

Team Number :	2020090030003
Problem Chosen :	Problem B

2020 APMCM summary sheet

The United States is at the time of the election. The two candidates - Trump and Biden have quite different ruling ideas. The victory of the Democratic or Republican Party is worth being discussed considering the future economic impact on China and the United States.

In the first question, we built three models. The first model is the Decision-making and Evaluation model, which takes into account the main factors affecting the US economy. For internal factors, we take education expenditures, environmental governance, domestic financial markets, immigration rate, industry development, taxation and employment. As for external factors we take import and export trade and monetary policy. We preliminarily measure the impact and changes that each feature has brought to the US economy. We conduct a simple correlation analysis on each indicator and the GDP data of the United States in the past 40 years, retain the more relevant features, and conduct a preliminary screening.

The second model is a regression model. After data preprocessing such as normalization and binarization, we adopted Filter, Wrapper, Penalty L1 and GBDT-based Embedded methods to select features, and then determine total imports, total output value, carbon emissions, immigration rate and taxation as the input features of the final regression model. Finally, with the establishment of the LASSO regression model, the regression equation of the US economy prediction is obtained.

The third model is a quantitative model of policy. We use history as a guide to classify all policies into three categories: positive, negative, and inaction ones. The policies of the two candidates are quantified based on the numerical rate of change of a feature brought about by a certain type of policy in a certain field between 1980 and 2020 as the underlying rate of change, plus random perturbations, so that we can simulate the changes and confidence intervals of a series of indicators such as carbon emissions, immigration rates, etc. over the period 2021-2025 if they are elected. With future predictions for each of these indicators, and based on the regression model, we can obtain predictions for the U.S. economic development corresponding to the two candidates.

In the second question, we fully consider the US-China game and the world game, and consider that the US-China game similar to zero-sum game and multi-cornered game. So on the basis of the first question, we need to change the output variable to China's economic GDP, add new input features, namely, the world's total GDP growth rate (as a measure of the distance from the zero-sum game), the economic growth rate of the United States, the European Union, and Japan (as the main competitors or other major economies), and conduct feature engineering. Eventually we choose the world GDP growth rate, the US GDP growth rate, carbon emissions, industrial production, and imports as the input features of the final regression model, and build a similar regression model to obtain the predicted values of China's economic development after the policy quantification.

In the first question, we predict that the U.S. economy will do slightly better in the next four years if Trump wins. In the second question, we predict that if Biden wins, China's economic development in the next four years will be slightly worse. Therefore, in response to the third question, we find that the international situation has a great impact on China's economy, so we propose that the Chinese government should participate in regional economic alliances, enhance its power of discourse and international participation, and block the combined suppression of the United States and its allies as much as possible.

Keywords: decision model, feature engineering, PCA, policy quantification, simulation, LASSO regression, game theory

Contents

I. Introduction	3
II. Model Hypothesis.....	3
III. The Establishment of Models.....	4
3.1 Model I.....	4
3.1.1 Problem Analysis	4
3.1.2 External factors	4
3.1.3 Internal factors	6
3.1.4 Evaluation Model.....	12
3.2 Model II.....	13
3.2.1 Data Display.....	13
3.2.2 Data preprocessing.....	13
3.2.3 Correlation analysis.....	14
3.2.4 Feature selection.....	14
3.2.5 Dimensionality reduction with PCA	16
3.2.6 Lasso Regression.....	16
3.3 Model III	17
3.3.1 Comparison Chart of Policies of Biden and Trump	17
3.3.2 Quantification of Policies.....	17
3.3.3 Visualization of predicted results	18
3.3.4 Prediction of U.S. Economic Development	20
3.4 Model IV ——Game Theory	21
3.4.1 Problem Analysis	21
3.4.2 Feature Engineering	21
3.4.2 Model Establishment.....	22
3.4.4 Model Evaluation.....	22
3.5 Question III	21
3.5.1 Biden's Philosophy of Governance	21
3.5.2 Prediction of Biden's Policy Adjustments and Impacts on China	21
3.5.3 China's economic countermeasures and policies	21
IV. Model Evaluation	25
4.1 Advantages of the Model	25
4.1.1 Quantification of policies	26
4.1.2 Strong Interpretability	25
4.1.3 Simplify Complexity	25
4.2 The Shortcomings of the Model.....	25
4.2.1 Without Considering the Opposing Team	25
4.2.2 Other Influencing Factors	25
4.3 Model optimization	26
4.3.1 Build more Regression Models	26
4.3.2 Conduct dynamic simulation.....	26
V. References	26

I. Introduction

1.1 Background

The adjustment of Trump's China policy since he took office has regarded China as the primary "strategic competitor." In the past three years, the US has successively provoked trade wars, technological wars, and public opinion wars, deepened military deployment against China, and publicly attacked the Chinese Communist Party and questioned China's political system. The continued provocation of the US has forced China to respond and countermeasures, and China-US relations have experienced a rapid decline. At the time of the U.S. election, the Democratic and Republican candidates' ruling ideas are very different. The impact of their election on the U.S. economy and even on the Chinese economy is profound and worthy of consideration. It is necessary for us to make strategic arrangements and planning in advance.

1.2 Restatement of the Problem

The US presidential election is held every four years. 2020 is the year of the president of the United States. Republican candidate Donald Trump and Democratic opponent Joe Biden are running for president. The candidates of the two sides have different political positions, administrative plans for finance and trade, economic and financial governance, and some other different major development areas (such as COVID-19 combat measures, infrastructure, taxation, environmental protection, medical insurance, employment, trade, Immigration, education, etc.). The election of different candidates will shape different strategic models of global economic and financial development, and will have a greater impact on the U.S. economy and the global economy (including the Chinese economy).

- In response to question 1, we need to obtain data by ourselves, and perform data analysis, quantify indicators, and analyze the impact of possible election on the US economy.
- In response to question 2, we need to establish a mathematical model and use relevant data to quantitatively analyze the impact of possible elections on the Chinese economy.
- In response to question 3, we need to make suggestions on China's economic countermeasures and policies in related fields in the two situations after the Democratic Party or the Republican Party wins.

II. Model Hypothesis

1. In the first two questions, because the epidemic is a black swan event, considering that a series of data such as gdp and industrial output value did not have a statistical

value of 2020, we have not considered the epidemic factor in the general trend of China-US economic quantitative forecast.

2. In order to simplify the model, it is assumed that the US economic development level is measured by the total GDP value, and China is the same.
3. The policy is directly linked to the change in the value of its corresponding field, and it is related by default.
4. The policy timeliness is relatively fast, that is, the presidential policy release can find traces from the corresponding data during the term of office.

III. The Establishment of Models

3.1 Model I

3.1.1 Problem Analysis

In the first question, we built three models. The first model is the Decision-making and Evaluation model, which takes into account the main factors affecting the US economy. The second model is a regression model. After data preprocessing, we must establish a regression model, the regression equation of the US economy prediction will be obtained. The third model is a quantitative model of policy. We use history as a guide to simulate the changes and confidence intervals of a series of indicators such as carbon emissions, immigration rates, etc. over the period 2021-2025 if they are elected. With future predictions for each of these indicators, and based on the regression model, we can obtain predictions for the U.S. economic development corresponding to the two candidates.

3.1.2 External factors

1. Import and Export Trade

In our dataset, we have four features. They are import money、export money、import rate、export rate. Now we will simply test the similarity and correlation between these features and then we can choose to use all of them or use some of them in the following model.

