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Original Paper

The Impact of Foreign Direct Investment on Regional Economic Growth and Income Convergence a Panel Data Study in China

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Abstract

Previous studies regarding the impact of FDI on regional economic growth and income convergence in China have mixed results and are far from being conclusive due to different datasets and methodologies used. This study thus used a panel data from China Statistical Yearbook covering all 31 Chinese regions to better understand the impact of FDI on regional economic growth and income convergence in China. For the period between 1999 and 2017, it found that neither FDI inflow nor labor has a statistically significant impact on the provincial economic growth. However, domestic investment in fixed assets does have a statistically significant impact on the provincial economic growth. Moreover, there is no absolute β income convergence among regions. Nonetheless, there is a conditional β income convergence (a moderate convergence speed of 7.49%) after controlling for all other growth factors: domestic investment in fixed assets, population growth rate, FDI inflow, export, and higher education enrollment.

Keywords

Chinese regional economic growth, foreign direct investment, absolute β income convergence, conditional β income convergence, Cobb-Douglas production function

1. Introduction

1.1 Arising Regional Economic Inequality Since 1990s

Numerous studies have recognized that FDI may contribute positively to the economic growth (Ali & Guo, 2005; Fleisher et al., 2010; Graham & Wada, 2001; Ma & Jia, 2015; Sun & Chai, 1998; Tian, 2007; Wang et al., 2014; Zhang, 2006).

FDI may promote economic growth. However, it is likely to have some serious drawbacks, which have caused the significant gap in regional economic growth for recent decades since 1978 (see Figure 1

below) (Fleisher et al., 2010).

As a result of the income gap created, it could cause more social turmoil and political instability over time (Fujita & Hu, 2001). If the income gap continues to get worse, it would destabilize the Chinese economy (Crane et al., 2018).

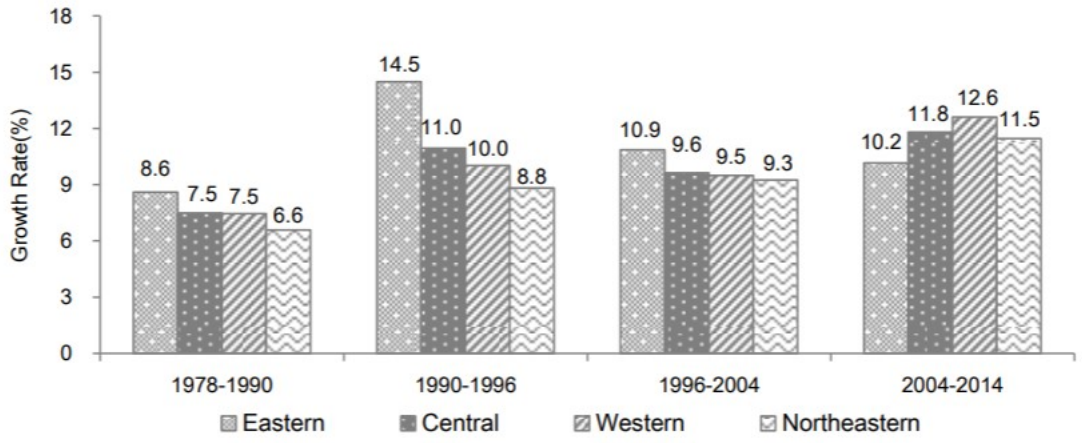

Figure 1. Growth Rate of GDP Per Capita of China's Four Regions 1978-2014

Note. Reprinted from "Analysis on the Regional Disparity in China and the Influential Factors," by F. Wang, 2016, *American International Journal of Humanities and Social Science*, *2*(4), p. 102. Copyright 2016 by American International Journal of Humanities and Social Science.

1.2 Overall Factors that Affect Regional Income Disparity Historically

In China, the reasons for the widening regional income gap are very complex and often in dispute (Wang et al., 2014). China's income gap can be decomposed into urban-rural gap, regional gap (inter-regional disparity), and intra-regional gap (Wang, 2016; Xie & Zhou, 2014).

Regional inequality often concerns inter-province gaps (Wang et al., 2014). These gaps are usually associated with the institutional and policy factors (Wang, 2016). The causes of income gaps between different regions may also include geographic location, labor migration, infrastructure level, urbanization, education, FDI, and international trade (Wang, 2016; Xie & Zhou, 2014).

Overall, previous research on what factors that affect regional economic growth and whether regional economy measured by GDP per capita growth in China is divergence or convergence are ambiguous and controversial due to various methodologies and scope of data used (Wei et al., 2009; Zhang, 2004).

Thus, this study was to investigate the FDI impact on regional economic growth in China, with the focus to fill the gap on whether there is an absolute and conditional β income convergence across provinces between 1998 and 2017.

The rest of the article is organized as follows. Chapter 2 briefly covers various topics regarding FDI and its impact on regional economic growth. Topics include disproportionate distribution of FDI in China, the skewed sources of FDI, the different entries and forms of FDI, and the distribution of FDI in

Chinese industry sectors. It also reviews methodologies of examining the impact of FDI on regional economic growth. Chapter 3 describes methodology and model specifications. The estimated results and analysis are presented in the Chapter 4. In Chapter 5, there are discussions, conclusions, and implications.

2. Literature Review

2.1 The Uneven Distribution of FDI

Region	Number of FIEs	Share (%)	Realized FDI Value (US$100 million)	Share (%)
Total	40910	100	1412.3	100
East	36613	89.5	1191.1	84.3
Central	2138	5.2	97.3	6.9
West	2137	5.2	92.9	6.6
Relevant departments	22	0.1	30.9	2.2

Figure 2. FDI Inflow to East, Central and West Parts of China in 2019

Note. Relevant departments involve banking, securities and insurance industries FDI statistics. From "Statistical Bulletin of FDI in China," by Ministry of Commerce, 2020 (http://images.mofcom.gov.cn/wzs/202012/20201230152644144.pdf). In the public domain.

The distribution of FDI varies by location, where the coastal province received over 90% of total FDI compared to other provinces, due to its economic and cultural advantage over the west (Broadman & Sun, 1997; Sun & Chai, 1998).

The east has self-enforcement mechanism due to an agglomeration effect, while the west has so many disadvantages such as poor industry infrastructure, physical long distance from ocean, and low level of living standards, so the west thus relies heavily on government investments to undergo industrialization to boost economy (Zhang, 2004). Ran et al. (2007) concluded that with the inflow of FDI to China, the eastern region seems to benefit from FDI, while the central and western region could not take advantage of it.

2.2 The Unbalanced Origins of FDI

Country/Region	Number of New FIEs	Share (%)	Realized FDI Value (US$100 million)	Share (%)
Total	40910	100	1412.3	100
Hong Kong (SAR, China)	17873	43.7	963.0	68.2
Singapore	1242	3.0	75.9	5.4
The Republic of Korea	2108	5.2	55.4	3.9
British Virgin Islands	304	0.7	49.6	3.5
Japan	1000	2.4	37.2	2.6
United States	1733	4.2	26.9	1.9
Cayman Islands	129	0.3	25.6	1.8
Netherlands	182	0.4	18.0	1.3
Macau (SAR, China)	1083	2.6	17.4	1.2
Germany	562	1.4	16.6	1.2
Taiwan (Province of China)	5252	12.8	15.9	1.1
Samoa	197	0.5	11.9	0.8
Britain	640	1.6	8.6	0.6
France	349	0.9	7.9	0.6
Republic of Ireland	45	0.1	6.6	0.5
Other	8189	20.0	45.0	3.2

Figure 3. Top 15 Investors of China as of 2019

Note. From "Statistical Bulletin of FDI in China," by Ministry of Commerce, 2020 (http://images.mofcom.gov.cn/wzs/202012/20201230152644144.pdf). In the public domain.

