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The Economics of Suicide: Evidence from LMICs and HICs

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Abstract

Suicide is an important global public health concern. This paper deals with the topic of suicide from an economic perspective. Thus, the study analyses the effect of key economic indicators on the suicide rate in low-and middle-income countries (LMICs) and high-income countries (HICs). The empirical analysis is made by employing the search variable selection method and using two algorithms: AutoGets and Swapwise. The data source for our dependent variable and other search variables is the World Bank development indicators database. The time series for the LMICs and HICs extends from 2000 to 2019. The most influential effect on the suicide rate in LMICs has shown to be female unemployment and per capita health expenditure. Female unemployment appeared to be the key economic indicator for the changes in the suicide rate in HICs. Besides, male unemployment, per capita health expenditure as well as old-age dependency ratio were also found to be influential indicators for the changes in suicide rate in HICs. The empirical results confirm the presence of a strong inverse relationship between the suicide rate and the influential economic variables in LMICs. In regards to the link between suicide rate and the influential economic variables in HICs, mostly it was found a positive relationship, except for the old-age dependency ratio. The findings reflect a need for formulating effective suicide prevention strategies and policies that could better hand out with extreme financial agonies at an individual level.

Keywords: suicide rate, LMICs, HICs, unemployment, GDP growth, AutoGets, Swapwise

1. Introduction

Suicide is an important global public health concern. Each year, approximately 800,000 individuals commit suicide, and more people attempt suicide (Demirci et al., 2020; Iemmi et al. 2016; Er et al., 2023; Akyuz & Karul, 2022; (Ziętarski & Pobłocka, 2022). At the global level, the highest suicide rates are observed in Eastern Europe and the lowest in Latin American and Muslim countries (Blasco-Fontecilla et al. 2012; Claveria, 2022). By the recent World Health Organization report on suicide (WHO, 2014), suicide prevention was underlined as a global public mental health matter and additionally, the United Nations proposal included suicide rates as a key indicator by 2030 for target 3.4 of the Sustainable Development Goals (UN, 2016). Suicide rates are lower in high-income Western countries compared with low-and middle-income countries (Blasco-Fontecilla et al., 2012; Claveria, 2022). As much as 75.5% of suicides happen in low-income and

middle-income countries (Bantjes et al., 2016; Iemmi et al., 2016). In many countries, suicide rates generally increase with age, even though there is also a decrease with increasing age but in a less number of countries (Demir, 2018). Research studies showed that in a lot of countries, suicide rates among those aged 65+ are higher than those among younger people. More precisely, studies showed that people aged 75+ have suicide rates that are three times higher than people aged 15-24 (Demir, 2018). As the population ages, the absolute number of suicides among elderly individuals is expected to increase (Wu et al., 2022).

This paper deals with the topic of suicide from an economic perspective. The goal of this research study is to explore to what extent the suicide rate during the period 2000–2019 is explained by changing economics in LMICs and HICs. The contribution of the research work is to show that rational behavior that is likely to be influenced by economic determinants is an important aspect of the decision to commit suicide. This paper is organized as follows. Section 2 presents the theoretical background of suicide from an economic perspective. Section 3 describes the literature review on suicide. Section 4 provides the data used and the methodology approach. Sections 5 and 6 present empirical evidence and the discussion, respectively. Section 7 concludes. At the very end of the paper, an Appendix is provided including the key graphs of empirical results.

2. Theoretical Background

Durkheim's position on association of socioeconomic factors with suicide is considered a *traditional sociological perspective*. Thus, Durkheim formulated a theory according to equality in income and wealth was intended to protect against suicide and argued that income inequality makes threats against social integration and results in anomie (Bantjes et al., 2016). The *theory of expected utility* was the first attempt to order the rules of rational behavior of individuals (Ziętarski & Pobłocka, 2022). Nevertheless, the assumptions made regarding making purchase decisions started to become more difficult as it was observed that people do not always make decisions objectively and rationally (Ziętarski & Pobłocka, 2022). Thus, Kimenyi and Shughart (1986) hypothesized that the expected utility of being alive is positively related to real income and negatively related to loss of income due to unemployment, and

therefore suicide rates would be expected to be negatively related to real income and positively linked to the unemployment rate. The *integrated motivational volitional model* of suicidal behavior suggests that suicidal behavior occurs as a result of feelings of being trapped; therefore, individuals who feel trapped by life's circumstances and who see no other options for escape use suicidal behavior as a means of seeking a solution (Bantjes et al. 2016). *Adaptation-level theory* proposes that individuals' perceptions and judgments of stimuli are related to their prior experience with them (Abdou et al., 2022). This previous experience defines a reference point or level of adaptation at which the current level of the stimulus is perceived as exceeding or not compared to it. This raises the concern that the general population may not perceive changes in economic insecurity (stimulus) based on absolute changes, but rather by reference to the regime of economic insecurity in which they occur (reference point), which at the aggregate level defines the prior experience of the population for economic insecurity (level of adaptation), (Abdou et al., 2022). There is micro-level evidence to suggest that adaptation and anticipation of job insecurity play a role in shaping the response of individuals to an increase in job insecurity. In other words, the response of individuals to changes in job insecurity is not based on absolute changes but rather depends on the reference. Thus, it is predicted that if the general population adapts and adjusts its expectations to the economic insecurity regime, one would expect that the increase in economic insecurity that occurs within high economic insecurity regimes would have little effect on suicides, given that they are expected (Abdou et al., 2022).

The economic theory of suicide, established by Hamermesh and Soss in 1974, (HS model), postulates that individuals commit suicide when their reduced lifetime future utility declines below a bearable threshold (Wisniewski et al., 2020). The future utility is a function of several variables, the most prominent of which is the level of permanent income. In situations of financial disaster, the benefit that a person can derive from life's circumstances may be reduced beyond the extent that they can withstand. According to Yaniv (2001), the HS model assumes that an individual will commit suicide if his/her lifetime utility at a certain minimum level of subsistence increases, while the

discounted value of permanent income over the remaining lifetime declines with one's remaining life expectancy declines, so that each year one approaches closer to the breaking point, *plus* a utility factor representing his/her "taste for living", to reach zero. Furthermore, Smith (2019) explains the HS model in more detail: Thus, in the HS model, it is assumed that people have perfect information about their future and make perfectly rational decisions. Specifically, individuals calculate the annual utility they will derive from the potential financial costs as well as benefits each year that they will live. These costs and benefits depend on their age, permanent income (e.g., their average annual income during their lifetime), and the costs of staying alive. The only non-economic consideration is a person's "taste for living", which is a constant "defined for the cohort at birth". When the present value of a person's reduced utility flow falls below zero, he/she makes a rational decision to kill himself/herself. The main predictions of the HS model are that suicide rates increase with age and are oppositely related to permanent income (Smith, 2019). The theoretical perspective of the HS model was tested empirically, specifying three main determinants of suicide: income, unemployment and age (Jalles & Andresen, 2015). The HS model is presented in eq. (1), (Botha, 2012).

