Assessing the Effects of G.D.P. and Methane Emissions on Mental Health Disorders

Question

How does GDP and Methane Emissions Impact Health Disorders Across the Globe?

Description

Mental health disorders are phenomena that increasingly affect individuals in countries across the world. Indeed, it is estimated that roughly 10.7% of individuals across the world suffer from a given mental disorder (Dattani and Ritchie, 2018). Mental health disorders come in various forms and levels of severity, which vary on an individual basis. Specifically, we are focusing on schizophrenia, bipolar disorder, anxiety disorder, drug use disorders, and depression—arguably, the most common mental health disorders. Equally as important, resources and counseling to combat said disorders are often limited or completely absent in certain regions of the world: a reality prompted by levels of political corruption, regime type, food security, and most importantly, GDP. As exemplified by scholars Patricio V. Marquez and Emily Hewelett in their journal evaluating mental health and human capital development in OECD countries, "A growing body of evidence shows that the social and economic losses related to unattended mental conditions, including substance use disorders, are staggering. In the world's most advanced economies — the 36 OECD countries — mental health affects an estimated 20 percent of the working-age population at any time, and its direct and indirect economic costs are estimated to account for about 3.5 percent of gross domestic product (GDP)," (Marquez and Hewelett, 2018).

As it relates to GDP, it is often believed that countries with a higher GDP tend to offer substantially more counseling and mental health services — not to mention the quality of said services (Berkeley Economics, 2018). As such, the prevalence of mental health disorders should theoretically be lower than in those countries where GDP is not high, but this need not be the case in every country with a high GDP.

Additionally, greenhouse gasses tend to impact various sectors of a country's economy, thereby also affecting the livelihood of individuals. Specifically, we hope to dissect the effects of methane emissions on the pervasiveness of mental health disorders — a chain effect that begins with a country's inability to control these emissions, the prosperity of new businesses and infrastructure, and, consequently, the livelihood of its inhabitants. We believe methane is more appropriate for our analysis due to the fact it has a shorter residence time in the atmosphere compared to CO2, and it is also the second most prevalent greenhouse gas (Somma, 2021). Further, methane traps more heat than carbon dioxide, thus dramatically impacting the ways individuals interact and their everyday lives. As a result, we can accurately gauge a country's more recent operations and their effect on overall mental health to determine a population's Well-being.

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1) GDP impacts various aspects of a given population's livelihood. In particular, these consequences can be detrimental to the mental health of the citizens of said population. We are interested in seeing whether a country's GDP affects the rate of mental health disorders across the world.
2) Climate change can have unintended consequences for the health of individuals. In particular, the emission of methane from coal mining, natural gas, and oil can drastically impact the health of a given population. We would like to explore the effect of these emissions on mental health disorder rates across the globe

Note: We will be using four categories to explain differences in GDP by countries — as set by the United Unions. We will conduct our analyses using the categories high-income, upper-middle income, lower-middle income, and low-income. Additionally, we will be focusing on the period 1992-2010 given that this gives us a decent grasp on the relationships we intend on exploring.