There are some reasons which may explain why Hong Kong and Taiwan (HKT) dominate the FDI in China. The empirical study summarized that the majority of FDI in China made by HKT is export-orientated, encouraged by low labor cost in China and incentives from the policies regarding this type of FDI. It also added that compared to HKT, FDI from the EU, US, and Japan, known as the Triad, supplying 90% of FDI globally, is market-oriented, discouraged by restrictive policies against market-oriented FDI (Zhang, 2005).

2.3 The Main Channels and Types of FDI

There are two channels through which FDI can enter the Chinese market. One is Mergers and Acquisitions (M&A), a major form of FDI in global countries other than China, where M&A accounts for only 5% of FDI on average in China. The second is Greenfield investment, which consists of three

types: Equity Joint Venture (EJV), contractual or Cooperative Joint Venture (CJV), and Wholly Foreign-Owned Enterprises (WFOE) (Huang, 2009).

In 2019, WFOE accounts for 74.6% of all foreign-invested enterprises (FIEs) and 66.3% of total FDI actually realized. In comparison, EJV accounts for 24.60% of all FIEs and 22.50% of total FDI actually realized. CJV is negligible and significantly smaller than EJV, which only accounts for 0.2% of all FIEs and 0.2% of total FDI actually realized (Ministry of Commerce, 2020). These three forms account for the vast majority of FDI in China (See Figure 4 below).

Forms	Number of FIEs		Realized FDI Value	
	Number	Share (%)	Value (Billions of dollars)	Share (%)
Total	40910	100	1412.3	100
Equity Joint Venture	10077	24.6	317.8	22.5
Contractual Joint Venture	70	0.2	3.3	0.2
Wholly Foreign-owned Enterprise	30533	74.6	936.1	66.3
Foreign Invested Share Limited Corporation	117	0.3	80.8	5.7
Others	113	0.3	74.2	5.3

Figure 4. Statistics of FDI by Form in 2019

Note. Other FIEs include partnerships and cooperative development projects, etc. From "Statistical Bulletin of FDI in China," by Ministry of Commerce, 2020 (http://images.mofcom.gov.cn/wzs/202012/20201230152644144.pdf). In the public domain.

2.4 The Distribution of FDI in Industry Sections

In China, the National Bureau of Statistics of China (NBSC) defines the scope of each industry: primary industries mainly refer to agriculture, forestry, animal husbandry, and fishery; secondary industries mainly refer to the mining industry, manufacturing, and utilities (electricity, gas, and water); the tertiary industry is mainly the service industry (NBSC, 2013).

In recent years, the tertiary industry has predominantly received the majority of FDI inflow (see Figure 5 below). After China joined the World Trade Organization (WTO) in December 2001, FDI was allowed in the service industry and restrictions for FDI with retail, wholesale, and distribution were gradually lifted by the end of 2004 (Branstetter & Lardy, 2006; Davies, 2010). Banking, financial services, insurance, and telecommunications were also open to FDI by the end of 2006 (Branstetter & Lardy, 2006).

Industry	Number of New FIEs	Share (%)	Realized FDI Value (US$100 million)	Share (%)
Total	40910	100	1412.3	100
Primary Industry	424	1.0	4.4	0.3
Secondary Industry	6262	15.3	422.3	29.9
Tertiary Industry	34224	83.7	985.5	69.8

Figure 5. Industries of FDI in 2019

Note. From "Statistical Bulletin of FDI in China," by Ministry of Commerce, 2020 (http://images.mofcom.gov.cn/wzs/202012/20201230152644144.pdf). In the public domain.

In 2019, according to Ministry of Commerce (2020), it said that "FDI mainly focused on manufacturing, real estate, leasing and business services, information transmission, software and information technology services, wholesale and retailing, finance and scientific research, technology service and geological prospecting" (p. 20).

Figure 6 below presented a picture of the most recent industrial structure breakdown in 2019, which emphasized that these industries accounted for 89% of total FDI in terms of number of new established FIEs and accounted for 89.2% of FDI actual used (Ministry of Commerce, 2020).

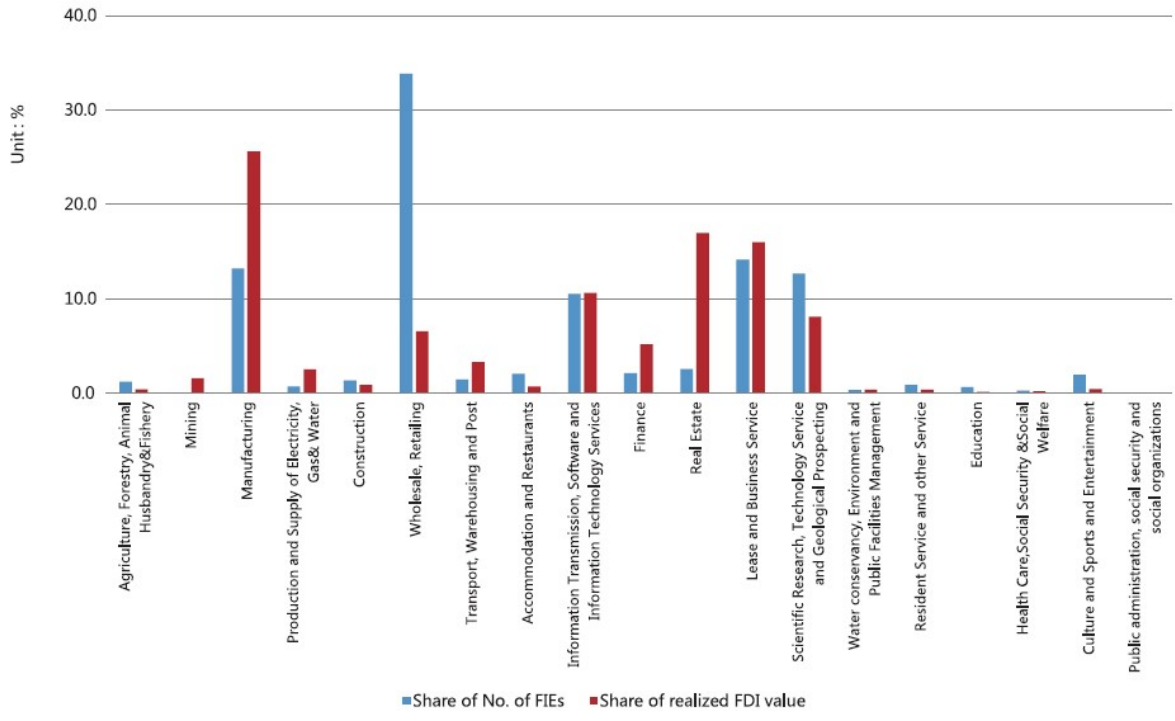

Figure 6. Industrial Structure of FDI in 2019

Note. From "Statistical Bulletin of FDI in China," by Ministry of Commerce, 2020 (http://images.mofcom.gov.cn/wzs/202012/20201230152644144.pdf). In the public domain.

2.5 Methodologies on Researching FDI and Regional Economic Growth

Methodologies on researching the relationship between FDI and regional economic growth vary, but most studies empirically use regression analysis based upon neoclassical models, with a series of panel data collected mainly from various issues of *Statistical Yearbook of China*.

Chen and Wu (2005) built an empirical model based on the endogenous growth model using the pooled cross-section (provinces) and time-series data covering the period from 1988 to 1998, and they revealed FDI may positively affect regional economic growth.

