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Comparison of Economic Growth between China and United States

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Abstract

This paper mainly focuses on comparing China's and the United States' growth rates and further investigating whether trade-openness is a significant factor that leads to the difference. Previous studies show that economic growth mainly concentrates on three factors – capital accumulation, employment and technology progress. Therefore, in the growth accounting part, we empirically estimate the production function of China and the US respectively and make some transformations to calculate the Total Factor Productivity (TFP), which can represent technology progress. By comparing several critical factors of production, we find that economic growth in the US shows a much more stable pattern than that of China.

To further explore whether trade-openness has a significant impact on economic growth, we apply the Error Correction Model (ECM) to analyze the long-run (LR) and short-run (SR) trade-openness effect on economic development and employ the democracy level as an instrumental variable to control the potential endogeneity issue in LR. We find US has both LR and SR significant trade-openness effects, which are almost of identical magnitude, while China only has an LR trade-openness effect. The endogeneity shows that trade openness is weakly endogenous in LR, which means that the LR economic development level will influence the level of openness in both China and the US.

To explain why the United States has a better trade-openness effect than China, we analyze the competitiveness of both countries in the research period and find that the United States has better competitiveness in the world market because of its first-mover advantage and the mature free-market system.

Keywords: openness, growth accounting, total factor productivity, democracy level, Error Correction Model (ECM)

Contents

1 Introduction

1.1 Research Background and Significance

In 1978, China embarked on a process of reform and opening up. In 2001, China joined the World Trade Organization and since then, it has been officially connected to world trade, with many products labeled "Made in China". In 2016, China's official currency, the RMB, was officially added to the IMF's basket of currencies. China's openness has also been growing since its reform and opening up.

It is well known that China has been recognized as the world's second-largest economy for its remarkable economic growth over the past 40 years, with a nearly 2-digit annual growth rate. But will China's extraordinary economic growth last forever? Will China overtake the United States to become the world's largest economy? With these questions and curiosities about China's economic growth, we compare the economic growth path between China and the U.S. and explore the effect of trade-openness.

1.2 Our Work

Based on such striking progress, we want to explore the reasons behind this and wonder whether China will catch up with the US. Specifically, we want to compare the economic growth path between China and US and explore the effect of trade openness, which is indeed our research question. And we will use a two-stage Least-Squares (2SLS) analysis and Error Correction Model (ECM) as our empirical strategy to identify trade-openness in economic growth.

We list our brief results here for you to have a glimpse. In the part of growth accounting, we conclude that United States' economic model tended to be mature, stable, and close to constant return to scale; the Chinese economic model was still growing and currently showing an increasing return to scale. Also, the path of economic growth was similar to that of capital growth. In the part of the trade-openness effect, the main conclusions are listed as follows. Openness had a more significant role in promoting economic growth in the United States, while openness did not affect China's economic growth in the short term. After the endogeneity test, it was found that the degree of openness in both countries would be affected by economic performance, which means weakly endogenous.

2 Literature Review

2.1 Theoretical Methods

Long-run economic growth has always been a vital position in economics. The history of economic growth can date back to Adam Smith's work, An Inquiry into the Nature and Causes of the Wealth of Nations (1776). However, the systematical development of the long-run economic growth theory started after Keynes (James, 1980). Harrod was the first to incorporate the essential conclusions of The General Theory of Employment, Interest and Money of Keynes in a model of capital accumulation (Walter, 1987). Then, there appeared the most influential theory, neoclassical growth theory, first developed by Robert

Solow (1957), Trevor Swan (1956) and James Tobin (1965) to counter Harrod's view of capitalist instability and stagnation, where the equilibrium of growth is determined by the rate of the growth of the labor force and the rate of technical change, both exogenous. And factor prices are adjusted via the forces of supply and demand operating in perfectly competitive markets to ensure the continuous full employment of capital and labor. More recently, Paul Romer (1990) proposed his Romer growth model based on the Solow growth model, where endogenous technical progress is allowed. In addition to the neoclassical models, the Neo-Keynesian school holds a fundamentally different view than the historical rate of accumulation in any era is as exogenous given. The class distribution of income plays a crucial role in reproducing this rate over time (James, 1980). More profoundly, the gap between these two schools is rooted in fundamental differences in their basic worldviews. While the neoclassical tradition adheres to a worldview in which cause and effect are separable and growth is a steady-state phenomenon, the evolutionary worldview is one of the historical circumstances, complex causal mechanisms, and turbulent growth patterns that appear to be far from a steady-state (Jan & David, 2006).

2.2 Existing Evidence

Most of the U.S. economic growth literature focuses on three main factors: productivity growth, capital accumulation, and technological change. Before the 1980s, the most important contributor to economic growth was the growth in capital input, and labor input was a significant contributor. However, from the 1990s to the present, economists have been increasingly concerned about technological change, especially since around 2000. This factor has proved that it is indeed powerful enough to determine the growth rate of the U.S.

A paper aiming to compare economic growth in Japan and that in the U.S. tells that most of the economic growth in the U.S. comes from the increase in capital input and labor input from 1960 to 1973; however, from 1973 to 1979, these two input factors became less critical to driving economic growth (Dale, 1988). When it comes to the 21st century, literature on the impact of technological progress increased, and among the relevant scholars, Jones stood out in this field. His Sources of U.S. Economic Growth in a World of Ideas (2002) says that long-run growth arises from the worldwide discovery of ideas, which depends on population growth; nevertheless, constant growth can temporarily proceed faster, provided research intensity and educational attainment rise steadily over time. In addition, growth accounting reveals that these factors explain 80 percent of recent U.S. growth, with less than 20 percent coming from world population growth. And his other work, The Future of US Economic Growth (2014), predicts that US economic growth is likely to slow due to a decline in educational attainment and research intensity.

