ESSAYS ON HUMAN CAPITAL AND PRODUCTIVITY ANALYSIS IN CHINA

By
LILI KANG

A thesis submitted to the University of Birmingham
For the degree of
DOCTOR OF PHILOSOPHY

Birmingham Business School
The University of Birmingham
March 2012

ABSTRACT

This thesis examines the Chinese economy by focusing on the specialized human capital themes of production processes, regional productivity disparities and convergence, cost competitiveness comparisons and private returns to education from 1978 to 2009.

Chapter 2 reviews the growth accounting model and measurement methods of its components such as capital services, labour inputs, labour composition index and Total Factor Productivity index.

China's spectacular economic growth is from unequal performance of provinces and regions. Thus, chapter 3 examines effects of the physical and human capital on disparities and convergence of labour productivity, Total Factor Productivity and average wages in China, incorporating the market reform factors. We find that composition-adjusted human capital is more important than capital services in the production function. We also overcome the endogeneity of schooling in the wage function with instrumental variables.

In chapter 4, we discuss industrial disparities and convergence across countries and provinces from labour costs perspective to figure out industries with comparative competitiveness advantage.

Moreover, we correct the Heckman selection bias problems of education returns in chapter 5. We find that education returns keep on rising over time, which support human capital hypothesis rather than the signalling effect for all age groups except the group educated during the "Cultural Revolution".

ACKNOWLEDGEMENTS

I would like to express my gratitude to my supervisor Professor Mary O'Mahony for her excellent supervision, support and comments, and co-supervisor Professor Stan Siebert who offers great help with labour economics. I appreciate the wonderful comments from my two examiners, Dr Michela Vecchi and Dr Fiona Carmichael, my chairman Professor Jim Love as well. Thanks for Andy Briggs' excellent editorial assistance.

I am grateful to the European Commission 7th framework program, staffs of EU KLMES for the data, the Carolina Population Centre for data and advice on the China Health and Nutrition Survey, China Economic Association 19th, 20th and 21th Annual Conferences (2008-2010), the Sheffield Work Pension and Employment Group (WPEG) Conferences (2009-2010), the West Midlands PhD Colloquiums (2008-2010) and the Birmingham Business School's Management Workshops (2010-2012).

I am greatly indebted to my mother XiuZhen Li, my father BoCai Kang, my husband Fei Peng and sweet family members for all their deep love, without which I could not start and continue my PhD.

TABLE OF CONTENTS

CHAPTER ONE: INTRODUCTION……………………………………………1

CHAPTER TWO: GROWTH ACCOUNTING ANALYSIS ……….........……....5

2.1 Introduction…………………………………………………….........……...5
2.2 Growth accounting model………………………………........…………..…7
2.2.1 Methodology………………………………………….….……..……7
2.2.2 Measuring capital services………………………………………8
2.2.3 Measuring labour composition index……………........…………....10
2.3 Measuring capital services in China…………………………....………........12
2.3.1 Data sources……………………………………..……..….......12
2.3.2 Measurement method…………………………........……………….13
2.3.3 Results……………………………………........…………………14
2.4 Measuring labour composition index in China……........…………..………..15
2.4.1 Data sources …………………………........……………………..15
2.4.2 Measurement method ……………………........…………….....……16
2.4.3 Results……………………………........………..……………….19
2.5 Total factor Productivity (TFP) ……………..........………………..………26
2.6 Contributions of labour and capital to GDP.........…………………………..……29
2.7 Conclusions……………………………........……………………………35

CHAPTER THREE: ECONOMIC REFORM AND PRODUCTIVITY CONVERGENCE……………………………………………………………38

3.1 Introduction……………………………………………………………38
3.2 Literature review ………………………………………………………42
3.3 Empirical specifications……………………….………………………51
3.3.1 Baseline empirical specifications………………………..………51
3.3.2 Empirical specifications for beta-convergence…………………53
3.4 Data Description………………………………………………………..55
3.5 Empirical results……………………………………………………..…59
3.5.1 Results of baseline regressions…………………………………..…59
3.5.2 Results of beta-convergence regressions……………..……………68
3.6 Endogeneity of Education……………………………..…………………72
3.6.1 Empirical specifications and choice of instruments ………………...72
3.6.2 Composition bias of age……….……………..…….………………..78
3.6.3 Data description………………………………………………….....80
3.6.4 Empirical results……………………………………………………..81
3.7 Conclusions……………………………………………………………84

