and hence this guarantees existence of a log-run association between SUICIDE and INFLATION. The long-run coefficient of INFLATION is positive and statistically significant at 10% significance level. This finding hint that an increase in inflation by 1% leads to a rise in suicide rate by 0.088%. Regarding to group specific estimation results, both coefficient of error correction term and long-run coefficient are statistically significant for just Romania, Spain, Switzerland and Czech Republic. Long-run elasticities are positive for Romania, Spain and Switzerland whereas it is negative for Czech Republic. A one percent increase in inflation lead to an increase in suicide rate by 0.090% in Romania, 0.135% in Spain, 0.612% in Switzerland.

Table 8
Long-run Elasticities for Eq. 1

Mean group estimation results		
	EC-coef.	Long-run coef.
	-1.353	**0.088**
	0.000	*0.061*
Group specific estimation results		
	EC-coef.	Long-run coef.
Austria	**-1.160**	**0.004**
	0.000	*0.968*
Belgium	**-1.576**	**-0.074**
	0.000	*0.382*
Bulgaria	**-0.248**	**0.175**
	0.665	*0.038*
Switzerland	**-1.798**	**0.612**
	0.000	*0.000*
Czech Republic	**-0.936**	**-0.171**
	0.051	*0.080*
Germany	**-1.037**	**0.015**
	0.000	*0.884*
Denmark	**-2.187**	**0.176**
	0.052	*0.411*
Spain	**-1.384**	**0.135**
	0.000	*0.011*
Estonia	**-1.127**	**-0.035**
	0.207	*0.881*
Finland	**-1.644**	**0.042**
	0.268	*0.769*

Notes: Coefficient estimations are in bold faces and P-values are in italic forms. We dropped Turkmenistan from the estimation since Turkmenistan has no observation for inflation.

Mean group estimation results		
France	**-1.469**	**-0.044**
	0.215	*0.814*
United Kingdom	**-2.113**	**0.033**
	0.000	*0.858*
Greece	**-1.196**	**1.270**
	0.085	*0.180*
Croatia	**-2.030**	**0.069**
	0.001	*0.369*
Hungary	**-1.374**	**0.059**
	0.000	*0.297*
Iceland	**-2.088**	**0.317**
	0.000	*0.131*
Israel	**-1.013**	**0.016**
	0.030	0.912
Kazakhstan	**-1.052**	**0.209**
	0.119	*0.077*
Kyrgyz Republic	**-0.907**	**0.036**
	0.152	*0.789*
Lithuania	**-1.621**	**-0.044**
	0.003	*0.292*
Luxembourg	**-2.118**	**0.600**
	0.003	*0.465*
Latvia	**-3.757**	**-0.208**
	0.032	*0.146*
Moldova	**-1.040**	**0.105**
	0.692	*0.408*

Notes: Coefficient estimations are in bold faces and P-values are in italic forms. We dropped Turkmenistan from the estimation since Turkmenistan has no observation for inflation.

Mean group estimation results		
Macedonia, FYR	**-0.833**	**0.020**
	0.290	*0.870*
Malta	**-1.808**	**-0.092**
	0.000	*0.911*
Netherlands	**-0.875**	**-0.006**
	0.029	*0.956*
Norway	**-1.588**	**-0.034**
	0.016	*0.816*
Poland	**-1.256**	**0.030**
	0.000	*0.645*
Romania	**-1.541**	**0.090**
	0.000	0.047
Russian Federation	**-0.125**	**-0.065**
	0.897	*0.691*
Serbia	**-0.464**	**-0.092**
	0.650	*0.571*
Slovenia	**-0.629**	**-0.100**
	0.613	*0.520*
Sweden	**-0.555**	**-0.044**
	0.680	*0.739*
Turkmenistan	**NA**	**NA**
	NA	*NA*
Ukraine	**-1.463**	**-0.020**
	0.010	*0.544*
Notes: Coefficient estimations are in bold faces and P-values are in italic forms. We dropped Turkmenistan from the estimation since Turkmenistan has no observation for inflation.		