As to the research on China's economic growth since 1952, the ongoing debate focuses on whether China's rapid growth during the reform is driven mainly by productivity growth or factor accumulation. On one side, many researchers conclude that productivity growth has played a significant role (for example, Chow, 1993, Borensztein & Ostry, 1996, Hu & Khan, 1997). In particular, Chow contends that capital formation played a principal role in China's economic growth, while there was nearly no technological progress from 1952 to 1980. The other two growth-accounting studies cited above found that, during the reform period after 1978, the role of capital accumulation was only

secondary, with productivity growth becoming the primary driving force of China's rapid economic growth. For example, Borensztein and Ostry (1996) conclude that the growth rate of TFP, which was pessimistic before the reform, rose to 3.8% per year in the post-reform period, accounting for more than one-third of the total increase in output.

Previous literature on China's economic growth during the reform period rarely centered on some director indicators of the reform. However, an empirical study (Andy & John, 2006) on the influence of expanding export on China's economic growth suggests that there is a bi-directional causal sequence between these two variables. Therefore, this paper intends to explore the causal relationship between openness and economic growth when comparing the growth of the US and China in a more straightforward way.

3 Data and Descriptive Statistics

3.1 Data Source

Due to the overall limit of data resources, we set the time span of the research period from 1972 to 2020.

Data sources are listed as follows. The Chinese data on employment comes from the Ministry of Human Resources and Social Security and the National Bureau of Statistics of China, while the American data on employment comes from the Federal Reserve Economic Data. For data on real GDP, capital formation, export and import, both countries' data comes from the World Development Indicator, a database in the World Bank. Finally, for the data of democracy index, both countries' data comes from the V-Dem Institute, University of Gothenburg.

3.2 Summary Statistics

Here is a summary table of our data, which contains the information of variables' names, countries, the number of observations, maximum value, minimum value and standard deviation.[1]

3.3 Data Processing

In the research model, some data is used after the necessary procession.

The capital stock for time t is calculated by capital formation taking a 1-year lag.

$$Capital\ Stock_t = Capital\ Formation_{t-1}$$

And openness per percentage of GDP, a new variable we created that represents the total amount of international economic activities, is calculated by export per percentage of GDP plus import per percentage of GDP.

$$Openness(\%\ of\ GDP) = Export(\%\ of\ GDP) + Import(\%\ of\ GDP)$$

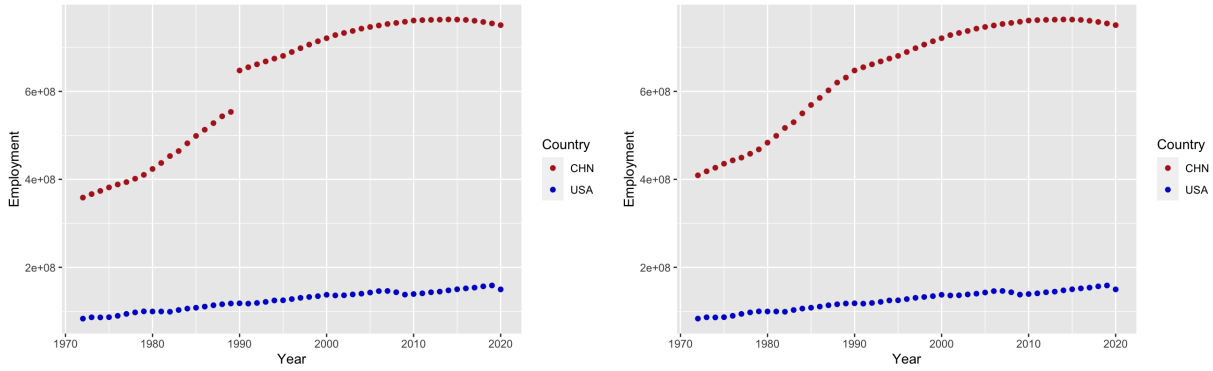
[1]We have 2 different kinds of democracy index as instrumental variable for 2 countries in the following endogeneity test.

Table 1: Data Summary

Variable	Country	Obs	Std.Dev.	Min	Max
$real\ GDP_t$	CHN	50	4.48e+12	9.98e+10	1.47e+13
$Capital\ Formation_{t-1}$	CHN	49	1.82e+12	2.65e+10	6.12e+12
$Employment_t$	CHN	50	1.2e+8	4.09e+8	7.63e+8
$Export(\%\ of\ GDP)$	CHN	50	9.15	2.788	36.035
$Import(\%\ of\ GDP)$	CHN	50	7.42	2.133	28.444
$Democracy\ Index$	CHN	50	0.0358	0.089	0.202
$real\ GDP_t$	USA	50	6.21e+12	1.16e+12	2.14e+13
$Capital\ Formation_{t-1}$	USA	49	1.22e+12	2.47e+11	4.49e+12
$Employment_t$	USA	50	2.25e+7	8.05e+7	1.59e+8
$Export(\%\ of\ GDP)$	USA	50	2.07	5.405	13.69
$Import(\%\ of\ GDP)$	USA	50	3.23	5.35	17.51
$Democracy\ Index$	USA	50	0.01203	0.898	0.95

3.4 Data Revision

In addition, there is some revision in Chinese employment data. However, you can see a breaking point in the employment graph before revision.