Wei (2008) used panel data between 1979 and 2003 to discover its relationship between FDI and regional inequality through augmented Cobb-Douglas production function, contending that GDP can be a significant factor that determines the amount of FDI in a province in China and higher GDP could lead to more FDI in one region.

Lin et al. (2011) introduced the panel cointegration model using province-level panel data from 1997 to 2006 to empirically explore the effect of FDI on Total Factor Productivity (TFP) across regions in China.Its empirical result found the spillover effects of FDI inflow may markedly result in economic growth and technological advancement in China for both short and long period within and cross regions.

Ma and Jia (2015) stated that the effect of FDI on income inequality has been examined by the neoclassical model of convergence and the augmented model with FDI introduced using provincial panel data for three periods: 1978-2007, 1978-1990 and 1991-2007. They found that during 1978-1990, regional economic growth showed a convergence trend while during 1991-2007, its growth rate became divergence (Ma & Jia, 2015).

3. Methodology and Model Specifications

3.1 Variables

3.1.1 Variables for Regional Economic Growth Model

The traditional Cobb-Douglas production function is a production function model with capital, labor, and technology as the main factors promoting economic growth (Cobb & Douglas, 1928):

$$Y = A\,K^{\alpha}L^{\beta}$$

among them, Y is the gross regional product; A is TFP; K is capital input; α is output elasticity of capital; L is labor input; β is the output elasticity of labor.

When dealing with regional economic growth issue, it assumes that the economic growth of each region is consistent with characteristics of the Cobb-Douglas production function. GDP can be used to measure regional output value. Capital and labor can be used to measure regional input. More specifically, domestic investment and FDI can be used to measure capital utilized.

The regional production function thus can be written as: $Y = f(DK, FDI, L)$, or as:

$Y = A\,DK^{\alpha}FDI^{\beta}L^{\gamma}$

Among them, A represents TFP. Y stands for GDP, DK stands for domestic investment, FDI stands for foreign direct investment, and L stands for total domestic human capital. The parameters α, β and γ represent the output elasticity of domestic investment, FDI and labor, respectively. Take the logarithm of both sides of equation to get:

$LnY = \partial + \alpha LnDK + \beta LnFDI + \gamma LnL + \varepsilon$

Based on the Cobb-Douglas production function above and previous work (Chen & Wu, 2005), it establishes a new econometric model:

$$Lny_{it} - Lny_{it-1} = \delta + \alpha * d_{LnDK_{it}} + \beta * d_{LnFDI_{it}} + \lambda * d_{LnL_{it}} + \varepsilon_{it}\ Eq. \quad (1)$$

Among them, i is the regional subscript, t is the time subscript, y_{it} represents the GDP per capita of each region over the years, d_LnDK_{it} represents annual growth rate of domestic investment in fixed asset in each province, and d_LnFDI_{it} represents annual growth rate of FDI inflow received by each province over time, measured by the actual amount used. d_LnL_{it} is annual growth rate of the number of employed persons in each province over time.

3.1.2 Variables for Income Convergence Test

The Solow model has important implication that saving and population growth could impact the real income (Solow, 1956). Solow assumes that saving rate, population growth, and technology are exogenous (Mankiw et al., 1992; Solow, 1956). Based on Mankiw et al. (1992), the following Solow growth model's steady-state income per capita formular below is derived from the Cobb-Douglas production function ($production\ at\ time\ t: Y_t = K(t)^{\alpha}(A(t)L(t))^{1-\alpha}\ where\ 0 < \alpha < 1$):

$$Ln\left(\frac{Y(t)}{L(t)}\right) = LnA(0) + gt + \frac{\alpha}{1-\alpha}Ln(s) - \frac{\alpha}{1-\alpha}Ln(n+g+\delta)$$

Later, Mankiw et al. (1992) in their seminal work extended the Solow growth model by taking into consideration the human capital accumulation (measured as percentage of working-age population in secondary school), and the augmented Solow model used for β conditional convergence is shown below:

$$Ln\left(\frac{Y(t)}{L(t)}\right) = LnA(0) + gt - \frac{\alpha+\beta}{1-\alpha-\beta}Ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}Ln(S_k) + \frac{\beta}{1-\alpha-\beta}Ln(s_h)$$

$\frac{Y(t)}{L(t)}$ represents income per capita, n and g refer to population growth rate and technological growth rate respectively, δ is the rate of capital depreciation, S_k is the investment as part of income in physical capital, s_h is the investment as part of income in human capital. α is the physical capital's share of income, and β is the human capital's share of income, where $\alpha + \beta < 1$.

If y^*represents the steady level of income per capita, then the convergence speed is defined as below:

$$\frac{dLn(y_t)}{dt} = \lambda[Ln(y^*) - Ln(y_t)]$$

Where $\lambda = (n + g + \delta)(1 - \alpha - \beta)$, then:

$$Ln(y_t) = \left(1 - e^{-\lambda t}\right)Ln(y^*) + \left(e^{-\lambda t}\right)Ln(y_{t-1})$$

The equation for estimating conditional convergence is thus formed below:

$$Ln(y_t) - Ln(y_{t-1})$$

$$= \left(1 - e^{-\lambda t}\right)\frac{\alpha}{1 - \alpha - \beta}Ln(s_k) + \left(1 - e^{-\lambda t}\right)\frac{\beta}{1 - \alpha - \beta}Ln(s_h)$$

$$- \left(1 - e^{-\lambda t}\right)\frac{\alpha + \beta}{1 - \alpha - \beta}Ln(n + g + \delta) - \left(1 - e^{-\lambda t}\right)Ln(y_{t-1})$$

Where y_{t-1} is GDP per capita in previous year.

To deal with the income convergence test, this study first employs the basic idea of β absolute convergence based up the previous work (Baumol, 1986):

$$Ln(y_{it}) - Ln(y_{it-1}) = \alpha + \beta Ln(y_{it-1}) + \varepsilon_{it}\, where\, \beta = \left(1 - e^{-\lambda t}\right)\, Eq. \qquad (2)$$

λ= rate of convergence

Note: y_{it} and y_{it-1} represents the GDP per capita of the current and previous year. If β is statistically significant and negative, there is absolute income convergence.

If absolute income convergence exists, then it implies that conditional convergence exists as well (Wei et al., 2009). Thus, the specification of second estimation equation for this study is derived from the augmented Solow model as well as the Cobb-Douglas production function mentioned before to better analyze the factors that may improve the rate of convergence:

$$Lny_{it} - Lny_{it-1} = \gamma_0 + \gamma_1 Ln(y_{it-1}) + \gamma_2 Ln(s)_i + \gamma_3 Ln(n + g + \delta)_i + \gamma_4 Ln(FDI)_i + \gamma_5 Ln(Export)_i + \gamma_6 Ln(Education)_i + \varepsilon_i, where\, \gamma_1 = \left(1 - e^{-\lambda t}\right)\, Eq. \qquad (3)$$

y_{it} and y_{it-1} are the same as the previous absolute convergence formula (Baumol, 1986). All growth factors mentioned in the augmented Solow model are included: s is specified as the ratio of the investment in fixed assets to GDP. n is the annual population growth rate; g is the technological growth rate; δ refers to the capital depreciation rate; $(g + \delta)$ is set to be 0.05 for all provinces over the entire period; Education is specified as the ratio of the number of students enrolled in higher education over population. FDI and export are introduced as important growth factors that promote economic growth, based on the previous work (Wei et al., 2009). FDI is defined as the ratio of actually used FDI to GDP. Export is defined as the ratio of total value of export to GDP. λ is estimated within the Stata software.

