Exploring the Nexus between Socioeconomic Factors and Suicide Rates: Evidence from Panel ARDL Analysis in ASEAN Nations

Hon Kwang Hui, Jerome Kueh Swee Hui, Shirly Wong Siew Ling

Faculty of Economics and Business, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia
Email: 20020352@siswa.unimas.my

Abstract
The study's objective is to assess the socioeconomic factors' influence on the suicide rate in the Association of Southeast Asian Nations (ASEAN) nations from 2000 to 2019. Panel data was utilised to analyse both linear and non-linear associations between age-standardised total suicide rates and socioeconomic factors by using the panel Autoregressive Distributed Lag (ARDL) approach. The empirical findings reveal that the age-standardised total suicide rate is positively significant with the unemployment rate, female labour force participation rate and alcohol consumption per capita, while negatively significant with current health expenditure and fertility rate. Additionally, there is a significant U-shaped linkage between per capita Gross Domestic Product (GDP) and the age-standardised total suicide rate, with the estimated turning point at about $65,150.00 United States Dollar (USD), after which higher GDP per capita is linked to a higher age-standardised total suicide rate in ASEAN countries. The findings of this study can serve as a guideline for ASEAN policymakers in making decisions and developing plans to prevent suicide in ASEAN countries through various policies and programmes.
Keywords: Socioeconomic Factors, Age-Standardised Total Suicide Rate, Association of Southeast Asian Nations (ASEAN), Panel Autoregressive Distributed Lag (ARDL).

Introduction
Suicide is described as the intentional action of causing one's own demise (Stedman, 1920). In ancient folklore and history, suicide often held significant meaning. People in the past believed that death was a transformation of life and then choose to suicide (Sheldon, 2017). Today, suicide has become a significant global public health concern. It is among the leading causes of death worldwide, resulting in more fatalities than war, homicide, malaria, breast cancer, and Human Immunodeficiency Virus (HIV) (World Health Organization [WHO], 2021).

Each year, over 800,000 people die by suicide, with roughly 20 attempts for every completed suicide (WHO, 2019).

The ASEAN age-standardised total, male, and female suicide rates in 2019 are demonstrated in Figure 2. Among ASEAN countries, Singapore reported the highest age-standardised total and female suicide rates, with 9.7% and 6.4%, respectively. This indicates that suicide is a serious problem in Singapore. According to Samaritans of Singapore (SOS) (2017), suicide in Singapore is more prevalent among elderly people, as the prevalence of a man-up mentality causes senior men to feel pressured to suppress their emotions rather than seek expert help. Consequently, this results in a higher male suicide rate (12.7%) compared with the female suicide rate.

At the same time, the highest age-standardised male suicide rate in ASEAN countries is in Thailand, with a rate of 13.9%. In contrast, the age-standardised female suicide rate in Thailand was approximately six times lower than that of males, with a rate of 2.3%. The Thailand Mental Health Department states that approximately 6 people attempt suicide every hour, or about 53,000 people every year in Thailand, with the majority aged between 60 and 64, reflecting a growing trend among seniors experiencing depression due to familial abandonment (Saksornchai, 2018).

In the Philippines and Brunei, both countries have the lowest age-standardised total suicide rate among ASEAN countries, with a rate of 2.5%. According to The Atlantic Philanthropies (2021), most suicides in the Philippines occur among youth who live in remote areas because they lack access to mental health care. In Brunei, apart from depression and other mental health issues, suicide is believed to encompass a range of socioeconomic, psychological, biological, environmental, behavioural, and cultural elements (Bandial, 2019).

Myanmar's age-standardised total suicide rate is 3.0%. The age-standardised male suicide rate is about five times higher than the female rate, at 5.1% and 1.1%, respectively. On the other hand, Cambodia exhibited higher age-standardised total, male, and female suicide rates compared to Myanmar, at 5.5%, 8.4%, and 3.1%, respectively. The important causes of suicide in both countries are substance addiction and pre-existing mental illness among people aged 25 to 40 in Myanmar, while trauma and abuse issues affect adolescents in Cambodia (The ASEAN Post, 2019). Unlike the cases in Myanmar and Cambodia, the ongoing economic crisis in Laos increases the likelihood of suicide among Laotians (Hutt, 2024), with the age-standardised total, male and female suicide rates of 6.0%, 8.6%, and 3.5%, respectively in 2019.

Vietnam has the second highest age-standardised female suicide rate of 4.2% compared with other ASEAN nations, while its total and male suicide rates are 7.2% and 10.6%, respectively. The family socioeconomic status and connectedness are the main factors contributing to youth suicide in Vietnam (United Nations Children's Fund [UNICEF] and Overseas Development Institute [ODI], 2017). According to Blum et al. (2012), living away from the parental home is protective, which means that most suicides occur among the youth who live with family members which leads to more family conflict.

