5-2019

Is China Going to be the World's Largest Economy? - Comparing Standard of Living in China and U.S in the Next Twenty Years

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Is China Going to be the World's Largest Economy? - Comparing Standard of Living in China and U.S in the Next Twenty Years

by

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A Thesis

Submitted to the Graduate Faculty of

St. Cloud State University

in Partial Fulfillment of the Requirements

for the Degree of

Master of Science in

Applied Economics

May, 2019

Thesis Committee:
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Abstract

Rapid economic growth in China has made China the world's 2nd largest economy in term of its gross domestic product (GDP) right after the U.S. (World Bank, 2019). Will Chinese economy surpass U.S. economy is a question many wonder. Some think that there is no debate whether Chinese economy will surpass U.S.'s, the only question is *when* will it happen (Bloomberg 2018). This paper compares the economic growth in China and U.S. from 1982-2016 in terms of their GDP per capita (standard of living) and examines whether Chinese economy will surpass U. S's in the next 20 years. The results indicate that independent variables such as capital, labor, saving and lagged GDP per capita have an effect on economic growth in China and variables like capital, FDI and lagged GDP per capita have an influence on economic growth in U.S. The result of this study suggests that in the next 20 years, China will not surplus U.S. in term of GDP per capita.

Table of Contents

Page

List of Tables 4

List of Figures 5

Chapter

1. Introduction 7

2. Literature Review 10

    Saving.. 10

    Trade.. 12

    FDI..14

3. Data and Methodology…... 19

    Data Description……………………………………………………………... 19

    Variable Description……………………………………………………….…20

    Methodology……………………….…………………………………………….20

4. Test Result……………………….. 25

    Unit Root Test…………………………………………………………….…. 25

    Ordinary Least Square (OLS) Regression Results..…………………………………..38

    Vector Autoregression (VAR)…………………………………………..…....42

    Granger Causality Test ………………………………………………….…62

5. Conclusion 70

References 72

Appendix……………………………………………………………………..…78

List of Tables

Table Page

1. List of Variables……………………………………………………………….…..…..19
2. Automatic ARIMA Forecasting for each Variable – China...……...………………........44
3. VAR Forecasting - LChina_Y ……………………………………………………….49
4. VAR Forecasting-China……………………………………………………..……. .50
5. Automatic ARIMA Forecasting for each Variable – U.S.………………………….……54
6. VAR Forecasting -LUS_Y ………………………………………………………...….59
7. VAR Forecasting- U.S…………………………………………………...……....60
8. Forecasted China_Y and US_Y……………………………………………………….66

List of Figures

Figure Page

1. Phillips-Perron Unit Root Test on LChina_Y ………………..……………………….….25
2. Phillips-Perron Unit Root Test on China_K…………………………………………………25
3. Phillips-Perron Unit Root Test on China_L…………………………………………….......26
4. Phillips-Perron Unit Root Test on China_S…………………………………………........27
5. Phillips-Perron Unit Root Test on China_Trade………………………………………......27
6. Phillips-Perron Unit Root Test on China_FDI…………………………………………………28
7. Phillips-Perron Unit Root Test on D(China_S) ………………………………………………..29
8. Phillips-Perron Unit Root Test on D(China_Trade)……………………………………………29
9. Phillips-Perron Unit Root Test on D(China_FDI)………………………………………... .30
10. Phillips-Perron Unit Root Test on LUS_Y…………………………………………..........31
11. Phillips-Perron Unit Root Test on US_K…………………………………………............31
12. Phillips-Perron Unit Root Test on US_L…………………………………………............32
13. Phillips-Perron Unit Root Test on US_S…………………………………………….........33
14. Phillips-Perron Unit Root Test on US_Trade……………………………………….…....33
15. Phillips-Perron Unit Root Test on US_FDI…………………………………………........34
16. Phillips-Perron Unit Root Test on D(US_K) ……………………………………………......35
17. Phillips-Perron Unit Root Test on D(US_L) ……………………………………………….....35
18. Phillips-Perron Unit Root Test on D(US_S) …………………………………………….....36
19. Phillips-Perron Unit Root Test on D(US_Trade) ………………………………………..37
20. Phillips-Perron Unit Root Test on D(US_FDI) …………………………………………….37

21. OLS Regression for China……………………………………………...............................38

22. Actual, Fitted, Residual graph-China………………………………………..……...........40

23. OLS Regression for U.S. ………………………………………...…………………....41

24. Actual, Fitted, Residual graph-U.S. …………………………….……………….............42

25. Automatic ARIMA forecasting for each variable……………………………………......43

26. VAR estimation - China……………………………………………………………….....46

27. Impulse Response Function- Response to Cholesky– China……………………….....48

28. VAR forecasting graph - China…………………………………………………..........51

29. VAR forecasting evaluation – China……………………………………………….........52

30. Automatic ARIMA forecasting for each variable – U.S. ……………….………………..53

31. VAR estimation – U.S. ………………………………………....................................56

32. Impulse Response Function- Response to Cholesky– U.S………………………………..58

33. VAR forecasting – U.S. ………………………………………....................................61

34. VAR forecasting evaluation – U.S. ……………………………………….....................62

35. Granger Causality test – China……………………………………….........................63

36. Granger Causality test – U.S. ……………………………………….............................65

37. China_Y and Forecasted_China_Y…………………………………………………………..67

38. US_Y and Forecasted_US_Y………………………………………………………..…67

39. Impulse Response Function – China……………………………………………..…68

40. Impulse Response Function – U.S………………………………………………………..69

Chapter 1. Introduction

Measuring economic activity in a country provides insight on the overall economic health and economic well-being of the people. Economic indicators allow people to analyze growth and contraction within a country. According to World Bank, “many WDI indicators use GDP or GDP per capita as a denominator to enable cross-country comparisons of socioeconomic and other data.” GDP measures the monetary value of final goods and services produced in a country in a given period (IMF). GDP per capita is a measure of a country’s economic output per person and it is calculated by dividing a country’s GDP by its total population. It shows the average of the living standard of residents in a country and it allows one to compare the prosperity of countries with different population size. For instance, U.S. spreads its wealth among approximately 328 million people, compare to China, whose population is about 4 times the number of people in U.S., it spreads its wealth among approximately 1.4 billion people (U.S. Census Bureau, 2019).

Many researchers wrote about the factors that can affect economic growth. Bhagwati and Shrinivasan (1978), Krueger (1980) and Feder (1983) found positive effect of export on economy. Lewis (1954), Rostow (1960), Fry (1980) and Giovannini (1983) found that higher saving rate would lead to higher growth in the economy. Dees (1988), Whalley and Xing (2010) and Chen (2011, 2018) emphasized on the positive relationship between FDI and economy growth.

Being the driver of the global economic engine and the world’s largest economy in term of its GDP (World Bank, 2019), the U.S. economy has important effects around the world. Long term stability of purchasing power and stable political environment has made the U.S. dollar the world’s foremost reserve currency (or world currency) and is used in most international transactions. To maintain their currency value and avoid volatile swings in foreign exchange rate, many countries have pegged their currencies to dollar. This means they use a fixed exchange rate to dollar; thus, their central bank controls their currencies and those currencies rise and fall along with the dollar. To maintain the peg, countries need to have lots of dollars available that's why many of these countries have lots of export to U.S.

Being the world's largest economy has also given the U.S. more influence in politics and international trade. U.S. played a major role in creating security organization such as United Nations and North Atlantic Treaty Organization (NATO). The U.S. also helped to promote economic development by creating the Marshall Plan, the General Agreement on Trade and Tariffs (GATT) and the North American Free Trade Agreement (NAFTA).

The U.S.'s economic, political and military power has also made its cultural pre-eminent. Global Fast Food industries like McDonald's and Pizza Hut; media and entertainment industry - Hollywood; technology innovation such as Apple and Microsoft can be seen in almost every region of foreign countries.

What would happen if China surpass the U.S.? Will these influences still remain? If China does surpass the U.S. as the world's largest economy, then it might be reasonable for the world to reconsider using the US currency as the foremost reserve currency. If Chinese currency also becomes one of the world's foremost reserve currency, then the value of the US dollar might tank, causing an economic disaster in the U.S.

China would also have more power in the international trade. It would have the ability to influence international trade policies and to impose its own trading rules. For instance, when Great Britain became the world's dominant power after defeated France in the Napoleonic Wars, its currency, Pound, was the world's reserve currency. It also imposed its own trading rule and forced Chinese market open to opium and when China refused, Great Britain launched into wars and Great Britain also discriminated against Indian textile production.

Chinese culture is one of world's oldest culture and has been considered the dominance culture in East Asia, originated more than 5000 years ago. Its language, ceramics, calligraphy, cuisine, martial arts, dance have a profound impact on the world. When China has more global economic and political influence, it's very likely that the world would become more influence by its cultural; especially with the help of its huge population, approximately 1.4 billion of people and the many more Chinese immigrates spread around the world.

Despite China being an emerging country, it has risen to the world's second largest economy, right after the U.S (Focus Economic, 2018). This paper will be comparing the economic growth in U.S. and China, the world's 1st and 2nd largest economies in term of GDP in the period of 1982-2016. It will examine the following question:

Will Chinese economy surpass the U.S. economy in the next 20 years in terms of its GDP per capita?

Unit Root Test-Phillips Perron (PP) will be used to check the stationarity of each variable. Granger Causality Test will be used to analyze the relationship between variables. VAR models will be used for forecasting the economic growth in China and U.S. in the next 20 years.

The structure of the paper is as follows: Part II is the literature review, Part III is the model, description of variables, and data description, Part IV shows the results from regression analysis, Part V is the forecasting and Part VI is the conclusion.

Chapter 2. Literature Review

Saving

Theoretical literature is unclear about the direction of causality between saving rate and growth and the relationship between saving and growth. The early growth model of Harrod and Domar (1939; 1946), Y=AK stated that output (Y) is proportional to capital (K) where A is a constant. With capital as the only factor in the model and constant marginal returns to capital, this model shows that output growth rate would be proportional to saving rate or investment. In other models, labors are also included but since in developing counties like Bangladesh and China where there are surplus of labors, growth would be proportional to saving rate that’s why Lewis (1954) believed that higher saving can lead to faster economic growth. Solow’s model (1956) assumed decreasing marginal return to capital lead to growth eventually stop but economies with higher saving rate can have higher steady state income (Agrawal, 2001). Assuming diminishing return to capital makes sense since adding more capital makes output increasing in a decreasing rate. For example, if a firm gets a unit of capital, a computer, the output can increase, but if this firm keeps adding more computers without adding more labors, the growth in output will gradually stops. Recent growth model by Romer (1986) agreed with Harrod and Domar’s assumption of constant return to capital and believed that higher saving rate and capital formation lead to higher output growth rate (Agrawal, 2011).

Consumption theories like permanent income and life cycle hypotheses implied opposite direction of causality between saving and growth. People choose their consumption and saving based on their current and future level of income. According to Modigliani (1970), life cycle hypothesis showed a positive relationship between saving and growth in income. He argued that with no growth in income and population, saving of the young would cancel out the dissaving of the old, therefore aggregate saving would be zero. But increase in income for young people make them richer than the old people, so young people would save more than the amount not saved by the old people, it showed a positive relationship between saving and growth. However, Carroll and Weil (1994) argued that, ceteris paribus, an exogenous increase in aggregate growth will make forward looking consumers feel wealthier and which lead to an increase in consumption, therefore less saving, which means the relationship between growth and saving can also be negative if consumption habit change with an increase in income (Agrawal, 2001).

The empirical work on the causality between saving rate and growth is also ambiguous. Agrawal used Granger causality analysis testing seven Asian countries using modern time series analysis. He chose East Asian countries because these countries are among the highest saving and growth rate in the world. After analyzing the behaviors of saving rate and growth in seven Asian countries, he found that high rate of growth in income per capital do lead to high saving rate in six out of seven East Asian countries. But in three countries, higher saving rate led to higher growth rate. However, the result is much stronger from growth to saving than the other way around. Saltz (1999) used vector error correction (VEC) and vector auto regression (VAR) to look at the relationship between saving and economic growth in 17 countries. The finding was ambiguous. In 2 countries, domestic saving was the cause of economic growth, but in 9 countries, economic growth was the cause of an increase in domestic saving, and in 3 countries, they found no causal relationship between the 2 variables. In the last 2 countries, they found a 2-way causal relationship between domestic saving and economic growth, meaning domestic saving was the cause of economic growth and economic growth was the cause of domestic saving. Caroll and Weil (1994) used five-year average rate of economic growth in OECD countries and found economic growth was a cause of saving by using Granger Causality test but was questioned by others and these people believed that if they used annual data instead then the causal relationship would be reversed. Misztal (2011) used co-integration and Granger causality test to analyze the relationship between domestic saving and economic growth in developing, emerging and developed countries. He used both Keynes model, saving is a function of economic growth and Solow hypothesis, saving is a determinant of economic growth. After looking at the correlation coefficient, Granger test and co-integration in both advanced countries and emerging and developing countries, Misztal found one-way, positive relationship between domestic saving in both advanced countries and emerging and developing countries, meaning gross domestic saving was the cause of GDP but not the other way around. This result is consistent with Solow hypothesis. And he concluded that the level of economic development in the countries is not important when looking at the relationship between saving and development. Krieckhaus (2002) used 32 countries in his research and found that higher domestic saving can cause an increase in investment and therefore cause an increase in economic growth. Katircioglu and Naraliyeva (2006) used Granger causality test and cointegration method to find the relationship between FDI, domestic saving and economic growth in Kazakhstan in the period of 1993-2002 and found a one-way, positive relationship between domestic saving and economic growth.

Trade

Many researchers believed that international trade was the main reason why East Asian countries were growing rapidly in the past years (Balassa,1971; Krueger, 1993; and Hughes, 1992). According to Zestos and Tao, countries participate in international trade for several reasons. First, by increasing export sectors, countries can achieve economies of scale. Exporting goods allows countries to increase production. Trade also allows countries to specialize in certain production which they have the lowest opportunity cost, in other words, comparative advantage. It is especially true for small countries where markets are too small for specialization. Second, trade promotes higher efficiency. It gives workers higher wage and firms, higher profit because only the most efficient companies can survive in the competitive international market. Trade also allows different products to come to the host country which means variety of selection are available to consumers, thus consumers can get higher quality products. Third, trade allows host countries to have access to higher level of technology. This is especially true to developing countries. Also importing similar products from foreign countries can encourage innovation. Competitive pressure from foreign opponent is important for growth (Jomo et al, 2001). On the other hand, countries that are against international trade argued that trade cannot increase productivity growth in countries due to lack of skills to make it work. For many developing countries, using a more advanced technology requires some training, a certain level of human capital and without having the skills to run these technologies, developing countries cannot gain much through trade. Other opponents of international trade pointed out that if developing countries have industries that are pretty new, then these infant industries would not be able to compete and survive in the international competition, thus these infant industries need to be protected. Furthermore, industries should be protected from dumping. Dumping occurs when manufacturers export products at a price that is lower in the foreign importing market than the price in the exporter's domestic market, often times because they have excess supply of certain product. Dumping can cause a big decline in the market price and thus drive other industries out of business. Friedrich List and Joseph Stiglitz are the few economists that are against free trade**.**

Zestos and Tao used 49 observations and looked at the causal relationship between trade and GDP growth in 2 countries: Canada and United States. They found that from period of 1948-

1996, Canada's economy has always been more open than the United States'. In 1996, total trade as a percentage of GDP for Canada was approximately 80% compared to approximately 25% for the U.S. (Zestos and Tao, 2002). After using Granger Causality test, Cointegration and Vector Error Correction model, they concluded that Canadian GDP is closely related with both the export and import. They believed that the reason why import was related to GDP growth was because Canadian mainly imported new technology and some other manufacturing products such as tools or machinery and these goods tend to help industrialize and contribute to the growth of the domestic economy. Canadian's export were mainly natural resources and by engaging in exporting, they got the foreign exchange they needed to pay for its imports. In contrast, for the U.S, even though the export and GDP were positive correlated, imports and GDP were not. Some of the explanations were the U.S. has been a major industrial country for a long time and they don't rely on imported technology and physical capitals to grow. Its large national market made it possible to be economically separated from the rest of the world. The U.S. was able to import goods and invest in foreign market regardless of its export level, so it made its import and export not so closely related, unlike other countries who have to export because it provides the required foreign currency to pay for their imports. Another explanation for the weaker Granger causality in the U.S. is that the U.S. government deficit since the early 1980s caused higher interest rate, which attracted foreign financial capital to the U.S. (Zestos and Tao).

FDI

FDI can facilitate host country's economic development by increase in capital formation, employment creation, knowledge spillovers and transfer technology. This view was supported by several others. Chen (2011) found that FDI has helped China's economic growth directly through increasing in capital inputs and indirectly through positive knowledge spillovers. Dees (1998) also supported this idea that FDI affected China's economic growth from spread of knowledge and ideas. Whalley and Xin found that China's foreign-invested corporations contributed more than 40% of its economic growth in the period of 2003-2004 and without FDI, its GDP growth rate might be about 3.4% points less (Whalley and Xing, 2010). According to the United Nations Conference on Trade and Development (UNCTAD), by the end of 2016, China attracted $1.35 trillion in FDI, making it the largest FDI recipient in the developing world. Policy change regarding FDI in China made attracting FDI possible.

According to the author of China's 40 Years of Reform and Development, Chunlai Chen in 1975, Deng Xiaoping, the Chinese former Chairman, commissioned the drafting of a document about "Four Modernizations", which is the modernization of agriculture, industry, science & technology and national defense, he strongly believed that by achieving these modernization would be crucial to China's economic development, and wanted to acquire advanced technology and management skills from foreign countries. However, these ideas were being fiercely attacked and he was being labeled as "capitalist" and removed from government party. But when he returned to office again in 1978, he reintroduced these ideas again and by seeing how other developing countries use FDI to facilitate their economic development and what FDI did to these countries, Chinese leaders started to realize the importance of FDI and believed it is an effective way to obtain advanced technology from foreign countries at the minimum cost. With the abundant of supplies of labors, FDI helped to better allocate Chinese resources. Eagerness of wanting to recover from economic disruption caused by Cultural Revolution and desperate demand for economic growth promoted initial changes to China's policies regarding FDI.

Growth of FDI in China can be divided into three phases: the first phase, 1979-1991; the second phase, 1992-2001 and the third phase, 2002-2017 (Chen, 2018).

The First Phase:

After the open-door policy in 1978, China opened four special economic zones, aka SEZs- Shenzhen, Zhuhai, Xiamen and Shantou in 1980. During this period, the Chinese government putted in a lot of effort to liberalize FDI policies and encourage FDI inflows, they did so by opening more areas to FDI and offering special tax incentives to foreign investors and introducing series of laws and regulation to attract FDI. However, the uneven implementing of FDI policies made coastal cities gained more benefit compared to inland, therefore, the gap in economic development and income level encouraged those skilled workers, capital and technical personnel to move to coastal region from inland (Chen, 2017). During this first phase, China was cautious about bring FDI into its country, so did the investors, so FDI inflow was about $1.8 billion annually.

The Second Phase:

After Deng Xiaoping visited DEZs and some other costal economical opened areas, he wanted to implement FDI policies nationwide. Chinese government implemented new regulation and policies that would further encourage FDI by opening 52 cities to foreign investors, granted 14 more coastal cities the preferential policies and declared 15 border cities and counties as open-border cities (Chen, 2018). Besides, China also established more duty-free zones and allowed foreign investors purchase land use rights for the building of infrastructure facilities (Wei, 1994). Wanting to expedite economic growth and close economic growth gap between coastal and inland region, in 1998, Chinese government also launched the West Development Strategy which covered 12 provinces, municipalities and autonomous regions (Garnaut et al, 2018). According to Chen, during this phase, due to the more systematic and consistent FDI regulatory framework, inflow of FDI in 1992 doubled from the previous year and reached $11billion, and it doubled again in 1993 reached $27.5 billion. However, due to the Est Asian Financial Crisis, it slowed after 1997 and declined in 1999.