If γ_1 is statistically significant and negative, there is a conditional β income convergence. The dummy variable for each region is introduced at the regional level to help identifying if there is a conditional convergence among the four economic regions (Wei et al., 2009). A total 3 dummy for the 4 economic regions was added using the Stata to avoid the dummy variable trap: central dummy, west dummy, and northeast dummy.

3.2 Research Questions/Hypotheses

3.2.1 First Question

The first research question: Whether FDI inflow, domestic investment in fixed assets, and employed labor have an impact on regional economic growth in China between the years 1999 and 2017? The hypotheses below address this question:

Hypothesis One

H_0: FDI inflow does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

H_1: FDI inflow has a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

Hypothesis Two

H_0: Domestic investment in fixed assets does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

H_1: Domestic investment in fixed assets has a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

Hypothesis Three

H_0: The total number of people employed in each province does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

H_1: The total number of people employed in each province has a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

3.2.2 Second Question

The second research question (absolute β income convergence): Whether there is an absolute β income convergence among regions in China between the years 1999 and 2017? The hypothesis below addresses this question:

Hypothesis Four

H_0: There is no absolute β income convergence among regions between the years 1999 and 2017 (i.e., $\beta = 0$: previous level of income per capita does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017).

H_1: There is an absolute β income convergence among regions between the years 1999 and 2017 (i.e., $\beta < 0$: previous level of income per capita has a statistically significant and negative impact on the provincial economic growth between the years 1999 and 2017).

3.2.3 Third Question

The third research question (conditional β income convergence): Whether there is a conditional β income convergence among regions in China between the years 1999 and 2017? The hypotheses below address this question:

Hypothesis Five

H_0: There is no conditional β income convergence among regions between the years 1999 and 2017 (i.e., $\gamma_1 = 0$: Initial level of income per capita does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017).

H_1: There is a conditional β income convergence among regions between the years 1999 and 2017 (i.e., $\gamma_1 < 0$: Initial level of income per capita has a statistically significant and negative impact on the provincial economic growth between the years 1999 and 2017).

Hypothesis Six

H_0: Domestic investment in fixed assets does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

H_1: Domestic investment in fixed assets has a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

Hypothesis Seven

H_0: Population growth rate does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

H_1: Population growth rate has a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

Hypothesis Eight

H_0: FDI inflow does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

H_1: FDI inflow has a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

Hypothesis Nine

H_0: Total value of export does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

H_1: Total value of export has a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

Hypothesis Ten

H_0: The number of students enrolled in higher education does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

H_1: The number of students enrolled in higher education has a statistically significant impact on the provincial economic growth between the years 1999 and 2017.

4. Data and Empirical Results

4.1 Sample and Data

4.1.1 Sample

The panel dataset includes all 31 provinces, direct-controlled municipalities, and autonomous regions in China. The 20 years ranging from 1998 to 2017 is selected as sample interval. A total of 620 observations was hence collected from various editions *China Statistical Yearbook* (1999-2018). The choice of sample interval is mainly because of data availability, but also because FDI began to enter China in large quantities during this period and increased steadily. In addition, Chongqing became a municipality directly under the Chinese central government in 1997 (Li, 2007), so it would better collect data since 1998. The collected panel dataset was input into an Excel file, which was processed and analyzed by Stata 15.1.

This study uses the definition of FDI by NBSC as the research dataset comes from *China Statistical Yearbook*. It uses NBSC's method which divides these provinces, direct-controlled municipalities, and autonomous regions into four major economic regions. Eastern regions include: Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; central region encloses provinces: Shanxi, Anhui, Jiangxi, Henan, Hubei, and Hunan; western region covers: Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang; northeast region comprises: Liaoning, Jilin, and Heilongjiang.

4.1.2 Data

FDI Inflow: This data is collected from tables called "Actually Used Foreign Direct and Other Investment by Region (USD 10,000)" in various editions *China Statistical Yearbook* (1999-2018). The foreign direct investment column includes the FDI inflow data for all 31 provinces, direct-controlled municipalities, and autonomous regions. This variable is deflated using the Consumer Price Index (CPI) from 1998 taken from the table called "General Price Indices" in *China Statistical Yearbook* 1999 edition (Federal Reserve Bank of Dallas, n.d.).

Total Investment in Fixed Assets: The total investment in fixed assets for 31 provinces, direct-controlled municipalities, and autonomous regions is calculated (Total-Foreign Funded-Funds from HK, Macao, and Taiwan) from tables called "Total Investment in Fixed Assets by Ownership (100 million RMB)" in various editions *China Statistical Yearbook* (1999-2018). It thus includes only domestic investment in fixed assets. This variable is deflated using CPI from 1998 taken from the table called "General Price Indices" in *China Statistical Yearbook* 1998 edition. Since this variable scale is in RMB 100 million, it is converted to USD 100 million using Stata. The annual exchange rates for converting are downloaded from the OECD website (OECD, 2021).

Employed Population: The total number of employed persons in each 31 provinces, direct-controlled municipalities, and autonomous regions is directly collected from tables called "Number of Employed Persons by Type of Industry and Region (in 10,000 persons)" in various editions *China Statistical Yearbook* (1999-2018).This data covers employment from all industries.

GDP Per Capita Growth: The provincial GDP is taken from tables called "Gross Domestic Product by Region (100 million RMB)" in various editions *China Statistical Yearbook* (1999-2018). The provincial GDP is then deflated using CPI from 1998 taken from the table called "General Price Indices" in *China Statistical Yearbook* 1999 edition (Federal Reserve Bank of Dallas, n.d.). Since this provincial GDP scale is in RMB 100 million, it is also converted to USD 100 million using Stata. The annual exchange rates for converting are downloaded from the OECD website (OECD, 2021). The provincial population data is collected from the table called "Total Population and Birth Rate, Death Rate and Natural Growth Rate by Region (in 10,000 persons)" in various editions *China Statistical Yearbook* (1999-2018). The real provincial GDP per capita is then calculated using the deflated provincial GDP divided by the provincial population in the panel data. The calculations of provincial GDP per capita growth are conducted using the Stata statistical software.

Export: The total value of export for 31 provinces, direct-controlled municipalities, and autonomous regions is taken from tables called "Total Value of Imports and Exports by Location of Importers/Exporters (USD 10,000)" in various editions *China Statistical Yearbook* (1999-2018). This variable is deflated using CPI from 1998 taken from the table called "General Price Indices" in *China Statistical Yearbook* 1999 edition.

Education: This data covers the number of students who enroll in higher education in all 31 provinces, direct-controlled municipalities, and autonomous regions each year, which is collected from tables called "Number of Schools and Students in Undergraduate or Specialized Courses in Institutions of Higher Education by Region" in various editions *China Statistical Yearbook* (1999-2018).

4.2Variable and Definition

Detailed variables and their definition used in the data analysis are presented in Table 1 below.