For Indonesia, the age-standardised total, male, and female suicide rates were 2.6%, 4.0%, and 1.2%, respectively. The study by Wirasto (2012) indicated that the majority of suicides in Indonesia were associated with family conflict, lack of respect for religion, and poor social integration. This can be elucidated by Durkheim's (1897) social theory of suicide, which posits that a reduction in social integration can result in egoistic suicide. Malaysia's age-standardised total suicide rate was 5.8%, while 9.0% and 2.4% for males and females, respectively. Every day, Malaysia sees 10 people die by suicide (Relate Malaysia, 2017). Most of the suicides happen among Indians, followed by the Chinese (Armitage, 2015; Lew et al., 2022; Ministry of Health Malaysia, 2011).
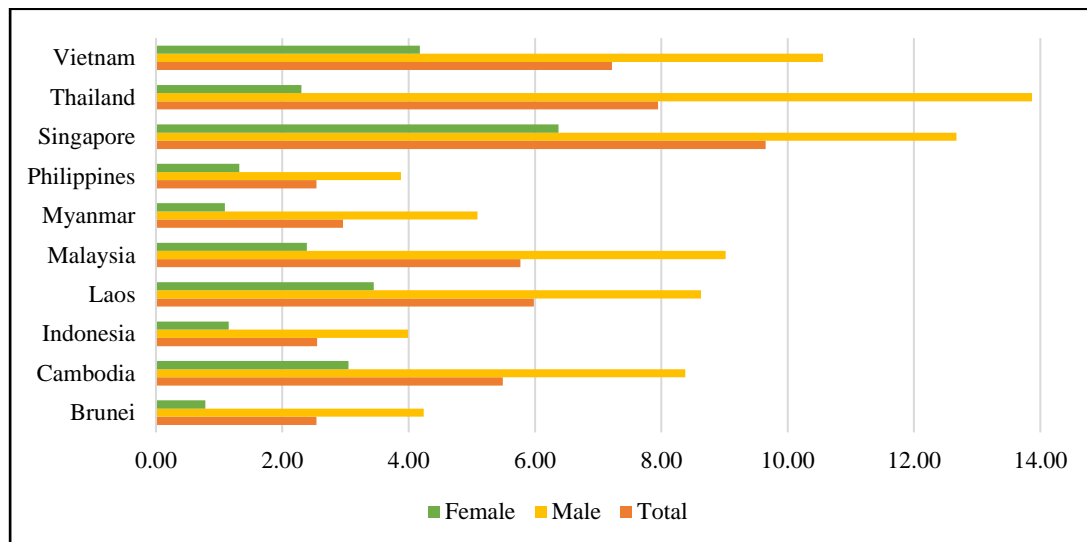

Figure 1. ASEAN Age-Standardised Total, Male and Female Suicide Rate in Year 2019
Source: WHO (2021)

ASEAN is an intergovernmental organisation of 10 Southeast Asia countries. Although the age-standardised total suicide rate of the Southeast Asia region decreased from 2000 to 2019, it is still higher than the global suicide rate. In 2019, the Southeast Asia region reached the third highest suicide rate compared with other regions. This high suicide rate results that suicide is not just a personal issue but also a national issue, even a regional issue, which means that the current policies and programmes implemented in ASEAN countries may not effectively prevent suicide. Also, the high suicide rate in ASEAN countries poses a challenge to achieve the goal of the United States Sustainable Goals (SDGs), which is to reduce the suicide rate by one-third by 2030 (WHO, 2019).

Besides, the past studies seem to support the linkage between socioeconomic factors and suicide (Jaen-Varas et al., 2019; Jalles & Andresen, 2015; Kunce, 2021; Lau et al., 2016; Machado et al., 2015; Minoiu & Andrés, 2008; Ross et al., 2012). Nonetheless, the previous studies have been centred on the experiences of Western and high-income economies nations, while understanding of the linkage between socioeconomic determinants and suicide in ASEAN countries (80% are lower- and upper-middle-income economies countries) is very weak. Hence, the findings from the past studies cannot represent the situation of suicide in ASEAN countries as the socioeconomic factors' impacts on suicide varied across countries and regions. This creates an issue that ASEAN countries find difficult and not suitable to adopt the

outcomes from previous studies as references in designing and implementing the suicide prevention policies and programmes. To fill this gap, this study's goal is to analyse the linkage between socioeconomic variables and ASEAN nations' suicide rates.

The outcomes of the paper provide valuable insights that could serve as guidelines for policymakers in ASEAN countries. Simultaneously, policymakers can better review the influence of socioeconomic policies on suicide accurately and productively. This will help them to implement more efficient policies to decrease ASEAN nations' suicide rates. The following sections of the study are laid out as follows: Section 2 covers the literature review, Section 3 outlines the methodology utilised for the empirical analysis, Section 4 examines and interprets the empirical findings, and the final section provides the study's conclusion.

Literature Review

Durkheim (1897) was the first to introduce the social theory of suicide. In his theory, he explained that suicide is impacted by aspects related to how individuals are incorporated into a social group that is governed by rules and customs. According to this sociological model, different levels of social integration and social regulation are linked to the incidence of societal suicide. The types of suicide in Durkheim's (1897) theory are shown in Table 1.

Table 1
Types of Suicide

Types	Explanation
Egoistic suicide	Egoistic suicide is caused by the reduction in social integration. To put it another way, it was the effect of excessive individuation, which meant people were becoming increasingly disconnected from their communities. Therefore, these individuals lack adequate social connections and support, ultimately leading them to suicide.
Altruistic suicide	Altruistic suicide is caused by a lack of individuation or a high level of social integration. It happened in a culture where the wants and interests of the entire society were valued more highly than the needs and interests of the individual. To put it another way, this form of suicide exemplified a callous morality that disregards the person.
Anomic suicide	Anomic suicide is caused by the moral deregulation and less clearly defined reasonable ambitions within a restrained social framework. In other words, it was the outcome of an imbalance between people's wants and their ability to meet those wants where resources were limited.
Fatalistic suicide	Fatalistic suicide was the outcome of a society that was repressive to the point where people would rather die than live. This sort of suicide was more likely to happen in a society where heavy regulation prevented people from archiving their dreams.

Source: Durkheim (1897)

In the economic theory of suicide, Hamermesh and Soss (1974) introduced the initial economic framework of suicide, depicting individual as rational, optimised actors who

chooses to end their lives when their total discounted lifetime utility hits zero. The lifetime expected utility's present value was formulated as:

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

(1)

where *Y* was permanent income, a represented as age, ω denoted as maximum age attainable, *r* presented as the discount rate, *P(m)* represented the likelihood of survival until reaching age *m*, and U_m was the consumption which in turn was an age's and income's function. This economic theory of suicide predicted that the suicide rate rose with age and fell with income, and Hamermesh and Soss (1974) demonstrated that these predictions are consistent throughout the course of time and among different states in United States (US).