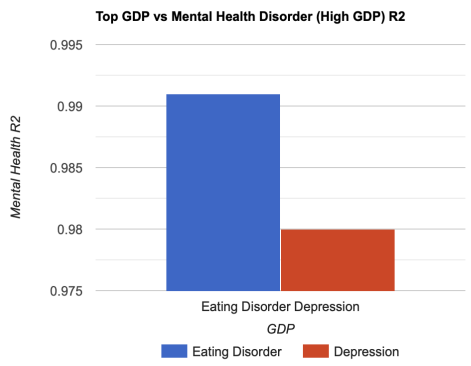
Data Cleaning and Collection

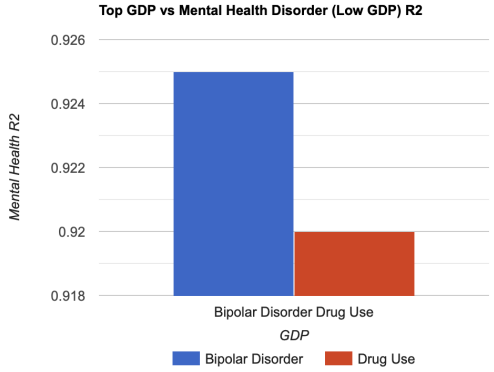
When looking at our dataset, we had come to find that the intersecting years from all three datasets were 1992-2010. We created a list of these years and dropped the years outside of this list. Additionally, given that the commonality among the datasets we are using is the feature "Countries," we figured out all of the countries included in each dataset and decided to use overlapping countries for our analyses. From there, we dropped countries that were not included in all three datasets. After filtering the data, we had a total of 154 countries that we could use, but we decided that we wanted to further categorize the countries. According to the UN, all of the countries in the world can be separated into four groups based on their GDP or their economies per capita: high-income, upper-middle-income, lower-middle-income, and low-income. We went through all of the countries on our list for every dataset and separated them based on the UN's classification of them. After this separation, we averaged the GDP from each category and used that information to conduct our analyses. We believed that using these categories would help with showing overall patterns more clearly and would help with making generalizations about the countries within our datasets, as opposed to analyzing each individual country.

Models

I. Linear Regression

Linear regression is a commonly used predictive analysis model. Overall, linear regression aims to evaluate whether a set of predictor variables does a good job in predicting an outcome, commonly known as the dependent variable. We are using simple linear regression to assess our first question, namely whether GDP affects mental health disorders across the globe. We perform linear regression on our four categories of countries (high, upper-middle, lower-middle, and low GDP), which we created based on set levels of GDP per capita by the United Union. In line with the assumptions of linear regression, we understand we are assuming there is linearity between GDP and mental health disorders; homoscedasticity, that is the variance of our residual should be identical for any value of our independent variable; and independence from both our dependent and independent variables. We further assume that there is little to no autocorrelation and multicollinearity.