CHAPTER FOUR: COST COMPETITIVENESS COMPARISONS AND CONVERGENCE……………………………………………………………………..87

4.1 Introduction……………………………………………………………87
4.2 Measurement method of unit labour cost ………………………………..89
4.3 Construction of the dataset………………………………………………93
4.4 Results……………………………………………………………………96
4.4.1 International comparisons of relative unit labour costs and drivers….97
4.4.2 Relative provincial unit labour costs within China………………103
4.5 Decompositions of relative unit labour costs ……………………………..111
4.6 Convergence in RULC, RLP and RNLC………………………………122
4.7 Conclusions…………………………………………………………….128

CHAPTER FIVE: A SELECTION ANALYSIS ON EDUCATION RETURNS……………………………………………………………..………..130

5.1 Introduction……………………………….…………………………130
5.2 Empirical specifications…………………………………………………134
5.2.1 Signal and human capital effects …………………………….....134
5.2.2 Heckman selection bias……..…………………………………...138
5.3 Data description……………………………………………………139
5.4 Empirical results……………………………………………………....144
5.5 Conclusions…………………………………………………….….157

CHAPTER SIX: CONCLUSIONS…………………………..………………...159

REFERENCES………………………………………………………..…………..169

APPENDICES……………………………………………………………........… 181

LIST OF TABLES

Table 2.1: Annual growth rate of real capital stock……………………..........….……15
Table 2.2: Urban share (by province and region)……………………………………..…..20
Table 2.3: Measured coefficients of wage rates by region using the average approach ……………………………………………………………….………………21
Table 2.4: Measured coefficients of wage rates by region using the OLS approach ……………………………………………………………………..…...…23
Table 2.5: Average labour composition index …………………….………….....…...25
Table 2.6: Annual growth rates of labour composition index…………………….…26
Table 2.7: Annual growth rates of Total Factor Productivity…………………………..29
Table 2.8: Sources of growth (without Labour composition index) ………………….31
Table 2.9: Sources of growth (with Labour composition index) ………..…………….34

Table 3.1: Changes of labour productivity, TFP and wages, 1978-2009………..40
Table 3.2: Data description of economic growth in China………………….…....58
Table 3.3: Production function and sensitivity tests using equation (3.1) …..…..60
Table 3.4: Fixed effect models using equation (3.2), 1978-2009 ……………....62
Table 3.5: Sensitivity tests for structural break (Y1994), fixed effect models, 1978-2009 using equation (3.3) ……………………………………………………………………64
Table 3.6: Sensitivity tests for 4 regions, fixed effect models, 1978-2009………………………………………………………………………….....66
Table 3.7: Regressions to test for beta-convergence in China using equation (3.7), 1978-2009……………………………………………………………………...………..69

Table 4.1: EU KLEMS code of industries……………………………………..…….95
Table 4.2: Unit labour costs relative to China across 19 countries, manufacturing subsectors…………………………………………………………………………...…..99
Table 4.3: Relative labour productivity 1978-1995 and 1995-2007, by 19 countries, relative to China, 12 manufacturing subsectors…………………………….…...…101
Table 4.4: Relative Nominal labour costs 1978-1995 and 1995-2007, by 19 countries,

relative to China, 12 manufacturing subsectors……………………………………102
Table 4.5: Unit labour costs 1978-1995 and 1995-2009, by 28 provinces, relative to China national level, 9 one-digit sectors………………………….……………104
Table 4.6: Relative labour productivity 1978-1995 and 1995-2009, by provinces, relative to China national level, 9 sectors……………………………….………107
Table 4.7: Relative Nominal Labour costs 1978 to 1995 and 1995 to 2009, 28 provinces, relative to China national level, 9 sectors…………………………….….…...109
Table 4.8: Decomposition of relative unit labour costs, 19 countries compared with China, 1978-1995 (Values have been timed 100)………………..…………………113
Table 4.9: Decomposition of relative unit labour costs, 19 countries compared with China, 1995-2007 (Values have been timed 100)…………………………....….115
Table 4.10: Decomposition of relative unit labour costs, 28 provinces compared with national level, 1978-1995 (Values have been timed 100)…………………….….…..118
Table 4.11: Decomposition of relative unit labour costs, other 28 provinces compared with national level, 1995-2009 (Values have been timed 100).......…………….….120
Table 4.12: Annual Growth rates of Coefficients of variations for across country comparisons……………………………………………………………..….125
Table 4.13: Annual growth rates of coefficients of variation for provincial comparisons……………………………………………………………….….128

