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RESEARCH ARTICLE

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The long-run analysis of the association between macroeconomic variables and suicide: the case of Turkic-speaking countries in Central Asia

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ABSTRACT

Using an unbalanced data set covering the years from 1990 to 2017, this study examines the long-run relationship between three selected macroeconomic variables (unemployment, per capita gross domestic product (GDP) and inflation) and suicide rates for Turkic-speaking countries in Central Asia and the South Caucasus (Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan). The mean group estimation results suggest that among the three macroeconomic variables under study, only the unemployment rate has a statistically significant relationship with the suicide rate for the Central Asian Turkic-speaking countries. Regarding country-specific estimations, results suggest that all macroeconomic variables under study correlate with the suicide rate for some countries in the sample. Overall, the empirical findings of the study suggest that unemployment and per capita GDP are important contributors of suicide and intentional self-harm in Central Asia. Estimation results also call attention to the inflation rate.

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suicides; unemployment; inflation; income per capita; economic crisis; Turkic-speaking countries in Central Asia

Introduction

According to modern economic theory, human capital can be an important part of national wealth. The suicide of an individual means a loss of human capital for the nation from an economic perspective. Thus, preventing suicide and developing suicide prevention strategies are important both from an economic and a social perspective. The issue is also recognized in the first-ever Mental Health Action Plan of the World Health Organization (WHO) in 2013 as suicide prevention and the goal of reducing the rate of suicide in member countries is adopted as an integral part of the plan (WHO 2014, 7). Accordingly, suicide prevention strategies need to be developed. However, in the first place, it is important to determine the reasons and causes of suicidal behaviours to develop suicide prevention strategies.

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More than a century ago, researchers such as Henry Morselli and Emile Durkheim recognized that economic uncertainty may contribute to an increase in the rate of suicide. During economic difficulties, household employment and disposable income decrease while prices increase. This situation may lead to stress-related disorders, depressive symptoms and mental health problems, and eventually may result in suicides (Bernal et al. 2013).

The question of whether there is a relationship between economic hardship and an increase in suicide was brought to the fore again with the COVID-19 pandemic. One of the proposed links between the COVID-19 pandemic and suicide rates is economic hardship. It is argued that economic difficulties brought by the pandemic might have led individuals to attempt suicide (Sher, 2020). The results of recent empirical studies indicate that whether the pandemic has led to an increased incidence of suicide is ambiguous (Shrestha et al. 2021; Bhuiyan et al. 2021; Clay 2020; Sher 2020). The answer to this research question may be clear from a longitudinal perspective, because a much longer time series may provide stronger and more uniform empirical findings.

Although most suicides take place in low- and middle-income countries (WHO 2014, 17–18), most of the research on suicide in the literature is on Western and developed countries (Savani et al. 2020). In this regard, Savani et al. (2020, 3) emphasizes that one of the least studied regions is Turkic-speaking countries in Central Asia, namely Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan. Suicide is a very sensitive topic in Central Asia due to religious and national traditions (Satybaldieva 2021). It is reported that this region has been experiencing high rates of unemployment and a rapid pace of growth in suicide and attempted suicide, particularly among the youth (Savani et al. 2020; Bakiev, Aliiaskarov, and Ismailov 2021). Thus, there is an urgent need to investigate suicide risk factors and determinants of suicide in this region to develop suicide prevention strategies. Among the few cross-country studies investigating factors associated with suicides in the Central Asian countries, there is no cross-country study investigating the relationship between macroeconomic factors and suicide in Turkic-speaking countries in Central Asia and the Caucasus. Moreover, research to date has not assessed the long-term effect of economic factors on suicide rates in Central Asia and the Caucasus. This study attempts to do just that.

Methodologically, focusing on Turkic-speaking countries in Central Asia and the Caucasus also provides a homogenous panel of countries.[1] For example, these countries were once republics in the USSR, they declared their independence around the same time, they have faced similar challenges inherited from the Soviet system and they possess religious, cultural and social similarities.

To examine the long-run relationship between selected three macroeconomic variables (namely unemployment, per capita gross domestic product (GDP) and inflation) and suicide rates and the impact of these macroeconomic variables on suicide rates for Turkic-speaking countries in Central Asia and the South Caucasus (Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan), both mean group estimations and country-specific estimations were carried out by using an unbalanced data set covering the years 1990–2017. For the objectives of the study, this research is structured as follows. The next section provides a literature review. The theoretical model, research hypothesis, data and methodology are provided in the third section, while the fourth section presents descriptive statistics and the estimation of results. The fifth section discusses the estimation results. Finally, the sixth section concludes.

Literature review

Numerous country-level empirical studies have 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 GDP growth rates are associated with increase in suicide in some countries (United States, England, Canada, Ireland, Spain, Italy, Australia, Greece, Russia, Latvia, Japan, Korea, Taiwan and Singapore) and decrease in suicide in others (Finland and Sweden).[2] Variations in the findings are attributed to the welfare system, social protection policies, culture and social structures of countries (Stuckler et al. 2011; Coope et al. 2014; Rajmil et al. 2014; Gajewski and Zhukovska 2017; Jacop et al. 2019; Gilmour et al. 2019).

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 macroeconomic conditions on suicide mortality is strongest among males and younger age groups (Chang et al. 2009; Barr 2012; Bernal 2013; Jalles and Andresen 2014; Coope et al. 2014; Breuer 2015; Rachiotis et al. 2015; Canu et al. 2019).