The Third Phase:

This phase began a year after China joined World Trade Organization (WTO) in 2001. After joining WTO, China amended more laws and issued more regulation to fulfill its commitments to WTO and for foreign investors to acquire China's domestic business. In 2002, China issued the Provisions on Guiding the Orientation of Foreign Investment and divided FDI into four categories: "encouraged", "permitted", "restricted" and "prohibited" to guide FDI inflows to targeted economic industries. Industries under "restricted" category were subjected to controls and limitation and these under "prohibited" categories were completely closed to FDI. In 2007, Chinese lawmakers unified tax rates for domestic and foreign companies and this new tax rate was 25%. In this phase, FDI increased to $108.3 billion in 2008 from $46.9 billion in 2001 (Chen, 2018).

According to Chen, at the end of 2014, the top 15 investors in China accounted for 87.5% of total FDI inflows in China, they were Hong Kong (China), 46.5%; British Virgin Islands, 8.8); Japan, 6.1%; the United States, 4.7%; Singapore, 45%; Taiwan (China), 3.8%; South Korea, 3.7%; Cayman Islands, 1.8%; Germany, 1.5%; Samoa, 1.5%; the United Kingdom, 1.2%; Netherlands, 0.9%; France, 0.9%; Mauritius 0.8%; and Macau (China); 0.7%. Also, developing economies accounted for 68.7% of FDI inflows in China, followed by 18.09% from developed economies. Tax haven or countries that have low tax rate accounted for 13.1% of total FDI.

Chen (2018) also talked about how FDI contributed to China's economic growth through four channels. First, FDI caused a higher demand for labor thus, created employment and increase in total output, therefore boosted its economic growth. FDI also increased China's fixed capital formation through its FDI attraction. Moreover, FDI is the leading source for technology transfer for developing countries so it is expected to increase China's economic growth. Lastly, FDI can cause knowledge spillovers, so it is expected to accelerate Chinese firm's efficiency and productivity.

Chapter 3. Data and Methodology

Data Description

All data were obtained from the World Bank's World Development Indicator (WDI). Data for FDI was available in the period of 1982-2017 for China and 1970-2017 for U.S. Data on gross saving rate was available in the period of 1982-2017 for China and 1970-2016 for U.S. Data on gross capital formation and how much products were imported and the total amount of goods that were exported were available for both countries since 1960, but up to 2016 for U.S. and 2017 for China. Data on GDP per capita growth in both counties were available from 1961 to 2017 and data on population growth rate in both countries were available in the period of 1960-2017. R&D would be an important variable that can influence economic growth since technology affects economic growth in the long run, but unfortunately almost all R&D related data for China were unavailable and the earliest available R&D data for China, Researchers in R&D (per million people) didn't start until 1996. Since at least 30 number of observations would be needed to run regression analysis and get accurate results, despite the importance of R&D, it has to be excluded in this paper. The fact that all the data were available in both countries since 1982 and the data for saving, trade and capital formation were available up to 2016 for the U.S., resulted this paper will consist 35 number of observations (1982-2016). Table 1 provides a description of the variables used in the model.

Variable Description

Table 1

List of Variables

Variables	**Description**
Capital (K)	Gross fixed capital formation (% of GDP)
Labor (L)	Population growth (annual %) as a proxy for labor participation rate
Savings (S)	Gross savings (% of GDP)
Openness to trade (Trade)	Summation of Exports of goods and services (% of GDP) and Imports of goods and services (% of GDP)
Foreign direct investment (FDI)	Foreign direct investment, net inflows (% of GDP)
GDP per capita (Y)	Constant (or real) GDP per capita, 2010 U.S. dollars
LY	log (Y)
LY (-1)	log (Y) lagged in 1 period, or last year GDP per capita

Methodology

Cobb-Douglas production function is widely used to represent the relationship between the two inputs, capital and labor and the amount of output that can be produced using these inputs. It states that dependent variable Y is the function of independent variables K and L.

Cobb-Douglas production function:

General form: Y=F (K, L)

Specific form: $Y= A K^{\alpha} L^{\beta}$ where $0 < \alpha$ and $\beta < 1$

- Y = total production
- L = labor
- K = capital
- A =technological progress
- α and β=output elasticities (if $\alpha + \beta = 1$, constant return to scale, if $\alpha + \beta > 1$, increase return to scale, if $\alpha + \beta < 1$, decrease return to scale)

There are also other variables that can affect economic growth. In conducting this research, I will be examining additional independent variables such as: gross saving as percentage of GDP, Foreign Direct Investment (FDI) as percentage of GDP, openness to trade (summation of imports and exports of goods and services) as percentage of GDP, and for the economic growth, GDP per capita will be analyzed as the dependent variable.

The general form of the regression model and the interpretation of the coefficients are as follows:

1) $lY_{it}=\beta_0 +\beta_1 K_{it}+\beta_2 L_{it}+\beta_3 S_{it}+\beta_4 trade_{it}+\beta_5 FDI_{it}+\beta_6 lY(-1)_{it}+\varepsilon_{it}$

Where i is the country, China or U.S, t is the time series, β_1 to β_6 are the coefficient of each independent variables, $lY(-1)_{it}$ is the lagged logarithm of constant/real GDP per capita in 2010 U.S. dollars in 1 period, S is saving.

- β_0: the intercept or the change in y when changes in all other variables are 0
- $\beta_1 K$: for every 1% increase in K, lY will increase by β_1%
- $\beta_2 L$: for every 1% increase in L, lY will increase by β_2%
- $\beta_3 S$: for every 1% increase in S, lY will increase by β_3%
- $\beta_4 trade$: for every 1% increase in trade, lY will increase by β_4%
- $\beta_5 FDI$: for every 1% increase in FDI, lY will increase by β_5%
- β_6 lY(-1): for every 1% increase in lagged log(y) in 1 period, lY will increase by β_6%
- ε_i is the error term

Unit Rroot-Phillips Perron. It is well known that if a chosen variable shows unit roots, it would violate classical econometrics, the presence of a unit root implies that a shock today has a long-lasting impact (Wooldridge, 2016), thus using procedures of classical econometrics would not be appropriate. Therefore, in order to estimate the model, we need to first check the stationarity of the chosen variables. Unit Root Test Phillips-Perron (1988) will be used to check the stationarity of each variable. A series is said to be stationary if the mean and autocovariances of the series do not depend on time. Any series that is not stationary is said to be nonstationary (Eviews user's guide).

One hypothesis is being tested:

The null hypothesis (H_0): variable is non-stationary, or it has unit root, ($p = 1$)

The alternative hypothesis (H_1): variable is stationary, or it has no unit root), ($p < 1$)

H_0 will be rejected if $|t_c|>|\text{critical value}|$, meaning variable has no unit root, therefore it is stationary.

H_0 will be failed to reject if $|t_c|<|\text{critical value}|$, meaning variable has unit root, therefore it is non-stationary.

Granger causality test. Granger causality is a way to investigate causal relation between two variables in a time series (Granger, 1969). A time series X is said to granger cause Y if the past value of X or lagged value of X provide statistically significant information and help to predict future values of Y and this prediction is based on the knowledge of past values of Y alone (Zestos and Tao, 2011). Pairwise causality test is the standard causality test that is a bidirectional test for Granger Causality between 2 variables. It shows the directional relationship between 2 variables, for instance, whether X causes Y or Y causes X.

One hypothesis is being tested:

The null hypothesis (H_0): X does not granger cause/effect Y (or Y does not granger cause X)

The alternative hypothesis (H_1): X does granger cause Y (or Y does granger cause X)

F statistics or p-value is being used to test Null hypothesis. AIC will be used to determine the number of lags included in the model.

H_0 will be rejected if p-value < 5%, meaning X does granger cause or effect Y

H_0 will be failed to reject if p-value > 5%, meaning X does not granger cause or effect Y.

Vector Autoregression (VAR). The vector autoregression (VAR), a multivariate regression is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables (Eviews). It treats every endogenous variable in the system as a function of p-lagged values of all of the endogenous variables in the system. In other words, in each equation, we regress the left-hand-side variable on p lags of itself, and p lags of every other variable, so the right-hand-side variables are the same in every equation, p lags of every variable. In VAR, each variable is not just related to its own past, but also to the past of all the other variables in the system (Diebold, 2017).

In the five-variable VAR (3), we have:

2) $lY_{it} = \Phi_{11}\, lY_{it-1} + \Phi_{12}\, K_{it-1} + \Phi_{13}\, L_{it-1} + \Phi_{14}\, S_{it-1} + \Phi_{15}\, trade_{it-1} + \Phi_{16}\, FDI_{it-1} + \Phi_{17}\, lY_{it-2} + \Phi_{18}\, K_{it-2} + \Phi_{19}\, L_{it-2} + \Phi_{20}\, S_{it-2} + \Phi_{21}\, trade_{it-2} + \Phi_{22}\, FDI_{it-2} + \Phi_{23}\, lY_{it-3} + \Phi_{24}\, K_{it-3} + \Phi_{25}\, L_{it-3} + \Phi_{26}\, S_{it-3} + \Phi_{27}\, Trade_{it-3} + \Phi_{28}\, FDI_{it-3}\ \varepsilon_{1,it}$

3) $K_{it} = \Phi_{11}\, lY_{it-1} + \Phi_{12}\, K_{it-1} + \Phi_{13}\, L_{it-1} + \Phi_{14}\, S_{it-1} + \Phi_{15}\, trade_{it-1} + \Phi_{16}\, FDI_{it-1} + \Phi_{17}\, lY_{it-2} + \Phi_{18}\, K_{it-2} + \Phi_{19}\, L_{it-2} + \Phi_{20}\, S_{it-2} + \Phi_{21}\, trade_{it-2} + \Phi_{22}\, FDI_{it-2} + \Phi_{23}\, lY_{it-3} + \Phi_{24}\, K_{it-3} + \Phi_{25}\, L_{it-3} + \Phi_{26}\, S_{it-3} + \Phi_{27}\, Trade_{it-3} + \Phi_{28}\, FDI_{it-3}\ \varepsilon_{2,it}$

4) $L_{it} = \Phi_{11}\, lY_{it-1} + \Phi_{12}\, K_{it-1} + \Phi_{13}\, L_{it-1} + \Phi_{14}\, S_{it-1} + \Phi_{15}\, trade_{it-1} + \Phi_{16}\, FDI_{it-1} + \Phi_{17}\, lY_{it-2} + \Phi_{18}\, K_{it-2} + \Phi_{19}\, L_{it-2} + \Phi_{20}\, S_{it-2} + \Phi_{21}\, trade_{it-2} + \Phi_{22}\, FDI_{it-2} + \Phi_{23}\, lY_{it-3} + \Phi_{24}\, K_{it-3} + \Phi_{25}\, L_{it-3} + \Phi_{26}\, S_{it-3} + \Phi_{27}\, Trade_{it-3} + \Phi_{28}\, FDI_{it-3}\ \varepsilon_{3,it}$

5) $S_{it} = \Phi_{11}\, lY_{it-1} + \Phi_{12}\, K_{it-1} + \Phi_{13}\, L_{it-1} + \Phi_{14}\, S_{it-1} + \Phi_{15}\, trade_{it-1} + \Phi_{16}\, FDI_{it-1} + \Phi_{17}\, lY_{it-2} + \Phi_{18}\, K_{it-2} + \Phi_{19}\, L_{it-2} + \Phi_{20}\, S_{it-2} + \Phi_{21}\, trade_{it-2} + \Phi_{22}\, FDI_{it-2} + \Phi_{23}\, lY_{it-3} + \Phi_{24}\, K_{it-3} + \Phi_{25}\, L_{it-3} + \Phi_{26}\, S_{it-3} + \Phi_{27}\, Trade_{it-3} + \Phi_{28}\, FDI_{it-3}\ \varepsilon_{4,it}$

6) $Trade_{it} = \Phi_{11}\, lY_{it-1} + \Phi_{12}\, K_{it-1} + \Phi_{13}\, L_{it-1} + \Phi_{14}\, S_{it-1} + \Phi_{15}\, trade_{it-1} + \Phi_{16}\, FDI_{it-1} + \Phi_{17}\, lY_{it-2} + \Phi_{18}\, K_{it-2} + \Phi_{19}\, L_{it-2} + \Phi_{20}\, S_{it-2} + \Phi_{21}\, trade_{it-2} + \Phi_{22}\, FDI_{it-2} + \Phi_{23}\, lY_{it-3} + \Phi_{24}\, K_{it-3} + \Phi_{25}\, L_{it-3} + \Phi_{26}\, S_{it-3} + \Phi_{27}\, Trade_{it-3} + \Phi_{28}\, FDI_{it-3}\ \varepsilon_{5,it}$

7) $FDI_{it} = \Phi_{11}\, lY_{it-1} + \Phi_{12}\, K_{it-1} + \Phi_{13}\, L_{it-1} + \Phi_{14}\, S_{it-1} + \Phi_{15}\, trade_{it-1} + \Phi_{16}\, FDI_{it-1} + \Phi_{17}\, lY_{it-2} + \Phi_{18}\, K_{it-2} + \Phi_{19}\, L_{it-2} + \Phi_{20}\, S_{it-2} + \Phi_{21}\, trade_{it-2} + \Phi_{22}\, FDI_{it-2} + \Phi_{23}\, lY_{it-3} + \Phi_{24}\, K_{it-3} + \Phi_{25}\, L_{it-3} + \Phi_{26}\, S_{it-3} + \Phi_{27}\, Trade_{it-3} + \Phi_{28}\, FDI_{it-3}\ \varepsilon_{6,it}$

Where i is the country: China or U.S., t is the time series, $\Phi_{\#}$ is the coefficient of each endogenous variables and ε is the error term in each equation

In the above models, each variable depends on 3 lags of the other variable other than 3 lags of itself; which can be useful in forecasting. Order (3) is being selected because AIC is minimized.

Chapter 4 Test results

Unit Root Test

China.

Null Hypothesis: LCHINA_Y has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		12.69164	1.0000
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.000742
HAC corrected variance (Bartlett kernel)	0.001433

Figure 1: Phillips-Perron Unit Root Test on LChina_Y

Phillips-Perron statistic value is 12.69164 and one sided p-value is 1.0000. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value is greater than the critical value, thus we reject the null hypothesis LChina_Y has a unit root or LChina_Y is non-stationary, meaning LChina_Y has no unit root and it is stationary.

Null Hypothesis: CHINA_K has a unit root
Exogenous: None
Bandwidth: 18 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		1.839225	0.9821
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	5.004016
HAC corrected variance (Bartlett kernel)	1.408310

Figure 2: Phillips-Perron Unit Root Test on China_K

Phillips-Perron statistic value is 1.839225 and one sided p-value is 0.9821. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value is greater than the absolute critical value at 10%, thus we reject the null hypothesis China_K has a unit root or China_K is non-stationary, meaning China_K has no unit root therefore it is stationary.

Null Hypothesis: CHINA_L has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.255924	0.0252
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.003103
HAC corrected variance (Bartlett kernel)	0.005884

Figure 3: Phillips-Perron Unit Root Test on China_L

Phillips-Perron statistic value is -2.255924 and one sided p-value is 0.0252. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is greater than the absolute critical value at both 5% and 10%, thus we reject the null hypothesis China_L has a unit root or China_L is non-stationary, meaning China_L has no unit root therefore it is stationary.

Null Hypothesis: CHINA_S has a unit root

Exogenous: None
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.762345	0.8739
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.557120
HAC corrected variance (Bartlett kernel)	4.401946

Figure 4: Phillips-Perron Unit Root Test on China_S

Phillips-Perron statistic value is 0.762345 and one sided p-value is 0.8739. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value is not greater than any absolute critical value, thus we failed to reject the null hypothesis China_S has a unit root or China_S is non-stationary, meaning China_S has a unit root therefore it is non-stationary.

Null Hypothesis: CHINA_TRADE has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.038872	0.6884
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	18.11307
HAC corrected variance (Bartlett kernel)	26.00118

Figure 5: Phillips-Perron Unit Root Test on China_Trade

Phillips-Perron statistic value is 0.038872 and one sided p-value is 0.6884. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value is not greater than any absolute critical value, thus we failed to reject the null hypothesis China_Trade has a unit root or China_Trade is non-stationary, meaning China_Trade has a unit root therefore it is non-stationary.

Null Hypothesis: CHINA_FDI has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.707674	0.4027
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.690143
HAC corrected variance (Bartlett kernel)	0.802760

Figure 6: Phillips-Perron Unit Root Test on China_FDI

Phillips-Perron statistic value is -0.707674 and one sided p-value is 0.4027. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is not greater than any absolute critical value, thus we failed to reject the null hypothesis China_FDI has a unit root or China_FDI is non-stationary, meaning China_FDI has a unit root therefore it is non-stationary.

Because variables China_S, China_Trade and China_FDI are non-stationary, 1^{st} differencing will be used to check for stationarity.

Null Hypothesis: D(CHINA_S) has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*

Phillips-Perron test statistic		-3.700725	0.0005
Test critical values:	1% level	-2.636901	
	5% level	-1.951332	
	10% level	-1.610747	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.294066
HAC corrected variance (Bartlett kernel)	2.291376

Figure 7: Phillips-Perron Unit Root Test on D(China_S)

Phillips-Perron statistic value is -3.700725 and one sided p-value is 0.0005. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is greater than absolute critical value, thus we reject the null hypothesis D(China_S) has a unit root or D(China_S) is non-stationary, meaning D(China_S) has no unit root therefore it is stationary.

Null Hypothesis: D(CHINA_TRADE) has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.048185	0.0002
Test critical values:	1% level	-2.636901	
	5% level	-1.951332	
	10% level	-1.610747	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	16.62138
HAC corrected variance (Bartlett kernel)	17.18242

Figure 8: Phillips-Perron Unit Root Test on D(China_Trade)

Phillips-Perron statistic value is -4.048185 and one sided p-value is 0.0002. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is greater than absolute critical value, thus we reject the null hypothesis D(China_Trade) has a unit root or D(China_Trade) is non-stationary, meaning D(China_Trade) has no unit root therefore it is stationary.

Null Hypothesis: D(DCHINA_FDI) has a unit root
Exogenous: None
Bandwidth: 27 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-17.16440	0.0000
Test critical values:	1% level	-2.639210	
	5% level	-1.951687	
	10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.102313
HAC corrected variance (Bartlett kernel)	0.079687

Figure 9: Phillips-Perron Unit Root Test on D(China_FDI)

Phillips-Perron statistic value is -17.16440 and one sided p-value is 0.0000. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is greater than absolute critical value, thus we reject the null hypothesis D(China_FDI) has a unit root or D(China_FDI) is non-stationary, meaning D(China_FDI) has no unit root therefore it is stationary.

Since the 1st difference of variables China_S, China_Trade and China_FDI are stationary, D(China_S), D(China_Trade) and D(China_FDI) will be used in the OLS regression for China model.

U.S.

Null Hypothesis: LUS_Y has a unit root
Exogenous: None
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		4.327050	1.0000
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.000293
HAC corrected variance (Bartlett kernel)	0.000562

Figure 10: Phillips-Perron Unit Root Test on LUS_Y

Phillips-Perron statistic value is 4.327050 and one sided p-value is 1.0000. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value is greater than the critical value, thus we reject the null hypothesis LUS_Y has a unit root or LUS_Y is non-stationary, meaning LUS_Y has no unit root therefore it is stationary.