Table 5.1: Data description for cross-sectional data……………………........………143
Table 5.2: Data description for pooled data (four age groups)…………..................144
Table 5.3: Ordinary Least Square regressions, by year………………...........……147
Table 5.4: Ordinary Least Square regressions, by cohort……………….....…...….148
Table 5.5: Heckman Selection Model…………………………………………154

LIST OF FIGURES

Figure 2.1: Real GDP per worker by region (Yuan in 1995)………….. …………6

Figure 3.1: Coefficients of variation, 1978-2009…………………..…………….41

Figure 4.1: Coefficients of variations of RULC for international comparisons…..…122

Figure 4.2 Coefficients of variations of RULC for provincial comparisons…..…126

Figure 5.1: Ordinary Least Square Model - marginal effects and low/upper limits……………………………………………………………………….…….150

Figure 5.2: Heckman Selection Model - marginal effects and low/upper limits…………………………………………………………………………..…155

ABBREVIATIONS

AW – Average wages

BLS - U.S. Bureau of Labor Statistics

CHIP - Chinese Household Income Project

CHNS - China Health and Nutrition Survey

CRS – Constant returns to scale

CSY - China Statistical Yearbook

CV - Coefficient of variation

ER - Exchange rate

EU - European Union

FDI - Foreign Direct Investment

GDP - Gross Domestic Product

GLS – Generalized Least Squares

GVA - Gross Value Added

ICOP - International Comparison of Output and Productivity

IO - Input-Output Table

IV - Instrumental Variable

KELMS - Capital (K), Labour (L), Energy (E), Material (M) and Service inputs (S)

KL – Capital per worker (capital deepening)

LCI - Labour Composition Index

LP - Labour Productivity

NBS - China's National Bureau of Statistics

NLC - Nominal Labour Cost

OLS - Ordinary Least Square

PIM - Perpetual Inventory Method

PPP - Purchasing Power Parity

P.R.C – People's Republic of China

PWT - Penn World Table

RLP - Relative Labour Productivity

RMB - Renminbi (China's currency)

RNLC - Relative Nominal Labour Costs

RULC - Relative Unit Labour Costs

SOE - State-Owned Enterprises

TFP - Total Factor Productivity

UK - The United Kingdom

ULC - Unit Labour Costs

UNCTAD – United Nations Conference on Trade and Development

US - The United States

UVR - Unit Value Ratios

CHAPTER ONE: INTRODUCTION

"Knowledge is the only instrument of production that is not subject to diminishing returns."

(Clark, 1923)

China introduced economic reforms and open-door policies in 1978. After thirty years' growth, China has surpassed Japan to become the second biggest economy in the world by 2010. Existing literature shows that the Chinese economic miracle has been mainly pushed by investment in both physical and human capital (Ding and Knight, 2011). However, investment in physical capital has shown diminishing returns in scale and cannot support a sustainable economic growth in China. Instead, as Clark said in his *Studies in the Economics of Overhead Costs* (1923), knowledge is the only instrument of production that is not subject to diminishing returns, making human beings the centre of the economy.

China should learn lessons from the experience of developed countries, and shift the centre of attention away from focusing solely on physical capital accumulation, towards human capital accumulation in areas such as education, skill and entrepreneurship. This challenge facing China raises our interest in the specialized human capital themes of production processes, regional productivity disparities and convergence, cost competitiveness and private returns to education.

The development of "Human capital theory" in the late 1950s and early 1960s followed the revolution of the neoclassical growth model, which focused on the contribution of labour and physical capital, as well as the unaccounted role of technology (Solow, 1956). Its empirical growth accounting framework, assessing the contribution of the various inputs to aggregate economic growth, was first introduced by Solow (1957) and later developed by Kendrick (1961). Dension (1962) and Jorgenson and Griliches (1967) extended and refined the analysis by considering changes in the composition of capital and labour.