$$Z(a, YP) = \int_a^\omega e^{-r(m-a)} U[C(m, YP) - K(m)]P(m)\omega m \qquad (1)$$

where Z refers to the present value of an individual's lifetime utility at age a, YP represents the permanent income that also can be referred to consumption, $U[\cdot]$ and $C[\cdot]$ are functions of the individual utility and consumption, ω is the highest achievable age, r represents the private reduce rate, K denotes the yearly cost of maintaining oneself, and $P(m)$ is the probability of living to age *m* considering survival to age *a*. A more focused connection between economic circumstances and destructive human behavior is provided by the *frustration-aggression theory* (Wisniewski et al., 2020). This theory proposes the idea that a negative impact on an individual's economic circumstances can prompt a person to engage in acts of aggression that are often self-directed. Therefore, an improvement in economic conditions reduces the degree of frustration that individuals feel and thus the propensity to harm themselves. This allows for a coherent argument for a link between suicide rates and business cycles (Wisniewski et al., 2020).

3. Literature Review

When economists talk about economic behaviors, they usually use words such as profit, loss, rate of return, cost, or risk. All these quantities are expressed in monetary terms (Ziętarski & Pobłocka, 2022). One study concluded that two of the seven dimensions that represent differences in people's attitudes towards money are the lack of money as a symbol of failure in life and the feeling of security provided by having money (Ziętarski & Pobłocka, 2022). Considering the materialism that drives value formation in contemporary societies, it is rational to expect that variations in suicide rates are also associated with economic factors and their fluctuations (Kunce, 2022). The paradigm that human behavior is based on rational choice calculus is well accepted by economists and therefore this paradigm has wide applicability in explaining social behaviors, e.g., variation in crime, fertility, marriage as well as suicide rates (Kimenyi & Shughart, 1986). Additionally, these authors showed that suicide rates are sensitive to economic variables such as income, employment and medical care costs. Economic variables like real gross domestic product (GDP) growth and the unemployment rate are identified as important determinants of suicide (Botha, 2012; Claveria, 2022).

Many empirical studies investigating the relationship between income or real GDP growth and suicide rates found negative associations, however, some researchers reveal the opposite result, hence, and Wisniewski et al. (2020) conclude that both the theoretical and empirical literature present different performances on the income effect to the prevalence of suicide (Botha, 2012). As an indicator of economic activity, Gross domestic product (GDP), is negatively correlated with suicide rates, suggesting that suicide rates

decrease during economic expansion and increase during recessions (Blasco-Fontecilla et al., 2012). Furthermore, it is suggested that the relationship between GDP *per capita* and suicide may follow an inverted U-shaped curve; with suicide trends decreasing after a certain threshold of economic development is reached. Thus, even though at low levels of GDP, increases in GDP are associated with increases in suicide rates, one time a given threshold of economic development is reached, further increases in GDP are not correlated with further increases in suicide rates. The threshold at which the inverted U-shaped curve begins to move downward can vary depending on specific social, economic and cultural differences within countries (Blasco-Fontecilla et al., 2012). GDP *per capita* is recognized as an important measure of the overall state of the economy and has a significant impact on suicides (Akyuz & Karul, 2022). Nevertheless, there is a limiting circumstance of GDP as an effective indicator for the economic prospect. Thus, GDP might not reflect real welfare (Akyuz & Karul, 2022) and measure total added value because a significant part of economic activity in developing countries is carried out in the informal sector.

More and more body of literature records the relationship between suicide and socioeconomic determinants, e.g., poverty, financial crisis, the condition of owing money and unemployment (Bantjes et al., 2016; Wu et al., 2022). Suicides are usually linked with recessions and higher unemployment rates (Vandoros & Kawachi, 2021) as well as the announcement of fiscal austerity measures. Unemployment is the most used economic indicator to analyze the relationship between suicide and economic factors (Akyuz & Karul, 2022; Kunce, 2022). Countries belonging to the group with a high suicide rate compared to countries belonging to the group with a low suicide rate according to Mann and Metts (2017) were those countries with lower health care costs, a lower at-risk-of-poverty rate, a higher percentage of total unemployment, and higher annual growth rates.

The existing literature on the relationship between economic insecurity and suicide points that the threat of losing a job and the associated financial insecurity are powerful enough to cause suicide (Abdou et al., 2022; Vandoros & Kawachi, 2021). Accordingly, Ziętarski & Pobłocka (2022) conclude that the deterioration

of a consumer's financial situation, e.g., job loss, can have a significant negative impact on their psychological state. At the macro level, economic, socio-cultural, and circumstances factors play an important role in the causes of suicide, like the positive association between unemployment and ended suicide (Iemmi et al., 2016). King (2020) hypothesized that an increase in economic development causes a decrease in suicide rates in countries worldwide. In the opinion of King (2020), researchers nowadays believe that the decision to commit suicide can be an expression of political, social or economic conditions. This current perception of suicide gave more meaning to the study of suicide rates, as they can now be used as an indicator of the quality of life of the average citizen in a given country. Furthermore, according to King (2020), the increasing economic development can lead to the carrying out of national mental health policies as well as infrastructures or universal healthcare, which in turn can reduce suicide rates. On the other hand, mental health clinical services and infrastructure are in most cases poor in low-income and middle-income countries since they have lower levels of general economic development (King, 2020). Therefore, it is assumed that good economic development is a key driver for countries to take preventative measures to lessen suicide rates.

An increasing number of international studies show that rates of suicide are related to periods of economic recession and economic prosperity (Yin et al., 2016). As stated by Stack (1981), the higher the unemployment rate, the greater the financial difficulty and disorders of the person in society and the higher the suicide rate. Kuroki (2010) points out that higher unemployment rates are related to higher suicide rates across countries. Suicide is associated with economic inequalities and economic shocks, and rapid booms and recessions (Bantjes et al., 2016). Kuroki (2010) also indicates for suicide increases in the time of recession in the U.S. Additionally, King (2020) also suggests that suicide rates decrease in times of economic expansion and increase in times of recession, as this is when economic development rises and falls, respectively, and this is supported by the view that economic crisis is a stressor. In the early 1990s, with the collapse of the Soviet Union, the member states (Russia, Belarus, Ukraine and the Baltic countries) entered a severe recession and a phase of major social changes. In the time of that

period, there was a significant increase in suicide occurrences in Russia, Belarus, Ukraine and the Baltic countries (Demirci et al., 2020).