Null Hypothesis: US_K has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.693881	0.4088
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.486431
HAC corrected variance (Bartlett kernel)	0.755481

Figure 11: Phillips-Perron Unit Root Test on US_K

Phillips-Perron statistic value is -0.693881 and one sided p-value is 0.4088. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is not greater than any absolute critical value, thus we failed to reject the null hypothesis US_K has a unit root or US_K is non-stationary, meaning US_K has a unit root therefore it is non-stationary.

Null Hypothesis: US_L has a unit root
Exogenous: None
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.657112	0.4250
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.004538
HAC corrected variance (Bartlett kernel)	0.004538

Figure 12: Phillips-Perron Unit Root Test on US_L

Phillips-Perron statistic value is -0.657112 and one sided p-value is 0.4250. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is not greater than any absolute critical value, thus we failed to reject the null hypothesis US_L has a unit root or US_L is non-stationary, meaning US_L has a unit root therefore it is non-stationary.

Null Hypothesis: US_S has a unit root
Exogenous: None
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.741989	0.3876
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.243246
HAC corrected variance (Bartlett kernel)	1.441030

Figure 13: Phillips-Perron Unit Root Test on US_S

Phillips-Perron statistic value is -0.741989 and one sided p-value is 0.3876. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is not greater than any absolute critical value, thus we failed to reject the null hypothesis US_S has a unit root or US_S is non-stationary, meaning US_S has a unit root therefore it is non-stationary.

Null Hypothesis: US_TRADE has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		1.022871	0.9160
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.384916
HAC corrected variance (Bartlett kernel)	1.489312

Figure 14: Phillips-Perron Unit Root Test on US_Trade

Phillips-Perron statistic value is 1.022871 and one sided p-value is 0.9160. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is not greater than any absolute critical value, thus we failed to reject the null hypothesis US_Trade has a unit root or US_Trade is non-stationary, meaning US_Trade has a unit root therefore it is non-stationary.

Null Hypothesis: US_FDI has a unit root
Exogenous: None
Bandwidth: 11 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.074250	0.6997
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.365628
HAC corrected variance (Bartlett kernel)	0.185772

Figure 15: Phillips-Perron Unit Root Test on US_FDI

Phillips-Perron statistic value is 0.074250 and one sided p-value is 0.6997. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value is not greater than any absolute critical value, thus we failed to reject the null hypothesis US_FDI has a unit root or US_FDI is non-stationary, meaning US_FDI has a unit root therefore it is non-stationary.

Since all the variables are non-stationary except for LUS_Y, 1^{st} differencing of these non-stationary variables will be used to check for stationarity.

Null Hypothesis: D(US_K) has a unit root
Exogenous: None
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.626792	0.0103
Test critical values:	1% level	-2.636901	
	5% level	-1.951332	
	10% level	-1.610747	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.350660
HAC corrected variance (Bartlett kernel)	0.210628

Figure 16: Phillips-Perron Unit Root Test on D(US_K)

Phillips-Perron statistic value is -2.626792 and one sided p-value is 0.0103. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is greater than absolute critical value at both 5% and 10%, thus we reject the null hypothesis D (US_K) has a unit root or D(US_K) is non-stationary, meaning D(US_K) has no unit root therefore it is stationary.

Null Hypothesis: D(US_L) has a unit root

Exogenous: None
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.059082	0.0033
Test critical values:	1% level	-2.636901	
	5% level	-1.951332	
	10% level	-1.610747	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.003530
HAC corrected variance (Bartlett kernel)	0.002500

Figure 17: Phillips-Perron Unit Root Test on D(US_L)

Phillips-Perron statistic value is -3.059082 and one sided p-value is 0.0033. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is greater than absolute critical value, thus we reject the null hypothesis D(US_L) has a unit root or D(US_L) is non-stationary, meaning D(US_L) has no unit root therefore it is stationary.

Null Hypothesis: D(US_S) has a unit root
Exogenous: None
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.988807	0.0000
Test critical values:	1% level	-2.636901	
	5% level	-1.951332	
	10% level	-1.610747	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.155965
HAC corrected variance (Bartlett kernel)	0.801564

Figure 18: Phillips-Perron Unit Root Test on D(US_S)

Phillips-Perron statistic value is -4.988807 and one sided p-value is 0.0000. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is greater than absolute critical value, thus we reject the null hypothesis D(US_S) has a unit root or D(US_S) is non-stationary, meaning D(US_S) has no unit root therefore it is stationary.

Null Hypothesis: D(US_TRADE) has a unit root
Exogenous: None
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.237641	0.0000
Test critical values:	1% level	-2.636901	
	5% level	-1.951332	
	10% level	-1.610747	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.447949
HAC corrected variance (Bartlett kernel)	2.437946

Figure 19: Phillips-Perron Unit Root Test on D(US_Trade)

Phillips-Perron statistic value is -6.237641 and one sided p-value is 0.0000. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is greater than absolute critical value, thus we reject the null hypothesis D(US_Trade) has a unit root or D(US_Trade) is non-stationary, meaning D(US_Trade) has no unit root therefore it is stationary.

Null Hypothesis: D(US_FDI) has a unit root
Exogenous: None
Bandwidth: 15 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.094910	0.0000
Test critical values:	1% level	-2.636901	
	5% level	-1.951332	
	10% level	-1.610747	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.378697
HAC corrected variance (Bartlett kernel)	0.114180

Figure 20: Phillips-Perron Unit Root Test on D(US_FDI)

Phillips-Perron statistic value is -7.094910 and one sided p-value is 0.0000. Based on the critical values provided at 1%, 5% and 10% levels, the calculated t value in absolute term is greater than absolute critical value, thus we reject the null hypothesis D(US_FDI) has a unit root or D(US_FDI) is non-stationary, meaning D(US_FDI) has no unit root therefore it is stationary. Since the 1^{st} difference of variables US_K, US_L, US_S, US_Trade and US_FDI are stationary, D(US_K), D(US_L), D(US_S), D(US_Trade) and D(US_FDI) will be used in the OLS regression for U.S. model.

Ordinary Least Square (OLS) Regression Results

China.

LChina_Y = 0.404933369153 + 0.00432475183731*China_K - 0.0597125396966*China_L + 0.00397961292061*DChina_S - 0.000368030530241*DChina_Trade + 0.00267408727574*DChina_FDI + 0.942709693083*LChina_Y(-1)

Dependent Variable: LCHINA_Y
Method: Least Squares
Sample (adjusted): 1983 2016
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.404933	0.101485	3.990084	0.0005
CHINA_K	0.004325	0.001178	3.671334	0.0010
CHINA_L	-0.059713	0.023498	-2.541170	0.0171
DCHINA_S	0.003980	0.002310	1.722962	0.0963
DCHINA_TRADE	-0.000368	0.000916	-0.401868	0.6909
DCHINA_FDI	0.002674	0.004298	0.622197	0.5390
LCHINA_Y(-1)	0.942710	0.012337	76.41059	0.0000

R-squared	0.999692	Mean dependent var	7.474667
Adjusted R-squared	0.999624	S.D. dependent var	0.852334
S.E. of regression	0.016532	Akaike info criterion	-5.185838
Sum squared resid	0.007379	Schwarz criterion	-4.871587
Log likelihood	95.15924	Hannan-Quinn criter.	-5.078669
F-statistic	14615.58	Durbin-Watson stat	1.398982
Prob(F-statistic)	0.000000		

Figure 21: OLS Regression for China

From Figure 21 above, we can see that variables China_K, China_L, and lChina_Y(-1) are statistically significant at 5% and DChina_S is statistically significant at 10% based on the p-value. Based on the regression analysis, when change in all other independent variables are 0, GDP per capita growth (LChina_Y) will change by 0.404933%. For every 1% increase in capital, GDP per capita in China will increase by 0.004325%. For every 1% increase in labor, GDP per capita in China will decrease by 0.059713%. For every 1% increase in saving, GDP per capita in China will increase by 0.003980%. For every 1% increase in trade, GDP per capita in China will decrease by 0.000368%. For every 1% increase in FDI, GDP per capita in China will increase by 0.002674%. For every 1% increase in last year GDP per capita, this year GDP per capita will increase by 0.942710%. R^2 statistic measures the success of the regression in prediction the values of the dependent variable within the sample. R^2 will equal to 1 if the regression model fits perfectly (Eviews). In this case. R^2 is 0.999692 meaning that 99.97% variation in LChina_Y or GDP per capita can be explained by intendent variables capital, labor, saving, trade, FDI and last year GDP per capita (Figure 22). Standard error of regression is the summary measure based on estimated variance of the residuals (Eviews). Smaller values of S.E. of regression is preferred. In this model, S.E. of regression is 0.016532 or 1.6532%. Akaike info criterion (AIC) is often used in model selection, it needs to be as small as possible because smaller the values, better fit the model. In this model, AIC is -5.1858. The result of this estimation is shown in Figure 22 below:

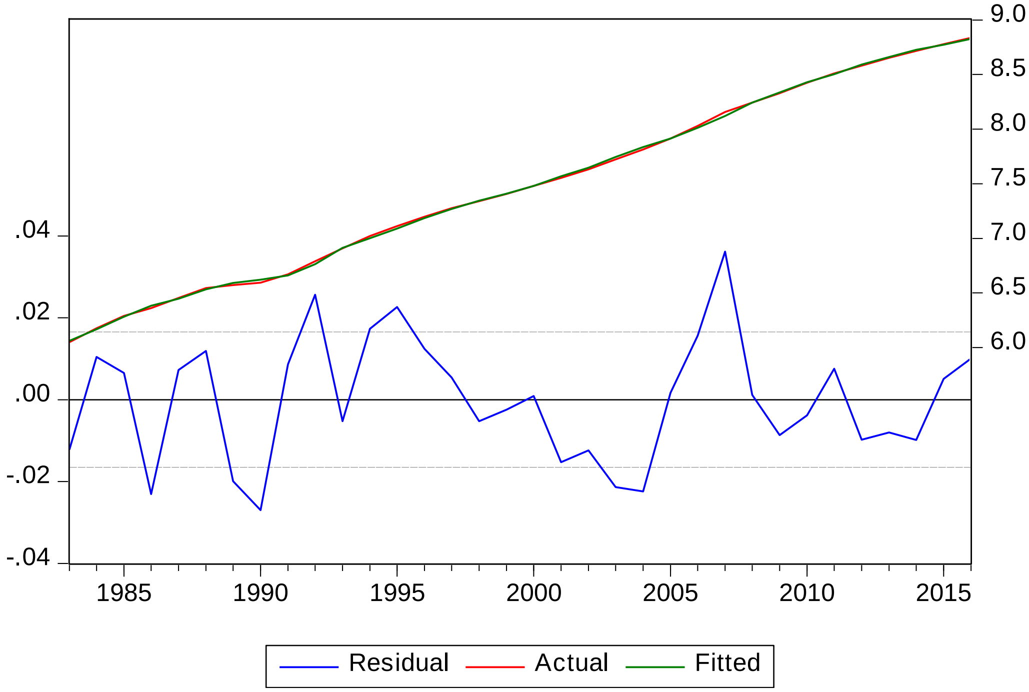

Figure 22: Actual, Fitted, Residual graph-China

U.S.

LUS_Y = 0.507575727447 + 0.0142110607548*D(US_K) - 0.0285837840245*D(US_L) - 0.000299043169509*D(US_S) + 0.000583814796331*D(US_Trade) + 0.00614646491008*D(US_FDI) + 0.953976981603*LUS_Y(-1)

Dependent Variable: LUS_Y
Method: Least Squares
Sample (adjusted): 1983 2016
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.507576	0.087040	5.831505	0.0000
D(US_K)	0.014211	0.002674	5.313766	0.0000
D(US_L)	-0.028584	0.021561	-1.325696	0.1960
D(US_S)	-0.000299	0.001494	-0.200192	0.8428
D(US_TRADE)	0.000584	0.001032	0.565492	0.5764
D(US_FDI)	0.006146	0.002725	2.255279	0.0324
LUS_Y(-1)	0.953977	0.008195	116.4088	0.0000

R-squared	0.998151	Mean dependent var	10.64519
Adjusted R-squared	0.997740	S.D. dependent var	0.168396
S.E. of regression	0.008005	Akaike info criterion	-6.636155
Sum squared resid	0.001730	Schwarz criterion	-6.321904
Log likelihood	119.8146	Hannan-Quinn criter.	-6.528986
F-statistic	2429.140	Durbin-Watson stat	1.712421
Prob(F-statistic)	0.000000		

Figure 23: OLS Regression for U.S.

From Figure 23 above, we can see that variables D(US_K), D(US_FDI), and LUS_Y(-1) are statistically significant at 5% based on the p-value. Based on the regression analysis, when change in all other independent variables are 0, GDP per capita growth (LUS_Y) will change by 0.507576%. For every 1% increase in capital, GDP per capita in China will increase by 0.014211%. For every 1% increase in labor, GDP per capita in China will decrease by 0.028584. For every 1% increase in saving, GDP per capita in China will decrease by 0.000299. For every 1% increase in trade, GDP per capita in China will increase by 0.000584%. For every 1% increase in FDI, GDP per capita in China will increase by 0.006146%. For every 1% increase in last year GDP per capita, this year GDP per capita will increase by 0.953977%. R^2 is 0.998151 meaning that 99.82% variation in LUS_Y or GDP per capita can be explained by intendent variables capital, labor, saving, trade, FDI and last year GDP per capita (Figure 24). In this U.S.

model, S.E. of regression is 0.008005 or 0.8005%. Akaike info criterion (AIC) is -6.636155. The result of this estimation is presented below:

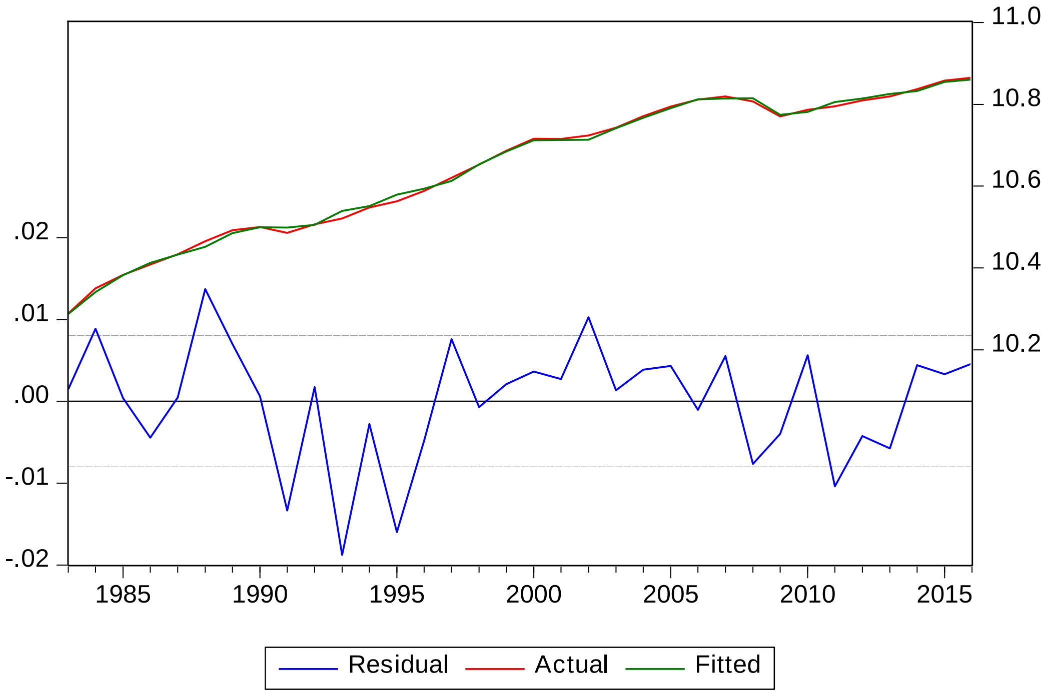

Figure 24: Actual, Fitted, Residual graph-U.S.

Vector Autoregression (VAR)

China. Before using VAR to forecast the growth of GDP per capita, each independent variable needs to be forecasted individually from 2017 to 2037 using univariate models-Automatic ARIMA Forecasting (*Figure 25*).

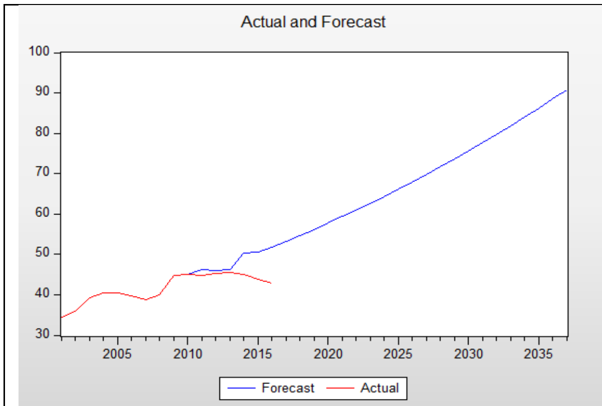

Figure a: Automatic ARIMA Forecasting-capital

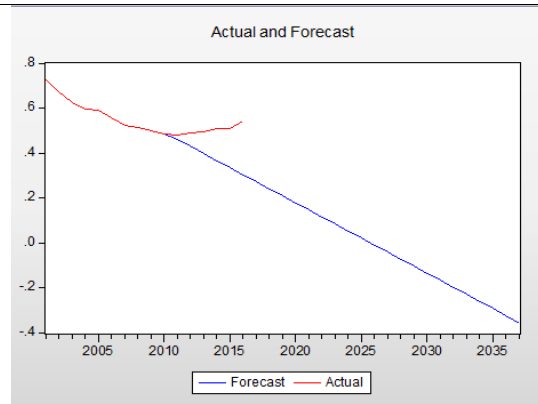

Figure b: Automatic ARIMA Forecasting-labor

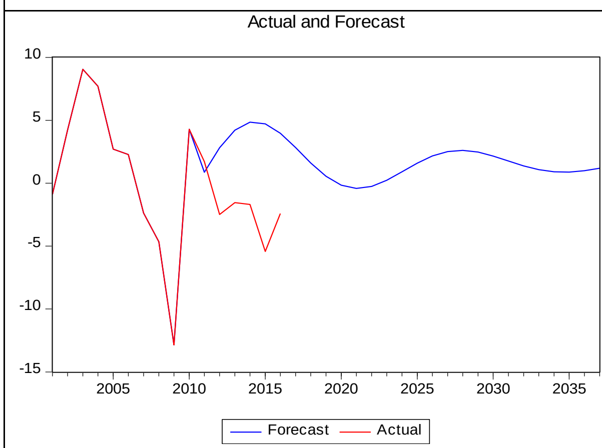

Figure c: Automatic ARIMA Forecasting-Trade

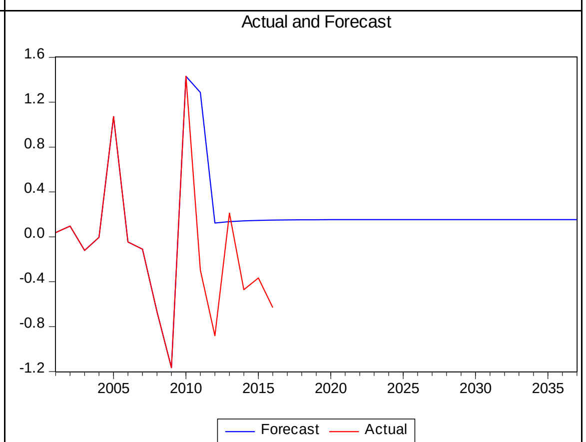

Figure d: Automatic ARIMA Forecasting-FDIq

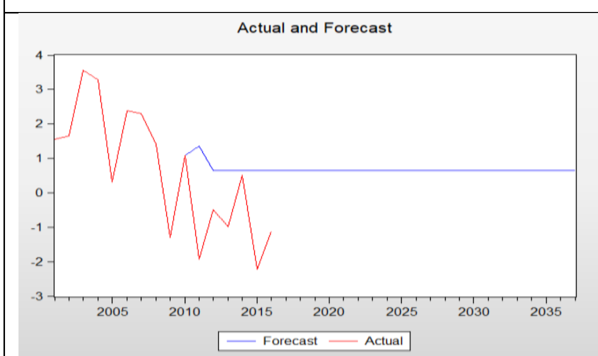

Figure e: Automatic ARIMA Forecasting-S

Figure 25: Automatic ARIMA forecasting for each variable

Table 2 provides the Automatic ARIMA forecasting for each variable in China during the period of 2017 to 2037.