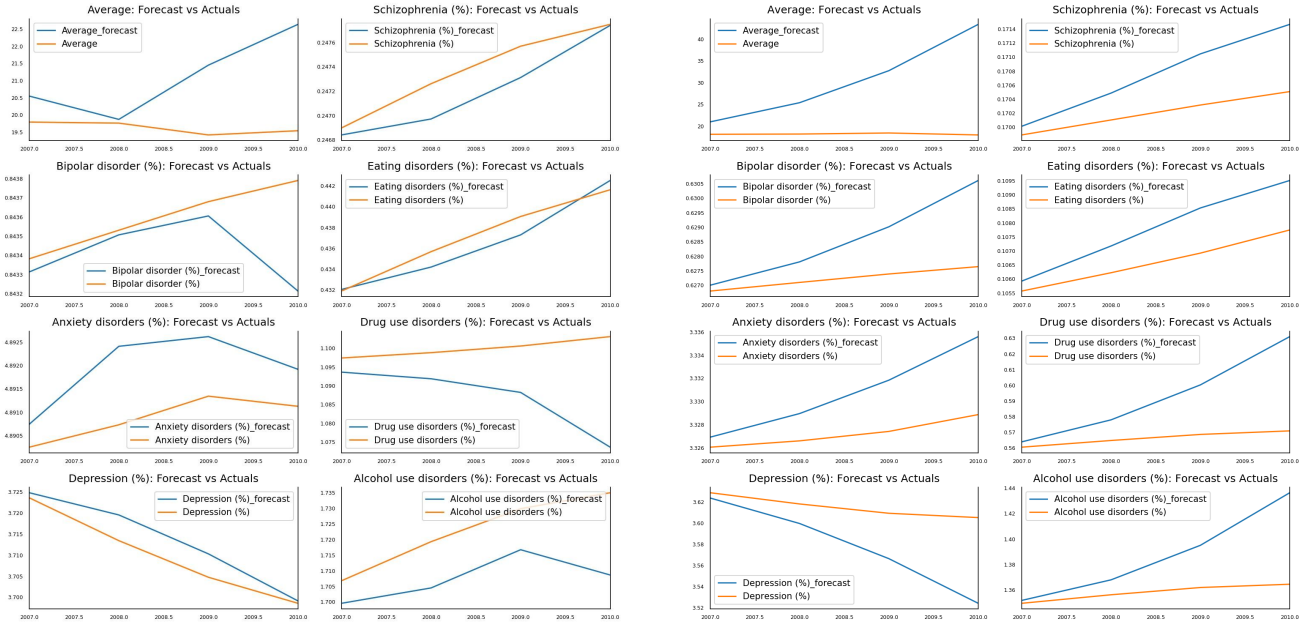




The most prevalent mental health disorders in high GDP countries (as measured by R^2) were eating disorders and depression; for upper-middle, it was schizophrenia and eating disorders; for low-middle GDP, it was schizophrenia and eating disorders; for low GDP, it was bipolar disorder and drug use. It becomes clear that middle [upper and lower] GDP countries have populations who suffer from schizophrenia and eating disorders, though eating disorders appear to be most prevalent in high-GDP countries. Specifically, high-GDP countries appear to be most concerned about the nature of their food consumption, which does not appear to be a concern in low GDP countries. At the same time, we notice a prevalence of depression among high-GDP countries which could be a consequence or precursor to eating disorders, as both of these mental health disorders often occur in sync — though by no means is this the case across all individuals. Low GDP countries show a rather unique prevalence of mental health disorders not seen by any of the other subgroups of GDP, namely bipolar disorder and drug use. Consistent with much research, drug use is most prevalent in impoverished countries. Coupled with drug use, mental health disorders often lack the necessary resources, hence the high rate of bipolar disorder.

II. Forecasting with Vector Autoregression (VAR)

Vector autoregression is a multivariate forecasting algorithm used to explore the influence of various time series. All of the variables in a VAR are treated symmetrically by including an equation for each equation that aims to capture the development or evolution of said variable within a given period. This treatment of symmetry on all variables is based on the lags of other variables in the model. Forecasting mental health disorders and methane using this model is appropriate given the relationship we are interested in exploring how the relationship between these variables changes over time. Additionally, VAR differs from univariate autoregressive models due to the fact we can account for feedback between our variables; we can use VAR to show how methane is a function of rates of mental health disorders and, how the rates of mental health disorders are, in turn, a function of GDP.



As can be seen, the actual and forecasted values for methane emissions and all mental health disorders for high-GDP countries are plotted on the left, while low-GDP countries are plotted on the right. For high-GDP countries, the forecasted values for methane emissions (plotted as average: forecast vs actuals) appear to follow a different trajectory than the actual values once we account for all other mental health disorders. Eating disorders and depression appear to follow a closer relationship in the forecasted values to the actual values. We see the opposite with drug use disorders, alcohol use disorders, and anxiety, exhibiting a distinct trajectory towards the end of the trend. As far as low-GDP countries are concerned, most mental health disorders follow a similar trend in the beginning**,** but they diverge as time goes on. In particular, forecasted values appear to have a higher trend compared to the actual values plotted. The forecasted values for eating disorders appear to follow the closest trend to the actual values.

III. Checking Linear assumptions

In order to evaluate whether linear regression with the four GDP categories and their average methane emissions released versus the average rate of people affected with different mental health disorders is valid, we had to check 4 assumptions on their residual values: whether they are mutually independent, independent of the covariates, normally distributed, and whether they have a constant variance.

1. **Mutual independence** was checked through the use of autocorrelation plots. Each plot graphs the residual values of the models created which has the average methane emission released from each GDP category as the independent variable and the average mental health disorder as the dependent variable. When looking at all of the disorders, all of them followed a general shape depending on income category the data was a part of. According to Figure 1, since there are very few points outside of the test bounds, all of the categories express mutual independence.

2. **Independence of the covariates** was checked through graphing the residuals of each model and X, which in this case was the average methane emissions released from each of the 4 categories of countries. Because there were over 25 graphs on to check this assumption, Figure 2 represents 4 of the graphs. For there to be independence of covariates we need to be able to see a linear pattern from these graphs. According to these four graphs we can see that for Eating Disorders, the High-Income and the Lower-Middle Income categories expresses no pattern, which means that these two graphs fails to meet this assumption. For the other two graphs there can be some downward pattern seen, but it does not look linear, which means that it fails to meet this assumption.

3. **Normal distribution** was checked by the use of Q-Q plots. Figure 3 shows that there are 4 graphs from the four different categories of GDP. There were Q-Q plots made for every mental health disorder we used, however, one was used to be evaluated in the figure because they were all very similar. As shown in figure 3, all four graphs look very similar and show that there is a normal distribution because the data is almost in a straight line.