In demographic history, the correlation between recessions and suicide is one of the best-indicated statistical associations and it is well-recognized that economic crises have an irritating effect on suicidal propensity (Reeves et al., 2014). Thus, in the two regions, i.e., North America and Europe, most affected by the worst financial crisis in 2008, suicides increased noticeably. Unemployment, changing incomes and household debt were posited as contributing factors to the sudden rise in suicides as a result of the European financial crisis in 2008 (Mann & Metts, 2017). The rise in suicide rates during the economic crisis of 2008 had a lot to do with the fear of unemployment and unemployment itself (Demirci et al., 2020). Additionally, an analysis of the relationship between suicides and unemployment in 27 European countries, found that there were 4900 excess suicides in 2009 compared to the past eight years, i.e., 2000–2007, (Merzagora et al., 2016). As claimed by Merzagora et al. (2016), through an increase in the unemployment rate or the prevalence of economic hardship, the economic crisis somehow affected the suicide rate in a way that exceeded other macro and micro factors. Economic crises put pressure on many individuals, which can damage their mental health and lead up to suicide. Consequently, after the global recession of 2008, nearly 5 000 extra suicides occurred in 2009 worldwide (King, 2020). Likewise, the stock market in China crashed in 2007 and experienced "severe volatility" that lead to "investment failure" shortly after and in the following year, there were increased suicide rates in China (King, 2020). For that reason, it is believed that changes in economic development extremely affect the quality of people's lives, for better or for worse. Yin et al. (2016) point out that previous studies in China found that suicides showed a unique sex difference, with a higher rate of females than males, and the rate was also considerably higher in rural than urban communities in China. With the rising economic development levels and substantial social changes, a dramatic decline in suicide rates is perceived in China in the past decades (Yu, 2022; Yin et al. 2016; Zhang et al. 2022).

Inflation gained greater importance in testing the relationship between suicide mortality and economic factors. Some studies examined the effect of inflation on suicide mortality and produced mixed results. Based on an analysis of four different developed countries, Akyuz and Karul (2022) suggest that the consumer price index is negatively associated with female suicide in the UK and total suicide in the USA. Akyuz and Karul (2022) investigated the relationship between suicide mortality and economic determinants for European countries in the period 2000–2011. According to the results of this study, there was a negative correlation between inflation and overall male suicides, in contrast to a positive correlation between inflation and female suicide mortality.

Shah (2011) hypothesized that as the old-age dependency ratio (the ratio of those 65+ to those below 65) increases, there will be fewer younger people available to care for older people and this, consequently, will increase burdening younger caregivers with increased levels of psychiatric morbidity leading to increased suicide rates in population. The main findings of Shah (2011) showed a significant and positive correlation between the old age dependency ratio and suicide rates in both sexes in the population. Using data from the World Health Organization, a cross-national study examining the relationship between suicide rates in the elderly and the old-age dependency ratio found significant positive correlations between suicide rates in both sexes in two age groups of the elderly (65-74 years and 75+ years), and the elderly dependency ratio for men, women and both sexes combined (Shah, 2011).

Iemmi et al. (2016) performed a systematic review to understand the relationship between suicidal ideations and behaviors and economic poverty in low-and middle-income countries. They identified 37 studies that met the inclusion criteria and the majority of studies reported a positive association. At the individual level, their findings indicate a relatively consistent trend showing that poverty, especially in the form of lower economic status, declined wealth and unemployment is related to suicidal ideations and behaviors. At the country level, there were insufficient data to draw clear conclusions, but available evidence suggests potential benefits in addressing economic poverty within suicide prevention strategies, about both persistent poverty and severe economic events (Iemmi et al., 2016). The key findings of Er et al. (2023) suggest that an

increase in economic insecurity is associated with an increased suicide rate. According to their estimates, higher economic insecurity is linked with an increased risk of suicide in high-income countries. For middle-and low-income countries, Er et al. (2023) found no such influence. In general, they concluded that existing and lagged economic insecurity is a concern for increased suicide risk, particularly in high-income countries. In high-income countries, suicide mostly occurs as a result of high-stress circumstances, e.g., financial matters, then break up from a spouse or family, severe pain resulting in illnesses and chronic diseases (Demirci et al., 2020). The impact of unemployment on suicide in HICs was extensively investigated in the wake of global economic crises. Therefore, an Australian study revealed higher rates of suicide following the 2006–2008 economic crises (Bantjes et al., 2016). After the 1997–1998 Asian economic crisis, a positive relationship was found between suicide and unemployment and a decline in gross domestic product (GDP) in Japan, South Korea and Hong Kong, but not in Taiwan or Singapore (Bantjes et al., 2016; Mann & Matts, 2017). Studies of suicides in Japan by economists also confirm the positive effect of unemployment on suicides, and also the signs of unemployment coefficients were significantly positive for both men and women (Kuroki, 2010). In addition, rising suicides in rural Japan led to consideration of the effects of urbanization and industrialization as contributing factors; thus higher suicide rates were found in underpopulated areas and less prosperous economies (Mann & Matts, 2017).

4. Data and Method

The rate of suicide is measured as the number of suicides per 100,000 population in a given year. The data source for the suicide rates as well as data for search variables i.e., female and male unemployment; GDP growth; inflation (consumer price); old-age dependency ratio; and health expenditures per capita is the World Bank development indicators (World Bank, 2023). The time series for the LMICs and HICs extends from 2000 to 2019. The present study did not incorporate the data after 2019 since those data are still not available in the database of the World Bank. The analysis of time series data is needed to see if economic theories of suicide will stand the rigorous diagnostic tests of the applied econometric algorithms. Time series analysis studies have the advantage of exploring the

subsequent influence of changes in potentially relevant variables and looking for a possible cause-and-effect relation (Mann & Matts, 2017).