In the next chapter, we review the growth accounting model and measurement methods of its components such as physical capital services, labour inputs, and labour composition index (LCI) and Total Factor Productivity (TFP) in China from 1978 to 2009. We distinguish workers' characteristics by their education levels to impute labour composition indices for regions and provinces. The labour composition indices are imputed by both the average (or cell) approach and by the regression approach. Compared to the average approach, the regression approach can increase the dimensionality of factors in the quality adjustment with few observations, by incorporating the interactive variables with regressions.

Chapter 3 uses the measurement results of physical capital services, labour inputs, LCI and TFP from chapter 2 to examine the determining factors of the severe regional disparity problem in China's economic growth (Knight and Song, 2001). If the increasing inequality in China is not corrected in time, the uneven growth in productivity and wage will not only threaten the ultimate success of China's economic reform, but is also likely to bring about serious social and political unrest (Chen and Feng, 2000). Understanding the drivers of the increasing economic gap between rich and poor regions has become an urgent task for Chinese economists.

Moreover, the neoclassical model of economic growth is based on the hypothesis that each province is converging towards its equilibrium state. We investigate whether there are provincial convergence trends of labour productivity, TFP and wages from 1978 to 2009. Knight and Song (2001) point out that there are two possible explanations for the rise of regional inequality in China: economic growth and policies of economic reforms. Therefore, we investigate provincial convergence by controlling the market reform factors such as ownership, One Child Policy, openness and fiscal expenditures on human capital. Furthermore, to analyse the human capital more efficiently, we correct the endogeneity problem of education returns using the Generalized Instrumental Variables method with three instruments (number of brothers, number of sisters and access to tap water).

In chapter 4, we extend the discussion of the last two chapters to the international level. We examine industrial disparities and convergence of labour costs across countries and internal provinces. This comparison is only applied to the manufacturing subsectors and checks whether China's position as "the world factory" has been affected by relative currency appreciation, rising labour productivity and nominal labour compensation after the mid 1990s. The internal provincial comparison aims to assess the comparative advantage of nine one-digit sectors for provinces' development strategies, according to their cost competitiveness. We illustrate the drivers and decomposition of the changes of relative unit labour costs for the cross-country and province comparison. The long time-period of our study, 1978-2009, also allows a thorough investigation of industrial cost convergence across countries and among provinces.

However, the neoclassical growth model does not address the sources of wage disparity. This gap has been filled by Schultz (1959; 1961b) on the role of knowledge and ability in accounting for productivity growth, and by Mincer (1958) on investment on human capital as a determinant of personal earnings (Ehrlich and Murphy, 2007). A further development, by Mincer (1974b), shows a profound impact on the measurement of private and social rates of returns to schooling and training. It also offers important insights concerning wage differentials and the sources of inequality in the distribution of labour compensation. Chapter 5 applies these methods on returns to schooling in China from 1989 to 2009. We verify the human capital hypothesis for China's education returns, rejecting the signal effect hypothesis that education just reflects signals of innate ability rather than the accumulation of human capital. Moreover, traditional Ordinary Least Square (OLS) estimates may be biased by selection problems and by mix-ups of cohort heterogeneity. Hence, we estimate the marginal effects of returns to schooling with the experience of increasing labour markets, using the Heckman Selection Model (Gronau, 1974; Lewis, 1974; Heckman, 1976) by four age cohorts.

In general, the data used in this thesis come from the EU KLEMS dataset, the Penn World Table (PWT) 7.0, the International Comparison of output and productivity (ICOP), the China Statistical Yearbooks (CSYs) published annually by the State Statistical Bureau of China, various issues of Statistical yearbooks published by local statistical bureaux, Population Census data published by State Council Population Census Office and the NBS Population Division (1985, 1993 and 2001), the Comprehensive Statistical Data and Materials on 50 Years of New China, and the China Household Nutrition Survey (CHNS) dataset. By combining these data with insights from economic theory this thesis attempts to shed new insights on Chinese economic development.