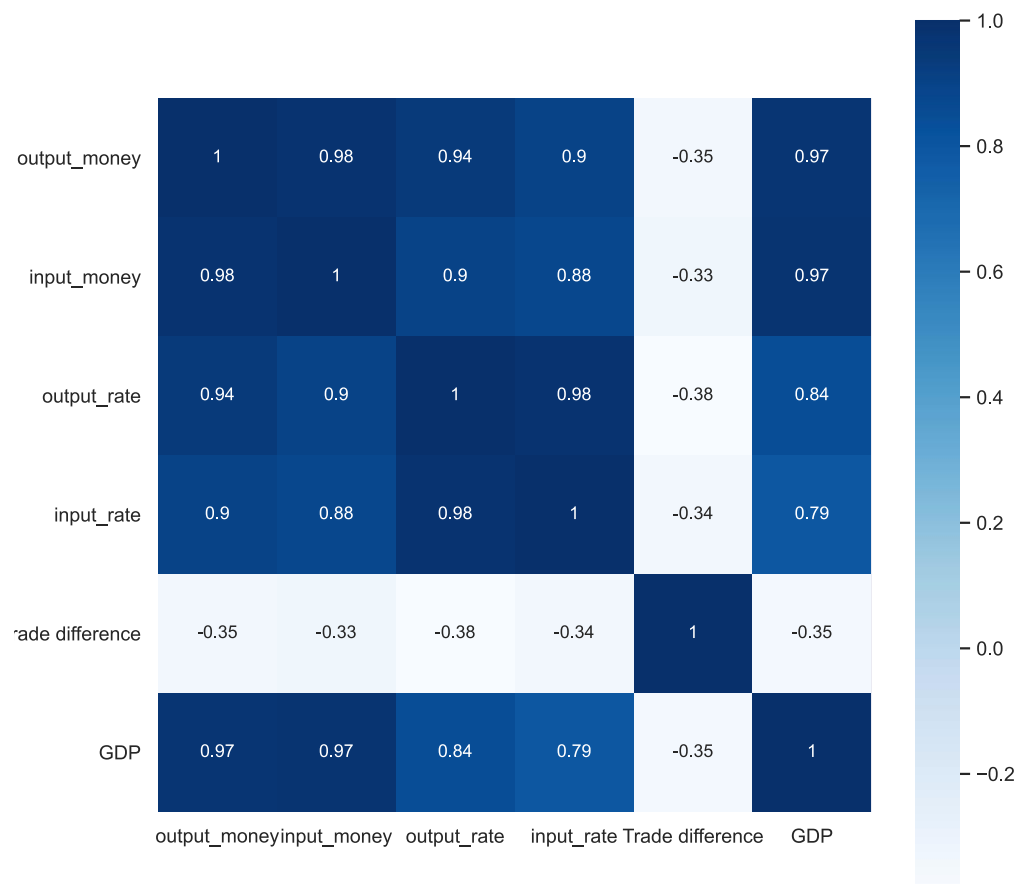


Figure1: The figure shows the heat map of the correlation matrix of total imports, total exports, import price index, export price index and GDP. We can see that the rightmost column, clearly shows a high correlation.

Import and export trade growth trends are relatively synchronized with overall economic growth trends. Usually, when the economy is growing fast, trade development is also relatively high. Another intuitive feature is that when the economy is growing rapidly, imports grow more than exports, leading to a trade deficit. When growth is slower, imports decline more than exports, indicating greater variation in import demand and domestic demand: fluctuations in the domestic economy generally affect fluctuations in import and export trade, and import and export trade also reflects and affects domestic economic growth to some extent.

2. Immigration

U.S. politicians haven't reached an agreement on the economic impact of immigration. Some conservatives have expressed concern about the economic impact of contemporary immigration to the United States, arguing that new immigrants with low levels of education and skills are causing unemployment and increasing the government's fiscal burden, and that the government should limit immigration. On the other hand, there are politicians who affirm the positive economic significance of immigration. They argue that immigrants play an important role in the development of

the U.S. economy and do not lead to unemployment and declining incomes for Americans. The arrival of large numbers of immigrants creates certain new industries and jobs, but also lowers the prices of many goods and services, which greatly benefits the consumers who purchase them.

3. International Political Relations

Politics and economics are not separate. The political relationship between the United States and China, and the political relationship between the United States and South America, are all closely related and affect the economic status of the United States. On the other hand, political disputes in other countries, even wars, etc., may have a positive effect on the U.S. economy. It is a world of clear multi-game and zero-sum-like games.

3.1.3 Internal Factors

1. Financial Markets

The impact of financial markets and the national economy is complex, and by no means one is the cause and the other the effect, but rather they are mutually influencing and intertwined. In order to simplify the model, we will analyze the correlation between financial markets and the U.S. economy from the perspective of correlation only. The financial markets we analyze here involve the M1 and M2 indexes, as well as Treasury bonds, bank bonds, and lending rates.

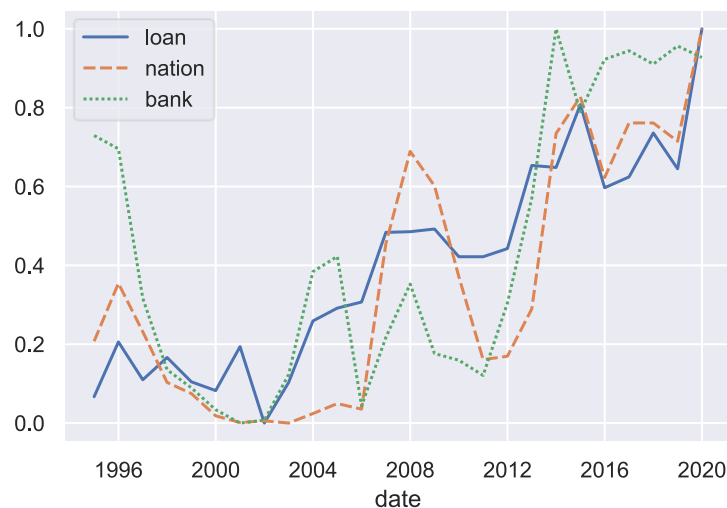


Figure2: We visualize standardized interest rates for state bonds, bank bonds, and mortgages. As gdp grows, various financial markets become more developed, the corresponding interest rates become higher.

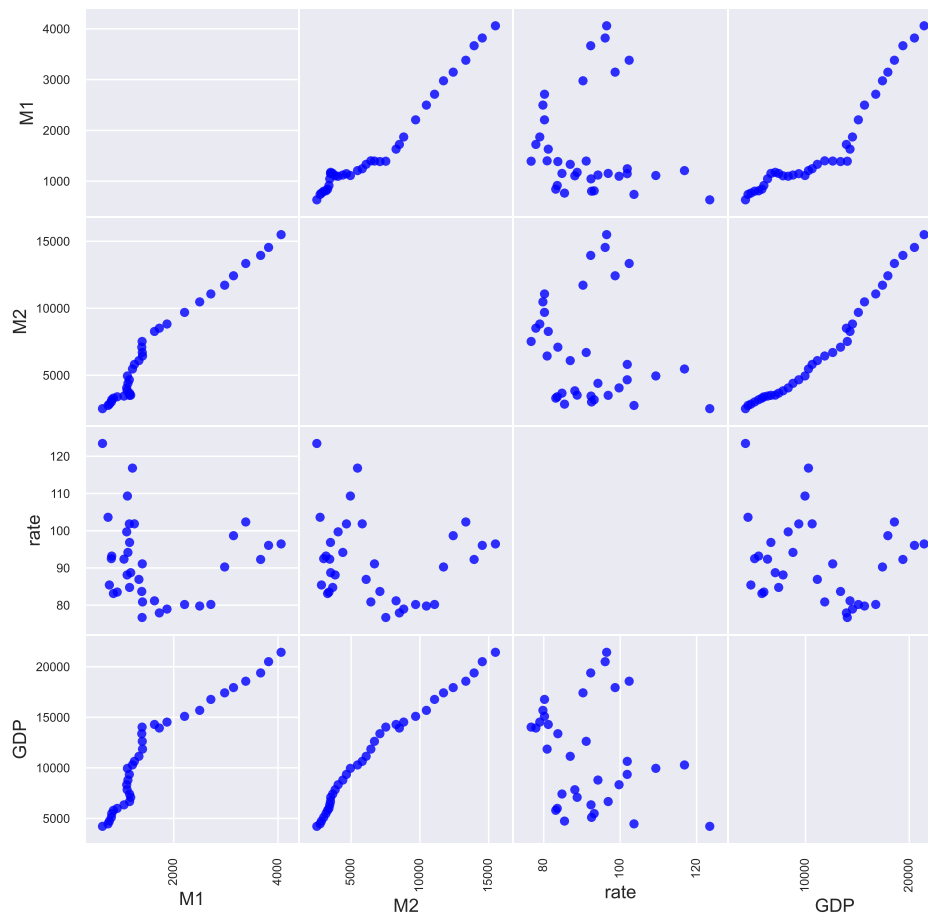


Figure3: As shown in the bottom row, the M1, M2 parameters are clearly correlated with GDP, while rate requires further investigation.