The latest advancements in variable selection technology led to the increasing popularity of methods that enable the data themselves to suggest the most suitable combination of regressors to use in estimation. These methods allow the researcher to provide a set of possible variables for the model, instead to specify a specific model. Our research study offers two different variable selection methods: Auto-Search/GETS and Swapwise. One of the newly introduced technologies is the AutoSearch/GETS algorithm for variable selection (Escribano & Sucarrat, 2011). AutoSEARCH algorithm follows the steps proposed by the AutoSEARCH algorithm of Escribano and Sucarrat (2011), which in turn, constructs upon the work of Hoover and Perez (1999), and is much the same as the technology behind the *Autometrics*. AutoSearch/GETS algorithm is a method of variable selection and this algorithm is similar to the automatic machinery, a backward uni-directional stepwise method. Thus, first, the model with all search variables (called the general unrestricted model, GUM) is estimated and then checked with several diagnostic tests. A certain number of search paths have been defined, by one for each insignificant search variable in the GUM. For each path, the precisely marked insignificant variable is removed and then several other variable removal steps are taken, and each time when removing the most insignificant variable, each time checking if the present model passes the series of diagnostic tests. If the diagnostic tests are failing after the elimination of a variable, that variable is returned into the model and prevented from being omitted again along this path. Once there are no more insignificant variables, or it is not possible to remove a variable without failing the diagnostic tests, variable removal ends. When all paths have been computed the final models made by the paths are compared using an ICS (information criteria selection). Then the best model is selected. One of the advantages of AutoSearch/GETS is that the set of potential variables could be broken into sets, and a search is performed on each set one at a time, then the selected variables from each set could be combined into a last set to be searched. This allows testing more potential variables as long

as enough potential variables are rejected, which means it is an excellent algorithm for indicator saturation research.

There are two Swapwise methods: Swapwise-Max R-Squared and the Min R-squared Increment method (IHS, 2022). *The Max R-squared Increment method* begins with adding the variable that maximizes the resulting regression R-squared. Then the variable that leads to the largest increase in R-squared is added. Next, each of the two variables added as regressors is compared individually to all variables not included in the model, calculating whether the R-squared could be improved by swapping the "in" with an "out" variable. If there is such an improvement, then the "in" variable is replaced by the "out" variable. If there is more than one swap that would improve the R-squared, the swap that gives the greatest increase is made. Once a swap is made, the comparison process begins again. After all comparisons and possible swaps are made, a third variable is added, with the variable selected to produce the greatest increase in R-squared. The three variables inside the model are then compared to all the variables outside the model and any R-squared increasing swaps are made. This process pursues until the number of variables added to the model reaches the specified limit by the user. *The Min R-squared Increment method* is very similar to the Max R-squared method. The difference lies in the swapping mechanism. In contrast with the Max R-squared swaps the variables that would lead to the greatest increase in R-squared, the Min R-squared method forms a swap based on the smallest increase.

5. Empirical Results

This Section presents the estimated models on suicide rates in LMICs and HICs, separately. The analyses will follow the models estimated with AutoGets selection method and Swapwise selection method with a few numbers of candidate economic variables to perform the best influential variables on the suicide rate. Our models contain annual data between 2000 and 2019 on the suicide rate for LMICs and HICs, along with annual data for the key economic variables for the same groups of countries. As a dependent variable is used the series SUICIDE that containing the annual rate of suicide per 100 000 population. There is total of 6 search regressors: female unemployment as % of the female labor force (FUN); male unemployment as % of the male labor force (MUN); GDP growth as annual % (GDPG); inflation-consumer prices as annual % (ICP); old-age dependency ratio as % of the working-age population (ODR); and current health expenditure per capita in current U.S. dollars (PCHE). The models also have an always-included constant.

Table 1 presents the results of the Auto-Search/GETS algorithm. The Schwarz criterion was used to decide between the final models from the candidates remaining in the selection algorithm. The information criteria used for model selection determine whether to include either the general model, i.e., the GUM (the model with all possible search variables), or the empty model (the model with zero search variables) as candidates (see Appendix). Only the AR LM test[1] and PET tests were selected as diagnostic tests steps (i.e., steps 1 and 3 of the AutoGets algorithm) during the path search. The estimated coefficients and associated summary statistics of the Auto/gets estimation together with the details of the selection process are shown in Table 1 separately for LMICs and HICs. The results show the percentage change in suicide rate to a range of search variables. Auto-search algorithm selected the best 2 regressors for LMICs and the best 4 regressors for the HICs. Unemployment pressures appear to have a significant impact on the changing rate of suicide. Statistically speaking, the relationship is stronger for women than for males. Percentage changes in suicide rates are negatively linked with rising female unemployment in LMICs and positively with increases in both female and male unemployment in HICs. Per capita health care spending is effective in reducing suicide in LMICs but is ineffective in altering the outcome for HICs. Additionally, it was found a negative influence of the old-age dependency ratio on the suicide rate in HICs. Therefore, it revealed an inverse relationship between changes in the suicide rate and the aging in HICs.

Table 1. Auto/gets estimation results on suicide rate in LMICs and HICs:

Dependent variable: Suicide rate

Method: Variable selection				
Sample: 2000-2019				
Included observations: 20				
Number of always included regressors: 1				
Number of search regressors: 6				
Selection method: AutoGets				
Number of blocks: 1				
Low and middle-income countries LMICS model				
Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	22.66	2.049	11.06	0.000
FUN (female unemployment)	-1.502	0.324	-4.635	0.000
PCHE (per capita health expenditure)	-0.021	0.001	-22.40	0.000
Summary statistics				
R-squared	0.980	Mean dependent var	10.21	
Adjusted R-squared	0.978	S.D.dependent var	1.416	
S.E.of regression	0.210	Akaike info criterion	-0.149	
Sum squared resid	0.747	Schwarc criterion	0.001	
Log likelihood	4.488	Hannan-Quinn criter.	-0.120	
F-statistic	424.7	Durbin-Watson stat	1.179	
Prob(F-statistic)	0.000			
Selection summary				
Number of selected regressors: 2				
Number of models compared: 3				
High income countries HICs model				
Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	11.60	1.829	6.341	0.000
FUN (female unemployment)	0.206	0.044	4.682	0.000
MUN (male unemployment)	0.674	0.273	2.472	0.026
PCHE (per capita health expenditure)	0.001	0.001	4.782	0.000
ODR (old-age dependency ratio)	-0.208	0.038	-5.431	0.000
Summary statistics				
R-squared	0.896	Mean dependent var	14.08	
Adjusted R-squared	0.869	S.D.dependent var	0.394	
S.E.of regression	0.143	Akaike info criterion	-0.843	
Sum squared resid	0.306	Schwarc criterion	-0.594	
Log likelihood	13.43	Hannan-Quinn criter.	-0.795	
F-statistic	32.47	Durbin-Watson stat	2.068	
Prob(F-statistic)	0.000			
Selection summary				