4. **Constant variance** was checked through the use of plotting the absolute values of the residuals versus the fitted values. Figure 4 shows that there are 4 graphs from the four different categories of GDP. There were plots made for every mental health disorder we used, however, one was used to be evaluated in the figure because they were all very similar. As shown in figure 4, all four graphs show that there is no strong indication of dependency of the predictors because as one increases the other seems to remain mostly constant. With that said, there seems to be a constant variance.

Overall most of the assumptions were not violated, which means that there is not a strong dependency of these covariates. However, we can further explore these covariates because some of these assumptions were still violated, which means there could be some lack of independence among the various covariates.

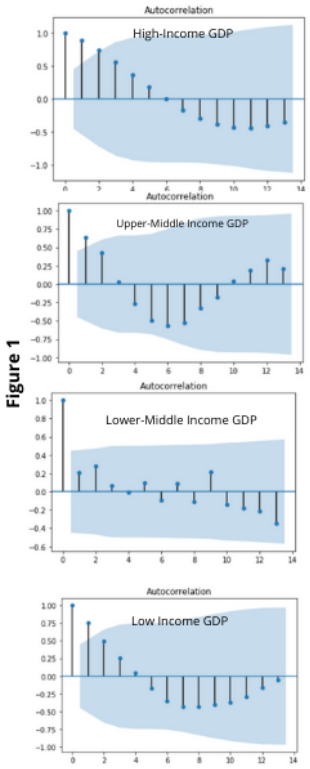


Figure 1

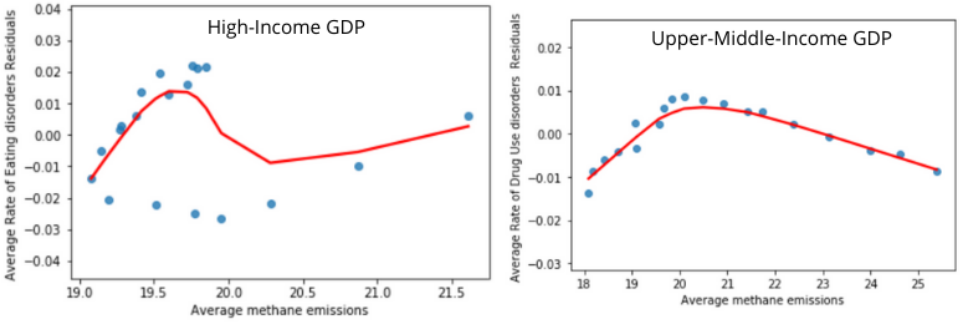
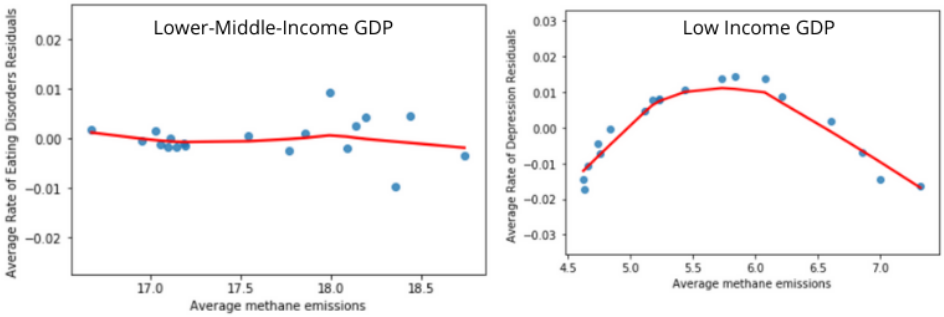