2. Industrial Development Indicators

The U.S. Federal Reserve Board publishes two economic indicators on the 16th of each month, including the Industrial Production Index (IPI). In an economy, both the IPI and capacity utilization vary pro-cyclically with the health of the economy, rising with a booming economy and falling with a sick economy. Moreover, both indicators reflect the economy over the same period, revealing the short-term state of current economic activity.

We examine the distribution, development, and correlation of the four major industries of manufacturing, agriculture, forestry, fishing, energy, and retail trade with the GDP of the U.S. economy. Finally, we selected manufacturing and agriculture as the two most correlated and representative variables for further examination. The

visualization results are as follows.

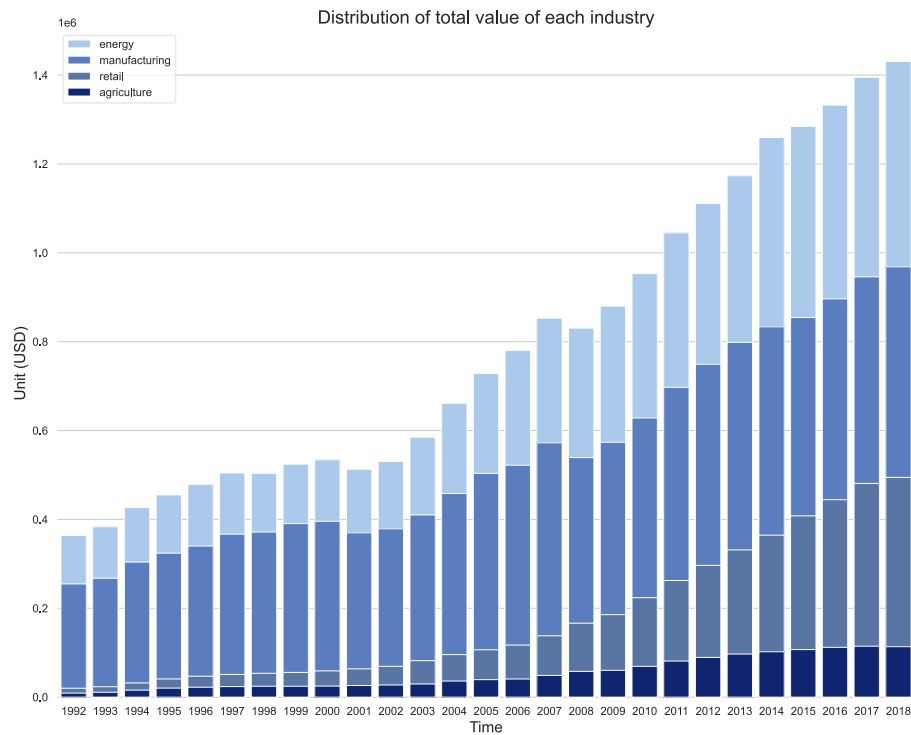


Figure4: Distribution of total value of each industry

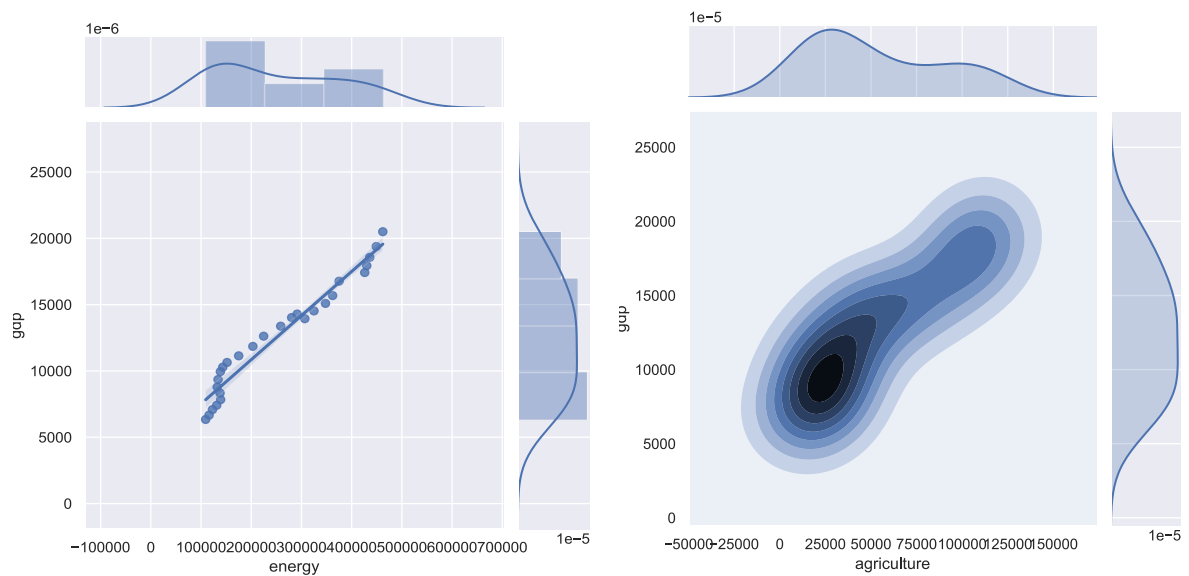


Figure5: Correlation analysis between energy (left) and agriculture (right) and GDP

3. Employment

Employment is the basis of people's livelihood. For a long time, people's attention to employment has been focused on how economic development can reduce the unemployment rate and expand the number of jobs, but the employment rate and the quality of employment can also have a negative effect on the level of economic development of a country. In economics, the relationship between labor and employment and economic development has been an important topic of inquiry. American economist Arthur Okun found an empirical relationship between economic growth rate and unemployment rate in cyclical fluctuations: for every 2 percentage points decrease in potential GDP, the unemployment rate increases by 1 percentage point, and there was an inverse relationship between the two. The development process in Western industrial countries shows that over longer time periods, there is generally a positive relationship between labor and employment and economic growth. Raising employment and stabilizing the level of employment is an important point in macroeconomics. If the unemployment rate in a country is too high, it means that the inhabitants of the country are not fully employed. If the employment rate of the inhabitants decreases, the employment level is too low or unstable, it is very likely to widen the gap between the rich and the poor, and then the economic and cultural problems of the whole society and the country will manifest and explode. This is a factor of waste of national labor and social unrest. Only by raising the national employment rate and stabilizing the social environment can the country promote the healthy development of the national economy, maintain social stability, and make the country stronger and more powerful.



Figure6: Wage per capita and unemployment rate

4. Monetary Policy

The relationship between money and the economy is very close. The monetary economy is mainly about interest rates, exchange rates, which directly affect savings, investment, and foreign exchange reserves. Changes in interest rates affect the demand for savings and investment: when interest rates fall, the demand for savings falls and

the demand for investment rises. The effect of changes in interest rates on international money markets is that low interest rates reduce the demand for assets on international markets. Since interest rates are the equivalent of the price of a currency, a fall in the price of a currency leads to a fall in investor demand for that currency's assets, and also drives down the value of that currency against other currencies.