Table 2

Automatic ARIMA Forecasting for each Variable - China

Year	K	L	S	Trade	FDI
2017	53.25342	0.560261	0.646162	-10.8916	-0.62937
2018	54.71409	0.565967	0.646162	-5.35498	0.808162
2019	56.21858	0.574072	0.646162	-7.65659	-0.53051
2020	57.76689	0.583197	0.646162	-8.9229	-1.52466
2021	59.35902	0.593827	0.646162	-6.59502	-0.83672
2022	60.99496	0.602325	0.646162	-6.33634	-0.6159
2023	62.67472	0.595805	0.646162	-7.92129	-0.84485
2024	64.3983	0.571657	0.646162	-5.14439	-0.58515
2025	66.1657	0.540857	0.646162	-4.12075	-0.36751
2026	67.97692	0.515303	0.646162	-5.02299	-0.45338
2027	69.83195	0.493204	0.646162	-5.97799	-0.755
2028	71.7308	0.468313	0.646162	-5.80141	-0.8053
2029	73.67347	0.443909	0.646162	-5.39416	-0.62411
2030	75.65995	0.424921	0.646162	-4.9529	-0.57898
2031	77.69026	0.408554	0.646162	-4.65915	-0.71562
2032	79.76438	0.391238	0.646162	-4.63989	-0.75598
2033	81.88232	0.37466	0.646162	-5.03695	-0.70936
2034	84.04407	0.359758	0.646162	-5.29722	-0.72444
2035	86.24965	0.343969	0.646162	-5.15048	-0.74742
2036	88.49904	0.3273	0.646162	-5.03312	-0.68997
2037	90.79225	0.313455	0.646162	-5.25968	-0.65716

VAR result – China. After forecasting each independent variable individually from period 2017-2037 using the univariate models-Automatic ARIMA, VAR can be used to forecast the growth of GDP per capita. VAR gets the best result using 3 lags in this model.

Vector Autoregression Estimates
Sample (adjusted): 1986 2016
Included observations: 31 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LCHINA_Y	CHINA_K	CHINA_L	DCHINA_S	DCHINA_TRADE	DCHINA_FDI
LCHINA_Y(-1)	1.562787	30.58983	-0.070558	-13.06959	-51.31473	21.74305
	(0.24073)	(34.3725)	(0.47275)	(25.7032)	(51.0797)	(11.4095)
	[6.49199]	[0.88995]	[-0.14925]	[-0.50848]	[-1.00460]	[1.90570]
LCHINA_Y(-2)	-1.313247	-25.43024	0.515548	-45.10676	-164.7801	-48.78044
	(0.35433)	(50.5933)	(0.69584)	(37.8329)	(75.1848)	(16.7938)
	[-3.70632]	[-0.50264]	[0.74090]	[-1.19226]	[-2.19167]	[-2.90467]
LCHINA_Y(-3)	0.728091	5.975677	-0.428718	49.14440	186.4742	26.92600
	(0.20691)	(29.5435)	(0.40633)	(22.0922)	(43.9035)	(9.80658)
	[3.51894]	[0.20227]	[-1.05509]	[2.22451]	[4.24736]	[2.74571]
CHINA_K(-1)	-0.001250	0.358465	0.000487	0.024470	0.794226	0.173555
	(0.00256)	(0.36573)	(0.00503)	(0.27349)	(0.54350)	(0.12140)
	[-0.48796]	[0.98014]	[0.09691]	[0.08947]	[1.46133]	[1.42963]
CHINA_K(-2)	-0.003505	-0.378160	0.003976	-0.163183	0.638363	0.026249
	(0.00254)	(0.36250)	(0.00499)	(0.27107)	(0.53870)	(0.12033)
	[-1.38061]	[-1.04320]	[0.79753]	[-0.60199]	[1.18501]	[0.21815]
CHINA_K(-3)	0.000577	-0.353660	-0.001290	0.370891	-0.347409	-0.058893
	(0.00237)	(0.33861)	(0.00466)	(0.25321)	(0.50320)	(0.11240)
	[0.24344]	[-1.04444]	[-0.27702]	[1.46475]	[-0.69040]	[-0.52397]
CHINA_L(-1)	0.130648	34.86050	2.005399	-11.70603	-50.67458	-2.199638
	(0.15439)	(22.0453)	(0.30320)	(16.4851)	(32.7606)	(7.31763)
	[0.84621]	[1.58132]	[6.61403]	[-0.71010]	[-1.54681]	[-0.30059]
CHINA_L(-2)	-0.246706	-49.53028	-1.536091	5.970469	50.95461	0.169632
	(0.19078)	(27.2406)	(0.37466)	(20.3701)	(40.4813)	(9.04216)
	[-1.29316]	[-1.81825]	[-4.09997]	[0.29310]	[1.25872]	[0.01876]
CHINA_L(-3)	0.002939	17.69254	0.589470	-9.158171	-40.86787	5.081405
	(0.10236)	(14.6158)	(0.20102)	(10.9295)	(21.7200)	(4.85153)
	[0.02871]	[1.21051]	[2.93238]	[-0.83793]	[-1.88158]	[1.04738]
DCHINA_S(-1)	9.24E-05	0.164590	-4.78E-05	0.225385	-0.031406	0.134467
	(0.00302)	(0.43082)	(0.00593)	(0.32216)	(0.64022)	(0.14300)
	[0.03062]	[0.38204]	[-0.00807]	[0.69961]	[-0.04905]	[0.94030]
DCHINA_S(-2)	-0.001418	0.240955	0.002046	0.027571	-0.209037	-0.040700
	(0.00256)	(0.36520)	(0.00502)	(0.27309)	(0.54271)	(0.12122)
	[-0.55457]	[0.65979]	[0.40730]	[0.10096]	[-0.38517]	[-0.33574]
DCHINA_S(-3)	0.007090	0.288826	0.001189	0.143171	-0.123494	0.199995
	(0.00275)	(0.39300)	(0.00541)	(0.29388)	(0.58402)	(0.13045)
	[2.57608]	[0.73493]	[0.21989]	[0.48718]	[-0.21146]	[1.53312]

DCHINA_TRADE(-1)	-0.001351	0.059568	-0.000334	-0.176913	-0.364817	-0.072378
	(0.00126)	(0.17935)	(0.00247)	(0.13412)	(0.26653)	(0.05953)
	[-1.07560]	[0.33213]	[-0.13525]	[-1.31910]	[-1.36877]	[-1.21576]
DCHINA_TRADE(-2)	0.000196	-0.045616	0.001589	0.080285	0.006012	0.090593
	(0.00103)	(0.14679)	(0.00202)	(0.10976)	(0.21813)	(0.04872)
	[0.19020]	[-0.31077]	[0.78720]	[0.73143]	[0.02756]	[1.85932]
DCHINA_TRADE(-3)	-0.000992	-0.115103	-0.001814	-0.051513	-0.149898	-0.028237
	(0.00115)	(0.16360)	(0.00225)	(0.12234)	(0.24313)	(0.05431)
	[-0.86593]	[-0.70355]	[-0.80627]	[-0.42106]	[-0.61655]	[-0.51997]
DCHINA_FDI(-1)	0.011459	-0.275612	0.002780	1.077751	1.318046	-0.324209
	(0.00634)	(0.90597)	(0.01246)	(0.67747)	(1.34632)	(0.30072)
	[1.80606]	[-0.30422]	[0.22310]	[1.59085]	[0.97900]	[-1.07810]
DCHINA_FDI(-2)	0.007050	-0.208719	-0.021089	0.021522	-0.217726	-0.659938
	(0.00479)	(0.68435)	(0.00941)	(0.51175)	(1.01699)	(0.22716)
	[1.47101]	[-0.30499]	[-2.24056]	[0.04206]	[-0.21409]	[-2.90514]
DCHINA_FDI(-3)	0.007521	0.578654	0.005376	0.209563	1.212778	-0.078012
	(0.00538)	(0.76812)	(0.01056)	(0.57439)	(1.14147)	(0.25497)
	[1.39800]	[0.75334]	[0.50890]	[0.36485]	[1.06247]	[-0.30597]
C	0.520518	-37.60620	-0.340146	78.26918	239.4548	-6.927899
	(0.31130)	(44.4497)	(0.61135)	(33.2388)	(66.0551)	(14.7545)
	[1.67207]	[-0.84604]	[-0.55639]	[2.35475]	[3.62508]	[-0.46954]
R-squared	0.999868	0.956306	0.997970	0.665266	0.817701	0.769261
Adj. R-squared	0.999669	0.890764	0.994925	0.163165	0.544252	0.423151
Sum sq. resids	0.002432	49.58356	0.009379	27.72625	109.4995	5.463221
S.E. equation	0.014236	2.032723	0.027957	1.520040	3.020754	0.674736
F-statistic	5031.469	14.59082	327.7421	1.324966	2.990328	2.222595
Log likelihood	102.5350	-51.26701	81.61289	-42.25717	-63.54705	-17.07989
Akaike AIC	-5.389354	4.533356	-4.039541	3.952076	5.325616	2.327735
Schwarz SC	-4.510459	5.412251	-3.160646	4.830971	6.204511	3.206630
Mean dependent	7.600778	36.81606	0.875276	0.338538	0.526483	0.033080
S.D. dependent	0.782242	6.150286	0.392446	1.661633	4.474589	0.888388

Determinant resid covariance (dof adj.)	3.50E-07
Determinant resid covariance	1.18E-09
Log likelihood	54.76386
Akaike information criterion	3.821686
Schwarz criterion	9.095059
Number of coefficients	114

Figure 26: VAR estimation - China

Error terms can also be called innovations, impulses and shocks and impulse response function is a shock to a VAR system. It identifies the responsiveness of the endogenous variable in VAR when 1 standard deviation or 1 unit of shock is applied to an error term. In impulse response function, all variables are assumed to be endogenous and it allows us to see the effect on VAR when a unit of shock is applied to each variable (Hossain Academy).

As shown in Figure 27 and Figure 39, when one unit of shock is applied to capital (K) or when K increases by one basis point, the growth of GDP per capita in China doesn’t change much in both short-run and long-run. When one shock is applied to labor (L) or when L increases by one basis point, the growth of GDP per capita increases marginally in the short-run, the first 4 years; but then it decreases in the long-run. It is consistent with the negative coefficient of labor in the OLS regression for China (Figure 21). When 1 standard deviation is given to saving, the growth of GDP per capita decreases marginal in the short-run, the first 2 or 3 years, then increases at a decreasing rate in the long-run. For every unit of shock applied to trade, the growth of GDP per capita decreases in a decreasing rate in both short-run and long-run then eventually grow marginally above 0%. When 1 shock is applied to FDI, the growth of GDP per capita increases in a decreasing rate in both short-run and long-run and eventually growth close to 0%.

Impulse Response Function

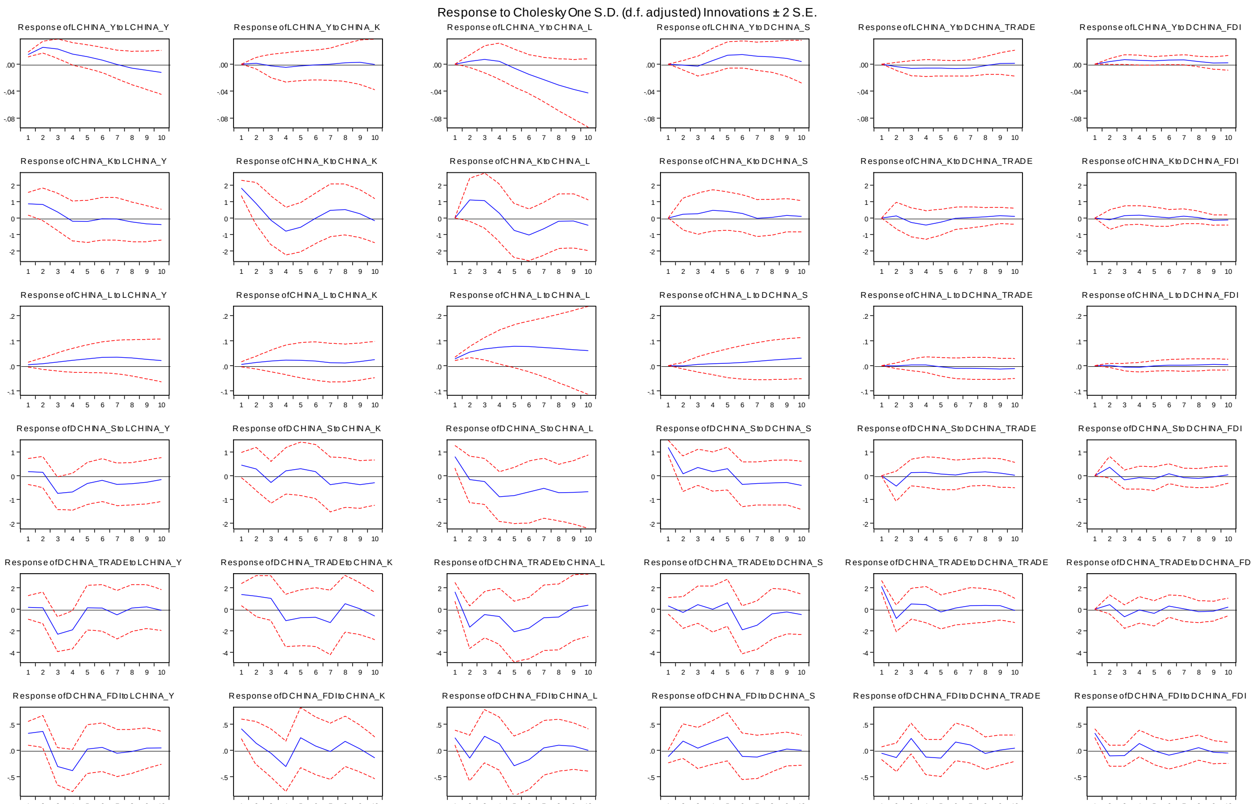

Figure 27: Impulse Response Function- Response to Cholesky One S.D. Innovations +/- 2 S.E - China

Table 3 provides the forecasting for the growth of GDP per capita in China during the period 2017-2037 using VAR model.

Table 3

VAR Forecasting - LChina_Y

Year	LChina_y
2017	8.89707
2018	8.949625
2019	8.997909
2020	9.03837
2021	9.073511
2022	9.107739
2023	9.141434
2024	9.172424
2025	9.20167
2026	9.231328
2027	9.261102
2028	9.289626
2029	9.317516
2030	9.345693
2031	9.373399
2032	9.400007
2033	9.426513
2034	9.453649
2035	9.480768
2036	9.507409
2037	9.533988

Table 4 provides the forecasting for variables capital, labor, saving, trade and FDI in 2017-2037 using multivariate model-VAR.

Table 4

VAR Forecasting-China

Year	K	L	S	Trade	FDI	lChina_Y
2017	45.95783	0.507654	-3.15049	-4.45677	-0.22614	8.89707
2018	45.76182	0.510132	-3.31313	-5.26402	-0.54502	8.949625
2019	45.7374	0.511696	-3.67928	-5.77726	-0.69084	8.997909
2020	45.87083	0.511018	-4.01998	-6.15163	-0.63848	9.03837
2021	45.99804	0.509797	-4.27191	-6.13687	-0.60648	9.073511
2022	46.09868	0.505029	-4.3349	-5.3978	-0.62575	9.107739
2023	46.26279	0.494772	-4.48229	-5.16345	-0.61336	9.141434
2024	46.3513	0.482589	-4.63634	-5.47776	-0.5769	9.172424
2025	46.36265	0.47068	-4.71726	-5.73706	-0.6332	9.20167
2026	46.48395	0.456898	-4.72649	-5.6075	-0.69231	9.231328
2027	46.7737	0.441046	-4.78574	-5.49422	-0.65641	9.261102
2028	47.04352	0.426236	-4.86735	-5.56006	-0.62459	9.289626
2029	47.2006	0.413364	-4.90102	-5.55265	-0.6795	9.317516
2030	47.33979	0.400526	-4.89595	-5.42054	-0.72905	9.345693
2031	47.51379	0.387441	-4.91228	-5.46214	-0.71711	9.373399
2032	47.6723	0.375348	-4.93103	-5.64038	-0.71371	9.400007
2033	47.82965	0.363763	-4.92464	-5.6673	-0.74551	9.426513
2034	48.04602	0.351493	-4.92442	-5.58154	-0.75049	9.453649
2035	48.28813	0.339341	-4.95936	-5.63631	-0.72632	9.480768
2036	48.48252	0.328692	-5.00085	-5.7978	-0.73547	9.507409
2037	48.6476	0.319198	-5.02965	-5.88679	-0.77447	9.533988

Figure 28 presents the forecasting graph for all the variables in China using VAR.

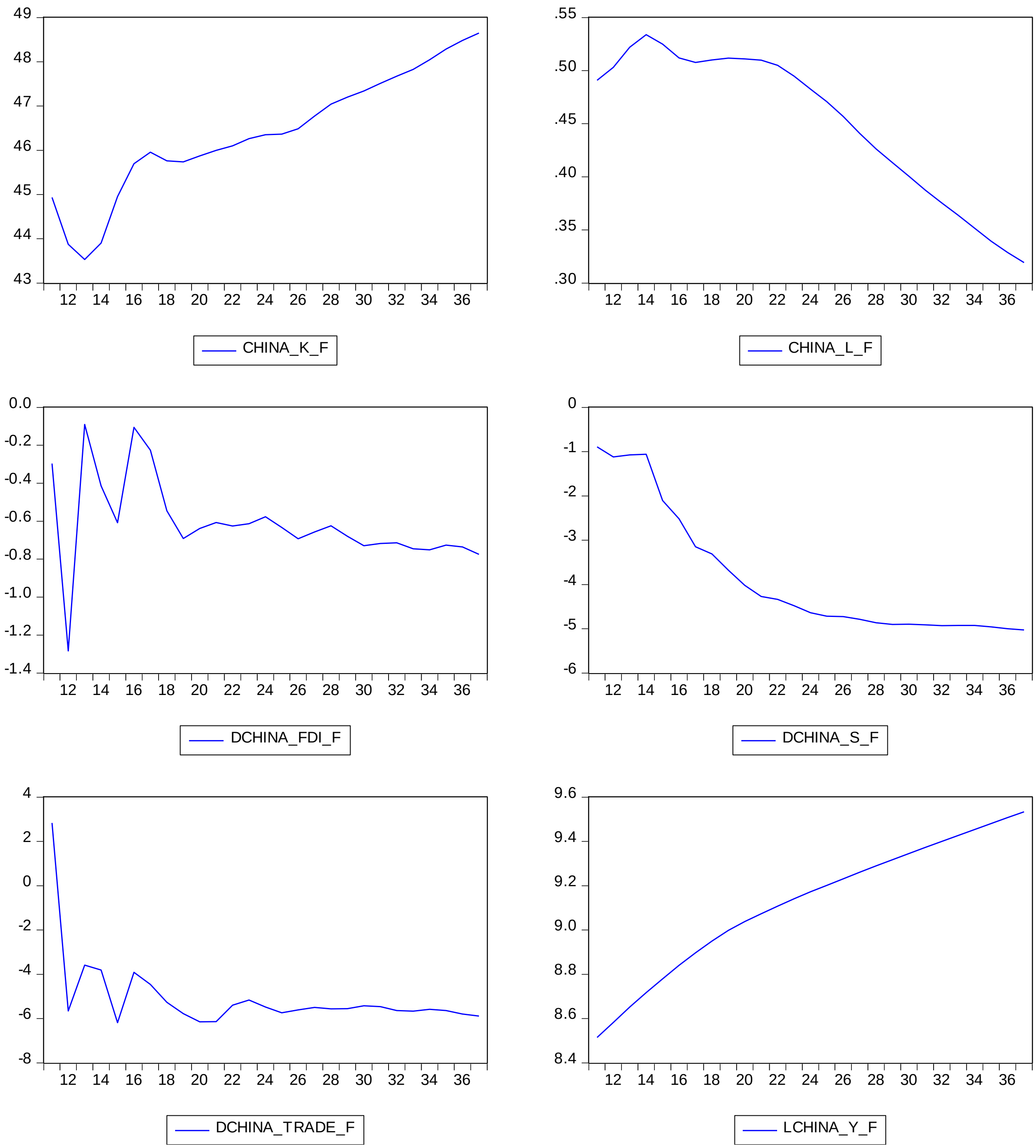

Figure 28: VAR forecasting graph – China

Figure 29 provides the summary table for VAR forecasting evaluation in China. This summary table includes Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Theil inequality coefficient (Theil).