CHAPTER TWO: GROWTH ACCOUNTING ANALYSIS

2.1 Introduction

Economic reforms in China have resulted in unprecedented economic growth since 1978. In the early years of the new millennium, however, China found itself with one of the highest degrees of regional inequality in the world and over its history (Yang, 2002; Kanbur and Zhang, 2005; Fleisher *et al.*, 2010).

Chinese province [1] show quite different growth paths with wide regional disparities in growth rates after the reforms and open-door policies launched at the end of the 1970s. In the first year of our study (1978), the industrial Northeast region[2] was the growth engine of China with the highest level of real GDP per worker (5,288 Yuan, about 633 US dollar in 1995)[3] among the four regions. At the same time, the real GDP per worker of the Coastal region was 2,964 Yuan which was a little higher than that of the Interior (2,022 Yuan) and the West (2,514 Yuan) regions, but only 56 percent of the Northeast region.

However, the Coastal has been growing much faster than other regions so that by the last year of our study (2009), its GDP per worker (48,818 Yuan) has increased about 16.5 fold over the thirty-two years. The Coastal has the highest annual growth rate at 8.6

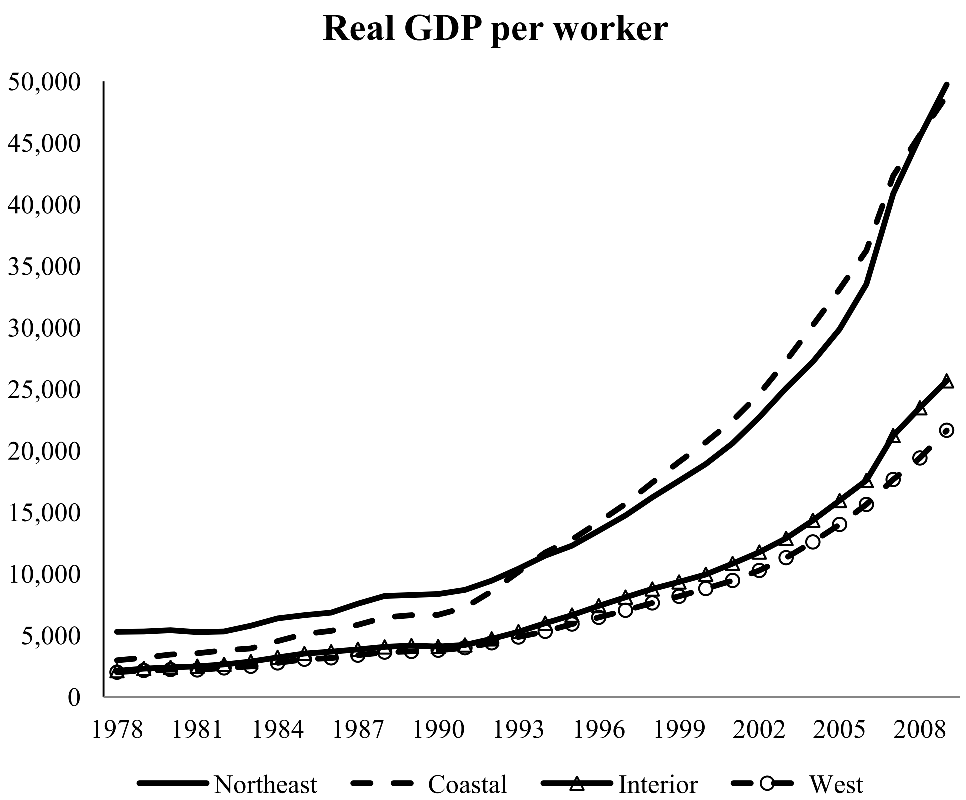
[1] China has 31 administrative divisions. We exclude Tibet due to lack of data. And, we combine Hainan with Guangdong, and Chongqing with Sichuan to ensure consistency over the entire period of 1978-2009, because Hainan was separated from Guangdong in 1988 and Chongqing was separated from Sichuan province in 1996. Thus, we analyze 28 provinces in this thesis.

[2] We categorize the 30 administrative divisions (excluding Tibet) into four regions in this thesis: the northeast region (including Heilongjiang, Jilin, Liaoning), the Coastal (including Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong-Hainan), the Interior (Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan) and west (Guangxi, Sichuan-Chongqing, Guizhou, Yunnan, Inner Mongolia, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang). The division of the four regions is based on research regarding the major economic and geographical clusters in economic growth and development in China. See geographic graph of regions in Appendix Table A2.1.

