An Examination of the Key Indicators for Modeling China's Economic Growth

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June 21, 2021

Econometrics – ECON 400

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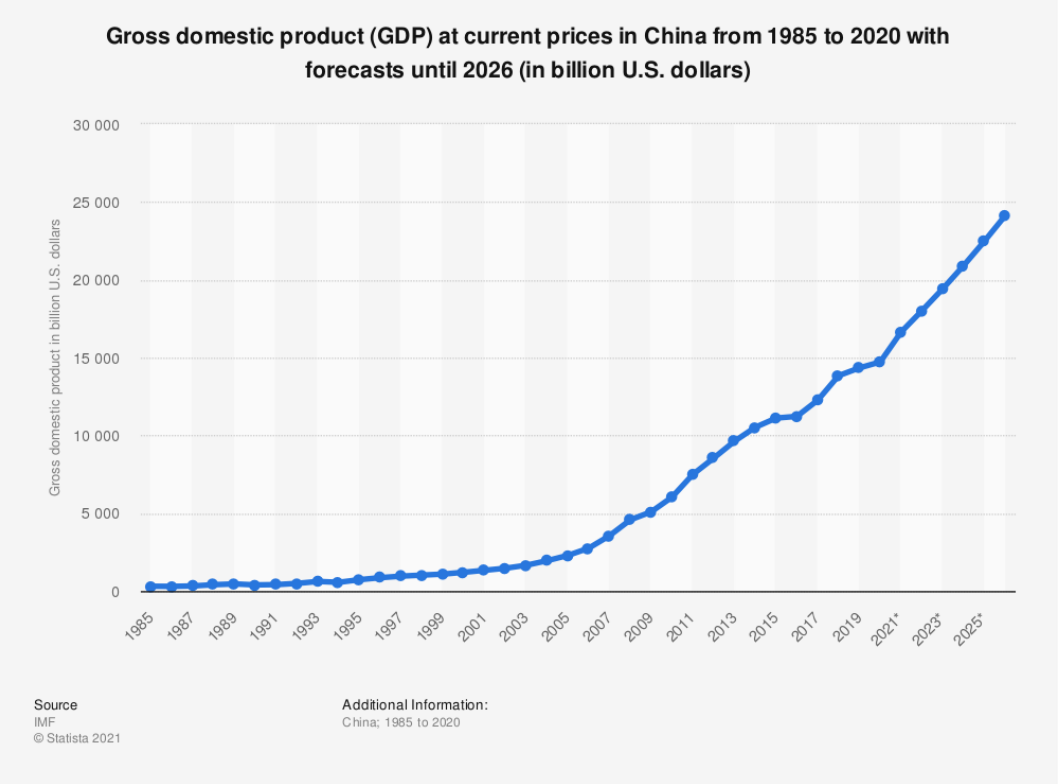
Abstract

Overtime we have consistently seen the positive economic effects that the free market creates. Many countries have adopted this more liberalized approach. One of the more notable cases is China. The focus of this paper will be to better understand the key indicators that lead to such a large growth in Chinas Gross Domestic Product (GDP). This cross-sectional study uses data from the world bank to create a model that accurately represents how China was able to grow at such a fast rate. The dependent variable will be China's GDP (growth %) and the independent variables being used are gross capital formation (% of GDP), population growth, birth rate, broad money growth (annual %), final consumption expenditure (current US$), general government final consumption expenditures, gross capital formation (annual % growth), unemployment, total (% of total labor force) (national estimate), and exports of goods and services (% of GDP).

An Examination of the Key Indicators for Modeling China's Economic Growth

Before China introduced a more democratic, free market approach to the economy, China's economy was very poor, stagnant, inefficient, and centrally controlled. In 1979 China underwent a serious reform that opened foreign trade and investment. After these market reforms Chinas economy became one of the fastest growing of all time "with real annual gross domestic product (GDP) growth averaging 9.5% through 2018" (Morrison, 2019)



The purpose of this paper is to identify the most important variables that have affected China's economy. According to everycrsreport.com, Economist's attribute most of China's rapid growth to two factors: large-scale capital investment and rapid productivity growth. Before 1979, China had low economic efficiency due to its lack of government spending and private sector.