Number of selected regressors: 4
Number of models compared: 4

Note: p-values and subsequent tests do not account for variable selection. Source: Author's calculations

The Swapwise variable selection method allows one to choose whether to use Max R-squared Increment or Min R-squared Increment and to select the number of additional variables to be included in the model. R-squared and Alpha-squared tables and graphs serve as diagnostic selection items when using the Swapwise method. R-squared tables and graphs show the selected value at each step, and alpha-squared is related to the change in R-squared at each step (see Appendix). The estimation with the Swapwise equation is similar to Auto-search, the summary of the estimation is presented at the top of Table 2, the middle part provides the results with the Swapwise estimation method, and after that, the selection summary is shown. Table 2 presents the result with the Swapwise algorithm-Max

R-squared Increment method linking the percentage change in suicide rate to a range of search variables. The number of additional variables was set to the best one; therefore, the Swapwise method selected the single variable that leads to the greatest increase in R-squared for both LMICs and HICs. Therefore, the application of the Stepwise method on LMICs and HICs revealed that the most significant economic variable for LMICs that influences the changing rate of suicide is the impact of the per capita health expenditure and the most important variable for HICs is the impact of female unemployment. The relationship between the suicide rate and per capita health expenditure in LMICs was negative and the relationship between female unemployment and the suicide rate in HICs was found to be positive.

Table 2. Swapwise estimation results on suicide rate in LMICs and HICs:

Dependent variable: Suicide rate				
Method: Variable selection				
Sample: 2000-2019				
Included observations: 20				
Number of always included regressors: 1				
Number of search regressors: 6				
Selection method: Swapwise – Max R-sqaured				
Stopping criterion: Number of search regressors: 1				
Low and middle-income countries LMICS model				
Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	13.17	0.165	79.61	0.000
PCHE (per capita health expenditure)	-0.018	0.001	-19.68	0.000
Summary statistics				
R-squared	0.955	Mean dependent var	10.21	
Adjusted R-squared	0.953	S.D.dependent var	1.416	
S.E.of regression	0.307	Akaike info criterion	0.568	
Sum squared resid	1.692	Schwarc criterion	0.668	
Log likelihood	-3.683	Hannan-Quinn criter.	0.588	
F-statistic	387.2	Durbin-Watson stat	0.803	
Prob(F-statistic)	0.000			

Selection summary				
Number of selected regressors: 1				
Added PCHE (per capita health expenditure)				
High income countries HICs model				
Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	11.66	0.406	28.73	0.000
FUN (female unemployment)	0.348	0.058	6.016	0.000
Summary statistics				
R-squared	0.668	Mean dependent var	14.08	
Adjusted R-squared	0.649	S.D.dependent var	0.394	
S.E.of regression	0.233	Akaike info criterion	0.022	
Sum squared resid	0.980	Schwarc criterion	0.122	
Log likelihood	1.775	Hannan-Quinn criter.	0.042	
F-statistic	36.19	Durbin-Watson stat	0.729	
Prob(F-statistic)	0.000			
Selection summary				
Number of selected regressors: 1				
Added FUN (female unemployment)				

Note: p-values and subsequent tests do not account for variable selection. Source: Author's calculations

6. Discussion

In this paper, the most important economic determinants of suicide on a macroeconomic level were tested. These factors have received deserved attention from the academic community. To clarify the underlying mechanisms of this phenomenon, the empirical application was widened by extending the theoretical understanding of existing economic models of suicide. Generally, the framework of the study showed that suicide rates increase with other macroeconomic indicators. According to our results, unemployment rates by sex have a clear and recognizable effect on the percentage change in suicide rates in LMICs and HICs. The result is robust to two different econometric specifications based on variable selection algorithms. The traditional economic theories articulate the financial insecurities associated with suicide rates (see Abdou et al., 2022; Vandoros & Kawachi, 2021; Ziętarski & Pobłocka, 2022). However, this study widens the analytical power in this respect and indicates that financial insecurity has a greater reverberating within society than at first predicted by the theories. This research study established a relationship at the aggregate level and understood that a segment of interactions exists between aggregate circumstances and at-risk individuals (King, 2020).

In line with the research expectations, there is an inverse relationship between female unemployment and suicidal tendencies within societies of LMICs (Er et al., 2023; Yu, 2022; Yin et al., 2016; Zhang et al., 2022). Moreover, the results from LMICs showed that suicide rates are sensitive to economic variables such as medical care costs (Kimenyi & Shughart, 1986), i.e., per capita health expenditure. In the direction of this finding is the claim of King (2020) that the increasing economic development in low and middle-income countries can lead to the implementation of national mental health policies as well as universal healthcare, which in turn can reduce suicide rates. The unemployment status, for both genders, appears to significantly affect suicidality within the population in HICs as well. Additionally, the regression analysis suggests that rising unemployment contributes to suicidal tendencies for both genders in HICs. As stated, in the HICs sample, percentage changes

in suicide rates are related positively to rising unemployment (see Er et al., 2023; Iemmi et al., 2016; Mann & Metts, 2017; Merzagora et al., 2016; Bantjes et al., 2016; Kuroki, 2010; Stack, 1981).

The estimates also support the theory proposed by Hamermesh and Soss (1974), i.e., HS model, as some of the evidence indicates that suicide rates decline in times of rising personal income and unemployment (e.g., LMIC) and when falling unemployment leads to fall in suicide (e.g., HICs). However, women's increased participation in the labor force alone does not appear to be important in determining their suicidal behavior. The percentage change in female unemployment has a significant impact on the suicide rate, as the burden of providing a livelihood no longer rests solely on men (Wisniewski et al., 2020), e.g., HICs. Furthermore, suicide analyses by gender reveal that, unlike unemployed men in LMICs, unemployed men in HICs are less able to resist the pressure of suicidal impulses in an economy that is increasingly failing to fully utilize its labor force. Perhaps men in more developed economies feel the psychological impact more acutely as a result of the traditional cultural norms of gender roles in their societies. The impact of the age dependency ratio on the suicide rate in the HICs model using the AutoGets method was found to be negatively significant. These findings are inconsistent with the expectations of economic theory and research findings. However, it is possible that the age dependency ratio variable interacts with and is modified and mediated by cultural factors (Shah et al., 2008). Therefore, the contribution of the age dependency ratio on suicide rates, especially in different HICs, requires further study with formal measurement and including cultural factors with validated instruments.