(a) Employment before Revision

(b) Employment after Revision

In 1990, due to the change in the caliber of the investigation of China, there were two sets of data for the number of people employed in the whole society. We have 567.4 million people according to the old caliber and 647.49 million people with the new caliber. Therefore, to make the data consistent, it is necessary to adjust the employment data of the whole society before 1990. The adjustment method is to multiply the original employment number of each year by an adjustment coefficient (=64749/56740).

$$Employment_{after\ 1990} = \frac{64749}{56740} * Employment_{before\ 1990}$$

4 Methodology

4.1 Growth Accounting Logic

There are lots of production functions with various properties. For simplicity, we employ the Cobb-Douglas functional form of production to decompose output growth

into input growths and TFP growth, which is also widely used in other research works. The Cobb-Douglas production function model has many excellent properties for us to investigate growth rate and conduct some transformations. Standard original Cobb-Douglas form can be expressed as:

$$Y_t = A_t K_t^{\alpha} L_t^{\beta}$$

where Y_t represents real GDP, K_t represents the capital stock and L_t represents labor input for a country in year t = 1972,...,2020. Parameters α and β are the shares of contribution for capital and labor, respectively, also known as the capital and labor intensity. The A term represents Total Factor Productivity (TFP for short), which value reflects the state of technology, skill and education level in the workforce. Different α, β will lead to different returns to scale of the Cobb-Douglas production function:

$$\alpha + \beta = 1 \Rightarrow \textit{constant return to scale}$$

$$\alpha + \beta > 1 \Rightarrow \textit{increasing return to scale}$$

$$\alpha + \beta < 1 \Rightarrow \textit{decreasing return to scale}$$

Take natural logarithm on both side, then we can get our linear regression function where α and β can be estimated in the form as below:

$$lnY = ln(AK^{\alpha}L^{\beta}) = lnA + \alpha lnK + \beta lnL$$

$$\Rightarrow y = \delta + \alpha k + \beta l + \epsilon$$

where y=lnY, k=lnK, l=lnL. We can do linear regression using macro-data and estimate the capital intensity and labor intensity represented as alpha and beta with this linear form.

To derive the TFP growth rate from the Cobb-Douglas production function, we need a total differentiation for the logged form from both sides. The growth rate of technology, TFP, is derived through some simple mathematical manipulation.

$$g_Y = g_A + \alpha * g_K + \beta * g_L$$

$$g_A = TFP = g_Y - \alpha * g_K - \beta * g_L$$

Improving the total factor productivity is one crucial driving force behind economic growth. Thereby, the late-developing countries need to identify the determinants.

4.2 Empirical Methods

4.2.1 Stationarity Test

The process seemed perfect, but spurious relationships might exist without stationarity and cointegration tests.

We apply the Dickey-Fuller (DF) Test and its robust version Augmented Dickey-Fuller (ADF) Test to test whether our time series are stationary or whether we need to take differences before getting a stationary series.

We consider DF and ADF regressions as follows, where we take capital for example:

$$\Delta k_t = \beta_0 + \beta_1 k_{t-1} + \epsilon_t \qquad (DF)$$

$$\Delta k_t = \beta_0 + \beta_1 k_{t-1} + \cdots + \beta_p k_{t-p} + \epsilon_t \qquad (ADF)$$

We introduce higher-order lag terms for ADF regression to control the potential autocorrelation and heteroskedasticity issue of error terms in DF regression. On basis of Newey & West (1987), we take $p = [4(\frac{T}{100})^{\frac{2}{9}}]$, where T is the sample size.

4.2.2 Cointegration Test and Long-Run Relationship

Then, in the face of the potential spurious regression, we follow the procedure put forward by Engle & Granger (1987) and conduct the cointegration test to test whether these three-time series are co-integrated or, in other words, whether they have a long-run relationship. We use lower-case letters y_t and k_t to denote the log value of GDP per capita and Gross Capital Formation per capita and use z_t to denote the openness index in year t. We used the gross capital formation last year to measure the capital use this year. In terms of the Cobb-Douglas production function assumption, there will be a linear relationship between the log value of GDP per capita and the log value of capita per capita.
We consider the static regression:

$$y_t = \delta_0 + \delta_1 k_{t-1} + \delta_2 z_t + v_t \qquad (1)$$

We extract the residual series from (1):

$$\Longrightarrow \widehat{v_t} = \hat{y_t} - (\widehat{\delta_0} + \widehat{\delta_1} k_{t-1} + \widehat{\delta_2} z_t) \qquad (2)$$

What we concern is the stationarity of these residuals. We apply ADF test again and consider:

$$\Delta\widehat{v_t} = \beta_0 + \beta_1 \widehat{v_{t-1}} + \cdots + \beta_p \widehat{v_{t-p}} + \epsilon_t \qquad (3)$$

If the error term series v_t is stationary, there does exist long-run equilibrium between Economic Performance, Capital, and Trade Openness, and the simple OLS will give us unbiased estimation for this long-run relationship.We denote this long-run relationship as:

$$y^E = \delta_0 + \delta_1 k^E + \delta_2 z^E \qquad (LR)$$

4.2.3 Error Correction Model and Short-Run Relationship

If GDP, Capital, and Trade Openness series are co-integrated and all $I(1)$, we can estimate their short-run relationship by Error Correction Model (ECM) which could take both shor-run dynamics and long-run dynamic into the consideration.

$$\Delta y_t = \underbrace{\alpha_0 + \alpha_1 \Delta k_{t-1} + \alpha_2 \Delta z_t}_{SR\ Dynamic} - \underbrace{\lambda(y_{t-1} - \delta_0 - \delta_1 k_{t-1} - \delta_2 z_{t-1})}_{LR\ Dynamic} + \gamma_t \qquad (SR.1)$$

