1. Introduction

The project of our group aims to explore the causal relationships between unemployment rate, inflation value, and GDP using Pragmatic Causal Feature Learning (PCFL) algorithm and confounder identification-free (CIF) method.

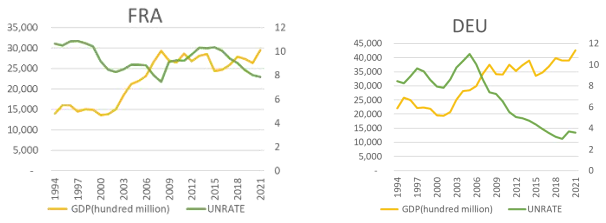
First, we collected the unemployment rate, inflation value and GDP of five countries, including China, France, USA, Denmark, and Germany. Then, we analyzed the data by calculating their correlation coefficient. We also determined the causal relationship using the directed acyclic graph and Additive Noise Model. After that, we use two methods, CIF method and PCFL method, to further explain the casual relationship. In CIF method, we built a model which not only can forecast the GDP when given the inflation value and unemployment rate, but also can ignore the effect from confounders. PCFL method shows how much effect each factor has on the GDP by identifying coarsened variables.

Ultimately, we concluded that the unemployment rate has a causal effect on inflation rate and GDP. Also, inflation rate has a causal effect on GDP. In addition, two models were set up to explain how unemployment rate and inflation rate affect the GDP.

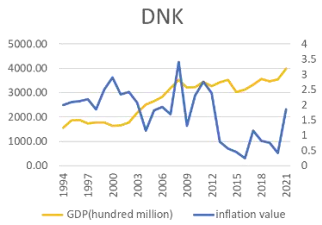
2. Data processing

We collect GDP, inflation rate and unemployment rate data for some countries from 1994 to 2021. The included countries are China, the United States, Germany, Denmark and France. In our project, GDP measures the monetary value of final goods and services produced in a country in a given period of time. Inflation rate refers to an overall increase in the Consumer Price Index (CPI), which is a weighted average of prices for different goods. Unemployment rate is measured in numbers of unemployed people as a percentage of the labor force.

To visualize the relationship between unemployment rate, inflation value and GDP, we first drew the line charts of each country and calculated the correlation coefficient. According to the graphs and coefficient, it is easy to find out that unemployment rate and inflation value have negative correlation with GDP, though the correlation is not that strong. Due to the page limits, we only display the line charts which typically show the relationship.



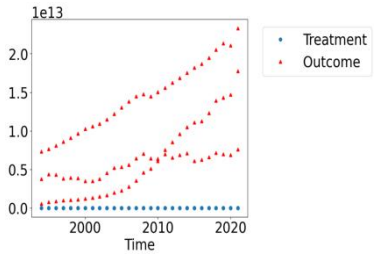
The line chart between GDP and Unemployment Rate (with corrlation coefficients equal to -0.40 in France and -0.76 in German)

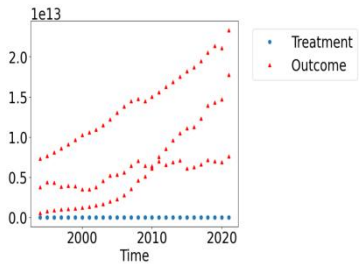


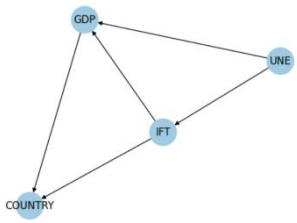
The line chart between GDP and Inflation value (with corrlation coefficient equals to -0.43 in Danmark)

3. Methodology

To get the first view of the causal relationship between features, we introduce directed acyclic graphs(DAG) and [1]additive noise model(ANM). To normalize the overall data, we regard Germany, Denmark and France as a whole country. We calculate the combined GDP of these three countries. We also average the inflation rates and unemployment rates in the three countries. In order to distinguish the data of different countries, we label China as 0, the United States as 1 and European countries as 2. We use Pandas in python to merge data and finally we get a 112*4 data table. In a DAG, each vertex represents an object or event, and each directed edge represents a causal relationship between two objects or events. In specific, we firstly estimate the sparse inverse covariance matrix between variables to discover conditional independence relationships between variables and construct the skeleton structure. Next, we decompose each variable into its causal and non-causal components. ANM represents each variable as a linear combination of its parent nodes plus a random noise term. Then, by performing regression analysis on these variables, it estimates the causal and non-causal parts of each variable and uses the relationships between these parts to infer causal structure. Finally, we use networkx library in python to visualize the causal graph. From the visualization result, we can see that from 1994 to 2021, the correlation between GDP and inflation rate and the correlation between GDP and unemployment rate are weak, but unemployment rate has a causal effect on inflation rate and GDP and inflation rate has a causal effect on GDP.







4. Significance and novelty of the study

In this project, the two models we use owns certain degree of innovations. For PCFL method, it is the developed method of causal feature learning (CFL). It helps to find out more targeted feature learning while preserving the basic information of causality. For CIF method, it is first applied on picture feature learning. However, through our efforts, it can be used on the concrete data and gives a confounder-free method. The results of our project help people get comprehensive understanding about the economic phenomenon and provide some provide guidance on macroeconomic policy making. To improve the GDP, government should pay more attention on reducing the unemployment rate and inflation value.

5. Conclusion

In conclusion, our project showed that there are causal relationships between inflation rate and GDP. Also, unemployment rate has a causal effect on both GDP and inflation value. Two models were set up in our project to explain how unemployment rate and inflation rate affect the GDP. The CIF model can predict GDP while provide the

unemployment rate and inflation rate. The PCFL model can show which factor is the main causal factor.

[1] Pramod Kumar Parida, Tshilidzi Marwala and Snehashish Chakraverty. "A multivariate additive noise model for complete causal discovery." Neural Networks 103 (2018): 44-54.