Table 1. All Variables Used in This Study and Their Definition

Variables	Definition
$rgdp_{it}$	real GDP in RMB, calculated using 1978 price, for province i at year t
$rgdppa_{it}$	real GDP per capita, calculated using *rgdp* divided by provincial population
g_rgdppa_{it}	annual growth rate of $rgdppa$, calculated by taking the natural log difference of $rgdppa$ between two consecutive years for each province i
$lag\_lnrgdppa_{it}$	natural logarithm of $rgdppa$ of the previous year for province i $lag\_lnrgdppa_{it} = lnrgdppa_{it-1}$
$rgdppa1998_{it}$	*Rgdppa* for province I at year t= 1998, $rgdppa1998_{it} = rgdp_{it}/$ provincialpopulation
$rinvest_{it}$	real domestic investment in fixed assets in RMB, calculated using 1978 price, for province i at year t
$dlnrinvest_{it}$	the difference between natural logarithm of *rinvest*between two consecutive years,

	$dlnrinvest_{it} = dlnrinvest_{it} - dlnrinvest_{it-1}$
$rfdi_{it}$	real FDI in RMB for province i at year t, calculated by first multiplying the annual exchange rates, then divided using 1978 price
$dlnrfdi_{it}$	the difference between natural logarithm of *rfdi*between two consecutive years, $dlnrfdi_{it} = dlnrfdi_{it} - dlnrfdi_{it-1}$
$lnrfdiratio_{it}$	natural logarithm of the ratio of *rfdi* to *rgdp*for province i at year t
$labor_{it}$	the number of employed persons for province i at year t
$dlnlabor_{it}$	the difference between natural logarithm of *labor*between two consecutive years, $dlnlabor_{it} = dlnlabor_{it} - dlnlabor_{it-1}$
central	all provinces, direct-controlled municipalities, and autonomous regions located in the central region
west	all provinces, direct-controlled municipalities, and autonomous regions located in the west region
northeast	all provinces, direct-controlled municipalities, and autonomous regions located in the northeast region
s_{it}	the ratio of *rinvest* to *rgdp*, for province i at year t
$lnsratio_{it}$	natural logarithm of the ratio of *rinvest* to *rgdp*,for province i at year t
ng_{it}	annual population growth rate for province i at year t,$ng_{it} = \frac{ng_{it}}{ng_{it-1}} - 1$
$lnng_{it}$	natural logarithm of the sum of *ng*, g (technological growth rate), and δ (capital depreciation rate), for province i at year t. (g + δ) is set to be 0.05
$rexport_{it}$	the total value of export inRMB for province i at year t,calculatedbyfirstmultiplying the annual exchange rates,thendivided using 1978 price
$lnrexportratio_{it}$	natural logarithm of the ratio of *rexport* to *rgdp*,for province i at year t
edu_{it}	the ratio of the number of students enrolled in higher education to population,for province i at year t
$lneduratio_{it}$	natural logarithm of *edu*,for province i at year t
Implied λ	the speed rate of convergence or divergence

Note. Data ranges from 1998 to 2017 and data on all variables (except annual exchange rates) are taken from various editions *China Statistical Yearbook* (1999-2018 edition). Base year of CPI is 1978 with (1978's CPI = 100). The annual exchange rates from 1998 and 2017 are retrieved from the OECD website (OECD, 2021).

4.3 Estimation Procedure and Stata's Application

This study followed an estimation procedure, including pre-estimation data diagnose for multicollinearity and heteroskedasticity, model selection among pooled Ordinary Least Squares (OLS), Fixed Effects (FE) model and Random Effects (RE) model, overall significance test for dummy variables and model validation for exclusion of Omitted Variable Biases (OVB) (Stoddard, n.d.).

4.3.1 Multicollinearity Diagnosis

Before estimation, it needs to ensure that there is no multicollinearity among regressors otherwise the estimation would be biased and unreliable. Variance Inflation Factors (VIF) is used to detect collinearity.

4.3.2 Heteroskedasticity Diagnosis

Although heteroskedasticity does not bias the coefficients' estimation, it makes the hypotheses testing unreliable, where there are biased standard errors causing bias in t statistics and confidence intervals (Williams, 2020). Breusch-Pagan / Cook-Weisberg test (BPtest) for heteroskedasticity is used to detect heteroskedasticity.

4.3.3 Model Selection between Pooled OLS and FE Model

If there exists no unobserved heterogeneity across different units, then Pooled OLS (POLS) instead of FE should be used because POLS is consistent and efficient. The F-test is used to examine the joint significance of unit-specific fixed effects.

4.3.4 Model Selection between Pooled OLS and RE Model

To test the existence of serial correlation among unit-specific unobserved heterogeneities, the Breusch and Pagan Lagrangian multiplier (BP-LM) test for random effects is used.

4.3.5 Model Selection between FE Model and RE Model

Further analysis is needed to examine whether the unobserved heterogeneities across units are correlated with regressors. Hausman test is used to examine this correlation.

4.3.6 Overall Significance of Dummy Variables

It uses F test to check the overall significance of added dummies. If the added dummies are significant as a whole, they are kept in the model. Otherwise, they are dropped.

4.3.7 Model Evaluation: the OVB Test

After model estimation, it is necessary to validate the model by checking if there exist omitted variables. The Ramsey RESET (Ramsey Regression Equation Specification Error Test) is used to detect OVB. Ramsey RESET checks if non-linear combinations of the fitted values are useful in explaining the response variable.

4.4 Estimation Results of Regional Economic Growth model

Table 3. Regional Economic Growth Model Analysisat National Level from 1999 to 2017

	(1)
	Regional Economic Growth
	1999-2017
VARIABLES	pooled OLS
dlnrinvest	0.232***
	(0.0423)
dlnrfdi	-0.00600
	(0.00750)
dlnlabor	0.0151
	(0.0117)
Constant	0.0605***
	(0.00719)
Observations	589
R-squared	0.241

Note. Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Estimation results for Eq. (1) in chapter 3.

For the regional economic growth model, there is no multicollinearity problem (mean vif: 1.01 < 5) but heteroskedasticity (p-value of BP test is 0.00<0.05). Thus, robust standard errors are used in estimation. Pooled OLS model is the final selected model because pooled OLS model is preferred over FE model (p-value of F-test is 0.91 > 0.05) and RE model (p-value of BP-LM) test is 1.00>0.05).

The coefficient of dlnrfdi is negative but insignificant even at 10% level. The coefficient of dlnrinvest is 0.232 and is statistically significant even at the 1% level, indicating that 1% increase in dlnrinvest is estimated to increase the g_rgdppa by 23.2%. The coefficient of dlnlabor is positive but also insignificant even at 10% level.

R-squared for economic growth model is low respectively. Meanwhile, the sign of dlnrfdi is inconsistent with expectation and coefficients of dlnrfdi and dln labor are insignificant, indicating potential problems. Indeed, the p-value of Ramsey RESET test is 0.00, less than 0.05, indicating that there is OVB. Thus, in the conditional convergence test, this study adds other relevant regressors as described in Chapter 1.

4.5 Estimation Results of Income Convergence Test

4.5.1 Absolute β Income Convergence at National Level

Table 4. Absolute β Income Convergence Analysis at National Level between 1999 and 2017

	(1) Absolute Income Convergence 1999-2017
VARIABLES	fixed effects
lag_lnrgdppa	0.103***
	(0.0116)
Constant	-0.153***
	(0.0283)
Implied λ	0.1082
Observations	589
Number of provinceid	31
R-squared	0.122

Note. Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Estimation results for Eq. (2) in chapter 3.

For the absolute β income convergence between years 1999 and 2017, there is no multicollinearity (mean vif: 1.00<5.00) and no heterogeneity problem (p-value of the BP test is 0.78 >0.05). FE model is preferred over the pooled OLS (p-value of the F test is 0.00 < 0.05), thus pooled OLS is excluded from model selection. After conducting Hausman test, FE model is preferred over RE model because p-value of Hausman test 0.00 less than 0.05.

The estimated coefficient of lag_lnrgdppa is 0.103 and is statistically significant even at the 1% level, indicating that 1% increase in lag_lnrgdppa is estimated to increase the g_rgdppa by 10.30%. It also carried out the absolute income beta test (H_0: =0; H_1:<0) with a left-tail t-test. The t-statistic for lag_lnrgdppa is 8.81 much more than the critical left-tail t-test value of -1.647, thus it fails to reject the H_0 at 5%, indicating that there is no absolute β income convergence between years 1999 and 2017.