Forecast Evaluation
Sample: 2011 2037
Included observations: 27

Variable	Inc. obs.	RMSE	MAE	MAPE	Theil
CHINA_K	6	1.688344	1.444355	3.242232	0.018961
CHINA_L	6	0.022707	0.021589	4.174450	0.022312
DCHINA_FDI	6	0.313410	0.254487	152.3514	0.273818
DCHINA_S	6	0.990150	0.802811	64.68835	0.333869
DCHINA_TRADE	6	1.949306	1.785903	43.14058	0.264595
LCHINA_Y	6	0.001438	0.000905	0.010491	8.28E-05

RMSE: Root Mean Square Error
MAE: Mean Absolute Error
MAPE: Mean Absolute Percentage Error
Theil: Theil inequality coefficient

Figure 29: VAR forecasting evaluation – China

U.S. The graph for each independent variable forecasting using univariate models-Automatic ARIMA from 2017 to 2037 can be seen below (Figure 30).

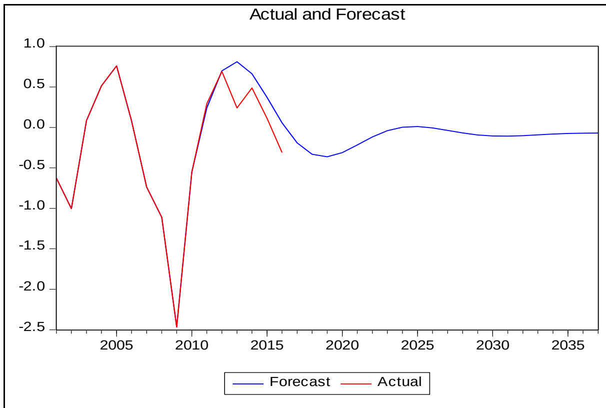

Figure a: Automatic ARIMA Forecasting-capital

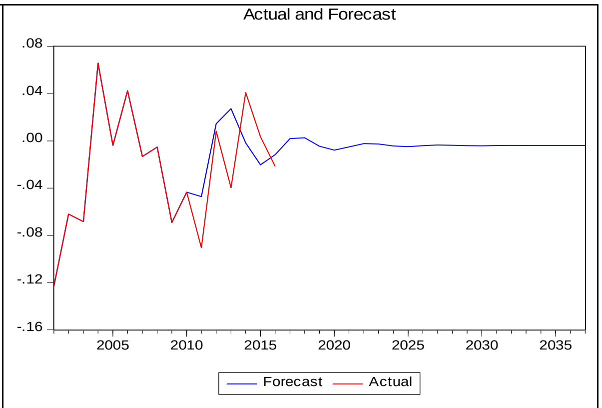

Figure b: Automatic ARIMA Forecasting- Labor

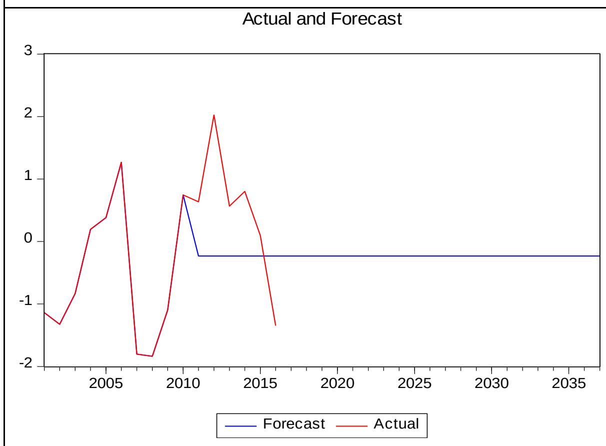

Figure c: Automatic ARIMA Forecasting-saving

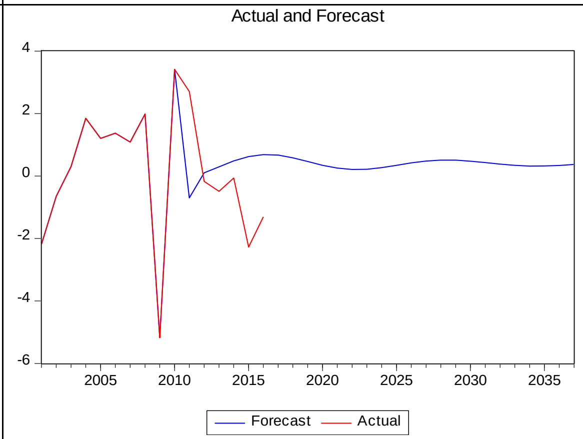

Figure d: Automatic ARIMA Forecasting-Trade

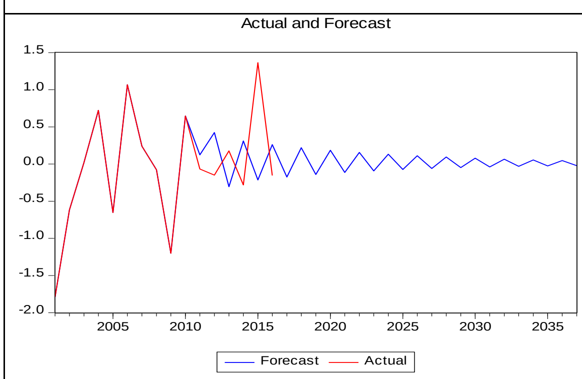

Figure e: Automatic ARIMA Forecasting-FDI

Figure 30: Automatic ARIMA forecasting for each variable – U.S.

Table 5 provides the Automatic ARIMA forecasting for each variable in U.S. during the period of 2017 to 2037.

Table 5

Automatic ARIMA Forecasting for each Variable – U.S.

Year	K	L	S	Trade	FDI
2017	-0.19117	0.002018	-0.23282	0.668491	-0.17394
2018	-0.3317	0.002719	-0.23282	0.584844	0.220346
2019	-0.36289	-0.00453	-0.23282	0.465313	-0.14067
2020	-0.31165	-0.0078	-0.23282	0.344616	0.1857
2021	-0.21736	-0.00511	-0.23282	0.252945	-0.11351
2022	-0.11782	-0.00223	-0.23282	0.209076	0.156611
2023	-0.04012	-0.00257	-0.23282	0.217289	-0.09141
2024	0.002854	-0.00429	-0.23282	0.268311	0.132126
2025	0.011206	-0.00479	-0.23282	0.343506	-0.0735
2026	-0.00616	-0.00404	-0.23282	0.42081	0.111452
2027	-0.0366	-0.00347	-0.23282	0.480698	-0.05905
2028	-0.06817	-0.00365	-0.23282	0.510688	0.093936
2029	-0.09246	-0.00404	-0.23282	0.507468	-0.04748
2030	-0.10558	-0.00409	-0.23282	0.476451	0.079036
2031	-0.10774	-0.0039	-0.23282	0.42921	-0.03829
2032	-0.10189	-0.00379	-0.23282	0.379752	0.066301
2033	-0.09207	-0.00386	-0.23282	0.340688	-0.03107
2034	-0.08206	-0.00394	-0.23282	0.320295	0.055361
2035	-0.07448	-0.00394	-0.23282	0.321055	-0.02549
2036	-0.07048	-0.00389	-0.23282	0.339842	0.045907
2037	-0.06995	-0.00388	-0.23282	0.36948	-0.02125

VAR result – U.S. After forecasting each independent variable individually from period 2017-2037 using the univariate models-Automatic ARIMA, VAR can be used to forecast the growth of GDP per capita. 3 lags were chosen to achieve the minimum AIC in this model.

Vector Autoregression Estimates
Sample (adjusted): 1986 2016
Included observations: 31 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LUS_Y	DUS_K	DUS_L	DUS_S	DUS_TRADE	DUS_FDI
LUS_Y(-1)	0.965770	-1.601031	1.441563	-20.88491	8.984832	-8.025883
	(0.38327)	(14.3231)	(1.87951)	(23.2899)	(51.8962)	(21.4148)
	[2.51982]	[-0.11178]	[0.76699]	[-0.89674]	[0.17313]	[-0.37478]
LUS_Y(-2)	0.169117	-15.50974	2.263729	-9.004342	24.32398	17.60754
	(0.60441)	(22.5874)	(2.96396)	(36.7279)	(81.8397)	(33.7709)
	[0.27980]	[-0.68665]	[0.76375]	[-0.24516]	[0.29721]	[0.52138]
LUS_Y(-3)	-0.178459	15.83263	-3.662017	25.70339	-34.21965	-9.677405
	(0.39520)	(14.7689)	(1.93800)	(24.0147)	(53.5113)	(22.0813)
	[-0.45157]	[1.07202]	[-1.88958]	[1.07032]	[-0.63948]	[-0.43826]
DUS_K(-1)	0.006068	0.558715	-0.061791	0.245529	-0.468460	0.675688
	(0.00986)	(0.36847)	(0.04835)	(0.59914)	(1.33504)	(0.55090)
	[0.61542]	[1.51632]	[-1.27796]	[0.40980]	[-0.35090]	[1.22652]
DUS_K(-2)	-0.002523	0.293083	-0.032886	0.805707	-0.207927	-0.874128
	(0.01075)	(0.40158)	(0.05270)	(0.65298)	(1.45503)	(0.60041)
	[-0.23482]	[0.72982]	[-0.62406]	[1.23389]	[-0.14290]	[-1.45588]
DUS_K(-3)	0.004861	-0.264208	-0.029116	-0.919442	-0.123953	0.776856
	(0.00696)	(0.26003)	(0.03412)	(0.42282)	(0.94215)	(0.38878)
	[0.69856]	[-1.01607]	[-0.85331]	[-2.17456]	[-0.13156]	[1.99821]
DUS_L(-1)	-0.043141	-0.879810	0.261954	-6.403708	-6.184850	1.605528
	(0.04669)	(1.74497)	(0.22898)	(2.83738)	(6.32246)	(2.60894)
	[-0.92391]	[-0.50420]	[1.14401]	[-2.25691]	[-0.97824]	[0.61539]
DUS_L(-2)	0.010704	-0.086827	0.180754	2.178735	2.696011	-1.735658
	(0.05255)	(1.96377)	(0.25769)	(3.19315)	(7.11522)	(2.93607)
	[0.20370]	[-0.04421]	[0.70144]	[0.68231]	[0.37891]	[-0.59115]
DUS_L(-3)	-0.006085	-0.989386	-0.303986	-6.536003	-2.533948	2.821545
	(0.04348)	(1.62490)	(0.21322)	(2.64213)	(5.88739)	(2.42941)
	[-0.13995]	[-0.60889]	[-1.42568]	[-2.47376]	[-0.43040]	[1.16141]
DUS_S(-1)	0.008462	0.176811	0.020717	0.440858	0.356823	0.237694
	(0.00346)	(0.12935)	(0.01697)	(0.21032)	(0.46866)	(0.19339)
	[2.44469]	[1.36694]	[1.22060]	[2.09610]	[0.76137]	[1.22909]
DUS_S(-2)	-0.000677	0.074089	0.008779	-0.353660	-0.287210	0.106016
	(0.00274)	(0.10231)	(0.01343)	(0.16636)	(0.37070)	(0.15297)
	[-0.24718]	[0.72415]	[0.65388]	[-2.12585]	[-0.77478]	[0.69306]
DUS_S(-3)	-0.001518	-0.047416	0.018214	0.324270	-0.580803	-0.065097
	(0.00297)	(0.11106)	(0.01457)	(0.18059)	(0.40240)	(0.16605)
	[-0.51064]	[-0.42694]	[1.24981]	[1.79564]	[-1.44336]	[-0.39203]

DUS_TRADE(-1)	-0.004682	-0.131127	0.001087	0.042061	-0.244310	-0.236993
	(0.00210)	(0.07847)	(0.01030)	(0.12759)	(0.28430)	(0.11732)
	[-2.22983]	[-1.67113]	[0.10555]	[0.32967]	[-0.85934]	[-2.02013]
DUS_TRADE(-2)	-0.001710	-0.139187	0.004387	-0.170601	-0.086267	0.089623
	(0.00278)	(0.10406)	(0.01365)	(0.16920)	(0.37702)	(0.15557)
	[-0.61410]	[-1.33763]	[0.32130]	[-1.00830]	[-0.22881]	[0.57607]
DUS_TRADE(-3)	-0.000982	-0.020803	0.016030	0.136192	0.739727	0.005461
	(0.00241)	(0.09009)	(0.01182)	(0.14648)	(0.32641)	(0.13469)
	[-0.40747]	[-0.23093]	[1.35606]	[0.92975]	[2.26628]	[0.04055]
DUS_FDI(-1)	-0.000332	-0.095616	-0.026996	-0.232281	0.458354	-0.160968
	(0.00519)	(0.19395)	(0.02545)	(0.31537)	(0.70273)	(0.28998)
	[-0.06399]	[-0.49299]	[-1.06071]	[-0.73653]	[0.65225]	[-0.55510]
DUS_FDI(-2)	-0.004548	-0.082232	-0.021589	0.476614	0.219862	-0.147570
	(0.00573)	(0.21412)	(0.02810)	(0.34817)	(0.77581)	(0.32013)
	[-0.79375]	[-0.38405]	[-0.76837]	[1.36893]	[0.28340]	[-0.46096]
DUS_FDI(-3)	-0.009355	-0.319557	-0.065310	-0.523293	-1.914931	-0.670190
	(0.00596)	(0.22290)	(0.02925)	(0.36244)	(0.80761)	(0.33326)
	[-1.56845]	[-1.43365]	[-2.23290]	[-1.44381]	[-2.37110]	[-2.01102]
C	0.481373	13.97454	-0.567042	45.30031	8.972457	1.253447
	(0.27750)	(10.3706)	(1.36085)	(16.8629)	(37.5752)	(15.5053)
	[1.73465]	[1.34751]	[-0.41668]	[2.68639]	[0.23879]	[0.08084]
R-squared	0.997467	0.853410	0.747784	0.816663	0.621155	0.595147
Adj. R-squared	0.993667	0.633525	0.369460	0.541658	0.052887	-0.012132
Sum sq. resids	0.001587	2.216069	0.038159	5.859228	29.09222	4.953739
S.E. equation	0.011499	0.429735	0.056391	0.698762	1.557033	0.642504
F-statistic	262.4891	3.881162	1.976569	2.969631	1.093068	0.980023
Log likelihood	109.1535	-3.094184	59.86269	-18.16457	-43.00259	-15.56251
Akaike AIC	-5.816357	1.425431	-2.636303	2.397714	4.000167	2.229839
Schwarz SC	-4.937462	2.304327	-1.757407	3.276610	4.879062	3.108734
Mean dependent	10.67465	-0.133631	-0.004897	-0.074206	0.322765	0.070791
S.D. dependent	0.144494	0.709870	0.071015	1.032131	1.599915	0.638642

Determinant resid covariance (dof adj.)	2.63E-09
Determinant resid covariance	8.84E-12
Log likelihood	130.5870
Akaike information criterion	-1.070127
Schwarz criterion	4.203245
Number of coefficients	114

Figure 31: VAR estimation – U.S.

As shown in Figure 32 and Figure 40, when one unit of shock is applied to capital (K), the growth of GDP per capita in the U.S. doesn't increase much in the first 2 years but then it increases in a decreasing rate in the long run, compared to the response of growth of GDP per capita in China for one shock in capital, which doesn't change much in both short-run and long-run. When one shock is applied to labor (L) or when L increases by one basis point, the growth of GDP per capita decreases in the short-run and reach its minimum between year 4 and 5, then it increases after year 5 and eventually approaches to 0 in the long-run. When one standard deviation is given to saving, the growth of GDP per capita increases in a decreasing rate in the first 3 years, and it decreases at a decreasing rate between year 4 and 5, then it increases again in the long-run after year 5. For every unit of shock applied to trade, the growth of GDP per capita decreases in a decreasing rate in both short-run and long-run. When one shock is applied to FDI, the growth of GDP per capita stays the same for the first 2 years but decreases and then reaches its minimum in year 3 and half. The growth of GDP per capita was zero in year 5 for one shock in FDI, but then increases in a decreasing rate in the long-run.