Literature Review

To better understand the growth of China's economy, Wayne Morrison researched the effects of the economic reforms that were introduced in 1979. He found that the central government-initiated incentives for farmers, which allowed them to sell on the free market. The government also established special economic zones to attract foreign investment, boost exports, and technological imports. Trade liberalization was also a key factor to China's success. Removing trade barriers increased competition.

Measuring China's Economy.

Since the reform, Chinas economy has grown faster than it ever had. Averaging a growth rate of 9.5% per year. This rapid growth means that their economy has doubled in size every eight years. The actual size of the economy has been a hot debate topic for economists. When measured in USD, Chinas GDP in 2018 was $13.4 trillion, and per capita GDP was $9608.

Long Term Growth.

Because China grew so quickly, it exceeds the pace of institutional development, and their and now gaps that need to be addressed to maintain a sustainable growth model. I will be analyzing China's growth model from 1978 to 2015 which is what allowed them to expand so quickly. At this point China will need to address the complex development challenges which includes migrating to a new growth model. China is currently the largest emitter of greenhouse gases, and its pollution rates affect other countries. Combining previous growth techniques with more sustainable methods would be ideal.

Data

The goal of this analysis is to determine the influence on GDP growth, and to establish a reliable model that accurately portrays the important factors in growth and can be used to predict growth in the future. I will be using GDP growth (annual %) as the dependent and the independent variables are listed below:

Characteristic	N = 37[1]
gdp_growth	9.55 (7.86, 11.33)
gross_capital_formation	37.7 (35.2, 40.5)
pop_growth	1.05 (0.59, 1.34)
birth_rate	17.0 (12.4, 19.9)
broad_money_growth	19 (15, 28)
log_final_consum_gdp	26.97 (26.00, 27.85)
gov_final_consum_growth	14.44 (13.75, 15.07)
unemployment	3.20 (2.60, 4.10)
Exports	18 (12, 25)

[1] Median (IQR)

All independent variables are in % of GDP or % annual increase form except for final consumption expenditure (current $US) which I will be using the logarithmic form. Gross Capital formation represents large capital investment. This is a key indicator for examining growth. Population growth and birth rate may be correlated to higher production. Broad money growth measures an economies money supply and cash flow. Final consumption expenditures and government consumption growth show the level of government spending for stimulus. Unemployment rate can have an inverse relationship with the GDP. Exports of goods and services (% of GDP) are another high average percent increase.

Before creating any regression models, the Classical Linear Model Assumptions must be discussed and met. The following list describes how these assumptions apply to the data used in this study:

1. **The Regression Model is "linear in parameters":** $y = \beta 0 + \beta 1x1 + \beta 2x2 + \ldots + \beta kxk$ + u

Where $\beta 1$, $\beta 2$, and βk are the slope parameters that describe the relationship between the independent variables and the dependent variable in the population. The u is the error term representing all unobserved and uncontrolled disturbance in the data. The regression models generated in this study are all linear in parameter, so the first assumption is satisfied.

2. Data Collection is Random: Since the data collected is from the World Bank, we can assume accurate and random samples since they employ a multitude of methods for collection. "Working closely with the Bank's regions and Global Practices, the group is guided by professional standards in the collection, compilation and dissemination of data to ensure that all data users can have confidence in the quality and integrity of the data produced." (World Bank, 2021)

3. No Multicollinearity: To test the collinearity of our models, R was used to test the correlations between the variables, and this can be found in appendix A. Although there was some correlation, the coefficients were not perfect. Several variables were removed to account for this, so the third assumption of Multicollinearity is met.

4. Zero Condition Mean: The zero condition mean tests whether given the values of the independent variables, there is a 0 for the expected value of the error term u. Although this is hard to test for, looking at the residual plots in the simple regression, we can see that the expected error is not zero, and this forth condition is satisfied.

5. Homoskedasticity: This condition checks if the variance of error term u was kept constant throughout the regressions and independent variables. I used White's test to check for heteroskedasticity which is a modified version of the *bptest**.