Before the 2008 subprime mortgage crisis (2001-2004), Alan Greenspan of the Federal Reserve repeatedly advocated lower interest rates, which to some extent contributed to the formation of a bubble property market; but then when the crisis erupted, interest rates increased a lot, and the mortgage that had to be replaced could not be repaid, a chain of links in the industry, coupled with the already poor economic liquidity, a combination of factors contributed to the whole economy. Paralysis. In short, monetary economics is closely related to macroeconomics, and monetary policy usually involves indirectly influencing interest rates and exchange rates through central bank increases and decreases in the money supply and foreign exchange reserves to improve the economic environment or achieve a macroeconomic objective.

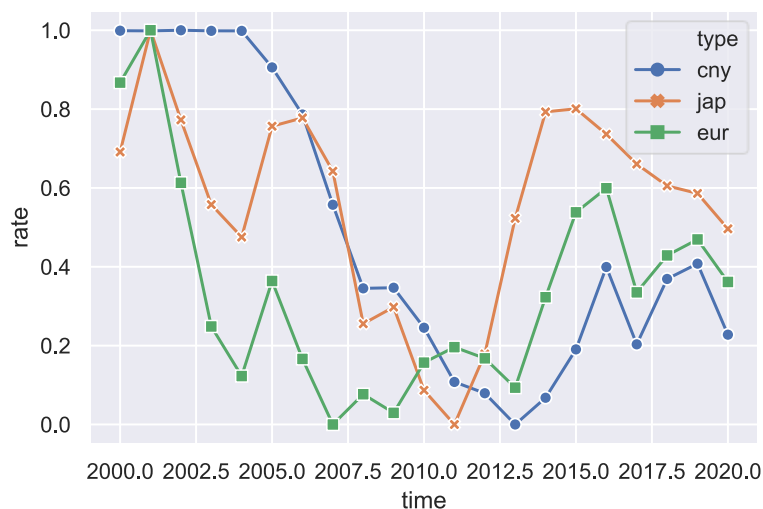


Figure7: We visualized the standardized exchange rates of the United States against the major currencies of three of the world's GDP powerhouses (China, the European Union, and Japan) and performed a confidence interval analysis, finding that the confidence intervals of these three countries overlap significantly. Therefore, in the subsequent analysis, we only keep the Chinese exchange rate to characterize the external exchange rate.

5. Taxation

Taxes are a way of distributing national income and the main source of revenue. The total tax revenue of the country as a share of the national income distribution has a direct impact on the formation of social accumulation funds. Secondly, the structure of the source of tax revenue affects the national economic structure of the society. Taxation also has an important impact on product structure. Finally, taxation can influence the development and improvement of the economic base of a society. Taxes have been used as a powerful lever for regulation by countries throughout the ages.

6. Medical Care

The impact of the health industry on the level of economic development is first of all reflected in the two-way coordination of the health industry on economic development. Health and economic development are mutually promoting and mutually restricting. The development of health cannot be separated from the overall investment of the state in the health sector, and the health sector largely depends on socio-economic development. The health industry's contribution to socio-economic development is directly reflected in the overall economic efficiency of society and the embodiment of value.

7. Environmental Protection

Environmental protection itself entails a corresponding cost, whether it is air pollution control, water pollution control or solid waste treatment.

On the other hand, environmental protection actually creates more jobs. According to a study of labor intensity in different industrial sectors in the United States, pollution control is a relatively labor-intensive industry compared to other industries, so a large amount of labor is required in the process of pollution control. More importantly, the adoption of environmental control policies will stimulate and encourage the emergence of new environmental industries.

8. Education

The growth of contemporary economies and the composition of national wealth are primarily the result of human capital. Education plays an important role in facilitating the optimization of human capital. In the modern production process, technological transformation and equipment upgrading are accomplished by the application of scientific and technological achievements to the production process by scientific and technological personnel: abundant natural resources and advanced production tools are made possible by the labor of highly qualified workers; high levels of production and economic efficiency are achieved by the management activities of a large number of highly qualified managers.

9. COVID-19

As COVID-19 spreads around the world, global financial markets have experienced significant volatility, with U.S. stocks melting down four times in less than two weeks (March 9-18). In addition to the panic caused by the epidemic, the recent general slowdown in world economic growth has been an important factor in the correction of capital markets. Global trade growth has slowed significantly over the past few years, and the CPB Global Trade in Goods Index shows that the volume of global trade in 2019 is 0.5% lower than in 2018, the first decline since the 2008 global financial crisis, and it is expected that the epidemic will further reduce the growth rate of global trade. Global intermediate goods account for more than half of all goods trade, and global supply chains have become tightly integrated. China, the United States, and Germany have become the hubs of the industrial chain in East Asia, North America, and Western Europe, respectively. The impact of the epidemic on the industrial chain will be especially pronounced in industries with a high degree of integration in the global value chain, such as automotive, electronics, and machinery equipment.

3.1.4 Evaluation Model

We do research from multiple data sets. As shown above, we conduct comparative analysis and visualization on the corresponding data in each field, and select the most valuable features from them to enter the subsequent model. So far, we can say with certainty that the main factors of the US economy are nothing more than these.

But our model can only be called big and comprehensive so far. In fact, the economy is a very complicated issue. For example, there are countless details in the field of taxation, involving different levels of taxation status of all classes. We have no way to study every small point in detail, so we can only be specific to some more important domain levels, instead of going further to analyze all the details in a domain.

3.2 Model II

3.2.1 Data Display

	tax	loan	nation	bank	wage	loss_rate	M1	M2	rate	agriculture	...	total	output_money	input_money	output_rate
time															
2019	4226.00	0.066895	0.207627	0.729469	18922.3	3.5	4059.2	15494.7	96.45	114268.48	...	1460724.38	209636.00	258517.00	125.2
2018	4030.00	0.205832	0.354520	0.695652	18016.6	3.9	3818.9	14538.8	96.06	113579.53	...	1430619.53	205116.00	264885.00	126.1
2017	3811.00	0.109777	0.231638	0.316425	16686.7	4.1	3666.8	13944.3	92.28	114653.12	...	1394886.12	203351.00	256469.00	124.5
2016	3568.00	0.166381	0.103107	0.135266	16290.2	4.7	3380.9	13341.2	102.35	112091.26	...	1332306.26	190688.00	234950.00	121.1
2015	3337.00	0.104631	0.074859	0.089372	15648.0	5.0	3146.4	12424.4	98.67	107056.40	...	1284348.40	181497.00	224854.00	119.9
2014	3002.00	0.082333	0.018362	0.033816	15010.5	5.6	2976.6	11719.7	90.26	102226.09	...	1259476.17	195002.10	240603.22	128.3
2013	2775.00	0.193825	0.001412	0.000000	14320.0	6.7	2711.7	11068.1	80.19	96995.27	...	1173472.27	192799.34	230192.63	132.3
2012	2450.16	0.000000	0.005650	0.007246	13955.5	7.8	2497.8	10475.7	79.77	89453.00	...	1111041.70	186630.00	224774.00	133.6
2011	2303.47	0.102916	0.000000	0.123188	13128.9	8.5	2207.8	9690.6	80.18	81303.90	...	1044996.70	177751.00	229499.00	132.1
2010	2162.71	0.259005	0.024011	0.384058	12625.0	9.4	1870.5	8823.0	78.95	69319.80	...	953162.50	165499.00	206176.00	127.5
2009	2104.99	0.291595	0.049435	0.422705	12006.9	9.9	1723.6	8511.0	77.92	60361.00	...	880191.85	143234.00	181924.00	119.7
2008	2523.99	0.307033	0.035311	0.043478	12211.5	7.3	1630.8	8269.2	81.17	58002.20	...	830609.90	132000.00	174126.00	115.8
2007	2567.99	0.483705	0.454802	0.217391	12227.2	5.0	1393.2	7521.8	76.69	48893.00	...	853033.00	147480.00	203585.00	119.3
2006	2406.87	0.485420	0.689266	0.352657	11590.3	4.4	1386.5	7094.2	83.68	40810.80	...	780595.80	128468.00	189217.00	112.5
2005	2153.61	0.492281	0.601695	0.176329	10795.0	4.9	1396.4	6698.2	91.10	39450.89	...	728250.49	113410.00	177210.00	107.7
2004	1880.11	0.421955	0.371469	0.159420	10453.1	5.4	1401.0	6436.7	80.87	36238.99	...	661498.67	102509.00	156639.00	104.8
2003	1782.31	0.421955	0.161017	0.120773	9623.1	5.7	1332.0	6093.6	86.92	29691.80	...	585073.40	90664.00	134257.00	100.8
2002	1853.14	0.442539	0.169492	0.304348	9154.5	6.0	1245.1	5808.3	101.85	27390.75	...	530683.10	81686.00	124531.00	98.6
2001	1991.08	0.653516	0.289548	0.570048	8930.7	5.7	1208.3	5466.8	116.82	26179.60	...	513038.01	78180.00	104966.00	97.6
2000	2025.19	0.648370	0.734463	1.000000	8730.4	3.9	1111.7	4948.3	109.32	24915.80	...	534333.98	90260.00	124296.00	100.1
1999	1827.45	0.807890	0.827684	0.789855	8201.0	4.0	1148.2	4661.7	101.83	24519.06	...	524398.73	84983.00	111493.00	99.0
1998	1721.73	0.596913	0.622881	0.922705	7708.7	4.4	1121.2	4397.0	94.17	24541.86	...	503854.36	78382.00	93127.00	98.5
1997	1579.23	0.624357	0.761299	0.944444	7221.7	4.7	1097.5	4054.3	99.70	23788.40	...	504675.30	79038.00	90327.00	102.0
1996	1453.05	0.735849	0.761299	0.910628	6768.4	5.4	1105.8	3839.3	88.12	22353.70	...	479068.80	72842.00	83317.00	103.2
1995	1351.79	0.644940	0.714689	0.956522	6331.2	5.6	1152.7	3661.6	84.76	20340.90	...	455207.90	69071.00	75342.00	104.4
1994	1258.57	1.000000	1.000000	0.927536	6047.4	5.5	1174.5	3515.4	88.73	15750.50	...	426699.20	62825.00	71281.00	101.1