Upon this theory, Brainerd (2001) explained that one's remaining life expectancy might have an impact on the choice to commit suicide. The high likelihood of survival means that the individual has high life expectancy. This increases the lifetime expected utility and reduces the probability of lifetime expected utility becomes zero before individuals dies from other causes. On the contrary, the decrease of life expectancy will increase the suicide rate, and this increase will worsen the decrease in life expectancy, resulting in even higher suicide rates, creating a negative cycle.

This paper will employ socioeconomic factors to examine the connection between the age-standardised total suicide rate in ASEAN countries, which include GDP per capita, unemployment rate, female labour force participation rate, fertility rate, per capita alcohol consumption, and expenditure on current health. There is a diffusely accepted concept that suicide increases if unemployment increases. Lin (2006), adopted two sets of panel data, from Taiwan's 23 cities (1979 – 2002), and from 7 Asia-Pacific countries (1976 – 2000), to observe the linkage between the suicide death rate and the unemployment rate. Based on the findings of fixed-effect estimation, both Taiwan's 23 cities and the 7 Asia-Pacific countries showed that the suicide death rate was positively significant with the unemployment rate, with the coefficient of 0.053 and 0.012, respectively. Lin (2006) outlined that unemployment could lead to a decrease in expected income. This could trigger adverse effects, potentially worsening both physical and mental health and consequently raising the likelihood of suicide. These findings parallel with the studies of Kõlves et al (2013), Kuroki (2010), Watanabe et al. (2006), and Ying and Chang (2009).

The income variable is also an important determinant of whether a person commits suicide. Most of the studies found that income decreases the occurrence of suicide (Andrés et al., 2011; Jalles & Andresen, 2015; Machado et al., 2015). Nonetheless, the study of Mitra and Shroff (2006), found a contrary result that income was positively significant to suicide in 22 major states in India. They explained that this result implied the theory by Durkheim (1897), called egoistic suicide, where economic advancement leads to more perceived and actual independence. Hence, people are cut off from the social network and familial connections that provide emotional succour and support to them. This causes emotional deprivation and increases the likelihood of suicide. In addition, Neumayer (2003), employed fixed-effect and random-effect estimation to figure out the nexus between socioeconomic factors and 68

countries' suicide rates from 1980 to 1999. Interestingly, Neumayer (2003), found that the linkage between income and suicide was non-linear, characterised by a convex curve, which means that higher income decreases the suicide rate and increases again when income reached a certain level.

Health expenditure tends to complement efforts to decrease suicide. Minoiu and Andrés (2008), employed US states' panel data from 1982 to 1997 to examine the influence of the health expenditure's share in the total state budget on suicide rates. Their findings, based on the system generalised method of moments (GMM), showed that the share of health spending was negatively significant with total and male suicide rates. After that, Ross et al (2012), conducted a similar study for the period from 1997 to 2005, using per capita health expenditure. Employing the same estimator, the result showed that per capita health expenditure was negatively significant to the male suicide rate. These findings imply that there is a supportive impact, as the effectiveness of the healthcare system contributes to determining the outcome of a suicide attempt, whether it results in fatality or not. Similarly, Milner et al (2012), found that health expenditure per capita was negatively associated with both male and female suicide rates. They explained that more resources allocated to health resulted in more treatment for depressed people and led to a reduction in suicide.

Besides the variable of health expenditure, Milner et al (2012), also concluded that the fertility rate provides stable social relationships in the family which helps to reduce suicide rates. These findings were similar to the study of Andrés et al (2011), in Japan for the period from 1957 to 2009 using the Autoregressive Distributed Lag (ARDL) cointegration procedure. A higher fertility rate increases social integration as children strengthen family ties and therefore decrease the likelihood of committing suicide (Andrés et al., 2011).

Koo and Cox (2008) used annual data from 1950 to 2003 to interpret male and female suicides in Japan. They employed the Ordinary Least Squares (OLS) estimation with de-trending methods, namely random walk, Hodrick-Prescott, and Band-Pass. Analogous to Andrés et al (2011), and Milner et al (2012), the fertility rate linked with the suicide rate negatively. Additionally, Koo and Cox (2008), found that the female labour force participation rate showed a significantly positive nexus with the suicide rate. The higher female labour force participation rate influenced men by the changes in gender roles, while women faced the burden of work without the advantages of social connections at work, leading to suicide (Koo & Cox, 2008; Milner et al., 2012; Neumayer, 2003).

Brainerd (2001), used 22 transition economies countries' panel data from 1988 to 1998 to analyse the connection between suicide rates and economic and social determinants. Based on the fixed-effect estimation results, per capita alcohol consumption was significantly positive related to the suicide rate. Andrés (2005), utilised a 15 European nations' panel data set from 1970 to 1998 to observe the nexus between socioeconomic variables and suicide rate. The findings were consistent with Brainerd (2001), showing a positive and significant linkage between alcohol consumption and suicide rate. Higher consumption of alcohol increases the likelihood of psychological episodes as well as less social integration, thereby increasing the likelihood of committing suicide.

Methodology

To evaluate the influences of socioeconomic variables on the suicide rates in ASEAN countries, this study utilised annual panel data from all 10 ASEAN countries, spanning 20 years from the year 2000 to 2019. All variables' data are extracted from WHO and The World Bank. Table 2 records the data description of variables adopted in the study.

Table 2
Data Description of Variables

Variable	Descriptions and Measurement	Source
SR	Age-standardised total suicide rate (per 100,000 population)	WHO
AC	Alcohol consumption per capita (litres)	
UR	Unemployment rate (% of total labour force)	The World Bank
FLB	Female labour force participation rate (%)	
FR	Fertility rate [births per woman (bpw)]	
GDP	Gross domestic product (GDP) per capita [constant 2015 in thousand in United States dollar (USD)]	
HE	Current health expenditure (% of GDP)	

Source: Authors' compilation.