Results

After testing all the Gauss-Markov assumptions, we can now go over the results and interpretations of the models that were utilized to test which variables have the greatest impact on GDP. I created three models all with varying uses of the independent variables. The best fit will meet all criteria.

Model 1: All Variables

The first model will include all the variables to see what proportion of variance can be explained.

gdp_growth = β0 + β1(gross_capital_formation) + β2(pop_growth) + β3(birth_rate + β4(broad_money_growth) + β5(log(final_consum_gdp)) + β6(gov_final_consum_growth) + β7(unemployment) + β8(Exports)

Model 2: Multicollinearity

The first model showed signs of multicollinearity in the variables, procedure can be found in the appendix A. Second model takes that into account and is shown below:

gdp_growth = β1(gross_capital_formation) + β2(Exports) + β3(unemployment) + β4(gov_final_consum_growth)

In this model I removed several of the variables to see how it affected the overall results. It dropped the r^2 values significantly since we reduced dimensions to four. Unemployment and government consumption were both negatively correlated while the other two were weaker positive. Moving on I will adjust the variables to get better p-values and increase r^2

Model 3: Replacing Variables

gdp_growth = β1(gross_capital_formation) + β2(Exports) + β3(unemployment) + β4(log_final_consum_gdp) + β5(broad_money_growth)

In my final model I replaced government consumption with household consumption (log). This provided a stronger negative coefficient since it is in dollar values. This could be somewhat weighted to heavily. I also add broad money growth which added more positive correlation and adding more explanation of variance.

Conclusion

To conclude, the final model used to predict GDP growth was able to explain about 41% of the model's variance. This multivariate model consisted of 5 variables:

- Gross Capital Formation
- Exports

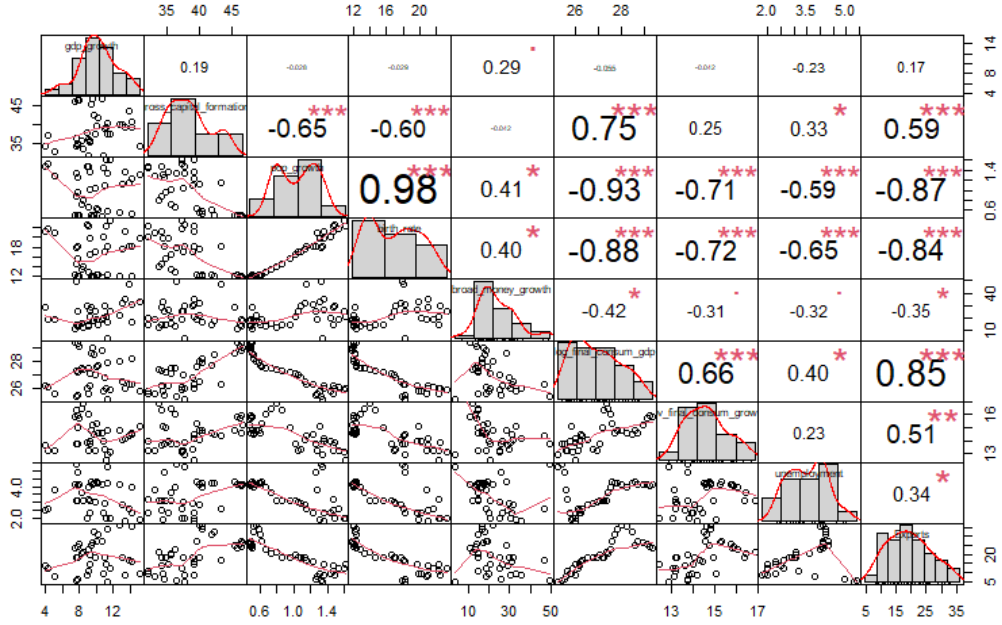
- Unemployment
- Log of Final consumption GDP
- Broad money growth