This equation can be further reparameterized as:

$$y_t = \theta_0 + \theta_1 y_{t-1} + \theta_2 k_{t-1} + \theta_3 k_{t-2} + \theta_4 z_t + \theta_5 z_{t-1} + \gamma_t \qquad (SR.2)$$

In this model, the coefficient of Error Correction Term (ECT) should be negative which means λ should be positive. That is, when Δk_{t-1} and Δz_{t-1} are both equal to zero, if y_{t-1} is above its LR equilibrium value ($\delta_0 + \delta_1 k_{t-1} + \delta_2 z_{t-1}$), y_{t-1}–($\delta_0 + \delta_1 k_{t-1} + \delta_2 z_{t-1}$) will be positive. To correct the error and come back to the equilibrium, λ should be positive to realize a negative Δy_t. Similarly, if y_{t-1} is below its LR equilibrium value ($\delta_0 + \delta_1 k_{t-1} + \delta_2 z_{t-1}$), ECM will automatically produce a positive Δy_t to draw y_t back to equilibrium.

4.2.4 Endogeneity and Instrumental Variable

When we are concerned about the effect of openness on economic performance, the potential endogeneity issue must be considered. When openness exerts influence on economic performance, the level of economic development could also affect openness at the same time, which will cause biased estimation. We employ an instrumental variable (IV), Legislative Constraint for Administrative Authority & Freedom Level and do Two-Stage Least Square (2SLS) Regression to control this issue.

We have two hypotheses about this IV:

1. $Cov(D_t, z_t) \neq 0$
2. $Cov(D_t, v_t | k_{t-1}) = 0$

Condition 1 indicates that the democracy Level will have an impact on the openness level in LR. According to the existing empirical study (Thacker, 2007), the domestic democratic level is crucial for the openness level. Although condition 2 is much more argumentative, based on traditional economic growth theories, the LR output is primarily determined by capital, labor, human resources, and natural resources, and we reasonably assume that the democracy level does not affect the LR economic performance.

For 2SLS Regression:

$$z_t = c^F + \pi^F D_t + \delta^F k_{t-1} + u_t^F \qquad (1st\ Stage)$$

$$y_t = \delta_0^S + \delta_1^S k_{t-1} + \delta_2^S \widehat{z_t} + v_t^S \qquad (2nd\ Stage)$$

We follow the procedure put forward by Hausman (1978) to test if the Trade Openness is endogenous to the Economic Performance.
Extract the residuals from the 1st stage regression:

$$\widehat{u_t} = z_t - (\widehat{c^F} + \widehat{\pi^F} D_t + \widehat{\delta^F} k_{t-1})$$

Add residuals into OLS regression and conduct t test towards δ_3.

$$y_t = \delta_0 + \delta_1 k_{t-1} + \delta_2 z_t + \delta_3 \widehat{u_t} + v_t$$

If δ_3 is statistically significant, the existence of endogeneity will be confirmed.

5 Empirical Analysis and Results

5.1 Growth Accounting

A country's economic growth is influenced by various factors, including its national productivity, level of science and technology, political policies, foreign investment, and the international political environment. No one can tell with certainty which factor will have the long-term impact that will put a country on the fast track to sustained economic growth. In the big picture of world economic development, many less developed countries and regions hope to be among the top of the world economy by copying or imitating the economic development path of developed countries. Still, the results are not always satisfactory, perhaps because of insufficient capital accumulation or backward production technology. This is the reason why the field of development economics has paid much attention to the field of economic growth accounting.

5.1.1 Production Function Estimation

We are eager to explore and compare the economic production patterns of China and the United States, analyze in-depth the economic growth paths of both countries, and identify the factors that have a long-term impact on their world economic status. Therefore, we test the existence of a long-run relationship between real GDP, capital accumulation and employment utilizing a stationarity test and a cointegration test, the results of which are shown in Table 2.

Table 2: ADF Test for Growth Accounting

Variables	Country	p value	lag
$\Delta \log(real\ GDP)_t$	CHN	0.0636	1
$\Delta \log(Capital\ Stock)_t$	CHN	0.0864	1
$\Delta \log(Employment)_t$	CHN	0.0173	3
Static Residuals	CHN	<0.01	3
$\Delta \log(real\ GDP)_t$	USA	0.0304	2
$\Delta \log(Capital\ Stock)_t$	USA	0.0256	3
$\Delta \log(Employment)_t$	USA	0.0236	3
Static Residuals	USA	0.0506	1

We now examine the results of the stationarity and cointegration tests. In exploring whether the time series is smooth, we find that real GDP, capital stock and employment level taking the natural logarithmic form under first-order differencing all have a p-value less than 0.1. This means that, fortunately, all p-values are significant at the 10% significant level.[2] This also ensures that our estimated production function is valid, i.e., there is a long-run causal relationship between real GDP, capital stock, and employment level.

[2]Here we relax the common significant level from 5% to 10%, which is acceptable in ADF test.

After the stationarity and cointegration tests pass, we perform formal linear regression estimation. Referring to the linear regression function we derived ($y = \delta + \alpha k + \beta l + \epsilon$), we ran the regression using R software and the results are shown in Table 3.

Table 3: OLS Regression Output

	CHN	USA
VARIABLES	y_t	y_t
k_t	0.8828***	0.7751***
	(0.0139)	(0.0725)
l_t	0.2485*	0.2262*
	(0.1226)	(0.0868)
Constant	-0.734	-11.505***
	(2.185)	(1.817)
Observations	48	48
R-squared	0.9968	0.9948

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Let's further analyze the results obtained from the regression. It is easy to see that China has higher capital and labor intensity than the U.S. According to the property of the Cobb-Douglas production function, China exhibits an increasing return to scale, with its sum of α and β approximating 1, while the U.S. exhibits a constant return to scale since the sum of α and β is slightly higher than 1. The constant term is negative before, but after the exponential transformation, it is still positive, so we still have a positive TFP.