Most of the previous studies investigated the linear relationship between socioeconomic factors on suicide rate. Nonetheless, it is crucial to examine the non-linear association between socioeconomic variables on suicide rate due to conflicting perspectives on the impact of income on suicide as posited by economic and sociological theories. Hence, both linear and non-linear models are utilized in this study. The study's linear model is specified as follows:

$$SR_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 HE_{it} + \beta_3 UR_{it} + \beta_4 FR_{it} + \beta_5 FLB_{it} + \beta_6 AC_{it} + \varepsilon_{it}$$

(2)

where SR presents age-standardised total suicide rate, GDP represents per capita GDP, HE denotes expenditure on current health, UR indicates as the unemployment rate, FR expresses as fertility rate, FLB denotes as female labour force participation rate, AC presents as per capita alcohol consumption, ε is an error term, i denotes as country and t is time period. The variables selection is based on both economic and social theory of suicide. The age-standardised total suicide rate is expected to have a positively linkage with the unemployment rate, female labour force participation rate, and per capita alcohol consumption, while a negative connection with per capita GDP, fertility rate, and expenditure on current health.

Then, this study adds a quadratic term of per capita GDP, which is adopted as a proxy of socioeconomic factor (Bhandarkar & Shah 2008; Shah et al. 2008), to observe the non-linear relationship with suicide rate in ASEAN countries. The non-linear model is specified as follows:

$$SR_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 GDP^2{}_{it} + \beta_3 HE_{it} + \beta_4 UR_{it} + \beta_5 FR_{it} + \beta_6 FLB_{it} + \beta_7 AC_{it} + \varepsilon_{it} \quad (3)$$

The GDP^2 is expected to have a positively sign, which means that per capita GDP is envisaged to have a non-linear relationship or called U-shaped nexus to the suicide rate. The convex curvilinear nexus of GDP per capita indicates that it is negatively linked with the suicide rate initially but becomes positively associated once GDP per capita surpasses a certain threshold.

The empirical testing procedures first determine the stationary among the variables by using panel unit root tests, namely the Levin-Lin-Chu (LLC) test and the Im-Pesaran-Shin (IPS) test. LLC test presumes homogeneity in the dynamic of the autoregressive (AR) coefficients for all panel members (Levin et al., 2002). While, IPS test allows heterogeneous coefficients and permits for individual effect, time trends as well as common time effect (Im et al., 2003). The models of LLC and IPS tests are represented in Equation (4) and Equation (5), respectively:

$$\Delta L_{it} = \alpha_i + \forall L_{it-1} + \sum_{j=1}^{\emptyset i} \beta_j \Delta L_{it-j} + \varepsilon_{it}$$

(4)

$$\Delta L_{it} = \alpha_i + \forall_i L_{it-1} + \sum_{j=1}^{\emptyset i} \beta_{ij} \Delta L_{it-j} + \varepsilon_{it}$$

(5)

where ΔL_{it} is a panel series that country i over time period t ($i = 1, 2, 3, …, N; t = 1, 2, 3, …, T$), $\emptyset_i$ is lags' number in the Augmented Dickey-Fuller (ADF) regression and ε_{it} is error term which supposed to be independent and normally distributed random variables for all i and t zero mean and finite heterogeneous variance. The hypothesis of the LLC test is shown as follows:

$$H_0: \forall = 0$$
$$H_1: \forall < 0$$

where the null hypothesis suggests that the unit root is exhibited in every series within the panel, whereas the alternative hypothesis indicates that the stationarity is exhibited in every individual series in the panel. Rejection of the null hypothesis of unit root exhibited in each series in the panel occurs when the *p*-value falls below the significance levels of 1%, 5%, or 10%. The hypothesis of the IPS test is shown as follows:

$$H_0: \forall_i = 0$$
$$H_1: \forall_i < 0 \text{ for all } i$$

where the null hypothesis means that the panel is not stationary, whereas the alternative hypothesis means that at least one of the individual series in the panel exhibits stationarity. The null hypothesis of the panel is not stationary will be rejected when the *p*-value is smaller than 1%, 5%, or 10% of a significant level.

After testing the stationary data, the long-run equilibrium nexus between the variables is investigated by utilising Pedroni's (1999), panel cointegration test. The Pedroni cointegration test comprises seven distinct statistics categorized into within-dimension (panel *v*-statistic, panel *rho*-statistic, Pedroni Panel *(PP)*-statistic, panel *ADF*-statistic) and between-dimension

(group *rho*-statistic, group *PP*-statistic, group *ADF*-statistic). If four or more out of the seven cointegration statistics are statistically significant at conventional levels, the null hypothesis of no cointegration will be rejected, indicating the presence of cointegration among the variables.

After that, this study adopts the panel ARDL estimation developed by Shin and Pesaran (1999) to both linear and non-linear models. ARDL estimation is preferred when conducting unit root tests for variables' stationarity determination, particularly whether they are stationary at level I(0), exhibit first differences I(1), or show mixed behaviour. The ARDL for the bound test is presented as follows:

$$\Delta SR_{it} = \beta_1 + \sum_{i=1}^{m} \delta_{ij}\Delta SR_{j,t-i} + \sum_{i=0}^{m} \theta_{ij}\Delta GDP_{j,t-i} + \sum_{i=0}^{m} \rho_{ij}\Delta GDP_{j,t-i}^2 + \sum_{i=0}^{m} \vartheta_{ij}\Delta HE_{j,t-i}$$
$$+ \sum_{i=0}^{m} \emptyset_{ij}\Delta UR_{j,t-i} + \sum_{i=0}^{m} \sigma_{ij}\Delta FR_{j,t-i} + \sum_{i=0}^{m} \tau_{ij}\Delta FLB_{j,t-i} + \sum_{i=0}^{m} \varphi_{ij}\Delta AC_{j,t-i}$$
$$+ \alpha_1 SR_{j,t-i} + \alpha_2 GDP_{j,t-i} + \alpha_3 GDP_{j,t-i}^2 + \alpha_4 HE_{j,t-i} + \alpha_5 UR_{j,t-i} + \alpha_6 FR_{j,t-i}$$
$$+ \alpha_7 FLB_{j,t-i} + \alpha_8 AC_{j,t-i} + \varepsilon_{it} \qquad (6)$$