Although it is difficult to disprove the statistical significance of the results, questions are raised about the overall economic importance of gained results. Further insights into suicidal tendencies can be obtained from the regression estimates for the other search variables. Inflationary pressures appear not to exert a significant influence on the changing rate of suicide, regardless of whether our focus is on LMICs or HICs. In this respect, our findings contribute clarity to the conflicting reasoning in the literature (Botha, 2012; Wisniewski et al., 2020). About income, GDP growth seems not to have any significant effect on suicidal

propensity in both samples for LMICs and HICs when a model with a full set of search (economic) variables is considered. Nevertheless, it is considered that there is a limiting circumstance of GDP as an effective indicator in producing a desired or intended result for the economic prospect. The reason for these circumstances in LMICs may be that GDP does not reflect true well-being in these countries (Akyuz & Karul, 2022) as a significant proportion of economic activity in low-and middle-income countries takes place in the informal sector. Thus, the result obtained regarding the relationship between GDP growth and the suicide rate in the LMICS model should not be taken for granted.

7. Conclusion

The existence of an efficient social and health care system is the key to limiting the negative impact of economic circumstances on the psychological and mental health of a population. A broadened understanding of the link between macroeconomic conditions and suicide would allow the formulation of effective suicide prevention strategies and policies that could better hand out with extreme financial agonies at an individual level. These points further emphasize the need during a period of economic crisis to identify population groups at high risk of suicide to focus some modest public resources on their needs. For this reason, research on suicide risk should be promoted, and data on suicide rate and the factors influencing it should be extensively spread.

Authors' Contributions

The Author is solely responsible for the conception and design of the study. The author fully and independently carried out the empirical analysis and interpreted both the theoretical and empirical results of this research work.

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Appendix

A: Suicide rate in LMICs, 2000-2019:

Suicide rate in low and middle-income countries (LMICs)
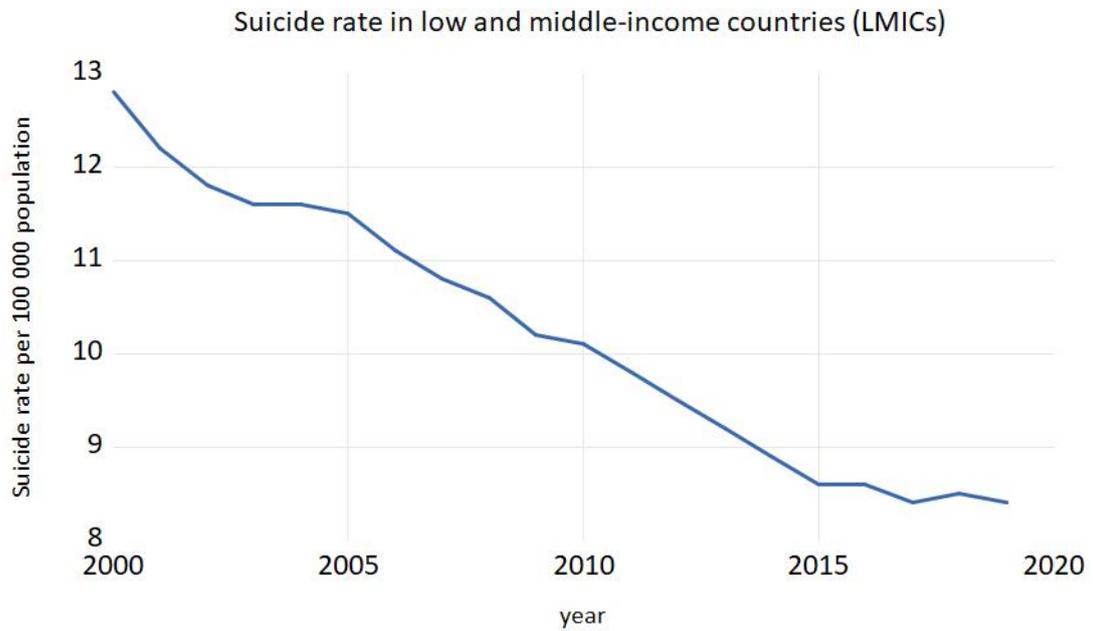
B: Suicide rate in HICs, 2000-2019:

Suicide rate in high-income countries (HICs)
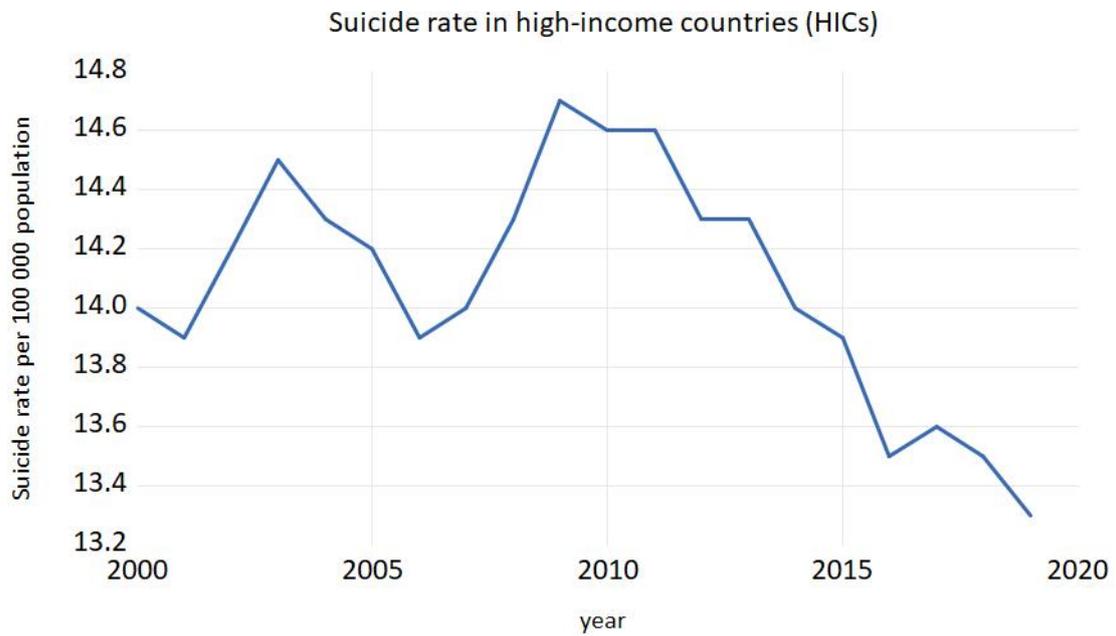
C: Schwartz criterion-AutoGets method, LMICs model:
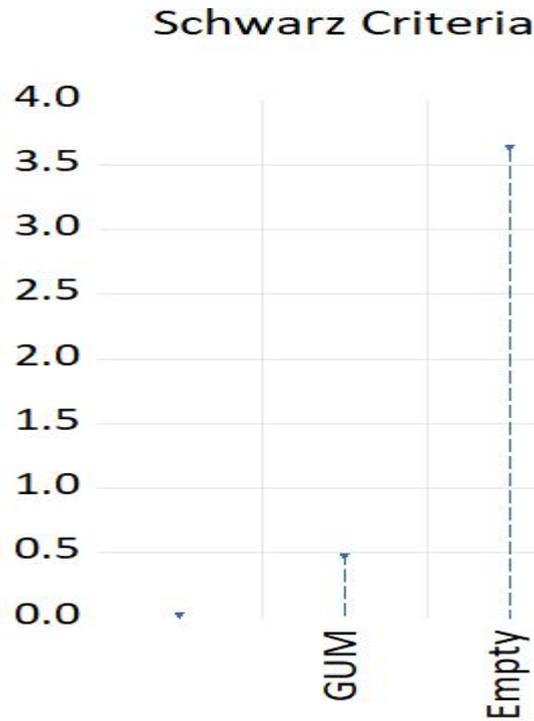
Schwarz Criteria