[3] All variables are in real terms based on 1995 RMB Yuan in this chapter. We use exchange rate 1US dollar=8.35 RMB Yuan to calculate the equivalent value in US dollar in 1995.

percent per year among the four regions, while the old growth engine, the Northeast gradually loses its power and achieves annual growth rate at 7.0 percent per year before 1994. In 2009, GDP per worker in the Coastal and Northeast regions are nearly double that in the two lagging regions - the Interior and West (see Figure 2.1). Therefore, the much higher economic growth rates of the Coastal enlarge the regional disparities of productivity in China. This chapter aims to explain the regional disparities of economic growth using a growth accounting approach.

Figure 2.1: Real GDP per worker by region (Yuan in 1995)



Data sources: (Hsueh and Li, 1999); various years China Statistical Yearbook (NBS, 1999); National Bureau of Statistics (1999).

2.2 Growth accounting model

2.2.1 Methodology

We apply the growth accounting framework to assess the contributions of the various inputs to aggregate economic growth. This methodology was first introduced by Solow (1957) and later developed in Kendrick (1961). Dension (1962) and Jorgenson and Griliches (1967) extended and refined the analysis by considering changes in the composition of capital and labour. The growth accounting model is based on production possibility frontiers where value added is a function of capital, labour, and technology. The production function is given by:

$$Y_{pt} = f(K_{pt}, L_{pt}, A_{pt}) \tag{2.1}$$

where Y is value added; K is an index of capital services; L is an index of labour inputs; A reflects Hicks-neutral technical change, all of which are indexed by provinces p (= 1,…, 28) and time t (=1978,…, 2009).

Under the assumptions of competitive factor markets, full input utilisation and constant returns to scale (CRS), the growth of value added can be expressed as the cost-share weighted growth of inputs and technological change. Using the trans-log functional form in such analyses, the growth accounting equation is:

$$\Delta \ln Y_{pt} = \overline{V}^{K}_{pt} \Delta \ln K_{pt} + \overline{V}^{L}_{pt} \Delta \ln L_{pt} + \Delta \ln A^{Y}_{pt} \tag{2.2}$$

The above equation indicates the proportions of value added growth accounted for growth in capital services K, labour inputs L and technical change measured as Hicks-neutral technical change A or Total Factor Productivity (TFP), respectively.[4] Because of our approach to measure capital services, Hicks-neutral technical change A only includes disembodied technical change. Moreover, $\overline{V}$ denotes the two-period average share of inputs K or L in nominal output defined as follows:

$$V_{pt}^{K} = \frac{P_{pt}^{K} K_{pt}}{P_{pt}^{Y} Y_{pt}}, \quad V_{pt}^{L} = \frac{P_{pt}^{L} L_{pt}}{P_{pt}^{Y} Y_{pt}}$$

$$\overline{V}^{K} + \overline{V}^{L} = 1$$

(2.3)

2.2.2 Measuring capital services

The starting point to measure capital stock is the perpetual inventory method (PIM), introduced by Goldsmith (1951). The PIM consist of adding the net investment data of the current year to an assumed base year of capital stock. Assuming geometric depreciation, the general formula is given by:

$$K_t = (1-\varphi)K_{t-1} + I_t \qquad (2.4)$$

where K_t is capital stock; φ is the depreciation rate; I_t is the investment which refers to investment in fixed assets.

For the aggregation of capital services over the different asset types (k, assuming

[4] The composition of labour inputs is measured as the labour composition index (LCI) which will be discussed later.