where i is countries, t represents time, Δ denotes as first variation factors, and m presents as ideal lag length. The hypothesis of panel ARDL estimation is shown as follows:

$$H_0: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 = \alpha_8$$
$$H_1: \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq \alpha_7 \neq \alpha_8$$

where the null hypothesis indicates that there is no cointegration whereas the alternative hypothesis represents that cointegration is exhibited between the variables. If the value of significant level (1%, 5% or 10%) is larger than *p*-value, the null hypothesis of no cointegration will be rejected. After determining the long-run correlation between the variables, the long-run model will be investigated which is specified as follows:

$$SR_{it} = \beta_2 + \sum_{i=1}^{m} \delta_{i2}SR_{j,t-i} + \sum_{i=0}^{m} \theta_{i2}GDP_{j,t-i} + \sum_{i=0}^{m} \rho_{i2}GDP_{j,t-i}^2 + \sum_{i=0}^{m} \vartheta_{i2}HE_{j,t-i}$$
$$+ \sum_{i=0}^{m} \emptyset_{i2}UR_{j,t-i} + \sum_{i=0}^{m} \sigma_{i2}FR_{j,t-i} + \sum_{i=0}^{m} \tau_{i2}FLB_{j,t-i} + \sum_{i=0}^{m} \varphi_{i2}AC_{j,t-i} +$$
$$\varepsilon_{it2} \qquad (7)$$

The differential calculus approach turning point estimation is then employed in Equation (3) for the GDP per capita's turning point estimation. The real quadratic function is shown as follows:

$$f: \mathbb{R} \to \mathbb{R}, f(x) = ax^2 + bx + c$$

(8)

where a, b, and c are real numbers and a ≠ 0. Then, the tuning point can be captured by taking the first derivative in Equation (8) and letting the equation to zero. The equations are shown as follows:

$$f'(x) = 2ax + b$$

(9)

$$x^* = \frac{-b}{2a}$$

(10)

The Equation (10) is then rewritten as follows:

$$GDP^* = \frac{-\beta_1}{2\beta_2}$$

(11)

where GDP^* is the turning point of GDP per capita, β_1 and β_2 are both linear and quadratic terms of GDP per capita's coefficients, respectively.

Results and Discussion

The empirical findings start with the panel unit root tests to determine the variables' stationarity. Table 3 displays the outputs of LLC and IPS unit root tests. The results demonstrate a combination of integration levels among the variables, indicating that some are stationary at I(0), I(1), or exhibit a mixed behaviour of both.

Table 3
LLC and IPS Tests' Results

Variables	LLC Test		IPS Test	
	Intercept	**Trend and Intercept**	**Intercept**	**Trend and Intercept**
	At level			
SR	-4.953***	2.281	-1.853**	3.486
GDP	8.818	-1.216	10.249	0.922
HE	-2.377***	-1.893**	-0.552	-1.358*
UR	-2.882***	-1.722**	0.466	-1.335*
FR	-6.461***	-7.405***	-6.685***	-8.342***
FLB	-1.699**	0.627	0.407	0.032
AC	-2.651***	-2.717***	-1.300*	-2.977***
	First Difference			
SR	-4.913***	-6.017***	-5.040***	-6.128***
GDP	-3.386***	-5.463***	-4.054***	-3.567***
HE	-9.880***	-8.123***	-9.079***	-8.163***
UR	-5.867***	-5.683***	-7.952***	-7.281***
FR	-6.045***	-1.283*	-5.152***	-2.628***
FLB	-2.507***	-2.096**	-5.913***	-3.739***
AC	-1.958**	-0.863	-4.099***	-1.738**

Note. Asterisk ***, **, and * denotes rejection at 1%, 5%, and 10% significant level.
Source: Authors' computation.

After investigating the variables' stationary, the Pedroni cointegration test is utilised for long-run equilibrium nexus investigation between the variables, and the outcomes are illustrated in Table 4. The findings from Table 4 show that four out of seven cointegration statistics are statistically significant at conventional levels. Thus, the null hypothesis that no cointegration is rejected and there is a long-run connection between age-standardised total suicide rate,

per capita GDP, expenditure on current health, unemployment rate, fertility rate, female labour force participation rate, and per capita alcohol consumption in ASEAN countries.

Table 4
Pedroni Panel Cointegration Test's Outcomes

Pedroni Panel Cointegration Test	Test Statistics
Within Dimension (Panel)	
v-Statistic	-3.139 (0.999)
rho-Statistic	4.119 (1.000)
PP-Statistic	-2.547 (0.005)***
ADF-Statistic	-2.341 (0.009)***
Between Dimension (Group)	
rho-Statistic	5.177 (1.000)
PP-Statistic	-3.837 (0.000)***
ADF-Statistic	-1.977 (0.024)**

Note. Asterisk *** and ** denotes rejection at 1% and 5% significant level. Amount in parentheses denote probability values.
Source: Authors' computation.

