# Identification of Economic Factors for Mass Depression Based on Panel Study and Machine Learning

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**Abstract.** Panel study and machine learning are important tools for analyzing various aspects of the economy. They allow researchers to study the dynamics of changes in different economic indicators, such as GDP, inflation, unemployment, etc. In addition, these tools can be used to determine causal relationships between social, economic and psychological factors what can allow us to predict the development of the economy and changes in people's life in the future. However, previous works in this sphere studied the connections between income and happiness, not taking into account the relationships between economic indicators and mental disorders. This article is aimed to analyze the relationship between economic factors and the level of mass depression based on a panel study and machine learning methods. Experimental results based on panel study and machine learning demonstrate effectiveness of our proposed econometric model.

**Keywords:** Panel Study Machine Learning Depression Identification Economic Factors Econometrics Models

## 1 Introduction

The increasing number of people suffering from depression and other mental diseases is one of the most challenging issues in the 21 century. According to


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World Health Association, around 280 million of people worldwide are suffering from depression, moreover, the World Health Organization assumes that 5% of men and 9% of female experience depressive disorders in their lifetime [10, 15]. Depression can lead to the development of other illnesses what effect on premature mortality [1,2,16] and even increase the suicide rates [9,11,14], that is why it is crucial for authorities to be aware of development of such illnesses. The innovation of this work is that it includes factors and figures from different spheres and examine their impact on the development of depression and other mental disorders. This allows us to broaden our thinking and to make more clear judgments [7,13]. Particularly, in addition to social-economic indicators, we also added urban population growth in our list of economic indicators, what allows to see the big picture. This article is aimed to determine how the main economic indicators are connected with mental disorders. After establishing the relationships, it will be possible to judge whether the country at the risk of mass depression. We believe that with the help of our research local authorities will be able to identify the upcoming health threats more effectively, and, what is the key point, much earlier, thus, many human lives would be improved or even saved.

## 2 Methods

This is a panel study which includes data from 196 countries throughout 27 years. In our research we mainly used econometrics and ordinary least square (OLS) analysis to make proper models. All implemented models have passed the Ramsey Test, the check for heteroscedasticity and multicollinearity, thus, all described models are trustful. Besides, in case with the depression analysis, the Fixed Effects model was used due to take into account each country peculiarity [7,13].

### 2.1 Dependent Variables

In addition to Depression, we also considered the following types of mental diseases: Schizophrenia, Bipolar disorder, Eating disorders, Anxiety disorders, Drug use disorders, Alcohol use disorders. All variables are examined as % of all population.

### 2.2 Economic Indicators

For each variable we make an econometric model with the following regressors:

- NY.GDP.MKTP.CD - GDP (current US$)
- NY.GDP.MKTP.KD.ZG - GDP growth (annual %)
- SI.DST.FRST.20 - Income share held by lowest 20%
- NY.GDP.DEFL.KD.ZG - Inflation, GDP deflator (annual %)
- SP.DYN.LE00.IN - Life expectancy at birth, total (years)
- EN.POP.DNST - Population density (people per sq. km of land area)

– SI.POV.NAHC - Poverty headcount ratio at national poverty lines (% of population)
– SP.URB.GROW - Urban population growth (annual %)
– Unemployment - Unemployment rate, (% of work force)
– GDP_PER_CAPITA - GDP per capita, (current US$)

### 2.3 Panel Study

In order to avoid omitted variable bias, we took regressors from different spheres [7,13]: pure economic, social and urban. We also have added the variable of control - Anxiety, as, by all means, anxiety disorders influence on the development of depression and other mental disorders. We conducted all measures using special econometric program Gretl.

## 3 Results

We calculated the correlation between all mental disorders and economic indicators as Fig. 1.

At the same time, we got the following depression model as Tabel 1.