There several cross-country studies investigate the association between adverse macroeconomic changes and suicides. Andres (2005) 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 impact of unemployment rates and GDP per capita were found on suicide rates after controlling for country-specific linear trends and country and year fixed effects. Stuckler et al. (2009) 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 suicide at ages younger than 65 years. Barth et al. (2011) evaluated the association between socio-economic factors (GDP, unemployment rates, labour force participation and divorce rates) and suicide rates for 18 countries by using panel-vector error correction models. They found that socio-economic factors are related to suicide rates, although this relationship varies by sex. Increasing unemployment is significantly associated with growing suicide in women. Breuer (2015) analysed 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 1999–2010. The results suggest that a 1% increase in unemployment is associated with a 1% increase in suicide among individuals aged younger than 65 years old by controlling region-specific trends. Gajewski and Zhukovska (2017) 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 suicide was found to be significant for the liberal group of countries (Canada, United States, Australia, New Zealand and the UK), while there is no significant association for the social-democratic countries (Norway, Sweden, Denmark, Finland and the Netherlands). Chang et al. (2009) investigated the impact of Asian economic crises in 1997–98 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. Using the ordinary least squares (OLS) regression analysis and establishing five different models, İlgün et al. (2020) examined

individual and socio-demographic determinants of suicide in 18 industrialized countries for the period 1983–2007. Their results indicate that unemployment rates have a statistically significant effect on suicide cases.

It can be noticed from the literature review that all cross-country studies investigating the association between adverse macroeconomic changes and suicides are in the context of European Union countries and high-income countries. Unemployment rate, GDP and GDP per capita are the most common factors leading to suicide among macroeconomic indicators in cross-country studies. Results of cross-country studies among European Union member states and high-income countries indicate that unemployment rates have a statistically significant effect on suicide cases.

Suicide rates in Turkic countries in Central Asia

The suicide rate (percentage share of deaths from suicide) data of the five Turkic countries (i.e., Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan) are reported in Table 1; their graphical illustrations are presented in Figure 1. Figure 1 reflects the trends of suicide rates over time for each country. The suicide rate in Azerbaijan drops by the end of 1994, after which the suicide rate sharply increases up to 2008 and then declines. Thus, the general pattern of the suicide rate in Azerbaijan, as in a cubic function, has two turning points: first, it falls, and second, it rises, and lastly, it decreases. Regarding the behavioural pattern of suicide rates in Kazakhstan, it acts in a parabolic function. More specifically, the suicide rate in Kazakhstan consistently augments by the end of 2006 and

Table 1. Suicide rate data for the period 1990–2017.

Year	*SUICIDE_AZE*	*SUICIDE_KAZ*	*SUICIDE_KGZ*	*SUICIDE_TKM*	*SUICIDE_UZB*
1990	0.37882479	2.5758047	1.7173885	1.032603	1.1746442
1991	0.35489062	2.5964213	1.7536337	0.99731458	1.1597264
1992	0.32137343	2.6865772	1.7504503	0.9923581	1.1185414
1993	0.31269118	2.7371824	1.7663325	1.0178369	1.1264129
1994	0.29141649	2.7800278	1.7706053	1.0341386	1.1619136
1995	0.30110828	2.9335746	1.8208208	1.0595854	1.1797368
1996	0.30150549	3.0392954	1.8131884	1.1395586	1.2741983
1997	0.30968383	3.0686658	1.8317657	1.268514	1.3446766
1998	0.32112436	3.0715999	1.8866274	1.4070432	1.3844075
1999	0.34967934	3.1426601	1.9616165	1.4995513	1.4456542
2000	0.39451529	3.4193657	1.9898241	1.5397555	1.4803102
2001	0.45107456	3.58203	2.0095908	1.5979721	1.4852502
2002	0.47164464	3.622287	2.0221786	1.6494642	1.4477376
2003	0.50464763	3.7042012	1.9952938	1.6582656	1.4155383
2004	0.55158392	3.8323667	1.9779356	1.6992852	1.4297027
2005	0.58900038	3.8614269	1.9669655	1.7333634	1.4653076
2006	0.62922995	3.862713	1.9371012	1.719992	1.459255
2007	0.69679965	3.7766425	1.8988675	1.6553039	1.4566501
2008	0.67731383	3.6484955	1.8426226	1.6024243	1.428982
2009	0.66477635	3.5138465	1.8210201	1.5125486	1.4048054
2010	0.65846255	3.4556982	1.8280542	1.469604	1.4014688
2011	0.64964368	3.3950195	1.865928	1.4411753	1.44392
2012	0.64054111	3.3446691	1.8766092	1.4132653	1.4836402
2013	0.63274227	3.315855	1.8414673	1.4026968	1.5057511
2014	0.61988067	3.2011406	1.8112539	1.3776386	1.5372726
2015	0.60318977	3.1322908	1.7801493	1.3202608	1.4944279
2016	0.58237194	3.115687	1.7634236	1.3490355	1.4907637
2017	0.5712804	3.1669813	1.7532151	1.3278422	1.4782984

declines after 2006 up to 2017. The overall pattern of suicide rates in Kyrgyzstan resembles a parabolic function with big and small peaks. The suicide rate in Kyrgyzstan deteriorates by 2003, mitigates between 2003 and 2009, and worsens between 2010 and 2012. Considering the pattern of suicide rates in Turkmenistan, it also possesses a parabolic shape. The suicide rate in Turkmenistan rises by the end of 2005 and then declines in 2006 and after. The overall trend of suicide in Uzbekistan is with fluctuations. It sharply increases between 1993 and 2001 and then fluctuates throughout the rest of the period.