D: Schwartz criterion-AutoGets method, HICs model:
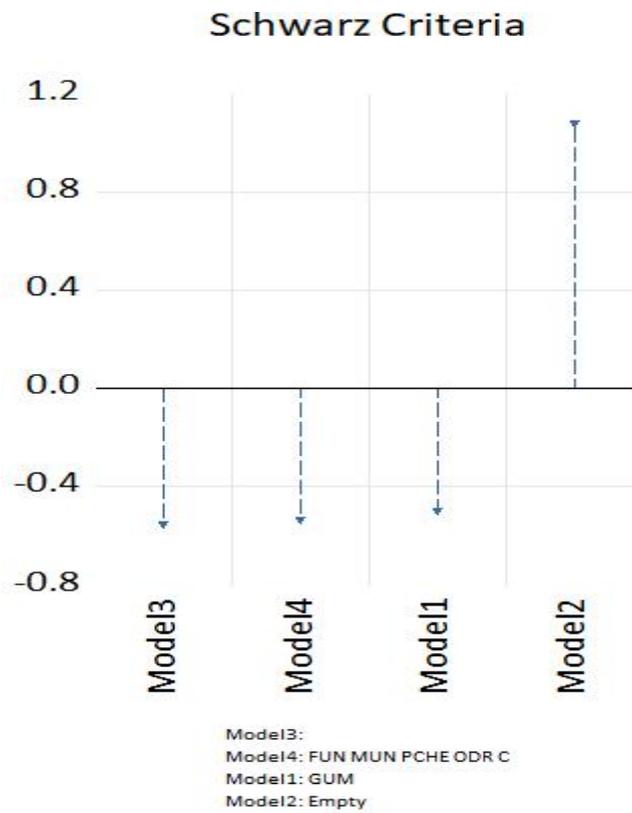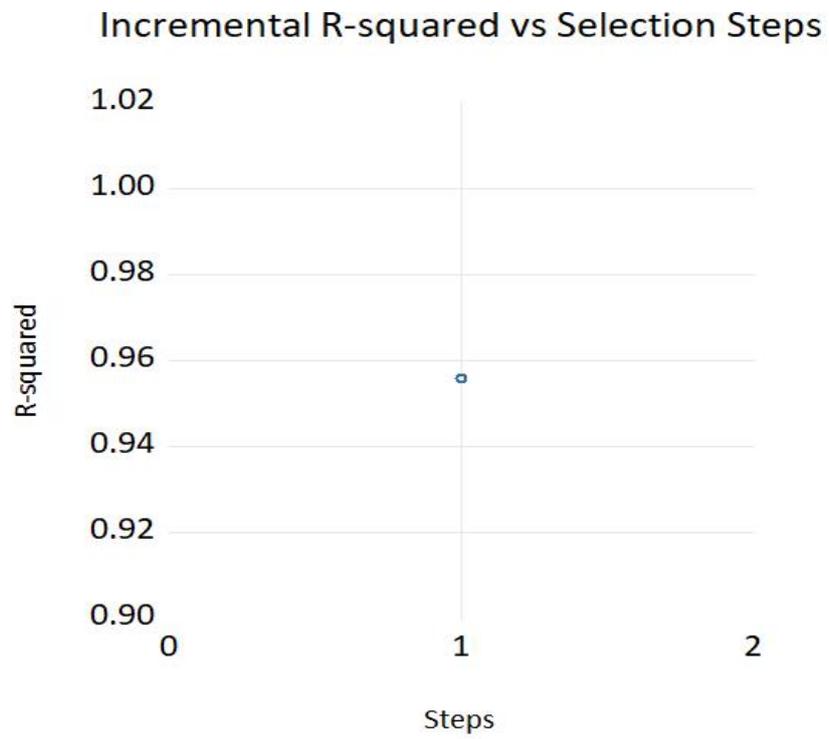
Schwarz Criteria