In addition, the R-Squared is still low around 12%, suggesting a poor goodness-of-fit in this regression model. This analysis also runs the Ramsey RESET test for OVB, the p-value of Ramsey RESET test for column 1 is 0.86 much more than 0.05, indicating that there is no OVB in this model.

4.5.2 Conditional β Income Convergence at National Level

Table 5. Conditional β Income Convergence Analysis at National and Regional Level between 1999 and 2017

	(1)	(2) Conditional Income Convergence Test 1999 - 2017	(3) Conditional Income Convergence Test 1999 - 2017
	Conditional Income Convergence Test 1999 - 2017	fixed effects	fixed effects
VARIABLES	fixed effects	with interaction dummy	with interaction dummy and year dummy
lag_lnrgdppa	0.151***	0.155***	-0.0777*
	(0.0164)	(0.0168)	(0.0442)
lnsratio	-0.0103	-0.00859	0.0297***
	(0.00940)	(0.00980)	(0.0102)
lnng	-0.0295***	-0.0296***	-0.0250***
	(0.00537)	(0.00537)	(0.00435)
lnrfdiratio	-0.00892	-0.0187*	0.00958
	(0.00693)	(0.0103)	(0.00896)
lnrexportratio	0.0153**	0.0143**	0.00451
	(0.00596)	(0.00604)	(0.00537)
lneduratio	0.0446***	0.0448***	0.0342**
	(0.00921)	(0.00930)	(0.0159)
central×lnrfdiratio		-0.00579	-0.0337*
		(0.0234)	(0.0192)
west×lnrfdiratio		0.0161	-0.00574
		(0.0130)	(0.0105)
northeast×lnrfdiratio		0.0253	0.000101
		(0.0190)	(0.0157)
Constant	-0.123**	-0.135**	0.437**
	(0.0557)	(0.0566)	(0.187)
Implied λ	0.1631	0.1689	-0.0749
Observations	581	581	581
R-squared	0.232	0.236	0.549

Year Dummy	Yes

Note. Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Estimation results for Eq. (3) in chapter 3.

Year dummy used the base year of 1999 as shown in the Stata result.

For the conditional β income convergence at national level between years 1999 and 2017 (column 1), There is no multicollinearity problem (mean vif: 2.50) and no heterogeneity (p-value of the BP test is 0.68 >0.05). FE model is preferred over the pooled OLS (p-value of the F test is 0.00 <0.05), thus pooled OLS is excluded from model selection. After conducting Hausman test, FE model is preferred over RE model because p-value of Hausman test 0.00 less than 0.05.

The estimated coefficient of lag_lnrgdppa is 0.151 and is statistically significant even at the 1% level, indicating that 1% increase in lag_lnrgdppa is estimated to increase the g_rgdppa by 15.10%. It also carried out a left-tail t-test (H_0: =0; H_1:<0). The t-statistic for lag_lnrgdppa is 9.15 greater than the critical left-tail t-test value of -1.647, thus it fails to reject the $\square_0$ at 5%, indicating that there is no conditional β income convergence between years 1999 and 2017.

In addition, the R-Squared is around 23.2%, improved significantly than the absolute β income convergence test, but still suggesting a poor goodness-of-fit in this regression model. Meanwhile, the signs of both lnrfdiratio and lnsratio are inconsistent with expectations and their coefficients are insignificant, indicating potential problems, such as OVB.

This analysis also runs the Ramsey RESET test for OVB, the p-value of Ramsey RESET test for column 1 is 0.0014 less than 0.05, indicating that there is omitted variables, which may cause OVB. The model needs to be improved. Therefore, additional variables of interaction dummy are added in the column 2 below.

4.5.3 Conditional β Income Convergence at Regional Level

For the conditional β income convergence at regional level with interaction dummy between years 1999 and 2017 (column 2), interaction term between region dummies (central, west, and northeast) and lnrfdiratio can help the study determine the impact of lnrfdiratio on regional economic growth (each regional dummy). Multicollinearity and heterogeneity are already checked and FE model is also selected in the conditional β income convergence at national level.

The estimated coefficient of lag_lnrgdppa is 0.155 and is statistically significant even at the 1% level, indicating that 1% increase in lag_lnrgdppa is estimated to increase the g_rgdppa by 15.50%. It also carried out a left-tail t-test ($\square_0$: =0; $\square_1$:<0). The t-statistic for lag_lnrgdppa is 9.23 greater than the critical left-tail t-test value of -1.647, thus it fails to reject the $\square_0$ at 5%, indicating that there is no conditional β income convergence between years 1999 and 2017.

In addition, the R-Squared is still around 23%, still suggesting a poor goodness-of-fit in this regression model. Meanwhile, the signs of both lnrfdiratio and lnsratio are inconsistent with expectation and the

coefficient of lnsratio is statistically insignificant, indicating potential problems, such as OVB.

This analysis also runs the Ramsey RESET test for OVB, the p-value of Ramsey RESET test for column 2 is 0.0004 less than 0.05, it thus rejects H_0 (H_0: the model has no omitted variables), indicating that there is omitted variables, which may cause OVB. The model still needs to be improved. As a result, year dummy as an additional variable, is added in the column 3 below.

For the conditional β income convergence at regional level with interaction dummy and year dummy between years 1999 and 2017 (column 3), interaction term between region dummies (central, west, and northeast) and lnrfdiratio can help the study determine the impact of lnrfdiratio on regional economic growth (each regional dummy).

The additional year dummy helps the study assess the year effect because there are factors that may change over time but are in-variant within each entity in which the year dummy can help the study to grasp. Multicollinearity and heterogeneity are already checked and FE model is also selected in the conditional β income convergence at national level.

The estimated coefficient of lag_lnrgdppa is -0.0777 and is statistically significant at the 10% level, indicating that 1% increase in lag_lnrgdppa is estimated to decrease the g_rgdppa by 7.77%. It also carried out a left-tail t-test (H_0: =0; H_1:<0). The t-statistic for lag_lnrgdppa is -1.76 less than the critical left-tail t-test value of -1.647, thus it can reject the H_0 at 5%, indicating that there is conditional β income convergence between years 1999 and 2017.

All of the interaction dummies are statistically insignificant except central × lnrfdiratio. To examine the total effect of FDI inflow for each region, both the coefficient of lnrfdiratio and interaction dummies should be considered. Thus, additional F tests are carried out (using commands “margins region, dydx (lnrfdiratio)” in Stata), and p values of the test for all regions are greater than 0.05, suggesting the lnrfdiratio has no statistically significant impact on regional economic growth overall.

For instance, when the central dummy equals to 1, the sum of estimated coefficient of central×lnrfdiratio and lnrfdiratio in this model is -0.02 (-0.0337+0.00958=-0.02), and is statistically insignificant (H_0: the coefficient of the lnrfdiratio for central region is equal to zero. H_1: the coefficient of the lnrfdiratio for central region is not equal to zero. Fail to reject H_0 because p value from the Z score is 0.184 more than 0.05).

In addition, it calculated the speed of convergence (conditional convergence λ with interaction dummy and year dummy (1999-2017) = “ ln(1/(1-_b[lag_lnrgdppa]))). Implied λ is -0.0749, suggesting that there is a moderate convergence speed of 7.49% among regions between years 1999 and 2017.

Moreover, the R-Squared is around 55%, significantly improved over the previous model, suggesting a decent goodness-of-fit in this regression model. Meanwhile, the conditional income convergence exists which are consistent with most of other studies.

The signs of lnsratio and lnng as well as lneduratio are all consistent with expectations. However, only the coefficient of lnrfdiratio and lnrexportratiois are statistically insignificant even at 10%, which are not expected and inconsistent with many studies, but their signs are still correct.