Recall that in the Solow growth model, when an economy has not yet reached a steady-state, it needs more capital accumulation to make savings increase and thus promote economic growth. Therefore, we interpret our regression results as follows: the U.S. already had a sound economic foundation before World War II and experienced decades of robust economic development after World War II and should have its mature and stable economic pattern; however, China experienced a more extended period of exploration of its development model after the founding of the country in 1949 and is still experiencing growth in economic development during this time span we are interested in and has not reached a steady-state, and therefore need more capital investment, higher α, to maintain high economic growth.

5.1.2 TFP Calculation

We then perform the calculation of total factor productivity. Using the formulas mentioned in the methodology section, we calculate the total factor productivity for China and the U.S. separately and plot the total factor productivity (TFP) over time by country. TFP in the U.S. is essentially constant, with minor fluctuations above and below zero; TFP in China shows an apparent upward trend until 1985, then stays constant until 2012, and then shows an upward trend after 2012. This may be due to China's development in industrial technology in the 1970s and the development of innovative entrepreneurship in China after 2012.

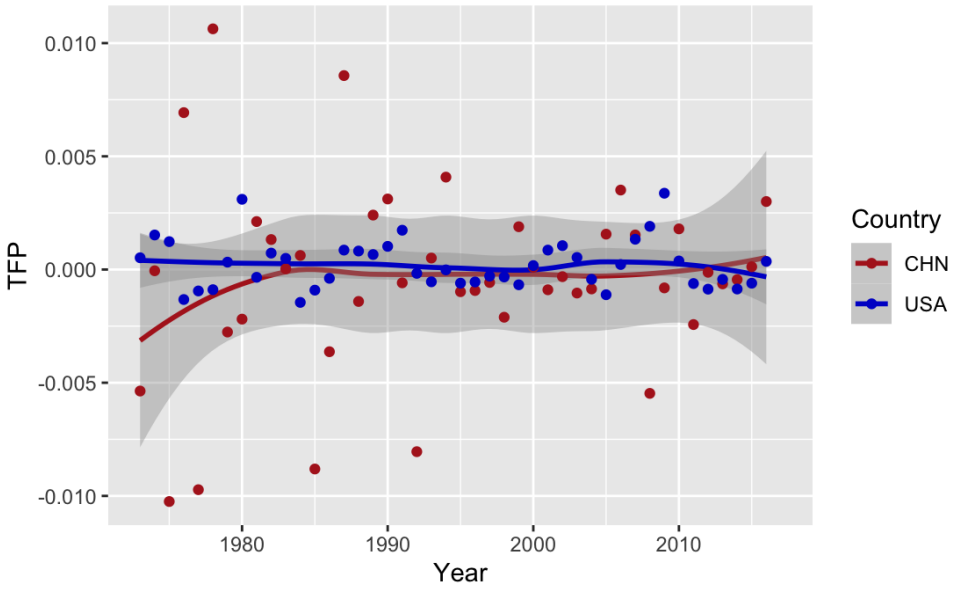


Figure 5.1: TFP of China and the U.S.

5.1.3 Growth Comparison

As for the part of growth comparison, we analyze through the plots of growth rate for capital stock, employment and real GDP.

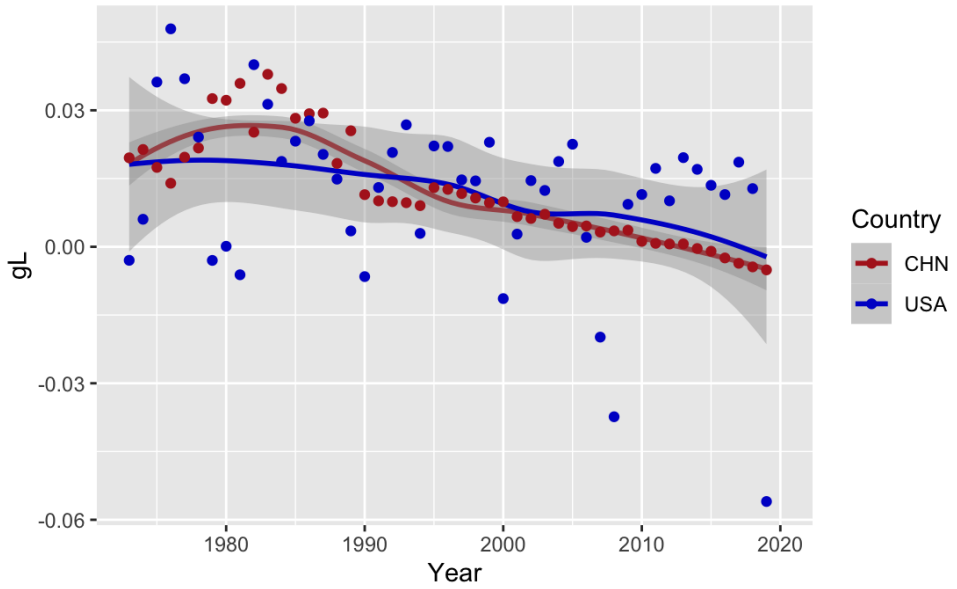
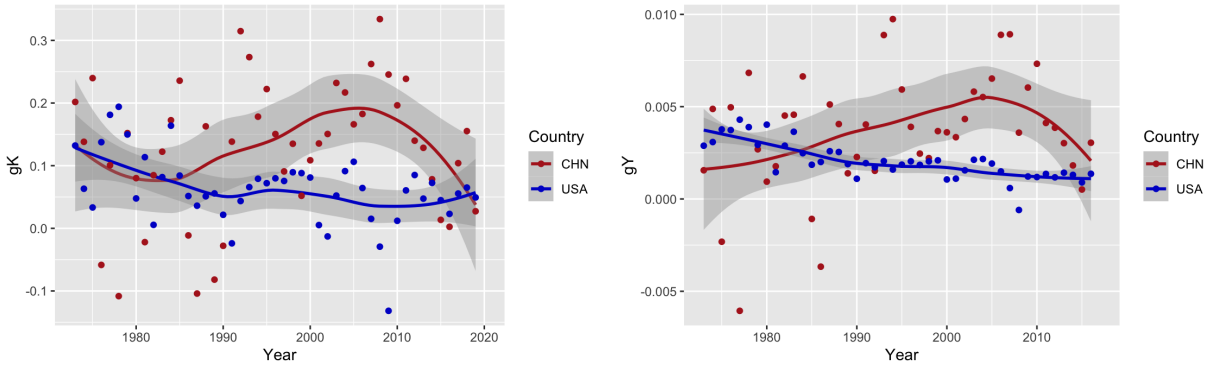