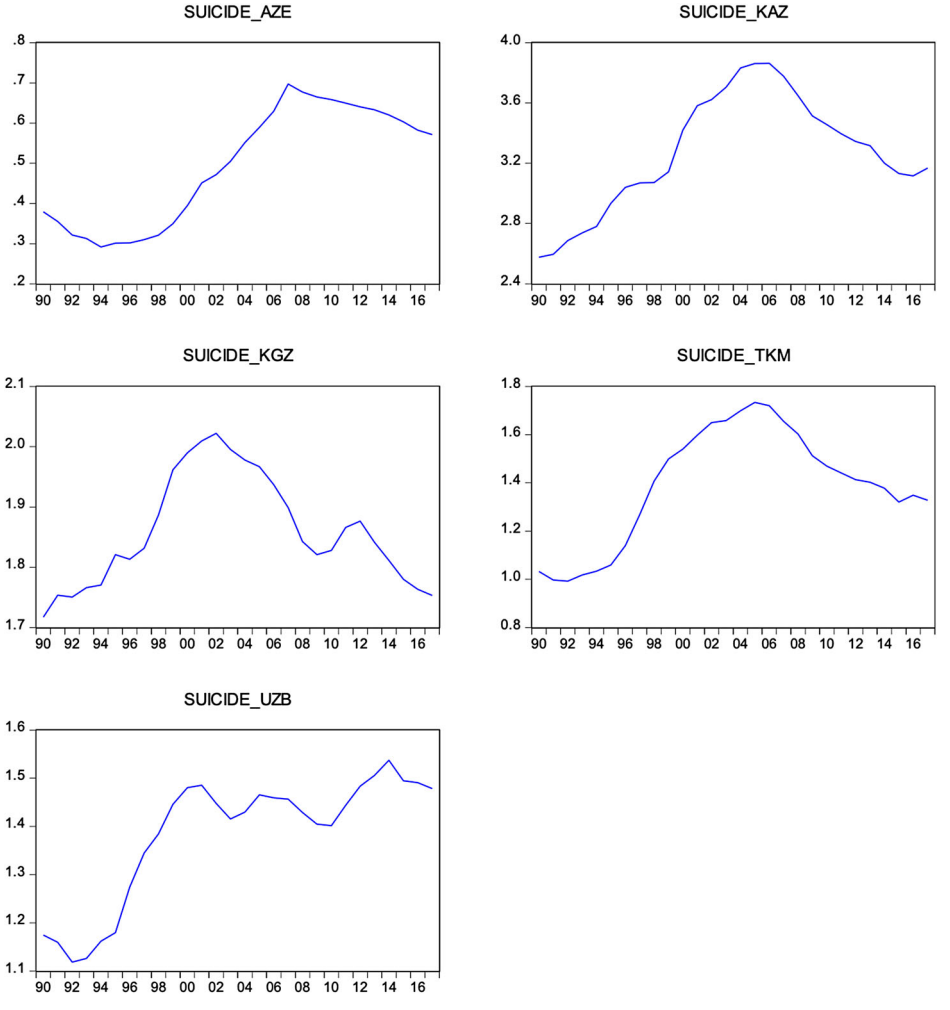

Figure 1. Suicide rate trends over time in Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan.

Note: The suicide rate in Azerbaijan drops by the end of 1994; after that it sharply increases until 2008, and then declines. The suicide rate in Kazakhstan consistently augments by the end of 2006, and declines after 2006 until 2017. The overall pattern of suicide rates in Kyrgyzstan resembles a parabolic function with large and small peaks. The suicide rate deteriorates by 2003, mitigates between 2003 and 2009, and worsens between 2010 and 2012. The suicide rate in Turkmenistan rises by the end of 2005, and declines in and after 2006. The overall trend of suicide in Uzbekistan fluctuates. It increases sharply between 1993 and 2001, and then fluctuates throughout the rest of the period.

Micro-data from surveys confirm the results of the macro-data outlined above. Wave 6 (2010–14) of the World Values Survey (WVS) (Inglehart et al. 2014)[3] includes a survey question measuring how suicide is justified in the society of each country. The survey contains four countries from the sample of this study (i.e., Azerbaijan, Kazakhstan, Kyrgyzstan and Uzbekistan) and asks the question: 'Please tell me for each of the following statements whether you think it can always be justified, never be justified, or something in between, using this card' on suicide. Table 2 reports the frequencies for the justification of suicide. There are 1500 participants in Kazakhstan, Kyrgyzstan and Uzbekistan, while there are 1002 participants in Azerbaijan. The survey results indicate that 88.22% of respondents in Azerbaijan, 77.87% of respondents in Uzbekistan, 68.33% of respondents in Kyrgyzstan and 68.13% of respondents in Kazakhstan do not approve of suicide, which is in the line of actual suicide rates of countries. On the other hand, 0.4% of respondents in Azerbaijan, 0.73% of respondents in Uzbekistan, 1.67% of respondents in Kazakhstan and 1.73% of respondents in Kyrgyzstan justify suicide. In terms of absolute determination of suicide, the highest justification of suicide is in Kyrgyzstan, while the lowest is in Azerbaijan. Meanwhile, 1.8% of respondents in Uzbekistan, 2.0% of respondents in Azerbaijan, 6.53% of respondents in Kyrgyzstan and 7.67% of respondents in Kazakhstan selected a score between 6 and 10, where such scores can be seen as the acceptance of suicide in society.

Table 3 displays frequencies for the justification of suicide derived from Wave 7 (2017–22) of the WVS (Haerpfer et al. 2022). The survey includes two countries from the sample of this study (i.e., Kazakhstan and Kyrgyzstan). There are 1276 participants in Kazakhstan and 1200 participants in Kyrgyzstan. Based on the frequency of the results, suicide was not justified by 54.23% of respondents in Kazakhstan and by 84.75% of respondents in Kyrgyzstan, while suicide was certainly justified by 2.43% of respondents in Kazakhstan and 0.83% of respondents in Kyrgyzstan.

Comparing the findings of Wave 7 of the WVS with Wave 6, it can be observed that the no justification for suicide dropped from 68.13% to 54.23% and always a justification for suicide jumped from 1.67% to 2.43% in Kazakh society over time. On the other hand, it can be observed that no justification for suicide increased from 68.33 to 84.75% and there always being a justification for suicide decreased from 1.73% to 0.83% in Kyrgyz

Table 2. Frequencies on the justification of suicide from Wave 6 of the World Values Survey.