This analysis also runs the Ramsey RESET test for OVB, the p-value of Ramsey RESET test for column 3 is 0.1109 greater than 0.05, it fails to rejects H_0 (H_0: the model has no omitted variables), indicating that there are no OVB, implying this model is satisfactory and better built.

Table 6. Hypothesis Summary

Research Question 1: Whether FDI inflow, domestic investment in fixed assets, and employed labor have an impact on regional economic growth rate between the years 1999 and 2017?		
No.	Hypothesis (H_0)	Results
1	FDI inflow does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.	Fail to reject H_0
2	Domestic investment in fixed assets does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.	Reject H_0
3	The total number of people employed in each province does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.	Fail to reject H_0
Research Question 2: Whether there is an absolute β income convergence among regions in China between the years 1999 and 2017?		
No.	Hypothesis (H_0)	Results
4	There is no absolute β income convergence among regions between the years 1999 and 2017	Fail to reject H_0
Research Question 3: Whether there is a conditional β income convergence among regions in China between the years 1999 and 2017?		
No.	Hypothesis (H_0)	Results
5	There is no conditional β income convergence among regions between the years 1999 and 2017	Reject H_0
6	Domestic investment in fixed assets does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.	Reject H_0
7	Population growth rate does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.	Reject H_0
8	FDI inflow does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.	Fail to reject H_0

9	Total value of export does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.	Fail to reject H_0
10	The number of students enrolled in higher education does not have a statistically significant impact on the provincial economic growth between the years 1999 and 2017.	Reject H_0

5. Discussions, Conclusions, and Implications

5.1 Discussions

5.1.1 Domestic Investment in Fixed Assets

The domestic investment in fixed assets has a striking positive contribution to overall economic growth in China shown in this study. Since the political reform and economic opening up, the acceleration of industrialization and urbanization has promoted the continuous investment and deepening of capital. However, it has led to serious regional economic inequality due to its early strategy. In the early stages of reform and opening up since 1978, supreme leader Deng Xiaoping pointed out: some areas should be preferred to develop first, and other areas developed later. The areas (eastern region) that develop first will lead to the development of other regions (central, west, northeast), and ultimately achieve prosperity.

As a result, the Chinese central government issued a series of regional policies balancing the distribution of domestic investment in fixed assets. In November 1999, it determined the strategy for the development of the western region (known as China Western Development). In 2003, it proposed the strategy of revitalizing the old industrial base in Northeast China (known as Revitalize the Old Northeast Industrial Bases). Driven by the policy, the fixed assets investment growth of the three major sectors has accelerated significantly, and the development pattern of the four major sectors of east, central, west and northeast is gradually taking shape.

5.1.2 FDI Inflow

FDI inflow may greatly promote economic growth as found in many studies. However, in this study, it has no significant impact in enhancing regional economic growth and conditional income convergence. One possible explanation is that FDI inflow from HKT has a positive effect on China's economic growth but has no long-term economic promotion effect. As mentioned before in Chapter 2, HKT dominates the FDI inflow in China while the developed countries and regions like the U.S. and the EU only account for a small share of total FDI inflow in China.

FDI from HKT is at a disadvantage in technology and scale compared to FIE from Europe and America. It mainly invests in labor-intensive sectors and tends to be a short-term investment. On the other hand, European and American FDI is more involved in high-tech industries. Technological innovation is still the source of economic growth.HKT is restricted by their low technological content. It is thus difficult to drive the increase of China's technological levels, so to a certain extent, its effect on economic growth is limited.

Another possible explanation is that the over-density of FDI in the eastern region has caused excessive competition in the industries it invests in, thereby reducing capital efficiency and affecting the increase in output. Considering the large number of FDI gathered in the eastern region, most of these capitals are concentrated in competitive industries, investment opportunities are thus reduced, FDI began to show signs of shifting to the central region. Moreover, the western region still lacks the investment environment of FDI, such as adequate infrastructure, human capital, etc., in order to absorb the incoming FDI for economic growth.

5.1.3 The Total Number of People Employed

Labor was found no significant impact on regional economic growth in this study. Overall, labor shortage is likely to be a major reason on minimizing regional economic contribution of labor. Although the total amount of labor resources is still relatively abundant, the problem of structural shortage of labor has gradually emerged.

First, the labor supply gap is relatively large. Currently, there are 170 million skilled labors, approximately 25% of total employed labor, while only 48 million are high-skilled workers, about 7% of the total employed labor (Du, 2020).

Second, the labor shortage weakens China's international competitive advantage. With the structural unemployment (mostly in high-skilled sector caused by the educational gap) and the significant increase in labor wages(especially in manufacturing and labor-intensive exports) in the past decades, China's demographic dividends and international competitive advantages are declining, and some multinational companies have turned their attention to Southeast Asia.

Third, the structural shortage of labor has led to the dual dilemmas of labor's difficulties in finding employment and firm's difficulties in hiring labor. Since the reform and opening up, China has carried out a series of market-oriented reforms, but the reform of the education system has lagged behind the market-oriented reforms, resulting in a disconnect between the education system and the labor market.

5.1.4 Absolute β Income Convergence

There is no absolute β income convergence among regions between the years 1999 and 2017, consistent with existing literature. The source of the convergence of China's economic growth needs to be further explored, such as the natural resource endowment of each province, the state's policies on each province, and the economic policies within each province, etc. A typical example is China's policy on the eastern coastal areas since the reform and opening up. The regional biased policy (open up and develop the east first) and the development strategy of rich regions (east) helping grow poor regions (central, west, and northeast) has played a certain role in mobilizing the enthusiasm of local economic development, but it actually exacerbated the imbalance of regional development to a certain extent.

Some studies, however, believed that the government policy adjustments can alleviate the imbalance of regional development. This research tends to take the absolute β income convergence study as a part of the comparative study and subordinate it to the condition β income convergence to illustrate the necessity of introducing other control variables for the condition β income convergence test.

5.1.5 Conditional β Income Convergence

There is conditional β income convergence among regions between the years 1999 and 2017 after controlling for all other growth factors: domestic investment in fixed assets (lnsratio), population growth rate (lnng), FDI inflow (lnrfdiratio), total value of export (lnrexportratio), and the number of students enrolled in higher education (lneduratio), consistent with existing literature. This implies that increase in domestic investment in fixed assets and the number of students enrolled in higher education, controlling the population growth can help promote regional economic growth and thus narrow the regional income inequality over time. Discussions indepth about these variables are in other parts in this section respectively: "Domestic Investment in Fixed Assets," "The Number of Students Enrolled in Higher Education", and "Population Growth Rate".

5.1.6 Population Growth Rate

In China, and most developing countries, controlling population growth doesn't hinder or even promote the economic development. The study also is consistent with this idea. Since the reform and opening up, despite China's rapid economic development and continuous improvement in overall national strength, its GDP has leapt to the forefront of the world, but due to overpopulation, China's per capita GDP still ranks behind the world's level.

The Chinese central government thus chose to implement the strategic decision of family planning in early 1980s. Although China has maintained a low fertility rate since 2000asaresultof family planning national policy, with the advent of an aging population, China's aging population is rapidly changing this favorable demographic structure, which will adversely affect its future economic growth potential. The "Green Paper on Population and Labor" issued by the Chinese Academy of Social Sciences (2019) pointed out that long-term population decline, especially accompanied by increasing aging, will bring about unfavorable socio-economic consequences.