Figure 5.2: Growth Rate of Employment

Let's first focus our attention on the growth rate of employment levels. The graph shows that the growth rate for employment is decreasing for both countries but decreasing faster for China, indicating that China's demographic dividends are shrinking over time. Also, the decrease became steeper after 1990, considering the effect of the birth control policy in China.

From today's perspective, China's one-child policy of the 1980s planted a time bomb for the future. This policy directly led to social problems such as demographic imbalance and increasing aging in China in the coming century, WHICH will have a direct structural impact on economic growth. The Chinese government is currently trying to implement a two- and three-child policy. Still, the effect is limited, attributed to the high cost of raising children after socio-economic development, which is also a common problem in developed countries.



(a) Growth Rate of Capital Stock

(b) Growth Rate of Real GDP

Next, we focus on analyzing the growth rates of capital accumulation and real GDP. The fact that the patterns of capital accumulation and real GDP growth rates are strikingly similar, we must associate and wonder if they have a stronger linkage than other variables. If capital accumulation does affect real GDP more directly in different ways, what events make this result possible?

As mentioned before, China underwent reform and opening up around 1980 and joined the World Trade Organization in 2001. It is essential to mention that the growth rate of capital accumulation in China showed a clear downward trend after the international financial crisis in 2008, which implies that China's economic development has been closely aligned with the world economic situation. The reform and opening-up have opened the long-closed doors of China in economic terms, the WTO accession has made it easier for foreign investors to enter the Chinese market, and the impact of the global financial crisis has shown that China's economic development has been greatly influenced by foreign investment. These events, which are closely related to openness, also reflect the possible relationship between openness and capital stock and real GDP. Therefore, openness might play a key role in boosting economic performance.

5.2 Openness

5.2.1 Stationarity and Co-integration Test

The unit root test results, which are shown in Table, imply that in both US and China, time-series y_t, k_t, and z_t are all stationary after taking the first-order difference. To test whether these series are cointegrated or not, we conduct an ADF test of residuals from the static regression and compare the ADF test statistic with the critical values from Engle & Granger (1987). As a result, the null hypothesis can be rejected at the 1% significance level, and we can conclude that y_t, k_t, and z_t are all cointegrated in both US and China.

Table 4: ADF Test Statistics

Variables	Country	$z(t)$	p value	T	Lag
$\Delta\log(GDP)_t$	USA	-5.017	0.0002	39	3
$\Delta\log(Capital)_{t-1}$	USA	-3.757	0.0189	38	3
$\Delta Openness_t$	USA	-6.927	0	39	3
Static Residuals	USA	-4.068	< 0.01	38	1
$\Delta\log(GDP)_t$	CHN	-3.792	0.0170	41	3
$\Delta\log(Capital)_{t-1}$	CHN	-3.543	0.0350	41	3
$\Delta Openness_t$	CHN	-4.963	0.0002	41	3
Static Residuals	CHN	-5.269	< 0.01	41	3

5.2.2 Estimation of Trade-Openness Effect in the US

The cointegration relationship indicates the existence of LR equilibrium which OLS could unbiasedly estimate. Plus, ECM can be employed to investigate the SR relationship. The regression results of the US are shown in Table 4. Our estimation is based on the macroeconomic data of the US from 1980 to 2019. We consider this period because there has been a substantial structural change in American Economy in the post-war period, and after stagflation in the mid-1970s, the model of economic growth in the US has been more and more stable. Hence, the estimation based on data after 1980 will be the most significant.

The Breusch-Pagan (BP) Test is a statistical test for the autocorrelation and heteroscedasticity of error terms. The null hypothesis of the BP Test is the constant variance. The test statistic of the BP Test in SR regression is 0.26 with a p-value equal to 0.6072, which implies the null hypothesis can't be rejected. The Ramsey Regression Equation Specification Error Test (RESET) is designed to test the misspecification issue of the equation form and its null hypothesis is that the model has no omitted variables. The test statistic is 1.65 with a p-value equal to 0.1969, which means that the SR regression equation form is correct. In addition, the negative coefficient of ECT in SR regression is significant, whose absolute value is less than 1. The estimated coefficient of ECT is -0.172 implying that about 17.2% of the discrepancy between the LR and SR economic performance is corrected within a year. This evidence together suggests our SR regression on the basis of ECM does make sense.