Table 9 below displays the long-run elasticities for the model in Eq. 2. The coefficient of error correction term is negative and statistically significant as seen from the mean group estimation results, ensuring the existence of a log-run relationship between SUICIDE and GDPPERCAP. The long-run coefficient of

GDPPERCAP is negative and statistically significant at 1% significance level. This finding suggests that an increase in GDP per capita by 1% results in a fall in suicide rate by 0.752%. Regarding to group specific estimation results, both coefficient of error correction term and long-run coefficient are statistically significant for Estonia, Finland, France, United Kingdom, Croatia, Kazakhstan, Lithuania, Latvia, Macedonia, Netherlands, Norway, and Ukraine. Long-run elasticities are negative for Estonia, France, United Kingdom, Croatia, Lithuania, Latvia, Netherlands, Norway, and Ukraine while they are positive for Finland, Kazakhstan, and Macedonia. A one percent increase in GDP per capita cause to a decrease in suicide rate by 1.286% in Estonia, 5.265% in France, 1.957% in United Kingdom, 0.636% in Croatia, 1.666% in Lithuania, 1.802% in Latvia, 2.537% in Netherlands, 0.828% in Norway, and 1.114% in Ukraine.

Table 9
Long-run Elasticities for Eq. 2

Mean group estimation results		
	EC-coef.	Long-run coef.
	-1.722	**-0.752**
	0.000	*0.005*
Group specific estimation results		
	EC-coef.	Long-run coef.
Austria	**-0.980**	**-2.679**
	0.426	*0.248*
Belgium	**-0.680**	**-1.865**
	0.512	*0.593*
Bulgaria	**-0.485**	**-0.615**
	0.588	*0.439*
Switzerland	**-1.228**	**0.020**
	0.000	*0.951*
Czech Republic	**-1.474**	**-2.320**
	0.136	*0.144*
Germany	**-0.286**	**0.333**
	0.344	*0.790*
Denmark	**-1.133**	**-1.834**
	0.330	*0.153*
Spain	**-1.976**	**-0.457**
	0.001	*0.133*
Estonia	**-1.447**	**-1.286**
	0.022	*0.005*
Finland	**-1.399**	**1.191**
	0.000	*0.000*
France	**-7.028**	**-5.265**

Notes: Coefficient estimations are in bold faces and P-values are in italic forms.

Mean group estimation results		
	0.020	*0.052*
United Kingdom	**-3.009**	**-1.957**
	0.001	*0.001*
Greece	**-1.643**	**-1.212**
	0.056	*0.183*
Croatia	**-1.834**	**-0.636**
	0.035	*0.020*
Hungary	**-1.094**	**-1.457**
	0.276	*0.413*
Iceland	**-1.728**	**1.038**
	0.000	*0.420*
Israel	**-0.355**	**0.399**
	0.416	0.777
Kazakhstan	**-1.662**	**0.568**
	0.009	*0.053*
Kyrgyz Republic	**-0.631**	**-2.415**
	0.212	*0.161*
Lithuania	**-1.907**	**-1.666**
	0.020	*0.054*
Luxembourg	**-1.898**	**0.492**
	0.028	*0.824*
Latvia	**-2.844**	**-1.802**
	0.007	*0.011*
Moldova	**-1.638**	**0.729**
	0.152	*0.184*
Macedonia, FYR	**-3.543**	**2.435**
	0.000	*0.056*

Notes: Coefficient estimations are in bold faces and P-values are in italic forms.

Mean group estimation results		
Malta	**-1.849**	**2.364**
	0.001	*0.771*
Netherlands	**-1.695**	**-2.537**
	0.017	*0.004*
Norway	**-1.799**	**-0.828**
	0.003	*0.098*
Poland	**-0.933**	**0.596**
	0.017	*0.529*
Romania	**-1.339**	**-0.151**
	0.000	0.536
Russian Federation	**-1.316**	**0.156**
	0.013	*0.347*
Serbia	**-1.577**	**0.045**
	0.011	*0.918*
Slovenia	**-2.729**	**-1.583**
	0.154	*0.011*
Sweden	**-1.396**	**0.011**
	0.024	*0.983*
Turkmenistan	**-0.872**	**-3.022**
	0.042	*0.148*
Ukraine	**-2.873**	**-1.114**
	0.006	*0.003*
Notes: Coefficient estimations are in bold faces and P-values are in italic forms.		