	Azerbaijan		Kazakhstan		Kyrgyzstan		Uzbekistan	
	Number	Frequency	Number	Frequency	Number	Frequency	Number	Frequency
1 (Never justifiable)	884	88.22	1022	68.13	1025	68.33	1168	77.87
2	22	2.20	128	8.53	184	12.27	127	8.47
3	24	2.40	84	5.6	78	5.2	90	6
4	24	2.40	38	2.53	40	2.67	36	2.4
5	28	2.78	113	7.54	71	4.73	52	3.46
6	4	0.40	36	2.4	32	2.13	7	0.47
7	3	0.30	22	1.47	19	1.27	3	0.2
8	4	0.40	18	1.2	5	0.33	5	0.33
9	5	0.50	14	0.93	16	1.07	1	0.07
10 (Always justifiable)	4	0.40	25	1.67	26	1.73	11	0.73
11 (Don't know)	0	0.00	0	0.00	1	0.07	0	0.00
12 (No answer)	0	0.00	0	0.00	3	0.2	0	0.00
Total	1002	100.00	1500	100	1500	100	1500	100

Table 3. Frequencies on the justification of suicide from Wave 7 of the World Values Survey.

	Kazakhstan		Kyrgyzstan	
	Number	Frequency	Number	Frequency
1 (Never justifiable)	692	54.23	1017	84.75
2	158	12.38	41	3.42
3	65	5.09	16	1.33
4	34	2.66	7	0.58
5	77	6.03	43	3.58
6	34	2.66	10	0.83
7	20	1.57	4	0.33
8	17	1.33	2	0.17
9	8	0.63	5	0.42
10 (Always justifiable)	31	2.43	10	0.83
11 (Don't know)	78	6.12	41	3.42
12 (No answer)	62	4.87	4	0.34
Total	1276	100	1200	100

society in time. The proportion of undecided participants rose from 0% to 6.12% in Kazakhstan and from 0.07% to 3.42% in Kyrgyzstan between the implementation of the two surveys. Moreover, the proportion of participants left the question unanswered rose from 0% to 4.87% in Kazakhstan and from 0.2 to 0.34% in Kyrgyzstan. In the meantime, in Wave 7, 8.62% (this figure was 7.67% in Wave 6) of respondents in Kazakhstan and 2.58% (this figure was 6.53% in Wave 6) of respondents in Kyrgyzstan preferred a score between 6 and 10 where such scores can be interpreted as the approval of suicide in the relevant society.

Literature review on Turkic countries in Central Asia

Although there are some country-level studies on the determinants of suicide in Central Asian countries, our literature review identified only two country-level empirical studies investigating the impact of economic factors on suicides in the Central Asian countries: Bakiev, Aliiaskarov, and Ismailov (2021) investigated factors leading to suicide and attempted suicide among the youth in Kyrgyzstan through face-to-face interviewing in the southern region of JalalAbad. They found that economic factors influenced suicidal behaviour among young people as well as social and psychological factors. Inoue et al. (2021) examined the correlation between annual suicide rates and economic factors such as unemployment rates, rates of increase in the consumer price index, total exports, and total imports in Kazakhstan. Their results indicate that the unemployment rate is highly correlated with suicide in Kazakhstan.

A few cross-country studies investigate factors associated with suicide in Central Asian countries (Ryssland 2000; Makinen 2000; Lester 1999; Wasserman, Varnik, and Eklund 1998; Wasserman, Varnik, and Dankowicz 1998). However, none investigated economic factors leading to suicide. Moreover, the long-term effect of economic factors on suicide rates in the Central Asia region has also not been assessed. Patterns of increasing suicide rates and unemployment among the youth in the region have been reported by Savani et al. 2020 and Bakiev, Aliiaskarov, and Ismailov 2021. Thus, there is an urgent need to investigate the risk factors for suicide and determinants of suicide in this region to develop suicide prevention strategies.

Model, research hypotheses, data and methodology

Model

The economic theory of suicide outlined by Hamermesh and Soss (1974) suggests that factors that lead to a decrease in the expected lifetime utility and future income streams are associated with suicide. Especially, the suicide rate is inversely related to permanent income while it is positively related to unemployment. In a similar vein, the suicide rate is also expected to be inversely associated with the inflation rate. When unemployment and inflation rise and permanent income decreases, the suicide rate will increase since the 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 an increase in the suicide rate of a society.

The basic economic theory of suicide presented by Hamermesh and Soss (1974) explains the variation in suicide rates by applying the utility maximization framework to suicide. The model specified a utility function, which took the average utility of a person at a certain age as:

$$U_m = U[C(m,\ YP) - K(m)]$$

where m is the age, K is the cost of staying alive each period, and YP is permanent income. The expected U_m of the individual is positively related his/her permanent income YP while it has negative relationship with the age m.

In the model the i-th individual's taste for living b_i is assumed to be normally distributed: $b_i \sim N(0, \sigma^2)$. Thus, an individual i at age a, with a permanent income YP, attempts suicide if the total discounted lifetime utility Z_i plus the individual's taste for living b_i reaches 0:

$$Z_i(a, YP) + b_i = 0$$

with

$$Z_i(a, YP) = \int_a^{\omega} e^{-r(m-a)} U_m P(m) dm$$

where ω denotes the highest attainable age, r is the discounted rate, U_m is the expected utility at age m, and $P(m)$ is the probability of survival to age m given survival to age a.

According to the model outlined above, a rational utility maximizing agent will take his/her own life if the expected utility of being alive becomes negative. Hence, as a testable hypothesis, it is hypothesized that the expected utility of being alive is positively related to real income and thus an increase in income per capita reduces the likelihood of suicide. In this line of argument, the expected utility of being alive can be negatively related to a decrease in real income through unemployment and inflation as such a surge in unemployment and inflation increases the likelihood of suicide (Breuer 2015; Kimenyi and Shughart 1986).

In this framework, an economic downturn can lead to loss of employment, reduced career progression, the threat of unemployment, increased debt, and financial strain, which in turn leads to increased stress at work, loss of status, loss of personal control,

increased anxiety, negative relationships, marital breakdown, reduced social support in the 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 (Bernal et al. 2013).