two kinds of asset types, for example, *S* for structures and *E* for equipment assets), it is assumed that aggregate capital services are a trans-log function of the services of individual assets. It is also assumed that the flow of capital services for each asset type *k* (=*S* or *E*) is proportional to its stock, independent of time. The Tornqvist quantity index of individual capital types as follows:

$$\Delta \ln K_{pt} = \sum_{k} \overline{w}^{K}_{k,pt} \Delta \ln K_{k,pt} \tag{2.5}$$

where $\Delta \ln K_{k,pt}$ indicates the growth of capital stock by capital type *k*, and weights are given by the period average shares of each type in the value of capital compensation. As we assume that marginal products are equal to real returns, also equal to rental costs, the weighting procedure ensures that inputs which have a higher price also have a larger influence in the input index. Hence, equation (2.5) can be rewritten as follows:

$$\Delta \ln K_{pt} = \overline{w}^{S}_{pt} \Delta \ln K^{S}_{pt} + \overline{w}^{E}_{pt} \Delta \ln K^{E}_{pt} \tag{2.6}$$

where $\overline{w}^{S}_{pt}$ are the period-average shares of asset *S* in total capital costs in province *p* and year *t*, and similarly for asset *E*. Weights are given by the average shares of each component in the value of capital compensation $\overline{W}^{S}_{pt} = \frac{1}{2}(W^{S}_{pt} + W^{S}_{p,t-1})$ and $W^{S}_{pt} = \frac{P^{S}_{pt} * K^{S}_{pt}}{P^{S}_{pt} * K^{S}_{pt} + P^{E}_{pt} * K^{E}_{pt}}$, where P^{K}_{spt} is the price of capital service from asset *S*.

Rental prices, or user-cost of capital, can be estimated using the standard approach grounded in the arbitrage equation derived from neoclassical theory of investment, introduced by Jorgenson (1963) and Jorgenson and Griliches (1967). In equilibrium, an investor is indifferent between two alternatives: buying a unit of capital at investment price $P^{I}_{sp,t-1}$, collecting a rental fee and then selling the depreciated structures for $(1-\delta_s)P^{I}_{spt}$ in the next period, or earning a nominal rate of return i_{spt}, on a different investment opportunity. The cost-of-capital equation is:

$$P^{S}_{pt} = P^{I}_{sp,t-1} * i_{spt} + \delta_S * P^{I}_{spt} - (P^{I}_{sp,t} - P^{I}_{sp,t-1}) \qquad (2.7)$$

This formula shows that the rental fee is determined by the nominal rate of returns, the rate of economic depreciation and the asset specific capital gains. We will use this method to measure capital services.

2.2.3 Measuring labour composition index

The labour composition index (LCI) [5] is an important component in the decomposition of labour input in the growth accounting literature (O'Mahony and Timmer, 2009), which is also called the "labour quality" index in Jorgenson *et al*. (2005) and Schwerdt and Turunen (2007). In emerging knowledge economy, changes in labour composition index is mostly driven by greater demand for skilled workers (Timmer *et al.*, 2010).

[5] The labour composition index adjusts the total hours worked for the composition of labour, which requires identification of separate, heterogeneous groups of labour input whose work-hours are likely to have varying effectiveness. The LCI is particularly important when we consider changes over time in the labour input. For example, consider the effect of the total number of hours remaining fixed over time, but the composition changing so that the hours are being performed by increasingly intelligent workers. These hours being more efficient will result in greater output.

To consider labour heterogeneity, we can multiply the number of employed persons[6] by the labour composition index to proxy human capital in the labour inputs. Labour composition index accounts for the level of skill provided per worker which increases with improvement of knowledge and innovation. Ignoring the growth of labour composition will underestimate the contribution of labour inputs to economic growth (Jorgenson, 2005). The growth rate of labour composition is as follows:

$$\Delta \ln LCI_{pt} = \Delta \ln L_{pt} - \Delta \ln H_{pt} \qquad (2.8)$$

$\Delta \ln H_{pt}$ is the growth rate of unadjusted labour input - number of employed persons at different education levels, which is defined as follows:

$$\Delta \ln H_{pt} = \ln \frac{H_{pt}}{H_{p,t-1}} \qquad (2.9)$$

$$H_{pt} = \sum_{m=1}^{4} h_{mpt} \qquad (2.10)$$

where h_{mpt} is the number of persons employed for the particular educational level *m* in the province *p* and year *t*. $\Delta \ln L_{pt}$ is the growth rate of weighted composition-adjusted labour inputs, and the weight is the average labour compensation share for a particular group (assuming there are four groups)

[6] The information of annual hours worked by education level/province/year is not available in China, so we use the number of employed persons instead.