The long-run elasticities for the model in Eq. 3 are provided in Table 10. The coefficient of error correction term is negative and statistically significant which ensures the existence of a log-run correlation between SUICIDE and UNEMPLOYMENT. The long-run coefficient of UNEMPLOYMENT is positive and statistically significant at 1% significance level which indicates that a rise in UNEMPLOYMENT by 1% causes suicide rate to increase by 0.238%. Regarding to group specific estimation results, both coefficient of error correction term and long-run coefficient are statistically significant for Belgium, Denmark, Estonia,

Finland, United Kingdom, Greece, Hungary, Lithuania, Latvia, Poland, Serbia, and Slovenia. Long-run elasticities are positive for Denmark, Estonia, United Kingdom, Greece, Hungary, Lithuania, Latvia, Poland, Serbia, and Slovenia whereas they are negative for Belgium and Finland. A one percent increase in unemployment rate causes to an increase in suicide rate by 0.222% in Denmark, 0.489% in Estonia, 0.407% in the United Kingdom, 0.563% in Greece, 0.558% in Hungary, 0.249% in Lithuania, 0.378% in Latvia, 0.257% in Poland, 0.265% in Serbia, and 0.514% in Slovenia.

Table 10
Long-run Elasticities for Eq. 3

Mean group estimation results		
	EC-coef.	Long-run coef.
	-1.501	**0.238**
	0.000	*0.011*
Group specific estimation results		
	EC-coef.	Long-run coef.
Austria	**-0.326**	**-0.365**
	0.515	*0.119*
Belgium	**-1.246**	**-0.630**
	0.008	*0.044*
Bulgaria	**-0.872**	**0.063**
	0.294	*0.701*
Switzerland	**-0.604**	**-0.049**
	0.000	*0.568*
Czech Republic	**-1.134**	**0.419**
	0.571	*0.665*
Germany	**-0.890**	**-0.111**
	0.000	*0.407*
Denmark	**-1.649**	**0.222**
	0.073	*0.051*
Spain	**-1.443**	**0.051**
	0.004	*0.259*
Estonia	**-2.563**	**0.489**
	0.001	*0.002*
Finland	**-1.391**	**-0.425**
	0.006	*0.000*
France	**-1.020**	**-0.226**

Notes: Coefficient estimations are in bold faces and P-values are in italic forms.

Mean group estimation results		
	0.342	*0.463*
United Kingdom	**-2.521**	**0.407**
	0.000	*0.020*
Greece	**-2.649**	**0.563**
	0.000	*0.010*
Croatia	**-2.119**	**0.116**
	0.002	*0.472*
Hungary	**-1.396**	**0.558**
	0.000	*0.000*
Iceland	**-1.480**	**-0.285**
	0.002	*0.176*
Israel	**-0.785**	**0.540**
	0.059	0.380
Kazakhstan	**-0.656**	**0.395**
	0.317	*0.697*
Kyrgyz Republic	**-1.197**	**0.939**
	0.247	*0.448*
Lithuania	**-1.599**	**0.249**
	0.056	*0.009*
Luxembourg	**-1.511**	**-0.532**
	0.073	*0.371*
Latvia	**-2.504**	**0.378**
	0.000	*0.001*
Moldova	**-1.183**	**-0.385**
	0.332	*0.152*
Macedonia, FYR	**-1.735**	**0.228**
	0.018	*0.863*

Notes: Coefficient estimations are in bold faces and P-values are in italic forms.

Mean group estimation results		
Malta	**-1.630**	**1.131**
	0.001	*0.576*
Netherlands	**-1.093**	**0.208**
	0.090	*0.381*
Norway	**-2.234**	**0.094**
	0.000	*0.589*
Poland	**-3.256**	**0.257**
	0.002	*0.018*
Romania	**-0.852**	**-0.122**
	0.152	0.827
Russian Federation	**-0.991**	**-0.101**
	0.121	*0.322*
Serbia	**-1.415**	**0.265**
	0.008	*0.051*
Slovenia	**-2.948**	**0.514**
	0.002	*0.002*
Sweden	**-0.330**	**0.634**
	0.596	*0.020*
Turkmenistan	**-1.341**	**2.405**
	0.066	*0.269*
Ukraine	**-1.991**	**0.434**
	0.150	*0.179*
Notes: Coefficient estimations are in bold faces and P-values are in italic forms.		