A large number of research results have shown that population aging directly leads to a reduction in the working-age population and a shrinking labor market, which slows down economic growth; although the negative impact on the capital-output ratio is not obvious, it may reduce labor productivity by significantly slowing down TFP growth or reducing the level of TFP and thus reduces the potential growth level of the economy in many Asian and European countries (Aiyar & Ebeke, 2016; Hsu, 2017; Thang, 2011; Westelius & Liu, 2016).

5.1.7 Total Value of Export

Export was found no significant impact on conditional income convergence in this study, while many studies have a converse conclusion. It can be partly explained by the long-term minimal effect of export on TFP in the Cobb–Douglas production function (Qian et al., 2011).

In the short term, if China has a large of surplus resources and products, including a surplus of labor (the reality, however, is serious shortage of labor explained above), China will need to use these idle resources to increase demand by expanding exports, thereby stimulating economic growth and achieving full employment.

In other words, under the condition of the existence of surplus products, export can promote economic growth. However, if the expansion of exports is not based on the use of surplus resources, but squeezes the resources of other sectors, the role of export driving up regional economic growth will be greatly reduced. The reason is that an increase in exports will lead to a decrease in output in the non-exporting sector, that is, the importing sector.

Under the restrictive economic conditions of shortage of resources and shortage of goods, export expansion, especially exports of shortage of resources, will further reduce supply, causing supply bottlenecks, leading to reduced production and economic recession (Qian et al., 2011). If China resolves the bottleneck in supply by importing scarce domestic production resources, then imports will promote economic growth.

In the long run, the effect of foreign trade on economic growth depends entirely on whether it can promote the increase of factor input (labor and capital) and the increase of TFP. Scholars purported that export-promoting technological progress is the strongest and most sustainable mechanism for promoting economic growth (Bhagwati, 1988; Gupta, 1985). Many countries tend to use the mechanism of export-promoting technological progress.

However, historically developing countries able to make good use of this mechanism are rare, and most developing countries have failed to effectively stimulate technological progress. Even if there is certain technological progress, it is difficult to achieve technological catch-up and surpass due to the small technological diffusion and dissemination effect of the export sector on the domestic sector. Therefore, the core issue to be solved urgently is how to properly use import and export to improve technological levels and increase the accumulation of domestic human capital.

5.1.8 The Number of Students Enrolled in Higher Education

The higher education enrollment has a significant positive impact on conditional income convergence, consistent with majority studies. To start with, education promotes the improvement of TFP and promotes economic growth by improving the quality of human capital. Formal school education plays a decisive role in the production of human capital, because good school education is the main way for people to form knowledge, ability and character, and is also a necessary foundation for job training. As an important source of knowledge-based economic growth today, human capital has become the core element of TFP. All other components of TFP depend more or less on the quantity and quality of human capital.

Moreover, education promotes the upgrading of industrial structure and promotes economic growth by improving the quality of workers. The continuous optimization and upgrading of the industrial structure are one of the important sources of economic growth. In a sense, the process of a country's economic growth is itself a process of continuous optimization and upgrading of the country's industries.

The industrial upgrading mentioned here not only refers to the upgrading of a country's economy from labor-intensive industries to capital-intensive industries, and then to the upgrading of knowledge and technology-intensive industries; it also refers to the focus of the national economy from the primary

industry to the secondary industry. It also refers to the optimization and upgrading of the internal structure of the three industries.

Lastly, education promotes consumption and promotes economic growth by adjusting the income distribution structure. Economic growth is affected by many factors, including investment, foreign trade, technological innovation, the quality of labor, and household consumption. As the final demand, consumption is the first driving force for economic growth.

In the past three years, although China's consumption rate has increased, it is still far below the level of developed countries and the world average. Insufficient consumption has become an important obstacle to the sustainable and healthy development of China's economy. In order to ensure the long-term sustainable growth of China's economy, expanding consumer demand is an inevitable choice to promote the transformation of China's economic growth mode from investment and export-driven to innovation-driven and consumption-driven.

5.2 Conclusions

Based on the quantitative analysis, it found that for the period between the years 1999 and 2017, FDI inflow and labor do not have a statistically significant impact on the provincial economic growth between, while domestic investment in fixed assets has a statistically significant impact on the provincial economic growth.

The result also indicated that there is no absolute β income convergence among regions. However, it suggested that there is a moderate conditional β income convergence among regions, after controlling for all other growth factors: domestic investment in fixed assets (lnsratio), population growth rate (lnng), FDI inflow (lnrfdiratio), total value of export (lnrexportratio), and the number of students enrolled in higher education (lneduratio).

It has some unexpected findings. First, FDI inflow was found no significant impact in promoting regional economic growth, even after controlling for all other growth factors. One possible explanation would be that FDI inflow from HKT has no long-term economic promotion effect. Another possible explanation is that the over-density of FDI in the eastern region has caused excessive competition in the industries it invests in, thereby reducing capital efficiency and affecting the increase in output.

Second, labor has no significant impact on regional economic growth in this study. Overall, labor shortage is likely to be a major reason on minimizing regional economic contribution of labor. Third, export has no significant impact on conditional income convergence in this study. It can be partly explained by the long-term minimal effect of export on TFP in the Cobb–Douglas production function.

Nonetheless, it has some weakness and limitations. First, the quality of data from the NBSC may be not ideal due to political reasons. Second, it has a decent size of sample, but datasets from multiple sources are recommended for comparison to gain more insights although in reality it is unlikely. In addition, this panel data study explored only several limited variables within a limited time frame. The unobserved heterogeneity like geography and culture in each province, which has been controlled for in this study, but unable to observe or measure now, should be added in the later study to make result

more robust.

5.3 Implications

5.3.1 Implications for Policymakers

The conclusion of this study has significant policy implications that may provide Chinese policymakers with more insights to form more effective policies to reduce the income inequality across different regions in the country.

First, the government may consider increasing more domestic investment in fixed assets to grow regional economy and reduce regional economic imbalance. For instance, strengthening investment in transportation infrastructure in various provinces, especially in the western and northern regions where the transportation infrastructure is relatively lagging behind, is conducive to promoting China's economic growth and the balanced development of the regional economy.

Second, the Chinese central government should consider continuing the improvement of family planning policy, while focusing on dealing with serious aging problem to stimulate regional economic growth. China implemented family planning to successfully deal with the surge of population growth, artificially reducing the proportion of children in the population, creating a productive labor force structure.

Last, China should consider increasing the number of students enrolled in higher education through further education reform to promote regional economic growth. Firstly, higher education is more difficult to adapt to the needs of the society; secondly, due to the single subject of running a school, the higher education system inevitably appears rigidity and lack of vitality; what's more serious is that because higher education is regulated by the government, local government policy can easily lead to overall deviations in higher education. Thus, more private higher education should been courage to diversify system and can better meet the need of labor market.

5.3.2 Implications for Other Developing Countries

The results and analysis of this study may have significant implications to other developing countries with similar economic and social underpinnings. The reason why China's experience is of great significance to developing countries is that China and the vast majority of developing countries have similar histories, have similar pursuits, and face similar problems. Both China and the vast number of developing countries have gone through hardships in history. Through the national liberation movement, they broke free from imperialism and colonialism and became independent economically and culturally less developed countries.

Today, they are struggling to achieve modernization. All have encountered problems in resources, funds, talents, technology, management experience, etc., as well as the difficulties caused by the implementation of adverse policies from developed countries. In other words, China and the vast number of developing countries share a common historical destiny.

The reason why China's experience is of great significance to developing countries is also because China's consistent arduous exploration for forming its own unique economic development path and

strategy to balance regional economic growth inequality and reach its modernization pursuit is a significant paradigm and an implication to the vast number of developing countries, such as Vietnam, Cuba, and North Korea.

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