**Table 1.** Depression Model

| | Coefficient | St. error | t-statistics | p-value | |
|---|---|---|---|---|---|
| const | 325,388 | 0,707587 | 4,599 | ¡0,0001 | *** |
| anxiety disorders | 0,354180 | 0,145535 | 2,434 | 0,0168 | ** |
| NYGDPMKTPCD | 0,000000 | 0,000000 | 4,352 | ¡0,0001 | *** |
| NYGDPMKTPKDZG | 0,00112238 | 0,00100377 | 1,118 | 0,2663 | |
| SIDSTFRST20 | −0,0239324 | 0,00750013 | −3,191 | 0,0019 | *** |
| NYGDPDEFLKDZG | −0,000230614 | 0,000412541 | −0,5590 | 0,5775 | |
| SPDYNLE00IN | −0,0134092 | 0,00500963 | −2,677 | 0,0088 | *** |
| ENPOPDNST | 0,000163380 | 0,000295864 | 0,5522 | 0,5821 | |
| SIPOVNAHC | −0,00107081 | 0,00145502 | −0,7359 | 0,4636 | |
| SPURBGROW | −0,00724004 | 0,00900659 | −0,8039 | 0,4235 | |
| population | −1,04580e−09 | 1.73E−05 | −6,051 | < 0,0001 | *** |
| unemployment_rate | −0,00358409 | 0,00199508 | −1,796 | 0,0756 | * |
| GDP_PER_CAPITA | −2,74364e−06 | 9.21E−02 | −2,978 | 0,0037 | *** |

The LSDV R-square for this model is 0,9956, '*' means that variable is significant on 10%, '**' - 5%, and '***' - 1%. Therefore, we could interpret four variables of interest (on 5%):