Model3:
Model4: FUN MUN PCHE ODR C
Model1: GUM
Model2: Empty

E: Incremental R-squared graph-Swapwise method, LMICs model

Incremental R-squared vs Selection Steps

F: Incremental R-squared graph-Swapwise method, HICs model

Incremental R-squared vs Selection Steps

G: Incremental Alpha-squared graph-Swapwise method, LMICs model

Incremental Alpha-squared vs Selection Steps

H: Incremental Alpha-squared graph-Swapwise method, HICs model

Incremental Alpha-squared vs Selection Steps

<hr>
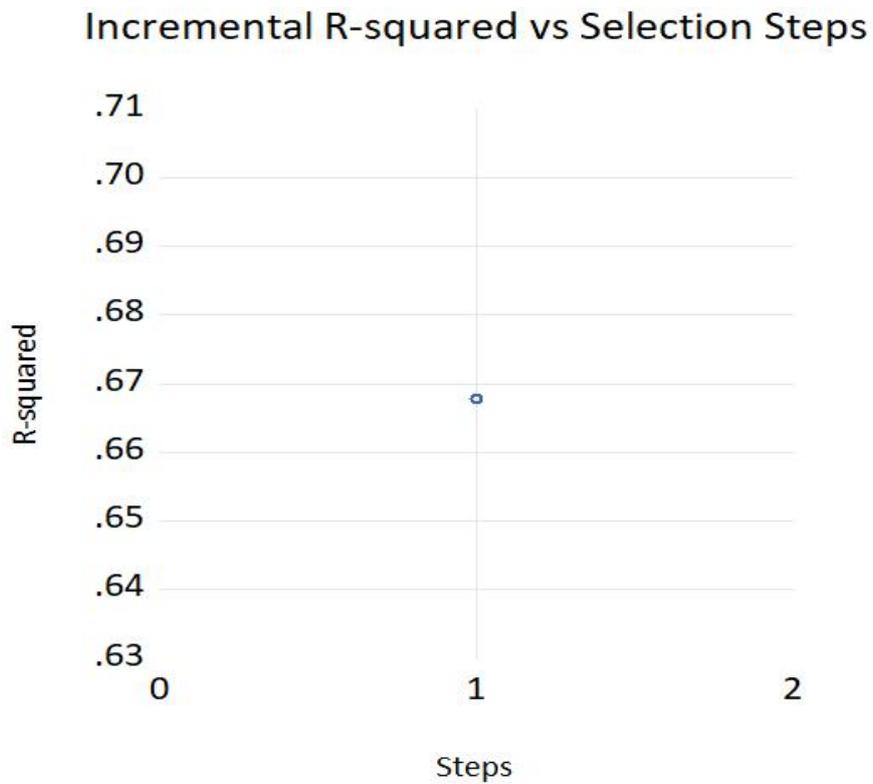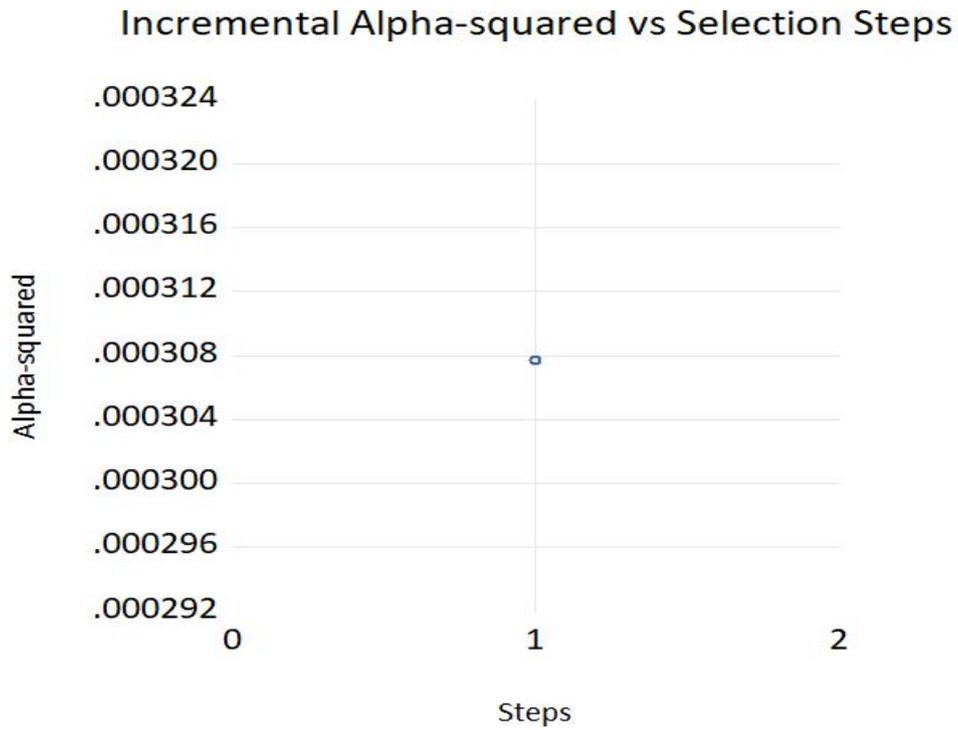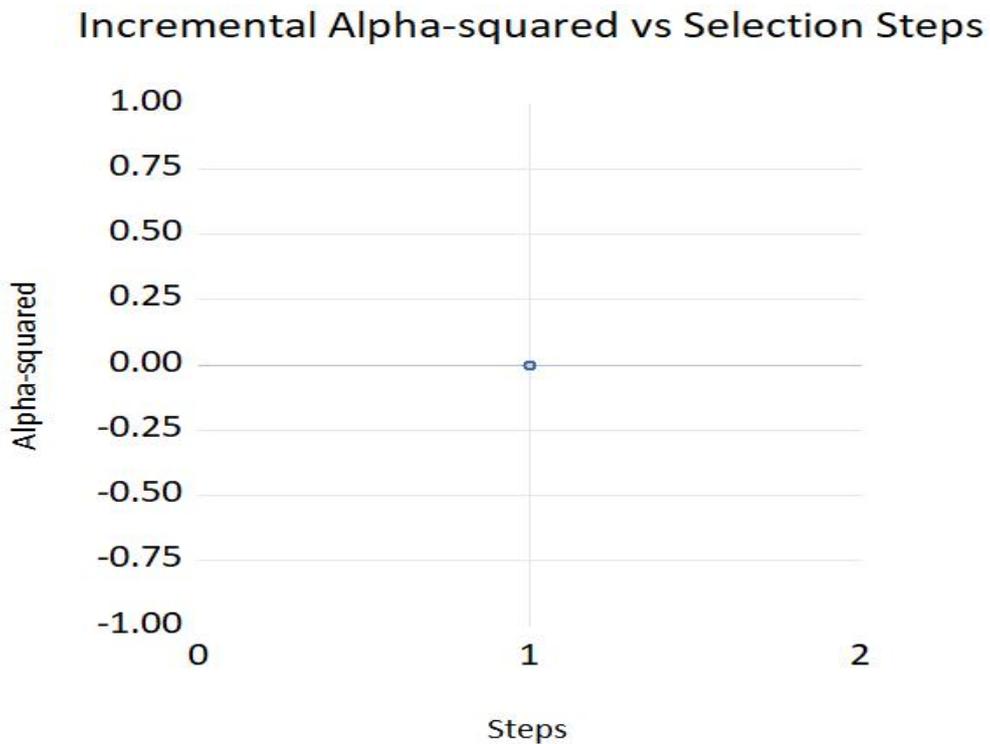
[1] At the 5% level of significance, the critical value in the Chi squared distribution for 2 degrees of freedom is 5.991. Since the obtained values of the Breusch-Godfrey Serial Correlation LM Test for the LMICs and HICs models are lower than the critical value (2.254 and 0.381, respectively), it can be concluded that there is no found heteroskedasticity in both models. Source: Bucevska (2009).

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