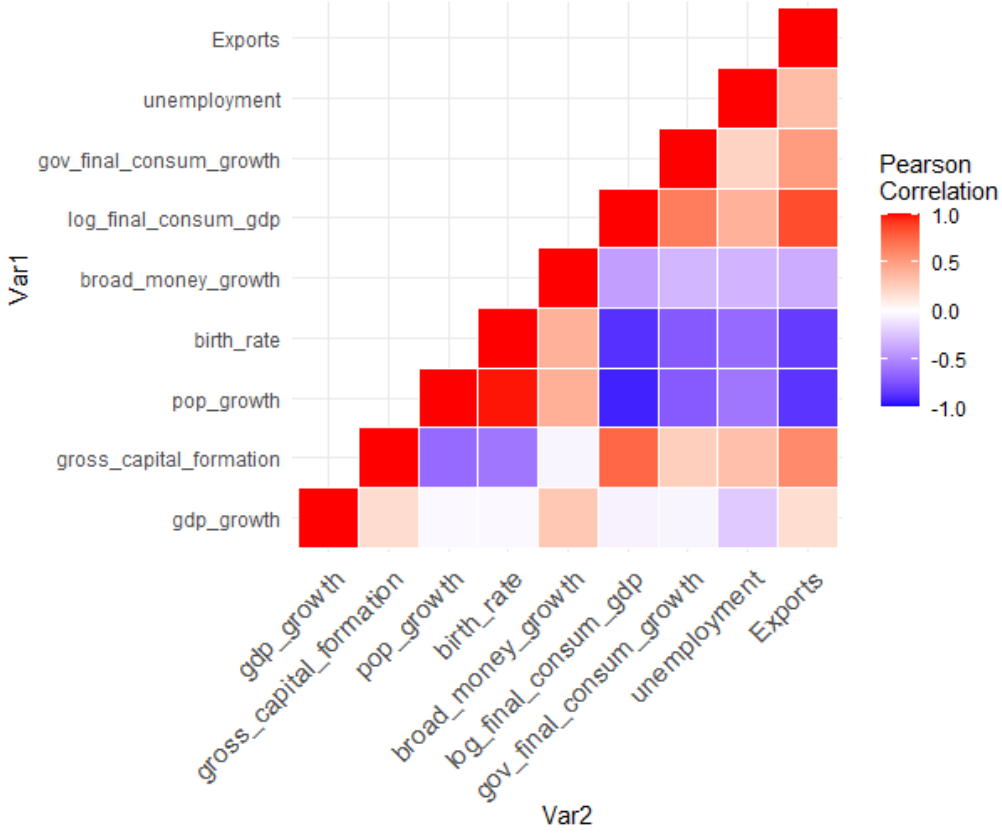
When the five Gauss-Markov assumption were met, these were the most influential factors. I am pleased with these findings, and they are in line with what experts have found to be important when explained the rapid growth of China's economy.

The growth of an economy involves hundreds if not thousands of factors. So, finding all of these to use in a model may not be possible. But these five factors were clearly impactful to China. The sheer quickness of their growth is an impressive feat and will likely be hard to replicate again in the future. Further studies could involve a more sustainable approach to economic growth.

Appendix A:

Correlation Matrices





Appendix B:

Whites test for Heteroskedasticity:

```
fitted_model4 <- fit4$fitted.values
bptest(fit4, ~ fitted_model4 + I(fitted_model4^2))

#Strongest fit based on multicollinearity and heteroskedasticity
```

```
        studentized Breusch-Pagan test

data:  fit4
BP = 3, df = 2, p-value = 0.2
```