Lastly, we performed Dumitrescu and Hurlin [38] heterogeneous panel non-causality test to identify the direction of causality among the series and displayed the findings in Table 11. There is no a causality relationship between SUICIDE and INFLATION variables while there is a uni-directional causality association between SUICIDE and GDPPERCAP variables running from GDPPERCAP to SUICIDE, and a uni-directional causality association between SUICIDE and UNEMPLOYMENT variables running from SUICIDE to UNEMPLOYMENT.

Table 11
Dumitrescu and Hurlin [38] Granger non-causality test

H0: GDPPERCAP does not Granger-cause SUICIDE.	
Z-bar tilde	P-value
3.855	0.000
H0: SUICIDE does not Granger-cause GDPPERCAP.	
Z-bar tilde	P-value
1.126	0.260
H0: UNEMPLOYMENT does not Granger-cause SUICIDE.	
Z-bar tilde	P-value
1.232	0.218
H0: SUICIDE does not Granger-cause UNEMPLOYMENT.	
Z-bar tilde	P-value
2.189	0.029
H0: INFLATION does not Granger-cause SUICIDE.	
Z-bar tilde	P-value
0.005	0.996
H0: SUICIDE does not Granger-cause INFLATION.	
Z-bar tilde	P-value
-0.366	0.714
Notes: Optimal number of lags is selected based on BIC criteria.	

Discussion

In summary, our estimation results suggest that %1 increase in per capita income causes 0.752% decrease in suicide rate while 1% increase in inflation and unemployment rate is associated with a rise in suicide rate by 0.088% and 0.238%, respectively. As the estimation results reveal that, among three macro-economic variables, per capita income has the largest impact on suicide.

Causality analysis provided in this study confirms the results of previous studies on the impact of GDP per capita on suicides. Meanwhile, a unidirectional causality running from suicide to unemployment is identified opposite to the expectations of previous studies on the effect of unemployment on suicides. However, this result is consistent with observations of Stuckler [22] that suicides rises both before and during times of increases in unemployment. In other words, it is observed that suicides increase with the

emergence of early indicators of economic crises when unemployment rate is still low as well as with economic recession when unemployment rate is high. Thus, this result also reconciles the conflicting results of previous studies.

Consistent with country-specific studies, our findings also indicate that estimation results for Finland regarding the impact of unemployment and GDP per capita on suicides is opposite to the group specific estimations of other countries in the sample. Besides Finland, it is found that estimation results of Czech Republic for the impact of inflation on suicides, estimation results of Kazakhstan and Macedonia for the impact of GDP per capita on suicides and estimation result of Belgium for the effect of unemployment on suicides are opposite to the group specific estimations of other countries.

Conclusion

According to the modern economic theory, human capital is one of the important wealth of nations. Suicide of an individual means the loss of the human capital of the nation from the economic point of view. Thus, preventing suicides and developing suicide prevention strategies are important both from economic and social point of view. Suicide prevention strategies need to be developed. At the first place, it is important to determine the reasons and causes of suicides to develop suicide prevention strategies.

This study suggests that there is a statistically significant cross-country long run association between suicides and macroeconomic variables of inflation, unemployment rate and per capita income. The results of the study indicate that while %1 increase in per capita income causes 0.752% decrease in suicide rate, 1% increase in inflation and unemployment rate is associated with a rise in suicide rate by 0.088% and 0.238%, respectively.

In regard to causality, there is no causality is identified between inflation and suicide. On the other hand, a unidirectional causality running from per capita income level to suicide and a unidirectional causality running from suicide to unemployment are found. A unidirectional causality running from suicide to unemployment can be stem from the fact that rise in suicides is associated with both early indicators of economic downturns and during economic downturns when unemployment increases.

Having found that adverse economic conditions such as increase in unemployment or inflation or decrease in per capita income triggers suicides and suicides are also associated with early indicators of economic crises, this study suggest that social and economic policy measures and programs related to labor market, health safety, family support and debt relief should be implemented both prior to and during economic crises in order to prevent suicides and loss of human capital of the society. Economic policies that result in a high level of unemployment or inflation should be critically assessed from the human cost of these measures.

Declarations

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable

Availability of data and materials:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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The authors declare that they have no competing interests.

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