Next, as the presence of mixed results for the variables' stationary in LLC and IPS unit root test, the panel ARDL estimation is adopted. The panel ARDL estimation's findings are shown in Table 5. Column (a) determines the linear relationship between the socioeconomic factors and age-standardised total suicide rate. The column (b) investigates the non-linear association between the variables by adding the quadratic form of GDP per capita. The findings in column (a) results that GDP per capita is negative and significant to age-standardised total suicide rate. A rise of 1% in GDP per capita is related to a decrease of 0.29% in the age-standardized total suicide rate, others remain unchanged. Then, GDP per capita is added a quadratic term in column (b) and the outcome revealed that there is a significantly U-shaped connection between per capita GDP and ASEAN countries' age-standardised total suicide rate. To calculate the turning point (or minimum point) of GDP per capita, Equation 11 is employed as follows:

$$\begin{aligned} \mathrm{GDP}^* &= \frac{-\beta_1}{2\beta_2} \\ &= \frac{-(-1.303)}{2(0.010)} \\ &= 65.15 \\ &\approx \$65{,}150.00 \text{ USD} \end{aligned}$$

The findings indicated that higher GDP per capita will lead to the reduction of age-standardised total suicide rate. When this negative link reaches the turning point around $65,150.00 USD, the higher GDP per capita will cause the increment of age-standardised total suicide rate in ASEAN countries. The U-shaped linkage between per capita GDP and age-standardised total suicide rate implies the theories by both Hamermesh and Soss (1974) and Durkheim (1897). The negative nexus implies the theory by Hamermesh and Soss (1974) that the increment in GDP per capita makes the ASEAN public able to cover their personal and family expenses and then decrease the happen of suicide. Nevertheless, excessive economic

expansion will result in moral deregulation and social integration reduction which will ultimately bring the occurrence of Durkheim's egoistic suicide. This result of the U-shaped nexus is similar to the study of Chansarn (2017) and Neumayer (2003).

Table 5
Panel ARDL Estimation's Findings

Dependent Variable (SR)	Panel ARDL Estimation	
	(a)	**(b)**
GDP	-0.285 (0.000)***	-1.303 (0.000)***
GDP^2	-	0.010 (0.000)***
HE	-0.043 (0.055)*	-0.231 (0.000)***
UR	0.232 (0.000)***	0.088 (0.000)***
FR	-0.957 (0.000)***	-1.993 (0.000)***
FLB	0.117 (0.000)***	0.067 (0.000)***
AC	0.144 (0.000)***	0.062 (0.000)***
Turning Point of GDP*	-	65.15

Note. Column (a) represents the results of linear model. Column (b) represents the results of non-linear model. Asterisk ***, **, and * denotes rejection at 1%, 5%, and 10% significant level. Amount in parentheses denote probability values.
Source: Authors' calculations.

The current health expenditure results a significantly negative association between age-standardised total suicide rate in both column (a) and column (b). When a percent increase in current health expenditure, age-standardised total suicide rate will reduce by 0.04% and 0.23%, respectively, others remain unchanged. This negative link is aligned with the previous studies (Milner et al., 2012; Minoiu & Andrés, 2008; Ross et al., 2012). The higher spending on current health makes more health services accessible for ASEAN's public due to the larger resources allocated to health. This can help everyone get complete treatment and avoid committing suicide.

Similar to current health expenditure, the fertility rate is negatively significant with ASEAN countries' age-standardised total suicide rate in both linear and non-linear models. When the fertility rate increases by 1%, age-standardised total suicide rate will decrease by 0.96% and 1.99%, respectively, others remain constant. This finding of negative linkage can be explained by the social theory of Durkheim (1897) that the presence of children makes people become more responsibilities in their family and society which will increase their family ties as well as social integration and then lower the people to commit suicide. This negative nexus between fertility rate and suicide rate is also agreed by the previous studies (Andrés et al., 2011; Koo & Cox, 2008).

The significant negative nexus between age-standardised total suicide rate is displayed in the unemployment rate. This negative outcome is the same as most of the past studies (Andrés et al., 2011; Kõlves et al., 2013; Kuroki, 2010; Lin, 2006; Milner et al., 2012; Neumayer, 2003; Watanabe et al., 2006; Ying & Chang, 2009). Remaining others constant, an increment of 0.23% and 0.09%, respectively, will occur in age-standardised total suicide rate if the unemployment rate increases by 1%. This can be illustrated that the higher unemployment

rate represents there are more people who are unemployed and losing their income to cover their daily needs. Being unemployed will cause them to fall into trepidation and lose self-confidence which may rise the likelihood of people committing suicide.

Moreover, the findings from columns (a) and (b) indicate a significantly positive result between the female labour force participation rate and age-standardised total suicide rate. Increasing 1% female labour force participation rate, will cause age-standardised total suicide rate to increase by 0.12% and 0.07%, respectively, remaining others unchanged. This means that females who work may have a decline in social integration as a result of role conflict and stress arising from engagement and then increasing the likelihood of committing suicide. The finding of a positively link between female labour force participation rate and suicide rate is aligned with the study of Andrés (2005), Milner et al. (2012), Neumayer (2003), and Ying and Chang (2009).

Lastly, the variable of alcohol consumption per capita demonstrates a positively significant connection with age-standardised total suicide rate in the study. When alcohol consumption per capita increases by 1%, age-standardised total suicide rate increases by 0.14% and 0.06%, respectively, others remain unchanged. This positive result is dissimilar with Durkheim's theory which explains that alcohol consumption is an individual-level factor and does not influence suicide. However, modern previous studies concluded that alcohol consumption is significant and positive to suicide (Andrés, 2005; Brainerd, 2001; Neumayer, 2003). The higher consumption of alcohol leads a higher prevalence of various psychological episodes and makes them lack support from society decreases social integration then increases the proclivity to commit suicide.

Conclusion

This study assessed the socioeconomic factors' impacts on ASEAN countries' suicide from year 2000 to 2019. The findings presented that all socioeconomic factors employed in this study meet the expected sign and are significant to the ASEAN age-standardised total suicide rate in both linear and non-linear models. Additionally, GDP per capita has a convex curvilinear nexus with age-standardised total suicide rate in ASEAN countries, with a turning point of about $65,150.00 USD.