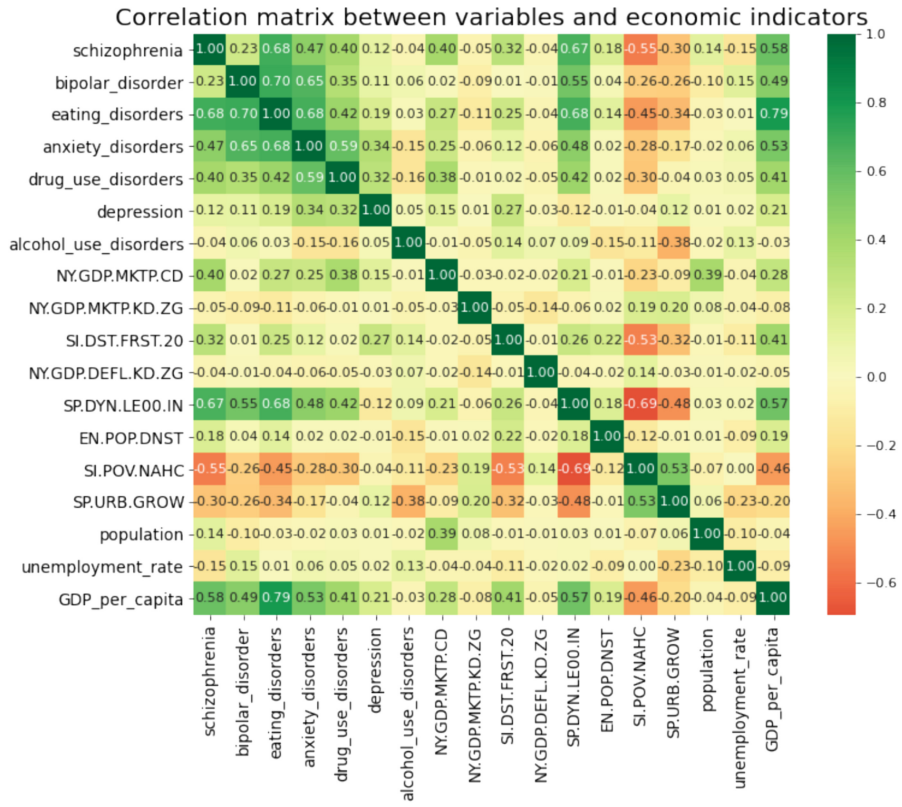


**Fig. 1.** Correlation matrix between variables and economic indicators

- GDP per capita - all things being equal, with an increase in GDP by one dollar, the number of people suffering from depression decreases by 2,74*e-6%
- Income share held by lowest 20% - all things being equal, with an increase in Income share held by lowest 20% by one dollar, the number of people suffering from depression decreases by 0,024%
- Life expectancy at birth, total - all things being equal, with an increase in life expectancy at birth, by one year, the number of people suffering from depression decreases by 0,013%
- Population - all things being equal, with an increase in population by one people, the number of people suffering from depression decreases by 1,05*e-9%
- Anxiety disorders - all things being equal, with an increase in anxiety disorders by one percent, the number of people suffering from depression increases by 0,35%

Now countries that have the highest rates of depression are shown in Fig. 2.

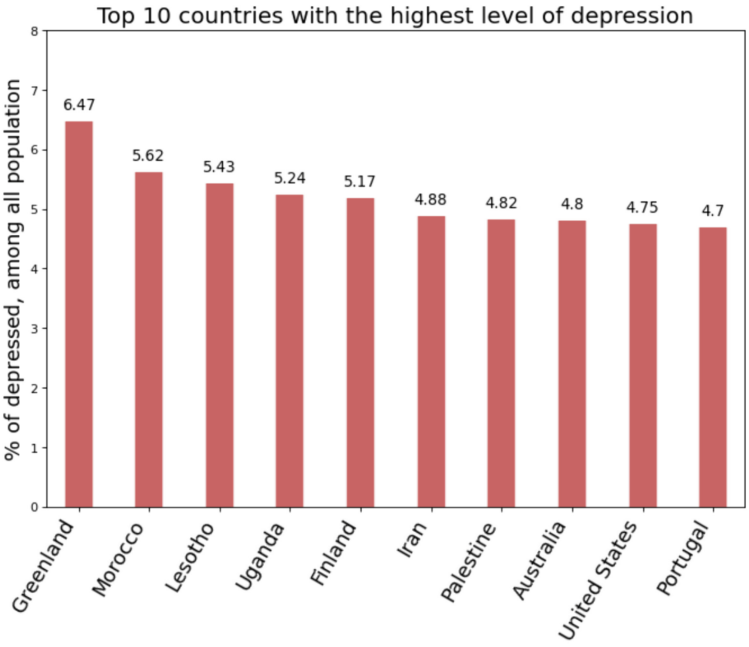


**Fig. 2.** Top 10 countries with the highest level of depression

As can be noticed, top ten includes mainly developing countries where GDP per capita quite small. The exceptions are Finland, Australia, United States, Portugal and Greenland as a special region of Denmark, where the GDP per capita is medium or higher. In case with Finland and Greenland, such higher level of depression could be explained by two factors: 1) isolated and low populated communities, as can be seen from the depression model, the population size is significant factor; 2) the lack of sunny days, what negatively effects on mood and emotional conditions [12]. As for other countries, the further deep analysis is required.

## 4 Discussion

This large-scale study based on worldwide panel data about depression showed that people who live in countries with low GDP per capita are more vulnerable to depression. We find that the relationship between depression and GDP per capita is strongly negative, and because of analyses of huge massive of date, the results are universal. At the same time, the connection between depression and anxiety disorders is strongly positive, thus, the following conclusions could be made: in countries with lower GDP per capita, more people tend to suffer from depression. Actually, this fact can be proved even statistically: the majority of the countries in the list of top 10 countries with high level of depression are

developing countries (Fig. 2); anxiety contributes to the development of depression and must be taken into account as well.

Considering all above we can suggest the authorities to take more measures to ease the burden and stress of the depraved people. As other studies showed [4,6,8], low-income group are at the higher risk of getting depression and having worse health condition in general [3,5], so, some government financial help is better be provided (subsidiaries, money allowance, etc.).

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