We can also notice the LR R-Squared is more than 99%, which is much greater than the SR R-Squared, only 46%, and the LR capital effect is much larger than the SR capital effect. These can be explained by the fact that the variation of LR output could be explained by the variation of LR capital accumulation very well, while in SR, the situation is very different and much more complicated. The SR economic fluctuation is very difficult to explain, which will be determined by a lot of factors other than capital variation.

The most important thing we concern with is the causal effect of trade openness effect on economic growth. These regression results clearly show that the LR and SR trade-openness effect is both significant. For example, the LR estimated coefficient of trade openness is 0.0092, which suggests that if the ratio of export and import over total

Table 5: TimeSeries USA Regression Output

VARIABLES	LR_US $\log(GDP)_t$	SR_US $\Delta\log(GDP)_t$
$Openness_t$	0.00920***	
	(0.00297)	
$\log(Capital)_{t-1}$	0.547***	
	(0.0640)	
$\Delta Openness_t$		0.00947***
		(0.00195)
$\Delta\log(Capital)_{t-1}$		0.230***
		(0.0622)
ECT_{t-1}		-0.172*
		(0.0876)
Time Trend	YES	NO
Constant	5.043***	0.0291***
	(0.519)	(0.00370)
Breusch-Pagan Test		0.26
Ramsey RESET		1.65
Observations	40	39
R-squared	0.994	0.462

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

output increases by 1%, the GDP per capita will rise by approximately 0.92% on average, which is almost the same as the SR trade-openness effect.

5.2.3 Estimation of Trade-Openness Effect in China

Table 5 shows the empirical results of China. Our empirical analysis is based on the macroeconomic data of China from 1978 to 2019. We consider this period because the reform of the market economy and openness policy was initiated in 1978. The pattern of economic growth in China is totally different between the pre-reform period and post-reform period.

Table 6: TimeSeries China Output

VARIABLES	LR_CHN $\log(GDP)_t$	SR_CHN $\Delta\log(GDP)_t$
$Openness_t$	0.00274**	
	(0.00120)	
$\log(Capital)_{t-1}$	0.886***	
	(0.0111)	
$\Delta Openness_t$		-0.00107
		(0.00301)
$\Delta\log(Capital)_{t-1}$		0.559***
		(0.139)
ECT_{t-1}		-0.567***
		(0.171)
Time Trend	NO	NO
Constant	1.731***	0.0362*
	(0.0491)	(0.0187)
Breusch-Pagan Test		0.85
Ramsey RESET Test		1.76
Observations	43	43
R-squared	0.997	0.323

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The SR ECM of China also makes sense. For the BP Test, whose test statistic is 0.85 with a p-value equal to 0.3571 and Ramsey RESET, whose test statistic is 1.76 with a p-value equal to 0.1720, suggesting that the null hypotheses can't be rejected. So, there is no autocorrelation, heteroscedasticity, or misspecification issue with the SR regression. The estimated coefficient of ECT is -0.567 and it is significant, meaning about 56.7% of the discrepancy between the LR and SR economic performance is corrected within a year.

For the trade-openness effect, which is very distinct from the US case, although there is a significant LR effect, the SR effect doesn't survive. If we consider the LR, an increase of export and export over total output by 1% will cause an increase of LR GDP per capita by 0.274%, which is much smaller than that of the US.

5.2.4 Estimation by 2SLS

To control the potential endogeneity issue, we employ the democracy level as an IV and then do a 2SLS estimation. Table 7 combines results from the OLS and 2SLS estimation.

Table 7: 2SLS Output

VARIABLES	OLS_USA $\log(GDP)_t$	2SLS_USA $log(GDP)_t$	OLS_CHN $log(GDP)_t$	2SLS_CHN $log(GDP)_t$
$Openness_t$	0.00920***	0.0143***	0.0027***	0.0057***
	(0.00297)	(0.0042)	(0.0069)	(0.0021)
$\log(Capital)_{t-1}$	0.545***	0.9632***	0.8862****	0.8678***
	(0.0640)	(0.0631)	(0.0460)	(0.0155)
Constant	5.043***	4.9743***	1.7315***	1.7344***
	(0.519)	(0.5131)	(0.2522)	(0.0508)
Time Trend	YES	YES	NO	NO
Cragg-Donald Wald F Statistic		35.355		22.234
Anderson LM Statistic		19.819		15.363
Sargan Statistic		0		0
R-squared	0.9936	0.9931	0.9968	0.9963
Observations	40	40	43	43

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To test this IV's validity, we are concerned with the weak identification test and under-identification test. Since we use only one IV, it is unnecessary to consider the over-identification test. The Cragg-Donald Wald (CWD) F Statistic is the test statistic for weak identification test, and this statistic is 35.355 for US and 22.234 for China. We compare them with the critical value put forward by Stock & Yogo (2005) and find that they are much larger than the 10% maximal IV size. So, our IVs in both US and China are powerful. The Anderson LM Statistic is the test statistic for the under-identification test. The Anderson LM statistic for the US is 19.819 with a p-value equal to 0, and that of China is 15.363 with a p-value equal to 0.0001. So, the null hypothesis must be rejected, and we can conclude that there is no under-identification problem. The above tests verify the validity of our IV, and then we can do further analysis based on 2SLS results.

The trade-openness effect of the US estimated by 2SLS is 0.0143, which is a little larger than that estimated by OLS. For China, the trade-openness effect estimated by 2SLS is 0.0057 which is also a little bigger than that estimated by OLS. But the relative magnitude between the US and China does not change. Therefore, it seems like the OLS underestimates the LR trade-openness effect because of the endogeneity.