This study makes important contributions to both theory and practice. This study reinforces the relevance of Durkheim's (1897) ideas about suicide, especially his views on how social integration and socioeconomic factors influence suicide rates. By showing that there is a U-shaped nexus between GDP per capita and suicide rates, this study also supports economic theory of suicide by Hamermesh and Soss (1974), which suggests that economic growth has complex effects on people's mental well-being. This blend of sociological and economic perspectives highlight how different forces interact to shape suicide trends, particularly in ASEAN countries. Apart from this, this study fills a gap in the existing literature by focusing on a region that has been underrepresented in suicide research. ASEAN countries, with their diverse socioeconomic backgrounds, provide a unique setting to explore these issues, and the findings about socioeconomic factors offer valuable insights for policymakers. Ultimately, this research helps adapt well-known theories to the specific realities of ASEAN countries, making it both timely and regionally significant.

From a policy perspective, this study's findings suggest ASEAN policymakers should be cautious of the potential negative impacts of both extreme poverty and excessive wealth when adopting an inclusive economic growth agenda to address both extreme poverty and wealth. Besides, the government should focus on enhancing accessibility and affordability of mental health services by expanding the health services' budget and reducing the barriers to accessing health resources. This helps to mitigate the effects of inadequate health expenditure on suicide rates in ASEAN nations. In addition, the governments should implement comprehensive job creation initiatives that focus on growth potential sectors. This involves collaborating with industries to identify emerging markets and promote entrepreneurship. Moreover, comprehensive family planning education programs should be considered to provide individuals with information on contraceptive methods, family planning options, and maternal healthcare. The wage gaps and barriers to career advancement faced by women should be addressed by carrying out educational programs that encourage females to pursue careers in diverse fields and equip them with skills relevant to the modern job market can contribute to greater female workforce participation and economic empowerment. Lastly, public awareness campaigns should be carried out to educate the population about the risks associated with excessive alcohol consumption, particularly its negative effects on mental health and suicide risk.

The time period of this study only spanned 20 years which is deemed relatively small from a statistical perspective. Besides, the issue of missing data causes some of the variables that potentially influence the suicide rate to be excluded from the study instead of employing the interpolation technique to prevent the bias of the study's results. Thus, future studies may involve expanding the sample size and including more potential variables that influenced suicide when the data are available. Employing sufficiently large sample sizes has the potential to yield more significant findings, as they can capture more information and mitigate the study's uncertainty risk.

References

Andrés, A. R. (2005). Income inequality, unemployment, and suicide: a panel data analysis of 15 European countries. *Applied Economics, 37*(4), 439-451.

Andrés, A. R., Halicioglu, F., & Yamamura, E. (2011). Socio-economic determinants of suicide in Japan. *The Journal of Socio-Economics, 40*(6), 723-731.

Armitage, C. J., Panagioti, M., Rahim, W. A., Rowe, R., & O'Connor, R. C. (2015). Completed suicides and self-harm in Malaysia: a systematic review. *General Hospital Psychiatry, 37*(2), 153-165.

Bandial, A. (2019). *Worrying climb in suicide rate requires urgent action, says health minister*. Retrieved from https://thescoop.co/2019/10/10/worrying-climb-in-suicide-rate-requires-urgent-action-says-health-minister/

Bhandarkar, R., & Shah, A. (2008). Association of general population suicide rates with fertility rates: a test of fertility as a measure of social integration. *Psychological Reports, 103*(3), 812-818.

Blum, R., Sudhinaraset, M., & Emerson, M. R. (2012). Youth at risk: suicidal thoughts and attempts in Vietnam, China, and Taiwan. *Journal of Adolescent Health, 50*(3), S37-S44.

Brainerd, E. (2001). Economic reform and mortality in the former Soviet Union: a study of the suicide epidemic in the 1990s. *European Economic Review, 45*(4-6), 1007-1019.

Chansarn, S. (2017). Economic development, economic problems, and suicide in Thailand: empirical evidence based on provincial data. *Asia-Pacific Social Science Review, 17*(1), 88-104.

Durkheim, E. (1897). *Le Suicide.* New York: Free Press.

Hamermesh, D. S., & Soss, N. M. (1974). An economic theory of suicide. *Journal of Political Economy, 82*(1), 83-98.

Hutt, D. (2024). *Can Southeast Asia tackle its epidemic of male suicides*. Retrieved from https://www.benarnews.org/english/commentaries/southeast-asia-male-suicides-011220241 65324.html

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, 115*(1), 53-74.

Jaen-Varas, D., Mari, J. J., Asevedo, E., Borschmann, R., Diniz, E., Ziebold, C., & Gadelha, A. (2019). The association between adolescent suicide rates and socioeconomic indicators in Brazil: a 10-year retrospective ecological study. *Brazilian Journal of Psychiatry, 41*(5), 389-395.

Jalles, J. T., & Andresen, M. A. (2015). The social and economic determinants of suicide in Canadian provinces. *Health Economics Review, 5*(1), 1-12.

Kõlves, K., Milner, A., & Värnik, P. (2013). Suicide rates and socioeconomic factors in Eastern European countries after the collapse of the Soviet Union: trends between 1990 and 2008. *Sociology of Health & Illness, 35*(6), 956-970.

Koo, J., & Cox, W. M. (2008). An economic interpretation of suicide cycles in Japan. *Contemporary Economic Policy, 26*(1), 162-174.

Kunce, M. (2021). The impact of socioeconomic factors on state suicide rates: revisited. *Journal of Statistical and Econometric Methods, 10*(4), 1-14.

Kuroki, M. (2010). Suicide and unemployment in Japan: evidence from municipal level suicide rates and age-specific suicide rates. *The Journal of Socio-Economics, 39*(6), 683-691.

Lau, E., Hamzah, S. N. Z., Tan, S. C. C., & Somonetti, B. (2016). Suicide and socioeconomic determinants in Canada: beyond morality and philosophy. *Quality & Quantity, 51*(4), 1843-1858.

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics, 108*(1), 1-24.