Research hypotheses

Based on the above theoretical foundations and previous research on the subject discussed in the literature review, the following three hypotheses are tested in the empirical analysis section:

Hypothesis 1: An increase in unemployment level stimulates suicide and intentional self-harm in Turkic-speaking countries in Central Asia.
Hypothesis 2: An increase in per capita income level alleviates suicide and intentional self-harm in Turkic-speaking countries in Central Asia.
Hypothesis 3: An increase in inflation level stimulates suicide and intentional self-harm in Turkic-speaking countries in Central Asia.

Data

This study examines the long-run relationship between selected three macroeconomic variables (namely unemployment, per capita GDP and inflation) and suicide rates and the impact of these macroeconomic variables on suicide rates for Turkic-speaking countries in Central Asia and the South Caucasus (Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan) by using an unbalanced data set covering the years from 1990 to 2017.

Data on suicide (*SUICIDE*) were obtained from the Institute for Health Metrics and are measured as a percentage share of deaths from suicide. Unemployment (*UNEMPLOY*) is given by the percentage share of unemployment in the total labour force, inflation (*INFLATION*) is represented by GDP deflator, and per capita GDP (*PCGDP*) is measured in terms of current US dollars. All macroeconomic variables were collected from the World Development Indicators (WDI) database published by the World Bank. Meantime, the logarithmic forms of each variable are used in analyses.

Estimation methodology

We first performed a cross-sectional dependency test.[4] Second, consistent with the finding of the cross-sectional dependency test, we applied a proper panel unit root. Given the fact that each variable is integrated order 1 (i.e., *I*(1)). Third, we conducted a panel cointegration test to figure out if there is a long-run association between macroeconomic variables and suicide. Moreover, we performed a parameter constancy test to find out if parameters are heterogeneous across panels. Based on the detection of long-run co-movements among variables and heterogeneous parameters, the long-run coefficients are estimated by utilizing a convenient panel estimation approach taking heterogeneous parameters into consideration.

When researchers are conducting multivariate regression analysis, then multicollinearity is a potential problem they may face. Multicollinearity is a problem in several senses; it can (1) inflate the variances of the coefficient estimators of the

model and thus make precise estimation difficult and coefficient estimators unstable, (2) make coefficient estimators and their standard errors very sensitive to small changes in the data, (3) lead to wider confidence intervals and hence force to easily acceptance of the null hypothesis (i.e., the true population parameter is zero), and (4) cause the coefficient estimators to take wrong (i.e., unexpected) signs. One of the remedial measures to be taken for multicollinearity problem is to drop troublesome independent variables (i.e., variables inducing multicollinearity) from the model. Therefore, instead of conducting multivariate analysis, we implemented a bivariate analysis owing to the identified multicollinearity problem among our unemployment, inflation, and per capita GDP variables based on the results of Farrar–Glauber multicollinearity test. Given the fact of the existence of multicollinearity (Farrar–Glauber multicollinearity test statistic is 125.7148 with a p-value of 0.0000 and in this test H_0: No Multicollinearity against H_a: Multicollinearity), we separately construct the following equations as the benchmark models:

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

$$SUICIDE_{it} = f(PCGDP_{it}, \mu_i) \tag{2}$$

$$SUICIDE_{it} = f(INFLATION_{it}, \mu_i) \tag{3}$$

where μ_i represents country specific fixed effect and it subscript indicates the i-th country's observation at time t.

Descriptive statistics and estimation results

Descriptive statistics

Table 4 depicts the summary statistics of mean, standard deviation (SD), minimum and maximum of series for each country in the sample of this study. When descriptive statistics are assessed across countries, it can be observed that the highest mean suicide rate belongs to Kazakhstan (i.e., 3.270804%), while the lowest mean suicide rate belongs to Azerbaijan (i.e., 0.493964%). Kazakhstan has the highest mean unemployment rate (i.e., 7.468148%); on the other hand, Turkmenistan has the lowest mean unemployment rate (i.e., 6.421111%). Regarding the mean inflation level across countries, the lowest and the highest mean inflation are observed in Uzbekistan (i.e., 61.59628) and Kazakhstan (i.e., 131.0127), respectively. Furthermore, the lowest and the highest mean per capita GDP are identified for Kyrgyzstan (i.e., US$671.0392) and Kazakhstan (i.e., US$5076.655), respectively. The data on per capita GDP have the largest dispersion (i.e., highest SD), whereas the data on suicide rates have the smallest dispersion (i.e., lowest SD) across and within countries. This means that the most homogenous variable in terms of the variability in observations is the suicide variable, while the most heterogeneous variable in terms of the variability in observations is the per capita GDP variable.

Table 5 displays the correlation coefficients among variables with the probability values. Suicide has a positive correlation coefficient with unemployment, inflation and per capita GDP variables. All correlation coefficients are statistically significant except that between suicide and unemployment.

Table 4. Descriptive statistics for each country.

		Mean	SD	Minimum	Maximum
Azerbaijan	*SUICIDE*	0.493964	0.146022	0.291417	0.6968
	UNEMPLOY	6.725185	2.65834	0.9	11.78
	INFLATION	104.8338	75.32086	0.002555	244.6336
	PCGDP	2888.278	2797.077	60.45862	7891.313
Kazakhstan	*SUICIDE*	3.270804	0.389085	2.575805	3.862713
	UNEMPLOY	7.468148	3.688072	0.9	13.46
	INFLATION	131.0127	123.4343	0.001389	400.1075
	PCGDP	5076.655	4354.551	1130.118	13890.63
Kyrgyzstan	*SUICIDE*	1.859069	0.091404	1.717389	2.022179
	UNEMPLOY	7.371481	2.431517	1	12.55
	INFLATION	67.043	54.96115	0.019344	173.6139
	PCGDP	671.0392	356.101	258.0492	1282.437
Turkmenistan	*SUICIDE*	1.389943	0.242082	0.992358	1.733363
	UNEMPLOY	6.421111	3.463753	1.4	12.7
	INFLATION	113.9469	105.8231	1.69E−05	273.754
	PCGDP	2834.177	2607.189	410.2729	7962.245
Uzbekistan	*SUICIDE*	1.381393	0.132009	1.118541	1.537273
	UNEMPLOY	7.094815	3.0996	1.9	13.3
	INFLATION	61.59628	77.5146	0.000083	257.1163
	PCGDP	1081.564	754.1809	383.3431	2615.025

Estimation results

We firstly applied Pesaran's (2015) cross-sectional dependence test where the null hypothesis claims that errors are weakly cross-sectional dependent. The findings of panels A–C in Table 6 hint that we can easily reject the null hypothesis at the 1% significance level for all models. According to the test results, we have no evidence for cross-sectional dependency and thus we can conduct the conventional panel unit root tests.