However, we need to do a further endogeneity test before we draw a conclusion. Table 8 illustrates the Hausman Test for Endogeneity. We follow the procedure of Hausman (1978) and consider the two stages of regression separately.

Table 8: Hausman Test for Endogeneity

VARIABLES	USA 1st Stage Regression $Openness_t$	USA Hausman Regression $\log(GDP)_t$	CHN 1st Stage Regression $Openness_t$	CHN Hausman Regression $\log(GDP)_t$
$Democracy_t$	118.0***		441.5805***	
	(19.85)		(93.6478)	
$Openness_t$		0.0143***		0.0057***
		(0.00410)		(0.0019)
$\log(Capital)_{t-1}$	-3.245	0.545***	5.0239***	0.8678***
	(2.625)	(0.0623)	(0.0475)	(0.1451)
$Error_{stage\ 1}$		-0.0100*		-0.0046*
		(0.00577)		(0.0024)
Time Trend	YES	YES	NO	NO
Constant	-68.21***	4.974***	-75.2807***	1.7344***
	(24.80)	(0.506)	(16.5895)	(0.4761)
Observations	40	40	43	43
R-squared	0.887	0.994	0.6553	0.997

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The significant democracy effect on the openness level further consolidates the strength of our IV. What we are concerned more in this part is the significance of the first-stage error in the second-stage regression. The t statistic of the US and China is -1.74 and -1.88, respectively, and both of these coefficients are significant at the 10% considerable level. From these not very large t statistics, we suppose trade openness in US and China are both weakly endogenous. That is when trade openness improves the LR economic performance, the level of economic development will also exert influence on the level of openness.

6 Discussion and Conclusion

6.1 Mechanism Analysis

The mechanism analysis attempts to explain why there is a vast difference in the trade-openness effect between China and the United States, which is actually the last part empirical results. In fact, a country's ability to compete in the world market implies the country's possible degree of openness. Therefore, in this part, we try to compare China

and the United States' competitiveness in the world market to confirm the veracity of the previous empirical results.

One aspect is that, at the starting point of the research period, the United States has already occupied an essential position in the world market, while China almost had no progress. This is because, before 1978, the Cultural Revolution in China had a severe impact on political and economic activities throughout the country. The Chinese government did not even solve the problems of food and clothing, not to mention paying attention to trade and openness. It was not until the end of 1978 that the Chinese government began to concentrate on the importance of opening up and then started to use the capital investment to drive rapid economic growth. By contrast, the United States had a better starting condition due to historical reasons. During the time of two world wars, the United States, on the one hand, reduced the cost of participating in the war through its neutrality and, on the other hand, quickly accumulated its capital power by selling weapons and other resources to the warring countries. In this way, the United States became the world's largest capital exporter at the end of World War II and continued to expand abroad vigorously after that, seeking an international outlet for its commodities and capital, which continued to strengthen its own economic strength. In summary, at the starting point of the research period, the United States had taken the lead in opening up and had already gained great occupation in the world market. This may set significant obstacles to Chinese opening up.

The other aspect is that, during the research period, as the main body of competitiveness, the conditions of enterprises in China and the United States were very different. In China, the enterprise management mechanism has not been completed. The enterprises have not truly become the legal entity and market competition subject that can operate independently, accounting for their own profits and losses with self-development and self-discipline. In addition, the enterprises cannot independently adjust their product structure and business strategies according to market changes. These restrictions may reduce enterprises' abilities and willingness to compete internationally. While in the United States, the free enterprise system has already matured. Enterprises are free to produce, and consumers are free to choose and buy. Each economic actor independently controls its resources, makes decisions, assumes risks and responsibilities, and relies on market price signals for coordination. The self-interest of each economic actor constitutes the fundamental driving force of market economic activities. In summary, the mature free enterprise system in the United States has made its enterprises more competitive in the world market. In contrast, the Chinese enterprise system lacks some features to motivate its enterprises and thus still has a long way to go.

To conclude the mechanism analysis part, the United States' first-mover advantage in opening up and the mature free enterprise system comprises its better competitive ability in the world market. Thus, better trade-openness impacts economic growth.

6.2 Conclusion

Here is a brief conclusion about the main results of the entire research.

In the part of growth accounting, the main conclusions are listed as follows. First of

all, China's TFP growth rate increased before 1985, remained stable until around 2015, which was not much different from the US TFP, and it showed a clear growth trend after 2015. Furthermore, the United States' economic model tended to be mature, stable, and close to constant return to scale; the Chinese economic model was still growing and currently showing an increasing return to scale. Last but not least, the path of economic growth was similar to that of capital growth; both countries had valued capital more than labor in their economic models, but China placed more weight on capital, which also shows that an economy that has not reached a stable level requires greater capital input.

In the part of the trade-openness effect, the main conclusions are listed as follows. Openness had a more significant role in promoting economic growth in the United States. The short-term effect of openness on economic growth in the United States was almost the same as the effect of long-term openness, which both were around 0.009. In addition, openness did not affect China's economic growth in the short term. After the endogeneity test, it was found that the degree of openness in both countries would be affected by economic performance, which means weakly endogenous.

6.3 Limitation

We had to admit that there are some limitations in the models. First, the form of production function might not be Cobb-Douglas. Second, we didn't control some major events worldwide that exerted a dominating effect on economic performance, which means the estimation might not be the most precise. Third, whether democracy is a perfect IV can be questioned. In the empirical results, democracy is still a strong instrument variable. Fourth, gross capital formation is not an ideal measurement of capital used in a year. However, with the limitation of resources, we can't use more precise measurements like the flow of capital services.

We believe that many of these deficiencies are due to our limited abilities. But it is the inadequacy that drives us to keep moving forward.

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