Impulse Response Function

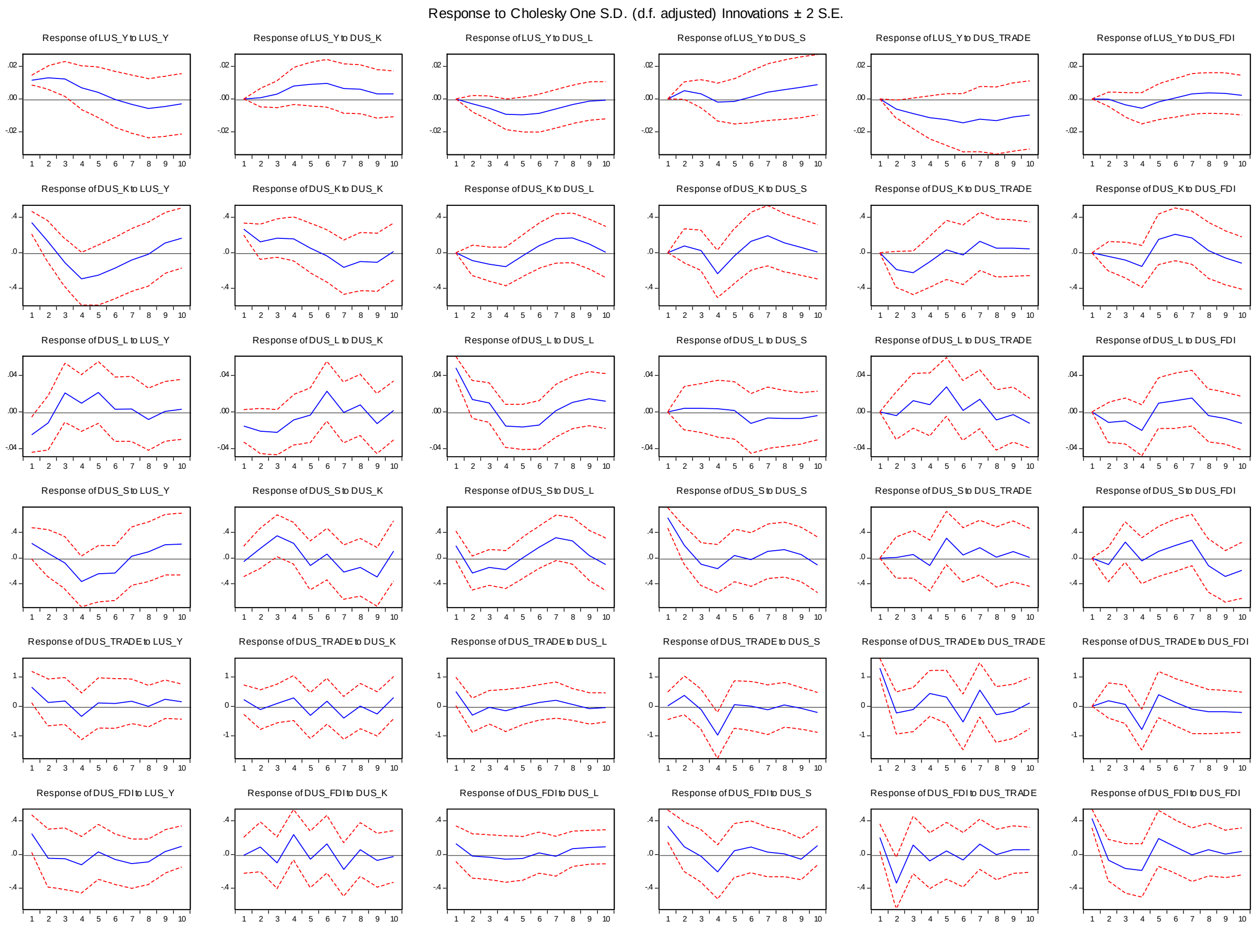

Figure 32: Impulse Response Function- Response to Cholesky One S.D. Innovations +/- 2 S.E – U.S.

Table 6 presents the forecasting for the growth of GDP per capita in U.S. during 2017-2037 using VAR model.

Table 6

VAR Forecasting -LUS_Y

Year	Lus_Y
2017	10.8853
2018	10.88994
2019	10.90686
2020	10.92344
2021	10.93922
2022	10.95165
2023	10.95726
2024	10.95418
2025	10.95293
2026	10.95444
2027	10.96125
2028	10.97456
2029	10.98803
2030	10.99724
2031	11.00041
2032	10.99904
2033	10.99637
2034	10.99877
2035	11.00652
2036	11.01824
2037	11.0306

Table 7 provides the forecasting for variables capital, labor, saving, trade and FDI in 2017-2037 using multivariate model-VAR

Table 7

VAR Forecasting- U.S.

Year	K	L	S	Trade	FDI	Lus_Y
2017	-0.64237	-0.14026	-0.73191	-0.03667	-0.37554	10.8853
2018	-0.68511	-0.15543	-0.64959	-2.08785	-0.66729	10.88994
2019	0.042295	-0.08003	-0.08329	0.643346	0.140341	10.90686
2020	0.510667	-0.01684	0.563189	1.212595	-0.05937	10.92344
2021	0.520467	0.018119	0.757122	-0.12742	0.051163	10.93922
2022	0.188326	-0.00966	-0.43954	-0.27678	0.305941	10.95165
2023	-0.16463	-0.03479	-1.06694	0.091289	0.216469	10.95726
2024	-0.67979	-0.09816	-1.22938	-1.12863	-0.09034	10.95418
2025	-0.73457	-0.1342	-0.94588	-0.36982	-0.33523	10.95293
2026	-0.41444	-0.13271	-0.36824	0.340211	-0.36504	10.95444
2027	-0.00443	-0.08973	0.253225	0.006171	-0.30144	10.96125
2028	0.419789	-0.03078	0.666883	0.688647	0.097435	10.97456
2029	0.53228	-0.00293	0.49842	0.621192	0.182553	10.98803
2030	0.24997	-0.01235	-0.11266	-0.30586	0.253528	10.99724
2031	-0.21708	-0.05801	-0.91231	-0.69568	0.167495	11.00041
2032	-0.53357	-0.10454	-1.11998	-0.52772	-0.0746	10.99904
2033	-0.62753	-0.1426	-0.89906	-0.75773	-0.31389	10.99637
2034	-0.34419	-0.13611	-0.35212	-0.17198	-0.32435	10.99877
2035	0.102211	-0.09682	0.248485	0.392375	-0.19654	11.00652
2036	0.420949	-0.04844	0.558238	0.310853	-0.02033	11.01824
2037	0.470714	-0.02099	0.322969	0.189588	0.206713	11.0306

Figure 33 presents the forecasting graph for all the variables in U.S. using VAR.

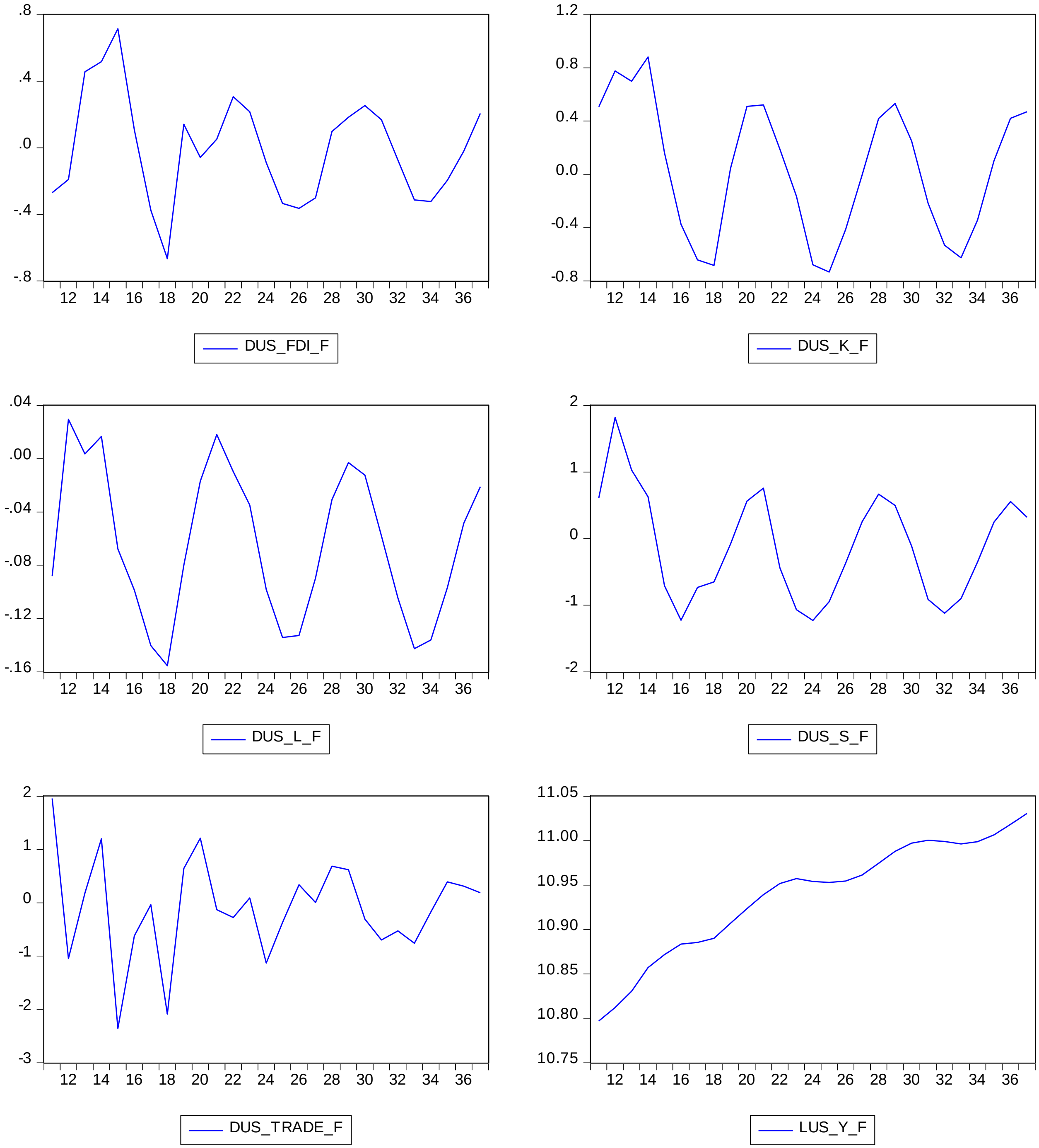

Figure 33: VAR forecasting – U.S.

Figure 34 provides the summary table for VAR forecasting evaluation in U.S. This summary table includes Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Theil inequality coefficient (Theil).

Forecast Evaluation
Sample: 2011 2037
Included observations: 27

Variable	Inc. obs.	RMSE	MAE	MAPE	Theil
DUS_FDI	6	0.456092	0.372562	108.0397	0.451448
DUS_K	6	0.266101	0.210741	35.11842	0.260781
DUS_L	6	0.048200	0.039924	271.7330	0.450421
DUS_S	6	0.398111	0.298892	35.21668	0.181517
DUS_TRADE	6	0.800981	0.721133	118.1592	0.268134
LUS_Y	6	0.013342	0.011297	0.104026	0.000616

RMSE: Root Mean Square Error
MAE: Mean Absolute Error
MAPE: Mean Absolute Percentage Error
Theil: Theil inequality coefficient

Figure 34: VAR forecasting evaluation – U.S.

Granger Causality Test

Figure 35 shows that at 5% statistics level, growth of GDP per capita (LChina_Y) in China does not granger cause capital (K), trade and FDI (0.0079 and 0.0550, 0.0157 respectively), it just means that the directional relationship or directional effect for variables K, trade and FDI is unidirectional from Y to capital, Y to trade and Y to FDI. Saving does not granger cause growth of GDP per capita at 5% (0.0315) means that the directional relationship for saving is unidirectional from saving to Y, which is consistent with the finding of Misztal (2011) and Krieckhaus (2002), a one-way, positive relationship between domestic saving and economic growth. Labor does not granger cause growth of GDP per capita at 10% (0.0757) meaning that the directional relationship for labor is also unidirectional from labor to Y.

China.

Pairwise Granger Causality Tests
Sample: 1982 2037
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
CHINA_K does not Granger Cause LCHINA_Y	32	0.70668	0.5571
LCHINA_Y does not Granger Cause CHINA_K		4.94417	0.0079
CHINA_L does not Granger Cause LCHINA_Y	32	2.58482	0.0757
LCHINA_Y does not Granger Cause CHINA_L		2.27750	0.1042
DCHINA_S does not Granger Cause LCHINA_Y	31	3.47962	0.0315
LCHINA_Y does not Granger Cause DCHINA_S		1.32782	0.2886
DCHINA_TRADE does not Granger Cause LCHINA_Y	31	1.25105	0.3134
LCHINA_Y does not Granger Cause DCHINA_TRADE		2.91363	0.0550
DCHINA_FDI does not Granger Cause LCHINA_Y	31	0.36955	0.7756
LCHINA_Y does not Granger Cause DCHINA_FDI		4.21833	0.0157
CHINA_L does not Granger Cause CHINA_K	32	4.27429	0.0144
CHINA_K does not Granger Cause CHINA_L		1.04796	0.3887
DCHINA_S does not Granger Cause CHINA_K	31	1.12411	0.3590
CHINA_K does not Granger Cause DCHINA_S		1.53624	0.2308
DCHINA_TRADE does not Granger Cause CHINA_K	31	0.41454	0.7441
CHINA_K does not Granger Cause DCHINA_TRADE		1.94483	0.1493
DCHINA_FDI does not Granger Cause CHINA_K	31	0.44483	0.7232
CHINA_K does not Granger Cause DCHINA_FDI		4.16923	0.0164
DCHINA_S does not Granger Cause CHINA_L	31	1.20803	0.3282
CHINA_L does not Granger Cause DCHINA_S		0.30533	0.8213
DCHINA_TRADE does not Granger Cause CHINA_L	31	0.29464	0.8289
CHINA_L does not Granger Cause DCHINA_TRADE		0.43474	0.7301
DCHINA_FDI does not Granger Cause CHINA_L	31	1.14169	0.3523
CHINA_L does not Granger Cause DCHINA_FDI		1.76061	0.1816
DCHINA_TRADE does not Granger Cause DCHINA_S	31	0.59843	0.6222
DCHINA_S does not Granger Cause DCHINA_TRADE		0.01785	0.9967
DCHINA_FDI does not Granger Cause DCHINA_S	31	0.44451	0.7234
DCHINA_S does not Granger Cause DCHINA_FDI		0.67923	0.5733
DCHINA_FDI does not Granger Cause DCHINA_TRADE	31	0.20754	0.8902
DCHINA_TRADE does not Granger Cause DCHINA_FDI		0.37976	0.7684

Figure 35: Granger Causality test-China

Figure 36 shows that at 5% statistics level, growth of GDP per capita (LUS_Y) in the U.S. does not granger cause capital (K), (0.0544), meaning that the directional relationship for variables K, is unidirectional from Y to capital instead of capital to Y. Saving does not granger cause growth of GDP per capita at 5% (0.0394) meaning that the directional relationship for saving is also unidirectional from saving to Y.

U.S.

Pairwise Granger Causality Tests
Sample: 1982 2037
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
DUS_K does not Granger Cause LUS_Y	31	1.17210	0.3410
LUS_Y does not Granger Cause DUS_K		2.92482	0.0544
DUS_L does not Granger Cause LUS_Y	31	1.29704	0.2983
LUS_Y does not Granger Cause DUS_L		1.09392	0.3708
DUS_S does not Granger Cause LUS_Y	31	1.99015	0.1423
LUS_Y does not Granger Cause DUS_S		0.10287	0.9576
DUS_TRADE does not Granger Cause LUS_Y	31	3.24941	0.0394
LUS_Y does not Granger Cause DUS_TRADE		0.85244	0.4790
DUS_FDI does not Granger Cause LUS_Y	31	1.38896	0.2702
LUS_Y does not Granger Cause DUS_FDI		0.59083	0.6270
DUS_L does not Granger Cause DUS_K	31	0.49888	0.6866
DUS_K does not Granger Cause DUS_L		0.95192	0.4313
DUS_S does not Granger Cause DUS_K	31	1.82131	0.1702
DUS_K does not Granger Cause DUS_S		2.35168	0.0975
DUS_TRADE does not Granger Cause DUS_K	31	4.14552	0.0168
DUS_K does not Granger Cause DUS_TRADE		0.77256	0.5207
DUS_FDI does not Granger Cause DUS_K	31	3.51525	0.0304
DUS_K does not Granger Cause DUS_FDI		2.00805	0.1397
DUS_S does not Granger Cause DUS_L	31	0.75222	0.5318
DUS_L does not Granger Cause DUS_S		1.51081	0.2371
DUS_TRADE does not Granger Cause DUS_L	31	0.66143	0.5838
DUS_L does not Granger Cause DUS_TRADE		0.22156	0.8805
DUS_FDI does not Granger Cause DUS_L	31	1.38551	0.2713
DUS_L does not Granger Cause DUS_FDI		0.03559	0.9908
DUS_TRADE does not Granger Cause DUS_S	31	0.68074	0.5724
DUS_S does not Granger Cause DUS_TRADE		2.82777	0.0599
DUS_FDI does not Granger Cause DUS_S	31	3.97793	0.0196
DUS_S does not Granger Cause DUS_FDI		2.02784	0.1368
DUS_FDI does not Granger Cause DUS_TRADE	31	2.89703	0.0559
DUS_TRADE does not Granger Cause DUS_FDI		1.07395	0.3788

Figure 36: Granger Causality test – U.S.

Table 8 provides the forecasting value for both China and U.S. in term of GDP per capita after taking the exponential of logarithm of China, exp(LChina_Y) and logarithm of U.S., exp(LChina_Y)

Table 8

Forecasting China_Y and US_Y

year	China-ydollars	U.S.-ydollars
2017	7310.522	53385.57
2018	7705.002	53634.07
2019	8086.161	54549.06
2020	8420.043	55461.13
2021	8721.188	56343.38
2022	9024.868	57048.01
2023	9334.138	57369.06
2024	9627.935	57192.38
2025	9913.672	57121.3
2026	10212.09	57207.26
2027	10520.72	57598.58
2028	10825.14	58369.9
2029	11131.3	59161.68
2030	11449.41	59709.06
2031	11771.06	59898.57
2032	12088.47	59816.4
2033	12413.17	59657.39
2034	12754.62	59800.31
2035	13105.25	60265.87
2036	13459.07	60976.06
2037	13821.6	61734.49

Figure 37 shows the actual (red line) and forecasted (blue line) GDP per capita in China from period 1982 to 2037.

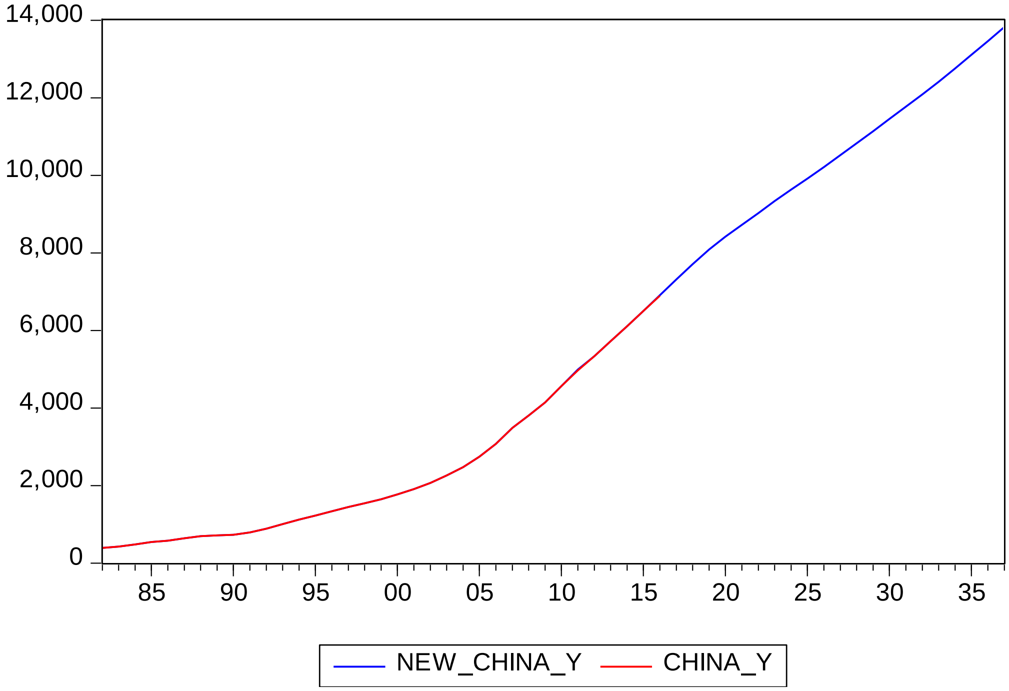

Figure 37: China_Y and Forecasted_China_Y

Figure 38 shows the actual (red line) and forecasted (blue line) GDP per capita in U.S during the period 1982-2037.