To avoid a potential spurious regression problem, given the fact of absence of cross-sectional dependency, we conducted two distinct conventional panel unit root tests, namely the ADF–Fisher panel unit root test and the PP–Fisher panel unit root test. The obtained panel unit root test results are displayed in Table 7. It exhibits panel unit root test findings for the variables *SUICIDE*, *UNEMPLOY*, *PCGDP* and *INFLATION*. Test results refute the claim of the null hypothesis without exception and thus indicate that while *SUICIDE*, *UNEMPLOY*, *PCGDP* and *INFLATION* variables are not stationary at levels, they turn to be stationary at first differences (i.e., *SUICIDE*, *UNEMPLOY*, *PCGDP* and *INFLATION* variables are integrated order 1). Since conventional co-integration tests require to have series with integration order 1 as in our variables, we were able to conduct a co-integration test.

Given the fact that all variables are integrated order 1, we implemented both versions of Westerlund (2005) panel cointegration test and the findings are reported in Table 7(A)

Table 5. Correlation matrix.

	SUICIDE	UNEMPLOY	INFLATION	PCGDP
SUICIDE	1			
Probability	–			
UNEMPLOY	0.1160	1		
Probability	0.1836	–		
INFLATION	0.1627	−0.3263	1	
Probability	0.0613	0.0001	–	
PCGDP	0.3272	−0.3498	0.8385	1
Probability	0.0001	0.0000	0.0000	–

Table 6. Cross-section dependence test results.

(A) Results for the model in equation (1)	
Test statistic	8.94
p-value	0.0000
(B) Results for the model in equation (2)	
Test statistic	10.845
p-value	0.0000
(C) Results for the model in equation (3)	
Test statistic	8.489
p-value	0.0000

for the version where the null and alternative hypotheses are H_0: No cointegration and H_a: Some panels are cointegrated; and Table 7(B) for the version where the null and alternative hypotheses are H_0: No cointegration and H_a: All panels are co-integrated. As seen from Tables 8 and 9, we failed to decline the null hypothesis of no cointegration between *SUICIDE* and *PCGDP* variables and between *SUICIDE* and *INFLATION* variables. On the other hand, we identified that there exists a cointegration relationship between *SUICIDE* and *UNEMPLOY* variables. Therefore, we argue that suicide and unemployment move together in the long run, but we are unable to observe such a long run co-movement between suicide and per capita GDP and between suicide and inflation.

Before choosing a suitable estimation technique for the implementation of long run analyses, researchers must be sure if the parameters of the model remain constant or not across the countries included in the sample. Therefore, we conducted a Swamy parameter constancy test where the null hypothesis asserts the homogeneity of parameters to check out if parameters vary across panels. Table 10 displays the test findings and as to the results we reject the null hypothesis asserting the constancy of parameters for all three models given in equations (1–3). This means that parameters in each model vary across panels and hence we should use an estimation method allowing for heterogeneous slope coefficients across panels. For that reason, we used Pesaran and Smith (1995) mean group estimation method to obtain long-run coefficients in terms of mean group estimation and country-specific estimation (i.e., heterogeneous slope coefficients for each country).

Long-run coefficient estimations for the model where suicide is the dependent variable and unemployment is the independent variable are given in Table 11. As seen from Table 11, the mean group coefficient estimation is positive and statistically significant, and this implies that a 1% rise in the unemployment rate leads to a 0.069% increase in the suicide rate. Moreover, we have positive statistically significant country-specific

Table 7. Panel unit root test (H_0 assumes individual unit root process).

		Level		1. Difference	
		Test statistic	p-value	Test statistic	p-value
SUICIDE	ADF–Fisher Chi-square test	7.8864	0.6399	32.3764	0.0003
	PP–Fisher Chi-square test	5.1901	0.8781	35.7448	0.0001
UNEMPLOY	ADF–Fisher Chi-square test	6.63897	0.759	88.2417	0.0000
	PP–Fisher Chi-square test	4.62366	0.9149	69.2478	0.0000
PCGDP	ADF–Fisher Chi-square test	1.3589	0.9993	29.608	0.001
	PP–Fisher Chi-square test	0.67528	1.0000	71.0697	0.0000
INFLATION	ADF–Fisher Chi-square test	23.0067	0.0107	100.324	0.0000
	PP–Fisher Chi-square test	16.9362	0.0758	23.1231	0.0103

Table 8. Panel cointegration test (H_0: No cointegration and H_a: Some panels are cointegrated).

Test statistics	*p*-value
(A) Results for the model in equation (1)	
2.8189	0.0024
(B) Results for the model in equation (2)	
−0.1371	0.4455
(C) Results for the model in equation (3)	
−0.7701	0.2206

Table 9. Panel cointegration test (H_0: No cointegration and H_a: All panels are cointegrated).

Test statistics	*p*-value
(A) Results for the model in equation (1)	
1.9314	0.0267
(B) Results for the model in equation (2)	
−1.096	0.1365
(C) Results for the model in equation (3)	
−0.284	0.3882

coefficient estimations for Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan. A 1% increase in the unemployment rate causes a jump in the suicide rate by 0.0741%, 0.0679%, 0.1631% and 0.0898% in Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan, respectively. Unemployment possesses the highest enhancing impact on suicide in Turkmenistan while the lowest one in Kyrgyzstan. However, no significant long-run association between suicide and unemployment was identified for Azerbaijan.