Based on the time series and the analysis of Model 1, we've finally selected: tax, loan, nation_rate, bank_rate, wage, loss_rate, M1, M2, agriculture, manufacturing, export_rate, export_money, import_rate, import_money as input features, and the US GDP as Output feature.

Obviously, this is a regression problem with too many features, making it a priority to do data preprocessing and feature filtering.

3.2.2 Data preprocessing

- Data Normalization:

After standardizing all the variables, we eliminated the dimensions in order to better select the more valuable variables.

- Binarization of specific feature thresholds:

We binarize export_rate and import_rate, uniformly set the value greater than 0 to 1, and set the value less than 0 to -1.

- Imputation of missing data

Regarding the data of immigration, we lack the data of 95-99 years. By default, we use linear fitting to fill in missing values.

3.2.3 Correlation analysis

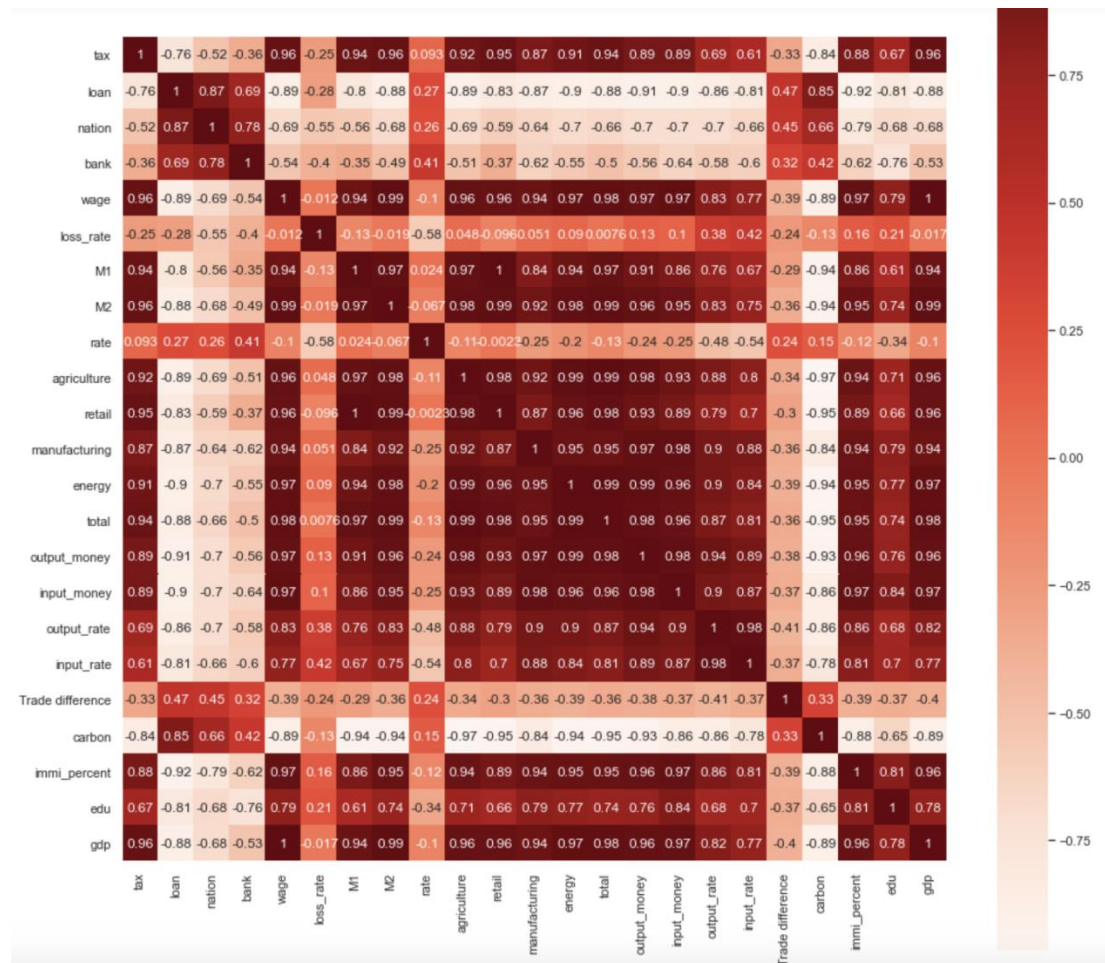


Figure8: Correlation matrix heat map of all features

We can find that there is a high correlation between variables, which easily leads to problems such as multicollinearity, so we must conduct feature selection.

3.2.4 Feature selection

When the data preprocessing is completed, we need to select meaningful features and input them into the machine-learned algorithms and models for training. Generally speaking, features are selected from two perspectives:

- Whether the feature diverges: If a feature does not diverge, for example, the variance is close to 0, that is to say, there is basically no difference between the samples in this feature, and this feature is not useful for distinguishing samples.
- The relevance of the feature to the target: This is more obvious, and the feature with high relevance to the target should be selected. Except for the variance method, the other methods introduced in this article are all considered from the relevance.

The methods of feature selection could be further divided into three in terms of the form:

- ① Filter: Score each feature according to divergence or correlation, set the threshold or the number of thresholds to be selected, and select the feature.
- ② Wrapper: According to the objective function (usually the prediction effect score), select several features at a time, or exclude several features.
- ③ Embedded: First use some machine learning algorithms and models to train to obtain the weight coefficients of each feature, and select features from large to small according to the coefficient. Similar to the Filter method, but through training to determine the pros and cons of features.

In the Filter method, we use the variance selection method: first calculate the variance of each feature, and then select the feature with the variance greater than the threshold. `input_money`, `tax`, `manufacturing`, `carbon`, `immi_percent`.

In the wrapper method, we finally choose the recursive feature elimination method. The recursive feature elimination method uses a base model for multiple rounds of training. After each round of training, the features of several weight coefficients are eliminated, and then the next round of training is conducted based on the new feature set.