Figure 2



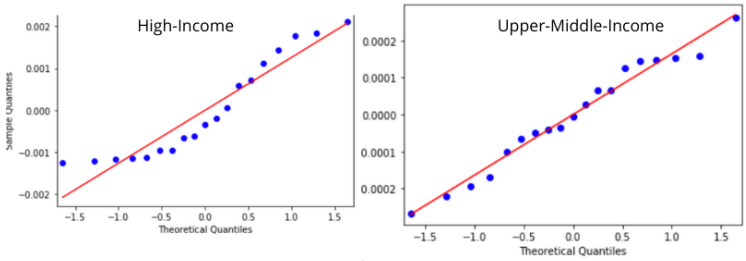
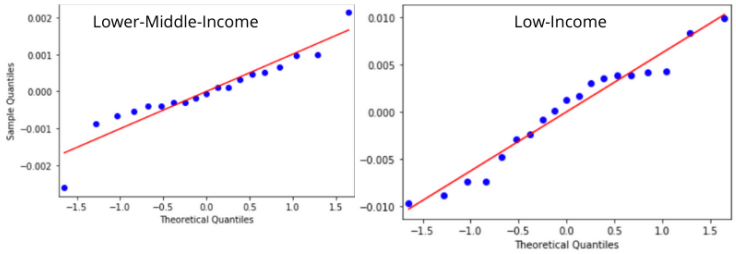


Figure 3



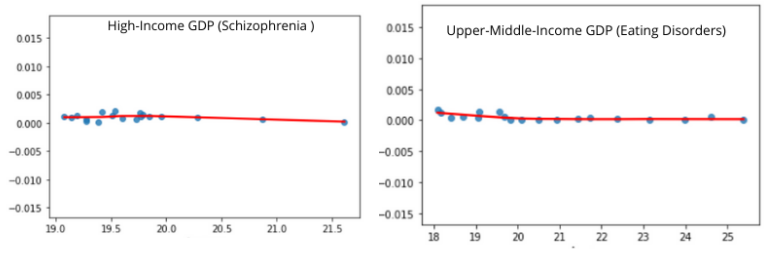
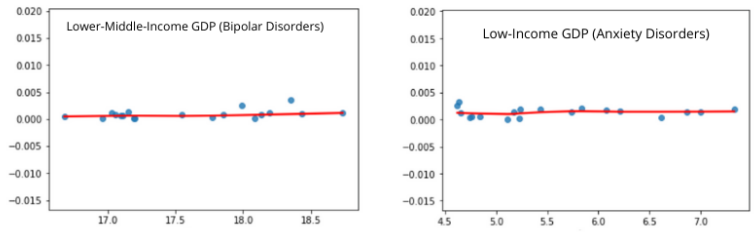


Figure 4



Discussion and Conclusion

I. Discussion

The linear regression model gives insight into the relationship between countries' GDP and their respective rates of mental health disorders. As it relates to our first question, eating disorders and depression appear to be most prevalent and of major concern in high-GDP countries. We see these two mental health disorders are not as prevalent in low-GDP countries. Instead, bipolar disorder and drug use appear to dominate mental health disorders given the needs and priorities of individuals living under these conditions. Nevertheless, further research would be needed to assess why these two mental health disorders are prevailing in low-GDP countries. In terms of the third model, because most of the assumptions were not violated, the relationship between methane emissions and mental disorder rates are not necessarily as strong as we first assumed. However, some assumptions were not violated which can indicate that future research may want to scrutinize these relationships more in depth.

II. Data Limitations

Still, a few constraints may have likely affected the accuracy of the findings from our data analyses. The VAR forecast model, for instance, lists predicted results from historical data and does not take into account external factors that might contribute to the volatility of mental health disorder diagnoses in comparison to methane emissions. Accordingly, within lower-income GDP regions, access to clinics and mental health experts responsible for these official diagnoses may be more sparse. As a result, there needs to be a more bounded environment to analyze these variables together. Another limitation present within the scope of this research is the loss of data points that occurred during the dataset cleaning phase in an attempt to make the data frames more uniform. Our methane "pivot" column consisted of only averaged-out values of the total sector including land-use and forestry. In the original dataset, by contrast, had more appropriate methane-emission rates for specific categorized sectors across different countries. In addition, our research only spans until 2010 and does not include more recent trends or data.

III. Future Research

There still exists a lot of potential to improve scholarship within this field of research. In a future exploration, it could be worthwhile to look at a specific country and its distribution of mental health disorders across socioeconomically-varying regions to compare our more general findings. It would also be interesting to see if the forecasted results from our aforementioned models can predict comparatively similar patterns in a more bounded environment, isolated from any external factors that may have limited the accuracy of our data. Furthermore, one constraint

experienced in our data is the fact that our values only span until 2010; future scholarship would like to explore more recent years.

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