Long-run coefficient estimations for the model where suicide is dependent variable and per capita GDP is independent variable are provided in Table 12. According to Table 12, the mean group coefficient estimation is negative but not statistically significant. As to the findings of country-specific coefficient estimations, we get negative statistically significant coefficient estimations for Kyrgyzstan, Turkmenistan and Uzbekistan. A 1% increase in per capita GDP leads to a drop in the suicide rate by 0.1172%, 0.2055% and 0.09% in Kyrgyzstan, Turkmenistan and Uzbekistan, respectively. Per capita GDP has the highest reducing impact on suicide in Turkmenistan, whereas the lowest one in Uzbekistan. On the other hand, we unexpectedly have a positive and significant coefficient estimation for Azerbaijan, and we have a negative and statistically insignificant coefficient for Kazakhstan.

Table 10. Swamy parameter constancy test.

Test statistics	*p*-value
(A) Results for the model in equation (1)	
1729.42	0.0000
(B) Results for the model in equation (2)	
3516.45	0.0000
(C) Results for the model in equation (3)	
2796.21	0.0000

Table 11. Results of long-run coefficient estimations for the model in equation (1).

	Long-run coefficient	*p*-value
Mean group estimation results	0.0691	0.0430
Group-specific estimation results		
Azerbaijan	−0.0494	0.3890
Kazakhstan	0.0741	0.0010
Kyrgyzstan	0.0679	0.0000
Turkmenistan	0.1631	0.0000
Uzbekistan	0.0898	0.0000

Table 12. Results of long-run coefficient estimations for the model in equation (2).

	Long-run coefficient	*p*-value
Mean group estimation results	−0.0651	0.2870
Group-specific estimation results		
Azerbaijan	0.1624	0.0050
Kazakhstan	−0.0752	0.1240
Kyrgyzstan	−0.1172	0.0000
Turkmenistan	−0.2055	0.0060
Uzbekistan	−0.0900	0.0000

Long-run coefficient estimations for the model where suicide is the dependent variable and inflation is the independent variable are depicted in Table 13. It discloses that the mean group coefficient estimation is positive but not statistically significant. Besides, we get positive statistically significant country-specific coefficient estimations for Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan. A 1% jump in inflation rate causes an increase in the suicide rate by 0.0274%, 0.0218%, 0.0352% and 0.0168% in Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan, respectively. Inflation has the highest impact on suicide in Turkmenistan but the lowest in Uzbekistan, while we have an insignificant negative coefficient estimation for Azerbaijan.

Discussion

About two-thirds of suicide attempts occur in low- and middle-income countries where unemployment rates are also high (Bantjes et al. 2016). Unlike high-income countries, unemployment remains a significant risk factor for suicide for most low- and middle-income countries. The availability of a social welfare safety net and social protection policies in high-income countries provides protection against suicide attempts stemming from economic difficulties (Wahlbeck and McDaid 2012). On the other hand, the lack of financial resources in low- and middle-income countries makes them more vulnerable to suicide due to economic difficulties such as unemployment (Lemmi et al. 2016; Meda et al. 2022).

Table 13. Results of long-run coefficient estimations for the model in equation (3).

	Long-run coefficient	*p*-value
Mean group estimation results	0.0160	0.1050
Group-specific estimation results		
Azerbaijan	−0.0215	0.1320
Kazakhstan	0.0274	0.0010
Kyrgyzstan	0.0218	0.0000
Turkmenistan	0.0352	0.0000
Uzbekistan	0.0168	0.0000

Although most suicides take place in low- and middle-income countries, the literature review on the association between adverse macroeconomic changes and suicides reveals that almost all cross-country studies on the subject are in the context of European Union member states and high-income countries. Evidence from these studies suggest that unemployment rates have a statistically significant effect on suicide cases.

Our investigation provides both mean group estimation results and country-specific estimation results. Our mean group estimation results suggest that among the three macroeconomic variables under study, only the unemployment rate has a statistically significant relationship with the suicide rate for Turkic countries in Central Asia. The estimation results reveal that a 1% rise in the unemployment rate leads to a 0.069 person increase in the suicide rate in the region. Thus, our empirical investigation reveals that unemployment is a major economic factor influencing suicide rates over long periods of time in the region. The results are in line with the results of the empirical literature on European Union member states and high-income countries (Stuckler et al. 2009, Breuer 2015, Gajewski and Zhukovska, 2017, Chang et al. 2009, İlgün et al. 2020). The results are also consistent with the results of country level studies of Bakiev, Aliiaskarov, and Ismailov (2021) and Inoue et al. (2021), which suggest that economic factors influence suicidal behaviour in Kyrgyzstan and Kazakhstan.

Regarding country-specific estimations, the estimation results suggest that all macroeconomic variables under study correlate with the suicide rate for some countries in the sample. For instance, a 1 percentage point jump in the inflation rate is correlated with an increase in the suicide rate by 0.0274%, 0.0218%, 0.0352% and 0.0168% in Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan, respectively; while a 1 percentage point increase in per capita GDP is related with a drop in the suicide rate by 0.1172%, 0.2055% and 0.09% in Kyrgyzstan, Turkmenistan and Uzbekistan, respectively; and further a 1 percentage point jump in the inflation rate is associated with an increase in the suicide rate by 0.0274%, 0.0218%, 0.0352% and 0.0168% in Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan, respectively.

When estimation results are assessed on a country basis, it can be noticed that all three variables have a statistically significant relationship with suicide rates in Kyrgyzstan, Turkmenistan and Uzbekistan. The unemployment rate and per capita GDP have a statistically significant association with suicide rates in Kazakhstan. None of the macroeconomic variables under study has a statistically significant correlation with suicide rates in Azerbaijan.