In the Embedded method, we have chosen two methods. First, we use the feature selection method based on the tree model. In the tree model, GBDT can be used as a base model for feature selection. In addition, we tried to use the base model with penalty terms. In addition to filtering out the features, we also performed dimensionality reduction. In fact, the principle of L1 penalty term dimensionality reduction is to retain one of multiple features that are equally relevant to the target value, so not being selected does not necessarily mean that it

is not important.

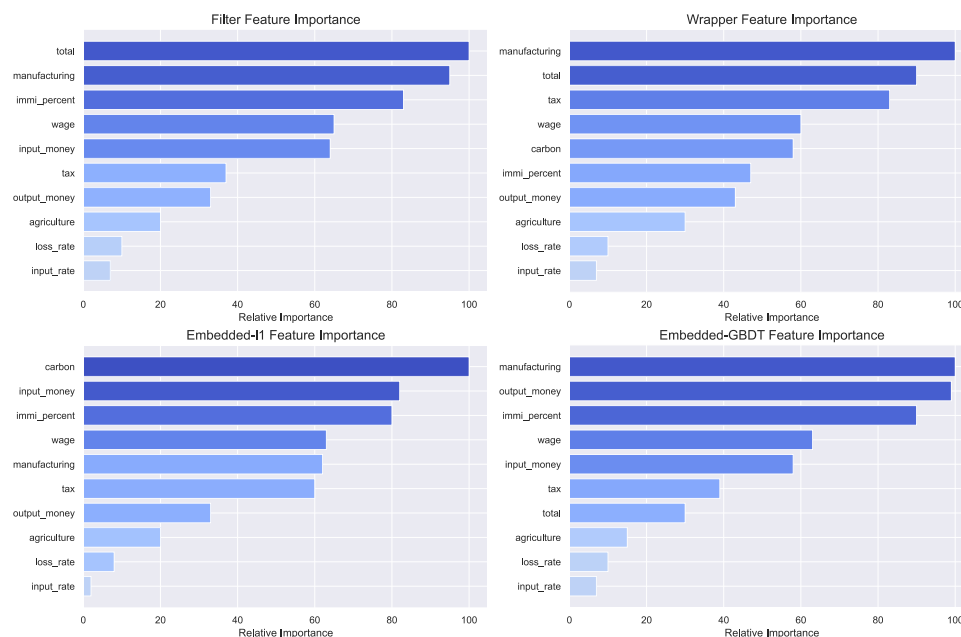


Figure9: Visualization of the top ten features based on four feature selection methods

Finally, we averaged the four sets of scores and chose manufacturing, wage, input_money, immi_precent, and carbon as the five most valuable and highest-scoring features to enter the regression model.

3.2.5 Dimensionality reduction with PCA

After the feature selection is completed, the model can be directly trained, but the feature matrix may be relatively large due to the small amount of data, so reducing the dimension of the feature matrix is also essential. In addition to the model based on the L1 penalty term, the common dimensionality reduction methods include principal component analysis (PCA). The essence of PCA is to map the original sample to a sample space with a lower dimension. PCA is to make the mapped sample have the greatest divergence. So PCA is an unsupervised dimensionality reduction method. After we tried to reduce the dimensionality, we found that the interpretability of the model was greatly reduced, so we chose to keep the original 5 features.

3.2.6 Lasso Regression

Similar to Ridge regression, LASSO (Least Absolute Shrinkage and Selection Operator)

regression penalizes the absolute value of the regression coefficients. In addition, it reduces variability and improves the accuracy of linear regression models. Consider the following equation:

Lasso regression is different from ridge regression, which makes the estimates of some regression coefficients be exactly zero. The larger the penalty imposed, the closer the estimate is to zero, which enables the selection from among n variables.

The final regression model we obtained is:

$$\text{GDP} = 0.329 * \text{input_money} + 0.279 * \text{tax} + 0.18 * \text{manufacturing} + -0.14 * \text{carbon} + 0.08 * \text{immi_percent}$$

3.3 Model III: Quantitative models of policy

3.3.1 Comparison Chart of Policies of Biden and Trump

It's clearly observed that there are major differences between the two in terms of immigration, environment, taxation, import and export trade.

President	Area	Content	label
Biden	Tax	Corporate tax reduction, tax increase for income above 100w	0
	Environment	Rejoin the Paris Agreement, promote clean energy and build bio-fuel plants	1
	Work	Raise the minimum hourly wage, raise the minimum salary	0
	Import&Export	Unite allies to pressure China and other countries	1
	Immigration	Reaffirmed commitment to refugees; lifted border emergency	1
Trump	Tax	Tax cuts for small and medium families and small businesses	0
	Environment	Develop traditional energy and withdraw from the Paris Agreement	-1
	Work	Commit to the return of manufacturing industry and abolish regulations that damage employment	1
	Import&Export	Withdraw from TPP and impose punitive tariffs to some countries	0
	Immigration	Strengthen border security and set up a separation wall	-1

3.3.2 Quantification of Policies

We look at the policy agenda proposed in these areas over the last 40 years of

U.S. history, and observe how it has changed over the corresponding historical period. This is used as a quantitative indicator of the policy.

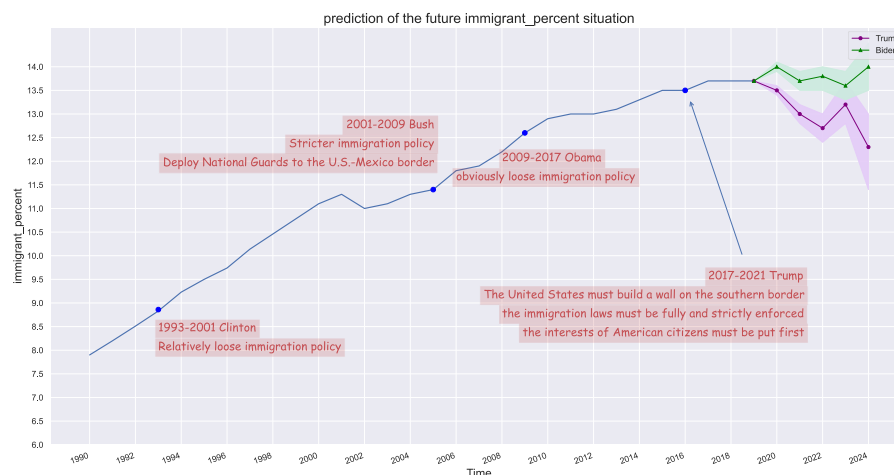
First, we rank the policies, i.e., we consider only one policy as positive, negative, or ordinary (no policy) in this area.

For example, we find that President Obama proposed aggressive emissions reductions, resulting in carbon emissions declining at an average rate of 1% per year during his term of office, while President Clinton cut environmental spending, resulting in carbon emissions increasing at an average rate of 0.8% per year during his term of office. We thus correspond to Trump and Biden (Trump's negative environmental policies and Biden's positive environmental policies), respectively, which gives us the growth rate of carbon emissions during Trump's term and the deceleration during Biden's. We add a random perturbation term to this and run 100 simulations on it, giving reasonable confidence intervals.

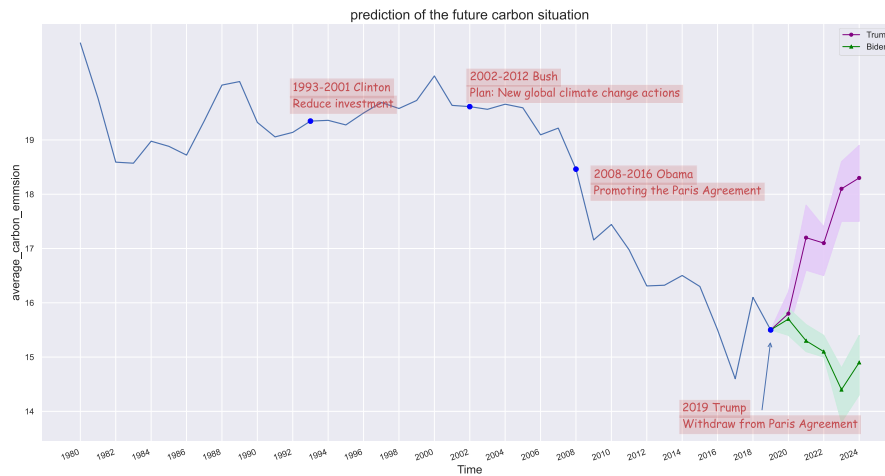
3.3.3 Visualization of predicted results

1. Immigration rate prediction for the next 4 years

Trump's extremely negative immigration policy cannot correspond to any period in history, so we learned from the relatively strict immigration policy during the Bush administration, which led to a directly halved rate of immigration. And in the 18-20 years, the growth rate of immigration in the United States rarely continued to increase. Therefore, our final simulation result of Trump is basically stable at about 13%, showing a downward trend, whereas Biden's prediction results show a steady progress, gradually increasing to about 14%. The simulation results are basically in line with cognition.