P-value is above 0.05

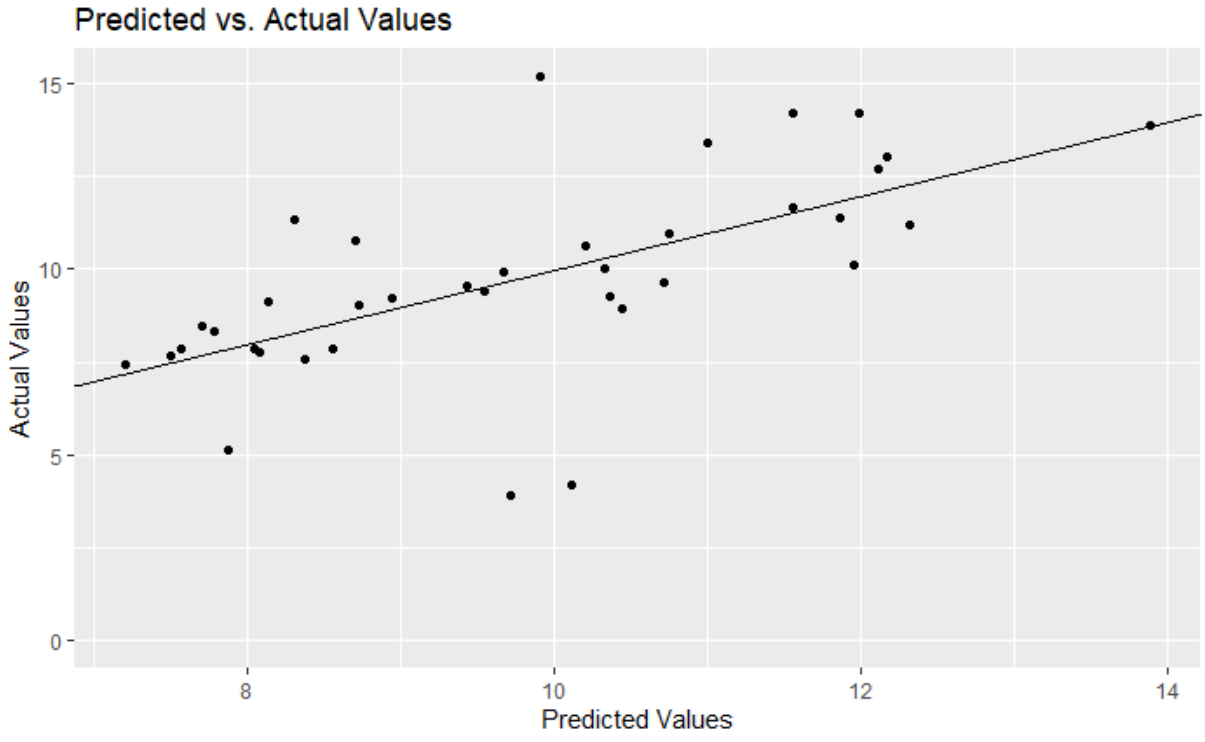
Residual summary of the best fit model:

```
Call:
lm(formula = gdp_growth ~ gross_capital_formation + Exports +
    unemployment + log_final_consum_gdp + broad_money_growth,
    data = proj_df)

Residuals:
   Min     1Q Median     3Q    Max
-5.908 -0.690  0.171  0.602  5.283

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)              60.4516    17.7731    3.40   0.0019 **
gross_capital_formation   0.3629     0.1465    2.48   0.0189 *
Exports                   0.2767     0.0807    3.43   0.0017 **
unemployment             -0.6988     0.4200   -1.66   0.1063
log_final_consum_gdp     -2.5140     0.8057   -3.12   0.0039 **
broad_money_growth        0.0214     0.0492    0.43   0.6674
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.2 on 31 degrees of freedom
Multiple R-squared:  0.413,     Adjusted R-squared:  0.319
F-statistic: 4.37 on 5 and 31 DF,  p-value: 0.004
```

F-statistic p-value < .05 and multiple R^2 at .413

Appendix C:

	gdp_growth		gdp_growth		gdp_growth	
Predictors	*Estimates*	*p*	*Estimates*	*p*	*Estimates*	*p*
(Intercept)	174.09	**<0.001**	12.05	0.125	60.45	**0.002**
gross_capital_formation	0.56	**0.001**	0.11	0.367	0.36	**0.019**
pop_growth	-9.51	0.147				
birth_rate	-0.55	0.330				
broad_money_growth	-0.03	0.524			0.02	0.667
log_final_consum_gdp	-5.78	**<0.001**			-2.51	**0.004**
gov_final_consum_growth	-0.25	0.692	-0.34	0.471		
unemployment	-2.59	**0.001**	-0.94	0.056	-0.70	0.106
Exports	0.10	0.350	0.08	0.274	0.28	**0.002**
Observations	37		37		37	
R^2 / R^2 adjusted	0.627 / 0.521		0.165 / 0.060		0.413 / 0.319	



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