Empirical research on the impact of macroeconomic factors on suicide mostly focus on unemployment and per capita GDP. Besides unemployment and per capita GDP, this study investigates the effect of inflation on suicide rates in Turkic countries in Central Asia. We found that suicide has a positive relationship with the inflation rate in the region. Empirical evidence on the relationship between inflation and suicide rates in the European Union countries and high-income countries is mixed. The estimation results of Ceccherini-Nelli and Priebe (2011) suggest a negative correlation between inflation and suicide rates in the USA and UK while estimation results of Solana et al. (2012) indicate a positive association between inflation and suicide attempts in Italy. During the COVID-19 pandemic it has been observed that inflation rates increased all over the world because of economic policies adopted by governments. Our country-specific estimation results indicate that the inflation rate is associated with an increase in suicide rates in Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan. Thus, the

Table 14. Pairwise granger causality tests.

Null hypothesis	*F*-statistic	Probability
UNEMPLOY does not Granger cause *SUICIDE*	6.07242	0.0031
SUICIDE does not Granger cause *UNEMPLOY*	1.86204	0.1598
INFLATION does not Granger cause *SUICIDE*	3.17827	0.045
SUICIDE does not Granger cause *INFLATION*	1.64471	0.1972
PCGDP does not Granger cause *SUICIDE*	10.5820	6.00E−05
SUICIDE does not Granger cause *PCGDP*	1.26887	0.2849
INFLATION does not Granger cause *UNEMPLOY*	11.3298	3.00E−05
UNEMPLOY does not Granger cause *INFLATION*	0.10628	0.8993
PCGDP does not Granger cause *UNEMPLOY*	5.57927	0.0048
UNEMPLOY does not Granger cause *PCGDP*	0.58435	0.5591
PCGDP does not Granger cause *INFLATION*	2.68135	0.0725
INFLATION does not Granger cause *PCGDP*	1.74331	0.1793

estimation results of this study also call attention to the inflation rate which has not been included in the previous studies. In suicide prevention strategies, inflation should also be considered as an important factor.

Regarding causality among the variables of the study, Table 14 exhibits pairwise Granger causality test results. As can be deduced, there is a unidirectional causality running from unemployment, inflation, per capita GDP to suicide. We also identified a unidirectional causality running from inflation to unemployment, from per capita GDP to unemployment, and from per capita GDP to inflation.

Conclusions

This study addresses the association between macroeconomic factors and suicide with a focus on Turkic-speaking countries in Central Asia and the South Caucasus (Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan and Uzbekistan) which is one of the least studied regions in the literature. Research to date has not assessed the long-term effect of economic factors on suicide rates in the Central Asian region.

Our mean group estimation results suggest that among the three macroeconomic variables under study, only the unemployment rate has a statistically significant relationship with the suicide rate for the Central Asian Turkic-speaking countries. The estimation results reveal that a 1% rise in the unemployment rate leads to a 0.069% increase in the suicide rate in the region. Regarding country-specific estimations, the estimation results suggest that all macroeconomic variables under study correlate with suicide rate for some countries in the sample (e.g., Kyrgyzstan, Turkmenistan and Uzbekistan). The estimation results also call attention to the inflation rate which has not been included in previous studies.

The results of this study indicate that adverse economic conditions such as an increase in unemployment or inflation or a decrease in per capita income can be associated with an increase in the suicide rate in the Turkic-speaking countries of Central Asia. Thus, the results of this study suggest that social and economic policy measures and programmes related to the labour market, health and safety, and family support should be implemented both prior to and during economic crises or pandemics such as COVID-19 to prevent an increase in suicide and hence a loss of human capita. Considering the high rates of unemployment particularly among the youth in the region, economic policies that result in a high level of unemployment should be critically assessed for their potential human cost.

Notes

1. A sample used in an econometric study can be constituted by a homogenous or heterogeneous panel of countries. On the other hand, it is more likely to get homogenous long-run parameter estimations (i.e., long-run parameter estimations remaining constant across countries) in a homogenous sample, while the probability of obtaining heterogeneous long-run parameter estimations (i.e., long-run parameter estimations varying across countries) is high in a heterogeneous sample.
2. See Rachiotis et al. (2015), Branas et al. (2015) and Economou et al. (2013) for Greece; Sullivan (2013), Reeves et al. (2012), Stuckler et al. (2012) and Demirci et al. (2020) for the United States; Chen et al. (2012) and Kuroki (2010) for Japan; Loh (2007) for Singapore; Pridemore et al. (2007) for Russia; Rancans et al. (2001) for Latvia; Chuang and Huang (2007) for Taiwan; Barr et al. (2012) and Coope et al. (2014) for England; Jalles and Andresen (2014) for Canada; Kennelly (2007) for Ireland; Gili et al. (2013) and Bernal et al. (2013) for Spain; Platt et al. (1992) for Italy; and Hintikka et al. (1999), Coope et al. (2014) and Rachiotis et al. (2015) for Finland and Sweden.
3. The latest WVS is Wave 7 (2017–22). However, Wave 7 includes only two countries (i.e., Kazakhstan and Kyrgyzstan) from the sample of this study, while Wave 6 (2010–14) contains four countries from the sample (i.e., Azerbaijan, Kazakhstan, Kyrgyzstan and Uzbekistan). That is why the results of both Waves 6 and 7 and a comparison of their findings are provided in the study.
4. A stationarity test is a must in time series of data or panel data analysis since a spurious regression (i.e., nonsense regression) problem could arise if the series used in the analysis are not stationary. Spurious regression displays a non-existing relationship even though there is no relationship between two variables. Once we regress one variable on the other variable, we can identify a statistically significant association between them in the presence of a spurious regression problem. Concisely, spurious regression obtains misleading statistical evidence of a linear relationship between non-stationary dependent and independent variables. Therefore, we first checked the stationarity status of our variables. Conventional panel unit root tests presume that disturbances in panel data models are cross-sectionally independent and thus they are appropriate in the absence of cross-section dependence. On the other hand, if disturbances in panel data models are cross-sectionally dependent, then second-generation panel unit root tests must be employed instead of conventional panel unit root tests. To decide between conventional and second-generation panel root tests, we firstly implemented Pesaran's (2015) cross-sectional dependence test where the null hypothesis claims that errors are weakly cross-sectional dependent.

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