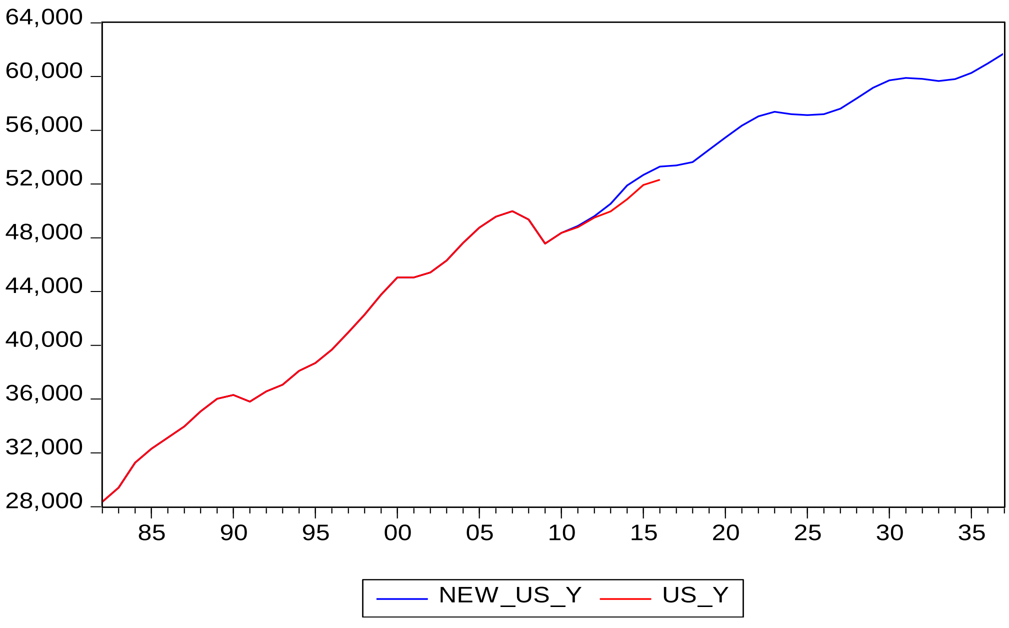

Figure 38: US_Y and Forecasted_US_Y

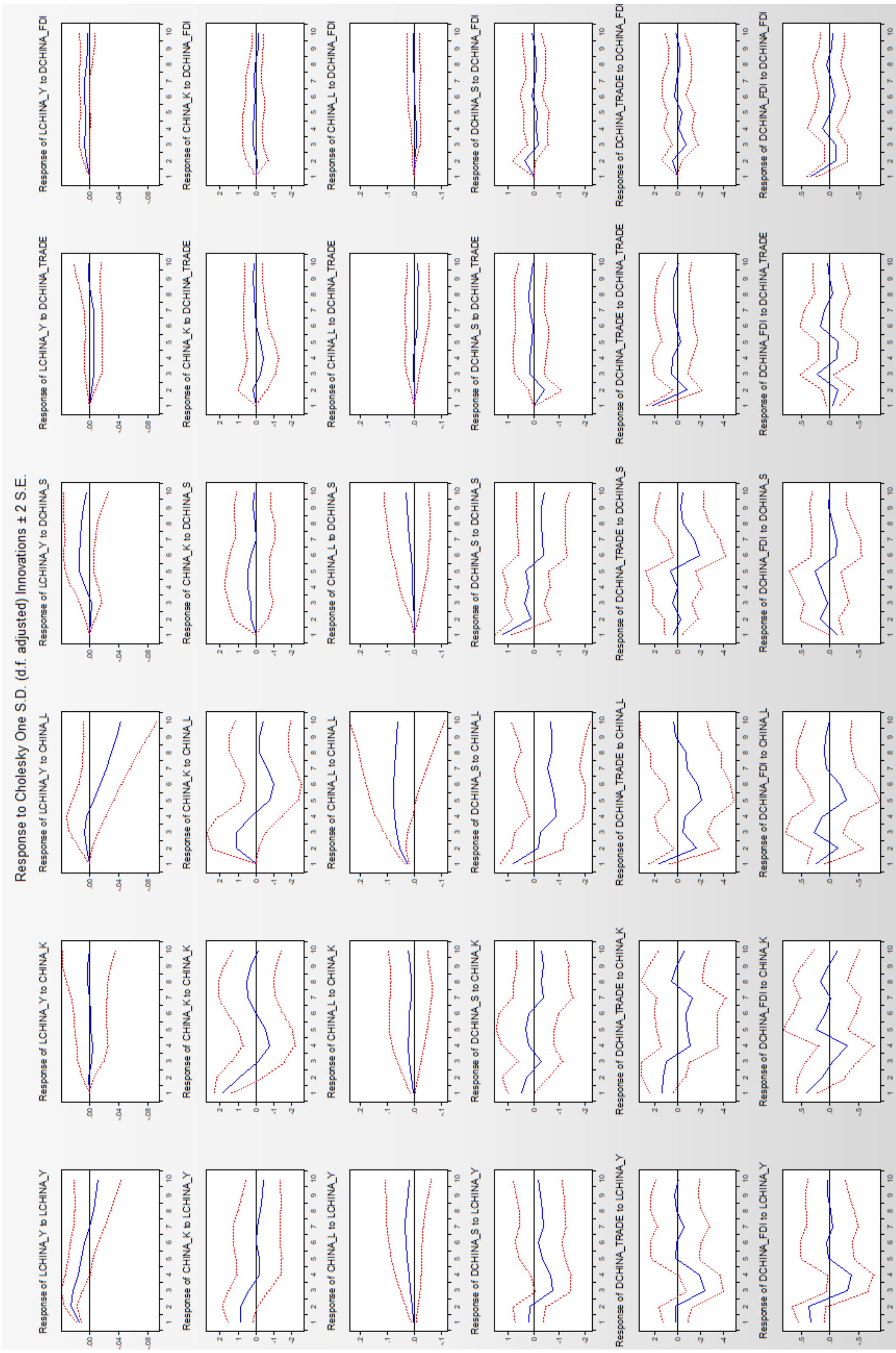

Figure 39: Impulse Response Function – China

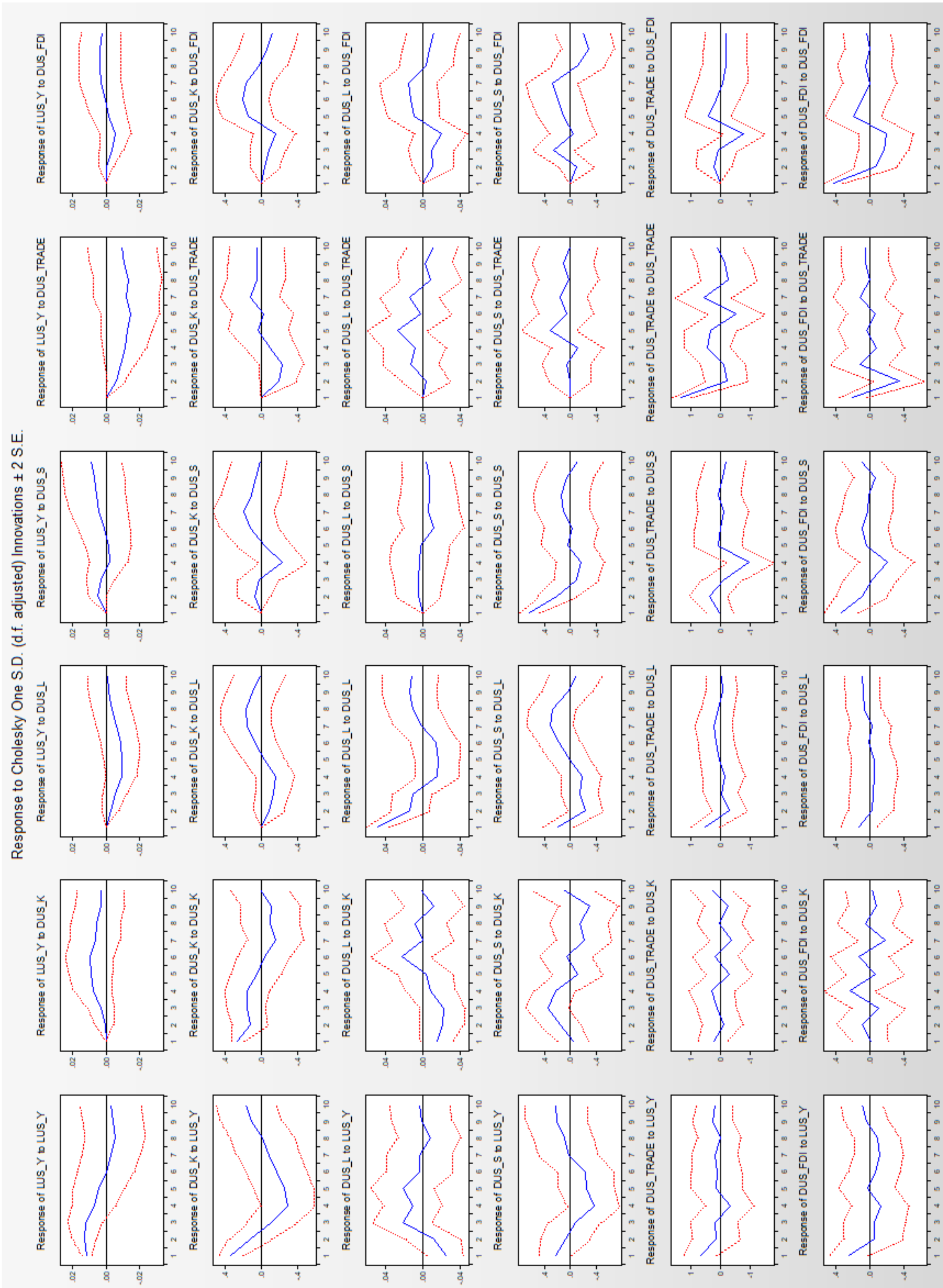

Figure 40: Impulse Response Function – U.S.

Chapter 5. Conclusion

This paper compares the economic growth in China and U.S. over the period of 1982-2016 in terms of their GDP per capita and examines whether Chinese economy will surpass the U.S.'s in the next 20 years, in the period 2017-2037. The OLS regression for China indicates that at the 5% significant level, capital, and lagged GDP per capita growth are positive and have a significant effect on GDP per capita growth; saving is also positive and have a significant effect on GDP per capita growth but at the 10% significant level, which is consistent with the finding of Misztal (2011) and Krieckhaus (2002) that saving is the determinant of economic growth and higher saving can cause an increase in economic growth. It is also consistent with the economic growth theories from Harrod and Domar (1939; 1946), Lewis (1954) and Romer (1986), which stated the positive relationship between saving and output growth rate. Labor, on the other hand, is negative and has a significant effect on GDP per capita growth at 5% significant level. The OLS regression for U.S. indicates that capital, FDI and GDP per capita in last year are positive and have a significant effect on GDP per capita growth in the U.S.

Even though Table 3 and Table 6 shows the growth of GDP per capita in China as close to that of the U.S. (8.9-9.5% and 10.9-11.0%, respectively), Figure 37 and Figure 38 tell a completely different story. They show that by year 2037, GDP per capita in China is slightly less than $14,000 but GDP per capita in the U.S. is slightly above $61,000, a humongous gap between the two countries. Table 8 provides the exact value amounts for both China and U.S. in the period 2017-2037 using VAR forecasting. This finding is not surprising at all. With approximately 1.4 billion of people, it is extremely hard for China to achieve a high GDP per capita. If China wants to have the similar amount of GDP per capita as in the U.S. by 2037, then its GDP need to be approximately 85.4 trillion!

This thesis excludes important variables like R&D and government spending on education due to unavailable data; if possible, for the future research, theses variables can be included to see whether adding them, more independent variables would become statistically significant and the effect of the added variables in explaining the impact on economic growth. If possible, future research should also use labor force participation rate for labor instead of using population growth rate as a proxy to see if this plays a role in the significance of the variable. Furthermore, future research can increase sample size to minimize the variance.

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Appendix

Table 1

Correlation Coefficients

China

	LCHINA_Y	CHINA_K	CHINA_L	DCHINA_S	DCHINA_TRADE	DCHINA_FDI
LCHINA_Y	1.000000	0.907271	-0.944509	-0.150682	-0.255506	-0.256949
CHINA_K	0.907271	1.000000	-0.880824	-0.087734	-0.154088	-0.085795
CHINA_L	-0.944509	-0.880824	1.000000	0.020122	0.156427	0.214630
DCHINA_S	-0.150682	-0.087734	0.020122	1.000000	0.579082	0.358601
DCHINA_TRADE	-0.255506	-0.154088	0.156427	0.579082	1.000000	0.523361
DCHINA_FDI	-0.256949	-0.085795	0.214630	0.358601	0.523361	1.000000

U.S.

	LUS_Y	DUS_K	DUS_L	DUS_S	DUS_TRADE	DUS_FDI
LUS_Y	1.000000	-0.031387	-0.199184	0.087666	-0.012206	0.034411
DUS_K	-0.031387	1.000000	-0.123884	0.541233	0.392676	0.472118
DUS_L	-0.199184	-0.123884	1.000000	-0.008619	0.108321	0.105312
DUS_S	0.087666	0.541233	-0.008619	1.000000	0.337225	0.304230
DUS_TRADE	-0.012206	0.392676	0.108321	0.337225	1.000000	0.411742
DUS_FDI	0.034411	0.472118	0.105312	0.304230	0.411742	1.000000

Table 2

Descriptive Statistics

China

	LCHINA_Y	CHINA_K	CHINA_L	DCHINA_S	DCHINA_TRADE	DCHINA_FDI
Mean	7.474667	36.22400	0.919184	0.352306	0.510025	0.039760
Median	7.442907	34.83651	0.826904	0.449499	0.216005	-0.046292
Maximum	8.838474	45.51477	1.610071	3.560879	9.056584	3.573720
Minimum	6.048774	24.56467	0.479150	-2.225028	-12.84744	-1.165728
Std. Dev.	0.852334	6.180659	0.401014	1.612395	4.290952	0.847592
Skewness	0.036053	0.040777	0.370187	0.047490	-0.528534	2.295139
Kurtosis	1.762400	1.904552	1.609415	2.034522	4.258627	10.31646
Jarque-Bera	2.177207	1.709432	3.515998	1.333323	3.827171	105.6850
Probability	0.336686	0.425404	0.172389	0.513420	0.147550	0.000000
Sum	254.1387	1231.616	31.25227	11.97841	17.34085	1.351856
Sum Sq. Dev.	23.97364	1260.618	5.306797	85.79394	607.6050	23.70763
Observations	34	34	34	34	34	34

U.S.

	LUS_Y	DUS_K	DUS_L	DUS_S	DUS_TRADE	DUS_FDI
Mean	10.64519	-0.088463	-0.006441	-0.110147	0.266161	0.067117
Median	10.70108	0.098676	-0.019440	0.078608	0.324748	0.063662
Maximum	10.86512	1.071907	0.206610	2.115672	3.416625	1.364265
Minimum	10.28896	-2.467234	-0.123028	-1.991451	-5.175583	-1.789402
Std. Dev.	0.168396	0.709313	0.068515	1.136452	1.557107	0.612352
Skewness	-0.435251	-1.143654	1.319254	0.045101	-1.117025	-0.590092
Kurtosis	1.894859	4.859136	5.421198	1.949489	5.978260	4.514412
Jarque-Bera	2.803736	12.30823	18.16722	1.574923	19.63643	5.222226
Probability	0.246137	0.002125	0.000114	0.454998	0.000054	0.073453
Sum	361.9364	-3.007729	-0.219010	-3.745004	9.049472	2.281962
Sum Sq. Dev.	0.935785	16.60311	0.154914	42.62026	80.01118	12.37419
Observations	34	34	34	34	34	34