Lew, B., Kõlves, K., Lester, D., Chen, W. S., Ibrahim, N. B., Khamal, N. R. B., . . . Chan, L. F. (2022). Looking into recent suicide rates and trends in Malaysia: a comparative analysis. *Frontiers in Psychiatry, 12*, 770252.

Lin, S. J. (2006). Unemployment and suicide: panel data analyses. *The Social Science Journal, 43*(4), 727-732.

Machado, D. B., Rasella, D., & dos Santos, D. N. (2015). Impact of income inequality and other social determinants on suicide rate in Brazil. *PLoS ONE, 10*(4), e0124934.

Milner, A., McClure, R., & De Leo, D. (2012). Socio-economic determinants of suicide: an ecological analysis of 35 countries. *Social Psychiatry and Psychiatric Epidemiology, 47*(1), 19-27.

Ministry of Health Malaysia. (2011). *National Suicide Registry Malaysia (NSRM) annual report for 2009.* Kuala Lumpur.

Minoiu, C., & Andrés, A. R. (2008). The effect of public spending on suicide: evidence from US state data. *The Journal of Socio-Economics, 37*(1), 237-261.

Mitra, S., & Shroff, S. (2006). Determinants of suicide rates in developing countries - an econometric investigation of the Indian case. *SSRN Electronic Journal*.

Neumayer, E. (2003). Are socioeconomic factors valid determinants of suicide? Controlling for national cultures of suicide with fixed-effects estimation. *Cross-cultural Research, 37*(3), 307-329.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics, 61*(S1), 653-670.

Relate Malaysia. (2017). *Suicide in Malaysia*. Retrieved from https://relate.com.my/why-get-help-2/suicide-in-malaysia/

Ross, J. M., Yakovlev, P. A., & Carson, F. (2012). Does state spending on mental health lower suicide rates? *The Journal of Socio-Economics, 41*(4), 408-417.

Saksornchai, J. (2018). *Thai suicides inflamed by urbanization, social stigmas*. Retrieved from https://www.khaosodenglish.com/featured/2018/09/10/thai-suicides-inflamed-by-urbanizati on-social-stigmas/

Samaritans of Singapore (SOS). (2017). *High prevalence of suicide in older adults a concern in Singapore*. Retrieved from https://www.sos.org.sg/pressroom/high-prevalence-of-suicide-in-older-adults-a-concern-in-singapore/

Shah, A., Bhat, R., MacKenzie, S., & Koen, C. (2008). A cross-national study of the relationship between elderly suicide rates and life expectancy and markers of socioeconomic status and health care. *International Psychogeriatrics, 20*(2), 347-360.

Sheldon, N. (2017). *10 troubled historical figures who committed suicide*. Retrieved from https://historycollection.com/suicide-club-10-historical-figures-ended-lives/

Shin, Y., & Pesaran, M. H. (1999). An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. In *Econometrics and Economic Theory in the 20th century: The Ragnar Frish Centennial Symposium.* Cambridge University Press.

Stedman, T. (1920). *Stedman's medical dictionary.* Dalcassian publishing company.

The ASEAN Post. (2019). *Suicides in Southeast Asia on the rise*. Retrieved from https://theaseanpost.com/article/suicides-southeast-asia-rise

The Atlantic Philanthropies. (2021). *Youth suicide rates have escalated in the Philippines*. Retrieved from https://www.atlanticphilanthropies.org/news/youth-suicide-rates-have-escalated-in-the -philippines

The World Bank. (2023). *Current health expenditure (% of GDP)*. Retrieved from https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS

The World Bank. (2023). *Fertility rate, total (births per woman)*. Retrieved from https://data.worldbank.org/indicator/SP.DYN.TFRT.IN

The World Bank. (2023). *GDP per capita (constant 2015 US$)*. Retrieved from https://data.worldbank.org/indicator/NY.GDP.PCAP.KD

The World Bank. (2023). *Labor force participation rate, female (% of female population ages 15+) (modeled ILO estimate)*. Retrieved from https://data.worldbank.org/indicator/ SL.TLF.CACT.FE.ZS

The World Bank. (2023). *Unemployment, total (% of total labor force) (modeled ILO estimate)*. Retrieved from https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS

United Nations Children's Fund (UNICEF) & Overseas Development Institute (ODI). (2017). *The nature of suicide amongst children and young people in selected provinces and cities in Viet Nam.* Vietnam. Retrieved from https://www.unicef.org/vietnam/media/986/file/Suicide%20 briefing.pdf

Watanabe, R., Furukawa, M., Nakamura, R., & Ogura, Y. (2006). Analysis of the socioeconomic difficulties affecting the suicide rate in Japan. *KIER Discussion Paper, 626*.

Wirasto, R. T. (2012). Suicide prevention in Indonesia: providing public advocacy. *Jpn Med Assoc J, 55*, 98-104.

World Health Organization (WHO). (2019). *Suicide in the world: global health estimates.* World Health Organization. Retrieved from https://www.quotidianosanita.it/allegati/allegato681222.pdf

World Health Organization (WHO). (2021). *One in 100 deaths is by suicide*. Retrieved from https://www.who.int/news/item/17-06-2021-one-in-100-deaths-is-by-suicide

World Health Organization [WHO]. (2021). *Alcohol, total per capita (15+) consumption (in litres of pure alcohol) (SDG Indicator 3.5.2)*. Retrieved from https://www.who.int/data/gho/data/indicators/ indicator-details/GHO/total-(recorded-unrecorded)-alcohol-per-capita-(15-)-consumption

World Health Organization. (2021). *Suicide rate estimates, age-standardized estimates by country*. Retrieved from https://apps.who.int/gho/data/node.main.MHSUICIDEASDR?lang=en

Ying, Y. H., & Chang, K. (2009). A study of suicide and socioeconomic factors. *Suicide and Life-Threatening Behavior, 39*(2), 214-226.