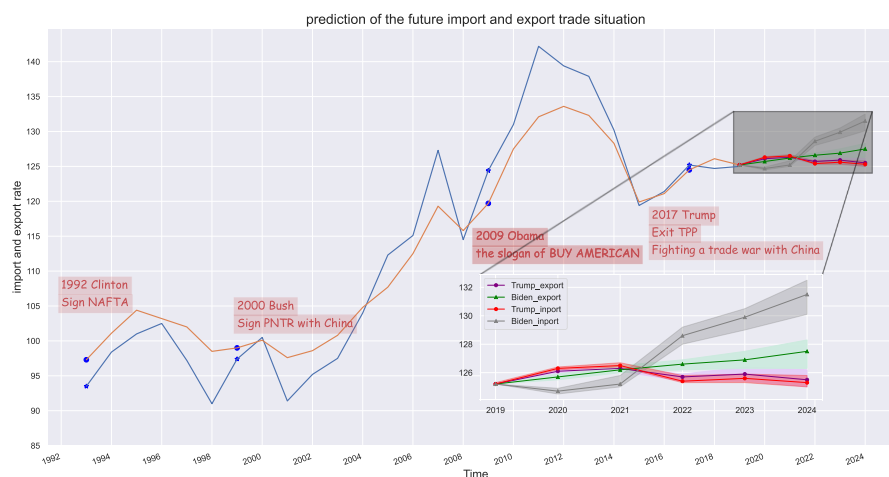


2. Carbon emissions rate prediction for the next 4 years



President Trump's withdrawal from the Paris Agreement and other operations have shown his negative attitude towards environmental protection. Therefore, during the 2020-2024 term, if President Trump is re-elected, his carbon emissions growth rate should be about the same as 2016-2020. Therefore, we added random disturbances on the basis of the 2016-2020 carbon emission growth rate, and simulated the above results. President Biden's relatively strict and proactive environmental protection policy will continue the steady slowdown in carbon emissions during the Obama era and further drop to about 14%.

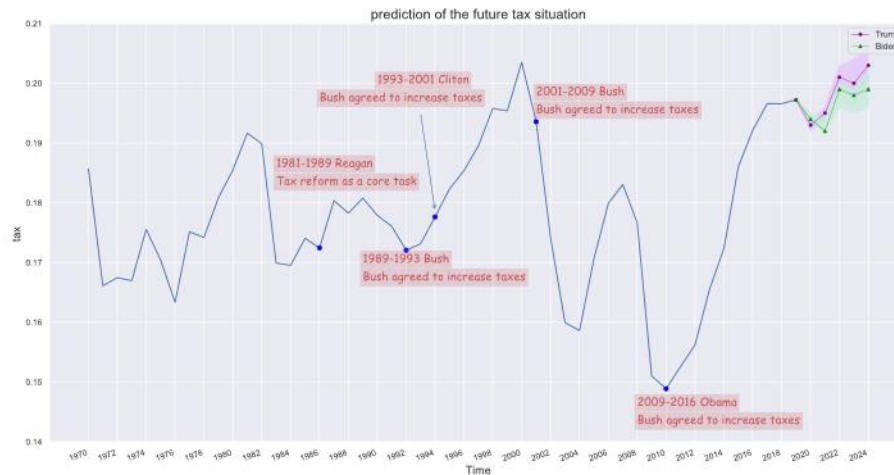
3. Value of import and export prediction for the next 4 years



In terms of import and export trade, Trump's policy is similar to the "Buy American Provisions" during President Obama's period. They are both a protectionist and relatively passive foreign trade policy. Therefore, we use the rate of change in import and export trade under President Obama as the basic value of Trump's growth rate in the next four years and add random disturbances. We think that Biden's policy is more similar to that of President Clinton. It belongs to uniting our allies and

establishing regional trade zones. We use this as a basis for growth and add random disturbances. Get the prediction result shown above.

4. Taxation prediction for the next 4 years



We observe that taxation policies are often extremely complex and are divided into various components. However, we have found that taxes fall first and then increase during almost every president's term. Therefore, we use this as a basis, and the average rate of tax decline in the previous presidents is regarded as the average rate of decline of these two presidents, which is equivalent to processing the rising stage. Finally, the simulation results shown above are obtained. In fact, there is no significant difference between the two.

3.3.4 Prediction of U.S. Economic Development

Combining model 2 and model 3, the regression formula of the impact on the US economy is obtained from model 2. Bring into it the predicted values for the next four years obtained in model 3.

In the end we come to the conclusion that Trump slightly surpasses Biden. The main reason is that the two policies are not very important to the economy in terms of taxation; while Trump's policy is more beneficial to manufacturing and industry; although the immigration policy is negative, the proportion of the immigration rate in the economic impact is relatively weaker than the other Several factors.

3.4 Model IV

——Game Theory Model

3.4.1 Problem Analysis

The relationship between China and the United States is not exclusively between China and the United States; it is also intertwined with the involvement of other major powers in the world. So we have to take into account factors other than China and the United States as well, it is a multi-cornered game.

The world economy as a whole is growing, but the rate of growth is slowing down. If the growth rate of the world economy goes to zero, it will be an absolute zero-sum game. Therefore, the game between the Chinese and American economies is currently in a zero-sum-like process of development towards a zero-sum game.

So, after analyzing the impact of the election of the two leaders on the U.S. economy, we continue with the previous question, leaving the original 20 input variables unchanged, but we need to add new features to them to match our game.

3.4.2 Feature Engineering

1. New Features

To fit our game model, we need to add new features to the input features.

(1) World total GDP growth rate. As a measure of the difference between a zero-sum-like game and a zero-sum game. The slower the total gdp growth rate, the closer it is to the zero-sum game, which can be used as an indicator of the intensity of competition among countries.

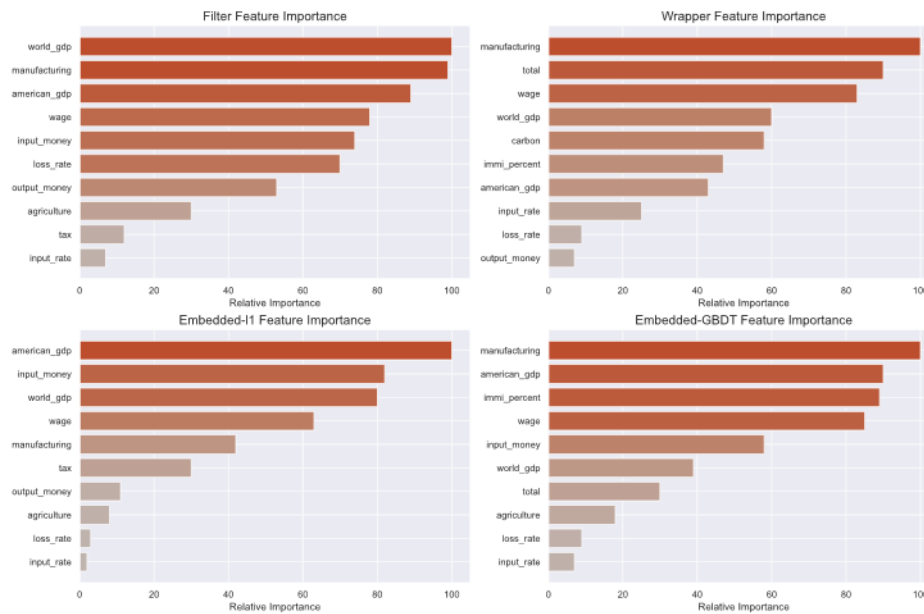
(2) The GDP growth rate of the United States. China and the U.S. are the main players in the world economic game, and it is also a measure of the gdp status of competing players in the zero-sum game, or zero-sum-like game stage.