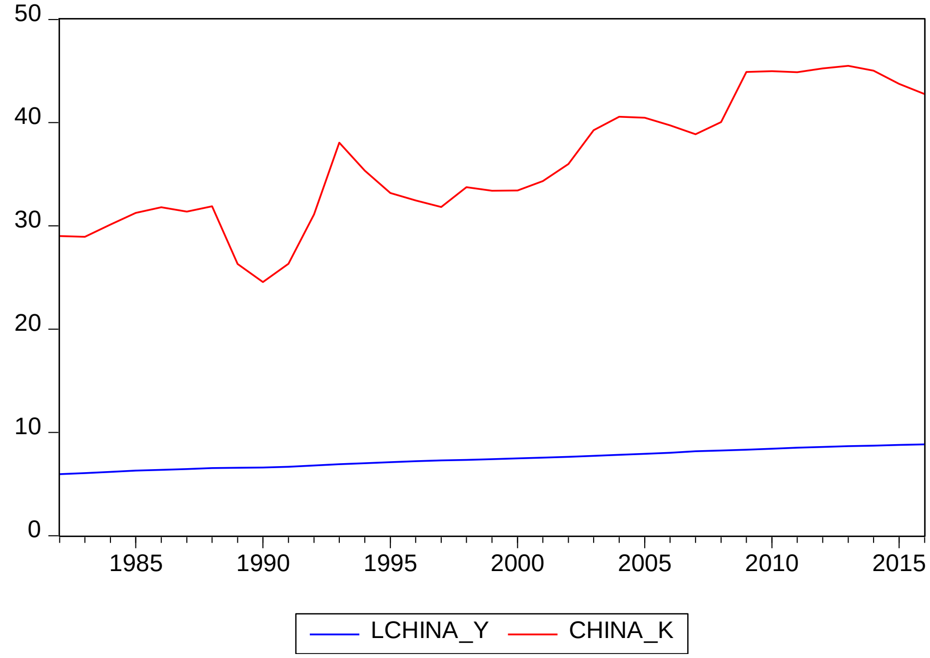

Figure 1: LChina_Y and China_K

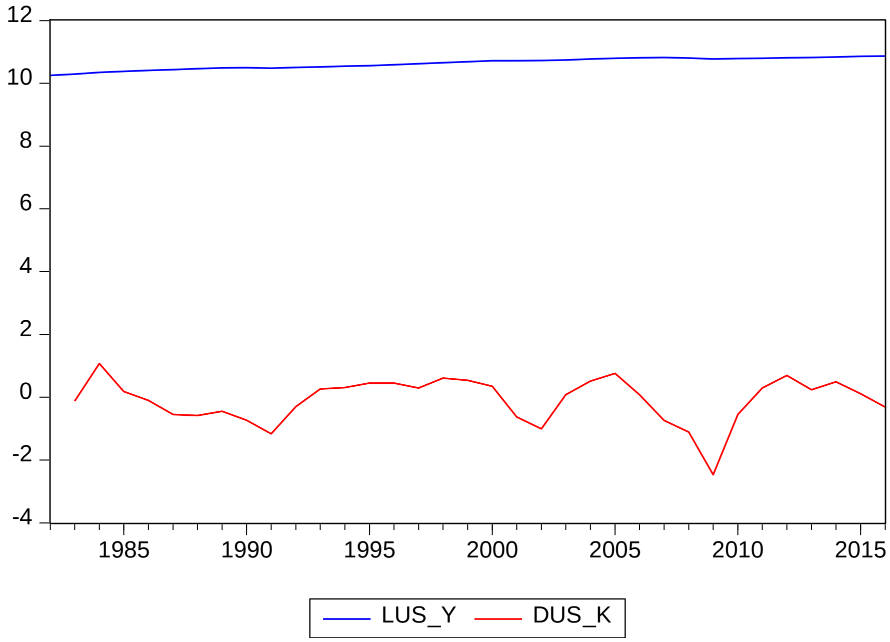

Figure 2: LUS_Y and DUS_K

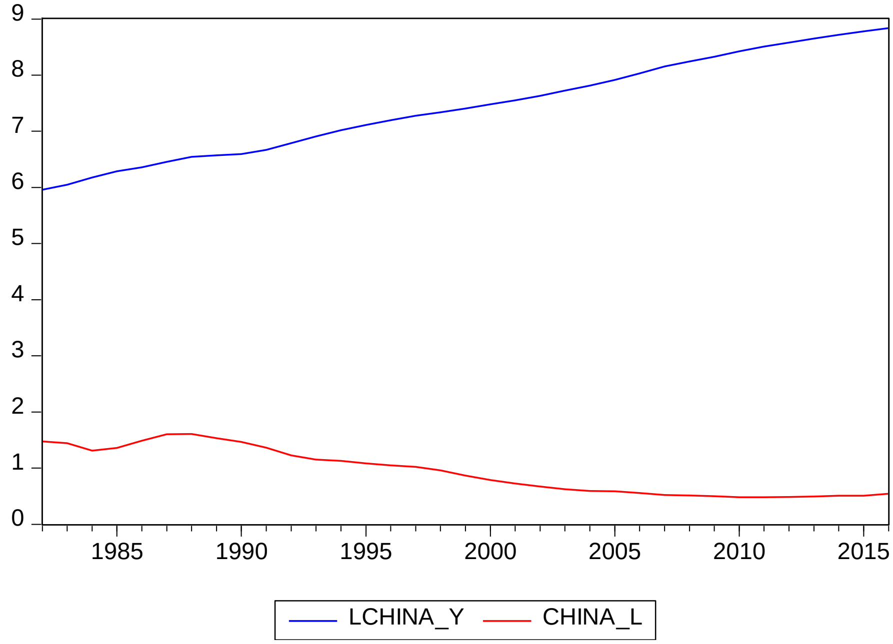

Figure 3: LChina_Y and China_L

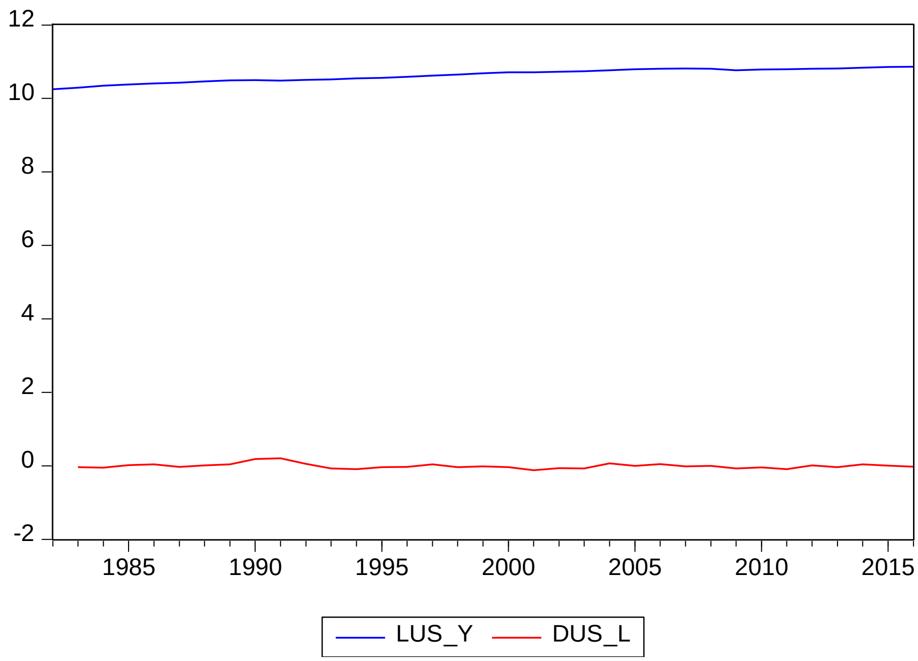

Figure 4: LUS_Y and DUS_L

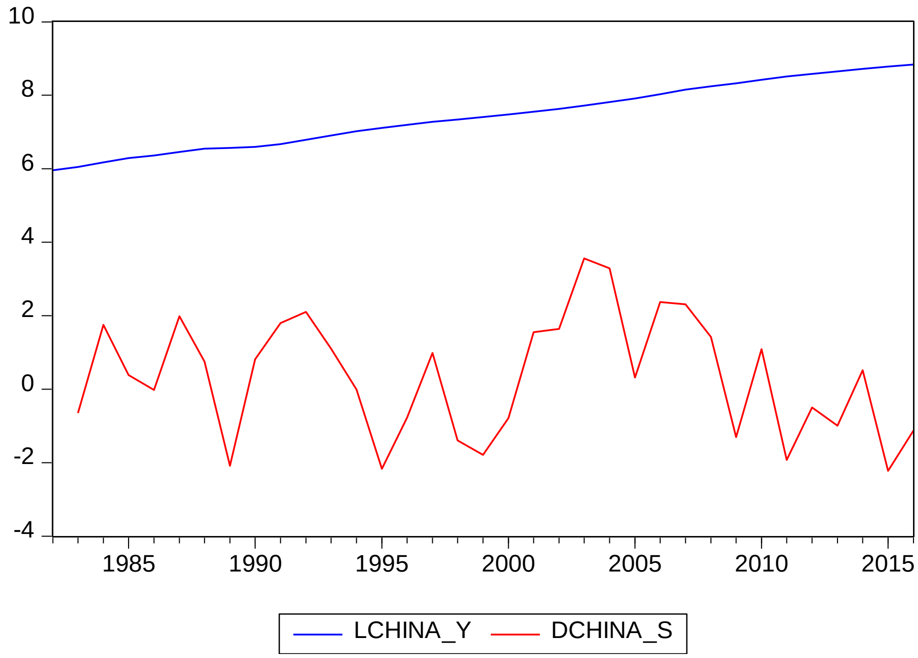

Figure 5: LChina_Y and DChina_S

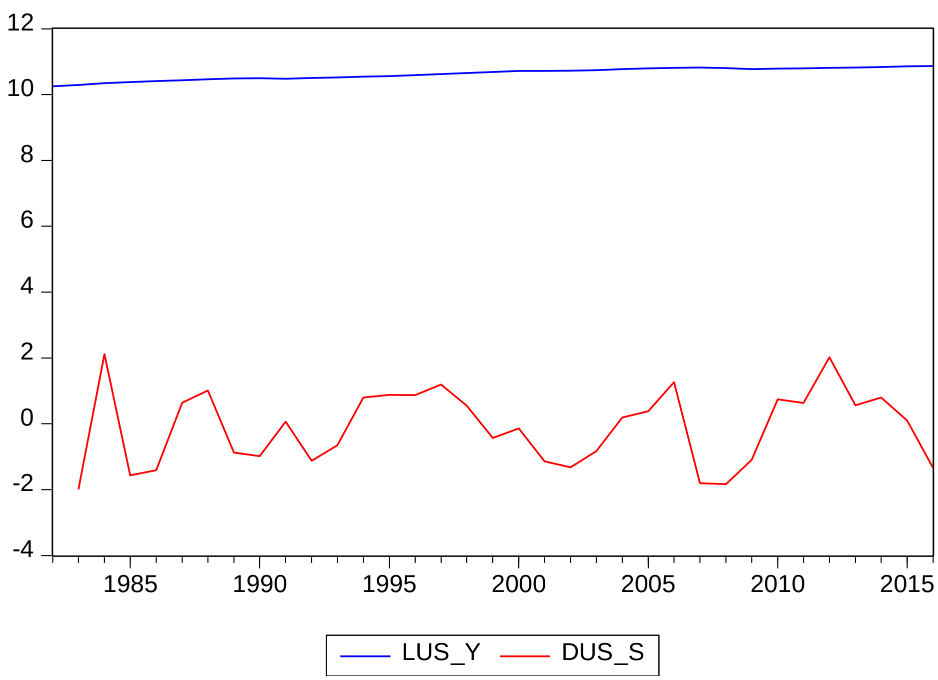

Figure 6: LUS_Y and DUS_S

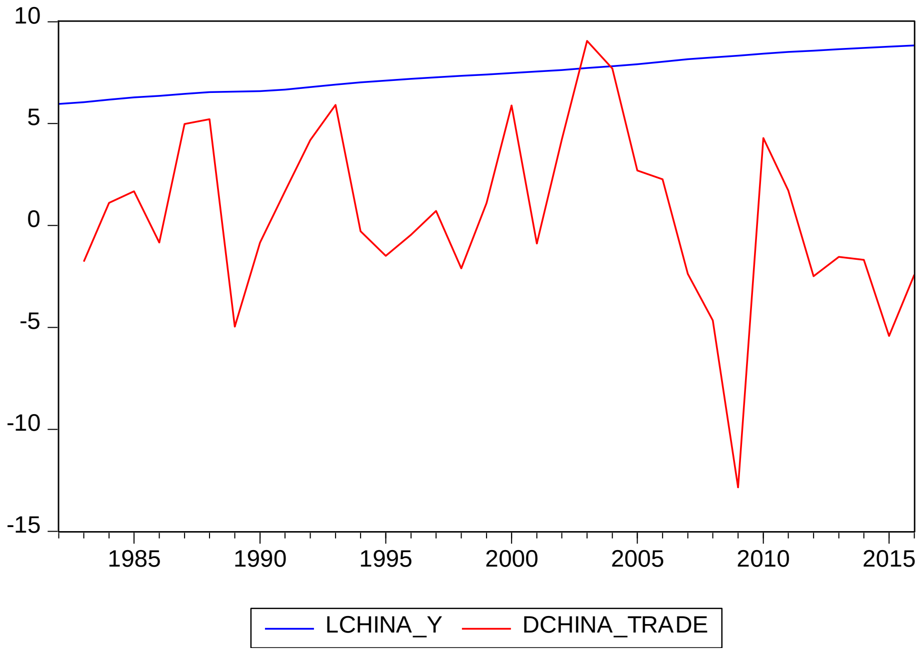

Figure 7: LChina_Y and DChina_Trade

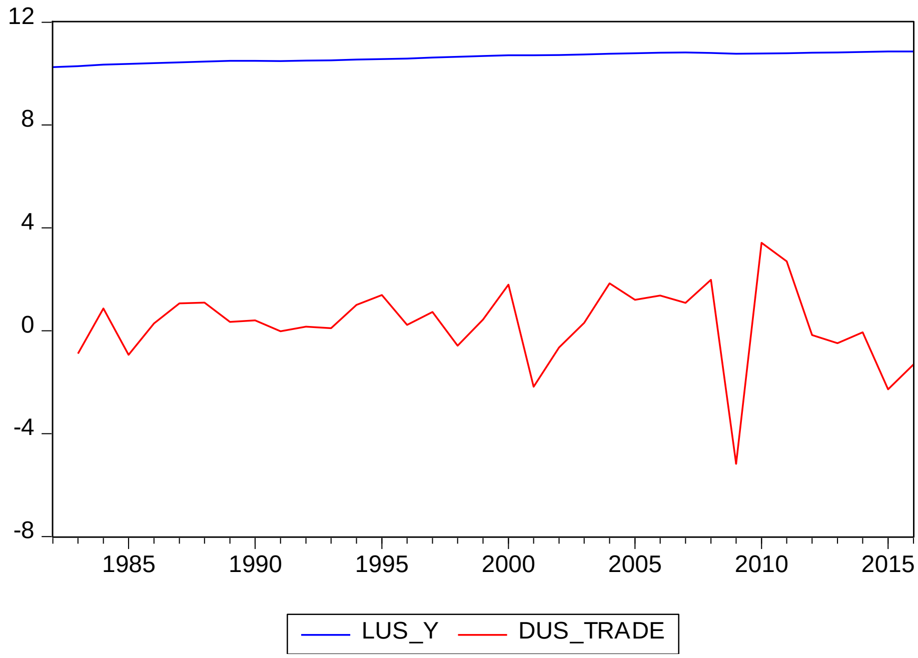

Figure 8: LUS_Y and DUS_Trade

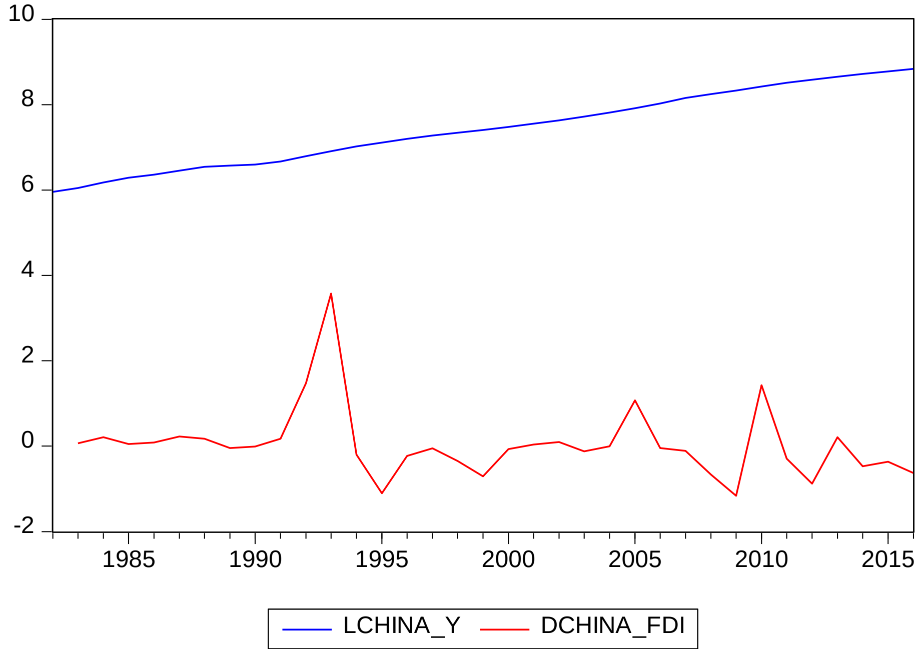

Figure 9: LChina_Y and DChina_FDI

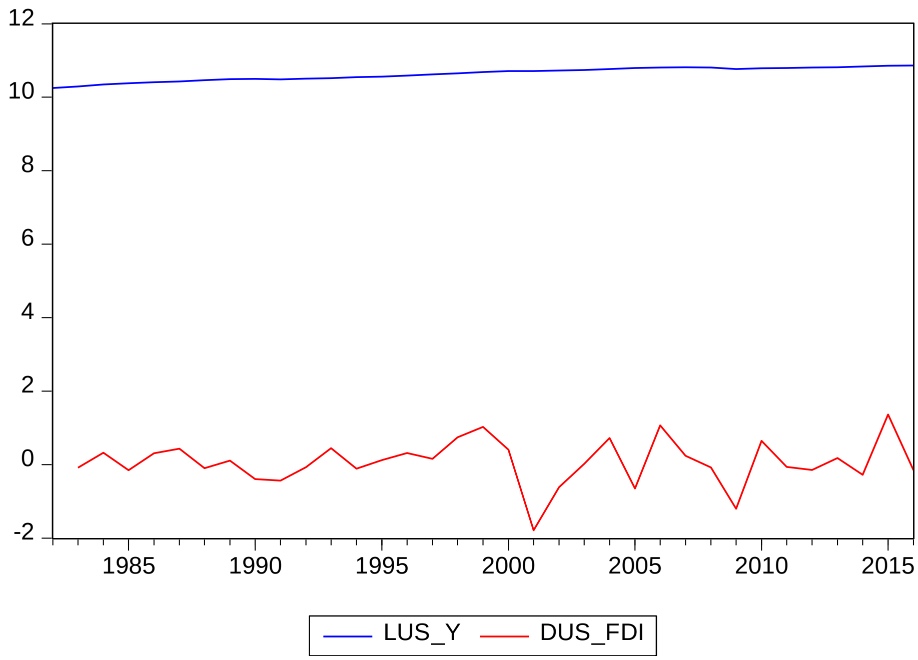

Figure 10: LUS_Y and DUS_FDI

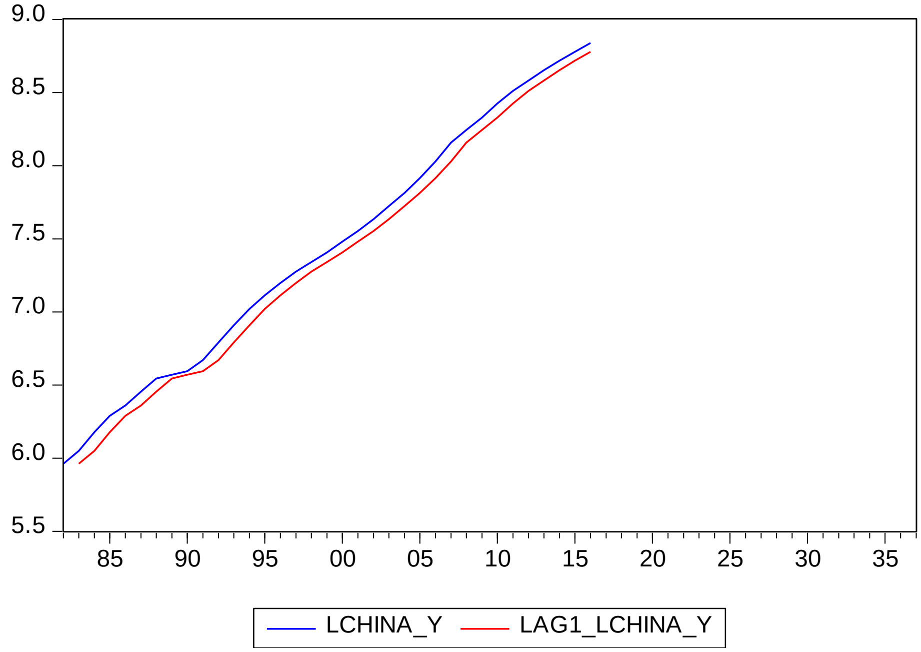

Figure 11: LChina_Y and Lag1_LChina_Y

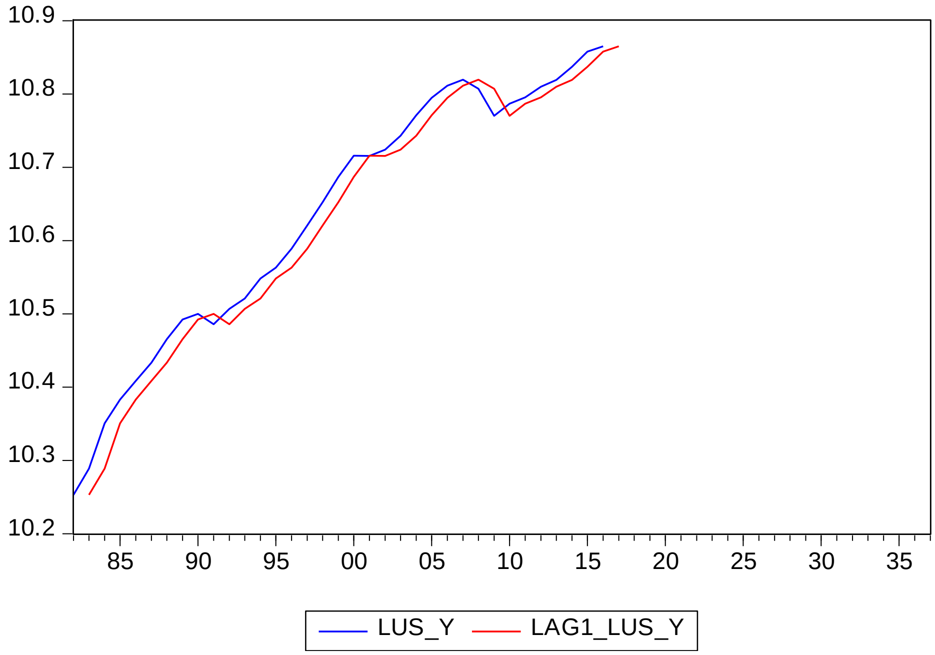

Figure 12: LUS_Y and Lag1_LUS_Y