(3) The GDP growth rate of Japan and the European Union. For the sake of model simplicity, only these two other major economies are considered.

(4) Change China's GDP as an output indicator.

2. New feature re-screening

Similar to the process in the previous question, we use four methods to filter and visualize features. Finally, the four items are averaged to get the final selected features for regression: `american_gdp`, `world_gdp`, `wage`, `input_money`, `carbon`.



3.4.3 Model Establishment

Considering the unity with the model in the first question, we still use lasso regression here

The final regression model we obtained is:

$$\text{GDP_china} = 0.215 * \text{american_gdp} - 0.149 * \text{world_gdp} + 0.13 * \text{wage} - 0.12 * \text{carbon} + 0.06 * \text{input_money}$$

All the feature is calculated after they have been normalized.

3.4.4 Model Evaluation

The regression equation is very interpretable. We can clearly find that the actual meaning of the equation is that the US economy and the world economy present an anti-reciprocal effect on China. That is, the slower the world economic growth and the faster the US economic growth, the greater the economic pressure on China. At the same time, the environmental quality of the United States also negatively affects China's economy. The other two indicators have smaller influence factors

3.5 Question III:

——Suggestions to China's economic countermeasures

With Biden's victory speech, the 2020 U.S. election is basically a foregone conclusion. Trump has yet to admit defeat, and the U.S. election is facing judicial battles and local demonstrations, the deep structural problems of social division in the U.S. cannot be solved by the president.

Next, Biden may form a new administration. The ensuing question of how and to what extent Biden will adjust his China policy will require special attention and study by China. We need to be prepared for the Biden administration's upcoming policy adjustments in China.

3.5.1 Biden's Philosophy of Governance

Biden was elected to the Senate at the age of 30, has spent 47 years in Washington politics, has chaired the Senate Judiciary Committee and the Foreign Relations Committee, was Obama's vice president for eight years, and is much more sophisticated and elegant than Trump. But if we only think that Biden is an "old fart" in politics and that he is too old to act, that may be a big mistake. Just as it would be a mistake to think that Trump can't escape a businessman's mindset and that market interests can be traded for strategic ones.

Biden's administration team will be more rational and traditional than the hysterical hawks that populate the Trump team. The members mainly include Antony Blinken, Ely Ratner, Susan Rice, Kurt Campbell and others. Blinken was an advisor to Biden when he was chairman of the Senate Foreign Relations Committee, and later served as national security advisor to Biden's vice president, and will likely serve as secretary of state in the Biden administration. Campbell served as Assistant Secretary of State for East Asian and Pacific Affairs during Obama's first term. These individuals will have very different policies toward China than in the Trump era. Blinken, for example, said at a U.S. Chamber of Commerce event in September, "I think it's unrealistic and ultimately counterproductive to try to completely decouple from China, as some people have suggested." Campbell agreed that "the Cold War mindset will make the United States less competitive in the long run, and simply focusing on containing China will not work.

3.5.2 Prediction of Biden's Policy Adjustments and Impacts on China

Biden might adopt the following policies.

1) The Biden administration will not advocate a cold war and all-out confrontation because they believe that it would be counterproductive and would damage U.S.

competitiveness and international image. The Biden administration will return to the Paris Climate Agreement, the World Health Organization, and work with China on regional security issues such as Iran and North Korea. And on education and human exchanges, the Biden team believes that attracting global talent and promoting education and human exchanges will increase U.S. competitiveness, so the stalled exchanges and cooperation between the U.S. and China can be gradually restored.

2) Building on its efforts to repair international relations and return to allied organizations, a Biden administration would most likely counter China by strengthening alliance leadership. The Biden administration will repair the damage done to alliances by the Trump administration and reassert its leadership in international organizations to create a new situation of containment against China. On economic and trade relations, the Biden administration would likely return as soon as possible to the TPP, which it had led in the Asia-Pacific region (the CPTPP had been established by Japan after the U.S. withdrawal), and delay the RCEP agreement through allies such as Japan, Australia, and South Korea, while restarting the TTIP with Europe.

3.5.3 China's economic countermeasures and policies

China's best response is to push forward reform and opening up with greater determination and force, specifically by using three key elements as a breakthrough to build and implement a "double cycle" strategy: the domestic cycle is important because domestic demand contributes greatly to China's GDP growth, while the external cycle is equally important. The external cycle is equally important, and export-oriented economies such as Guangdong, Shanghai, Zhejiang, and Jiangsu should seize the opportunity of the international cycle and rationally create new opportunities. We need to understand the United States rationally, and our goal is to coexist with the United States peacefully. The domestic cycle makes the domestic market bigger, which is more favorable to the international cycle.

First, vigorously promoting "new infrastructure" will help expand effective demand, stabilize growth and employment in the short term and increase effective supply in the long term, unleash China's economic growth potential, cultivate new economy, new technologies and new industries, promote reform and innovation, and improve people's welfare.

Second, it will accelerate the development of new types of urbanization and promote the integrated development of city clusters and metropolitan areas. It respects the objective law that industries and population are concentrated in advantageous areas; establishes and perfects a voluntary paid withdrawal mechanism for residential bases; takes the increase in the resident population as the main criterion for supplying urban land; optimizes the allocation of urban land between regions and cities; and promotes market-oriented cross-provincial land exchange and profit-sharing mechanisms.

IV. Model Evaluation

4.1 Advantages of the Model

4.1.1 Quantification of policies

First, we ternary general policies, label policies, and classify policies into active policies, passive policies, and conventional policies (no policies). For example, Trump's immigration policy is a negative policy, Biden's environmental protection is an active policy, and the taxation policies of both parties are regular policies. So we can look for similar policies from history as a reference.

4.1.2 Strong Interpretability

The parameters finally selected by our model can be reasonably explained. The impact of import and export trade, taxation, industrial development, environmental protection, etc. on the economy is obvious, and the final regression coefficient is also within a reasonable interpretation range. The coefficient of immigration and environment is significantly smaller than that of industrial development, import and export and taxation, that is, its influence is weaker than the latter.

4.1.3 Supported by the complete data

All our analyses are based on various social and economic data of the United States in the past 40 years. The authenticity of the data ensures the reliability of our model. We collect and compare data from open source data sets on the Internet and the U.S. Bureau of Statistics etc. to ensure the accuracy of the data.

4.2 The Shortcomings of the Model

4.2.1 Without Considering covid-19 as quantitative indicators

Covid-19 is a black swan incident. At present, most of the data in recent months is difficult to collect. It is difficult for us to fully incorporate 2020 into our model. In addition, the epidemic has not completely passed away. We have no way of knowing how it will develop in the future. When quantitatively analyzing the impact of candidates on the Sino-US economy, only qualitative analysis is done, not a complete quantitative analysis.

4.2.2 Other Influencing Factors

We have already considered dozens of factors that affect the economy. Of course, there are so many factors that affect the economy of a country, and we cannot take everything into consideration. At the same time, some data are very difficult to collect, such as the total amount of environmental governance investment.

4.3 Model optimization

4.3.1 Build more Regression Models

We mainly use the LASSO regression model, and we will try to use the stepwise regression model and the ridge regression model in the future. Different regression models have different ways to prevent overfitting. We will further observe whether some other features are decomposed.

4.3.2 Conduct dynamic simulation

Based on the actual economic levels of China and the United States, we conduct dynamic simulations and add random disturbances to simulate the economic relationship between China and the United States in the next four years to further support our model.

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