$$\Delta \ln L_{pt} = \Sigma_{m=1}^{4}[\frac{1}{2}(\frac{W_{mpt}h_{mpt}}{\sum_{m=1}^{4} W_{mpt}h_{mpt}} + \frac{W_{mp,t-1}h_{mp,t-1}}{\sum_{m=1}^{4} W_{mp,t-1}h_{mp,t-1}}) * \ln(\frac{h_{mpt}}{h_{mp,t-1}})] \quad (2.11)$$

where W_{mpt} is the average measured wage rate for particular education level *m* in province *p* and year *t*. In a competitive market, wage differentials should represent individuals' productivity differentials. The use of wage as a measure of a worker's productivity is based on the underlying assumption that relative wages are equal to the relative marginal products of workers. Various characteristics of actual labour markets, such as discrimination, union bargaining, signalling and mismatch, may result in violations of this assumption (Ho and Jorgenson, 1999). However, due to the lack of more direct measures, wage remains the best available proxy of a worker's productivity.

There are two methods, the average approach and the regression approach to measure wages. The average approach is to use the average compensation share attributable to a particular cell (Ho and Jorgenson, 1999) to estimate the wages W_{mpt}. They construct a quality/composition-adjusted measure of labour inputs based on a cross-classification of number of employed persons into a number of cells by observed worker characteristics. On the other hand, the regression approach is applied by the U.S. Bureau of Labor Statistics (BLS) (1993) and Schwerdt and Turunen (2007), using a Mincerian wage regression approach to estimate cell means. We try both methods in this chapter.

2.3 Measuring capital services in China

2.3.1 Data sources

To illustrate the effect of physical and human capital on productivity, we need measure variables such as value added, capital services, labour inputs and the labour composition index. Our data on capital services are mainly from macro level data in various years of the China Statistical Yearbook (CSYs), Population Census (State Council Population Census Office and the NBS Population Division, 1985, 1993 and 2001), Hsueh and Li (1999) and National Bureau of Statistics (1999). In this sector, we firstly follow the methods in Timmer *et al.* (2007) to construct the capital services in China.

Our investment data are from the National Bureau of Statistics (1999) and various Chinese Statistical Yearbooks, which provide information for three categories of capital - buildings and structures, machinery and equipment, and other assets. The "other assets" refers to the expenses related to the structures and installation projects and to the purchase of equipment. In line with Fu (2008), we reallocate the "other assets" into structures and equipments according to their ratios in investment excluding "other assets".

2.3.2 Measurement method

Hulten and Wykoff (1981) estimated depreciation rates of 3.7 percent for structure and 13.3 percent for equipment in the US. The Chinese official depreciation rates are unusually low, in line with the overestimated service life of fixed assets in the absence of markets during the central-planned period (Wu and Xu, 2002). Since the National Bureau of Statistics does not provide life length and depreciate rates for the different kinds of investments, we derive depreciation rates based on Chinese tax regulations.[7] According to equation (2.4), we have the capital stock of structures as follows:

[7] Before 1994, the legal life of structures is 40 years, and equipments' legal life is 18 years. After 1994, the structures' legal life is 30 years, and equipments' legal life is 13 years. Thus, the geometric depreciation rates for structures are 5 percent and 7 percent, and for equipments are 11 percent and 15 percent, with the 1994 as break.

$$K_{pt}^{S} = (1-\delta^{S})K_{p,t-1}^{S} + I_{pt}^{S} \tag{2.12}$$

The nominal rate of returns here is the one-year deposit rate, and the asset price is the capital deflator of investment for structure. To decide the starting point of capital stock from the value of gross fixed capital formation (1952 value, or the average value between 1952 and 1956) adjusted by its depreciation rates, we make a sensitivity test to compare their derived capital stock. We find that these two lists of capital stocks calculated are similar, because the investment was very low in the newly founded the People's Republic of China (PRC). So we choose to rely on the gross fixed capital formation in 1952 multiplying life time as the starting point to calculate the capital stock. After we get the nominal capital stock for structure and equipment, we add them together to get the nominal capital stock for each province *p* in each year *t*. Using the capital stock deflators, which equal to the GDP deflators from 1878-1991, and the investment deflators from 1992-2009, and imputed by the general retail price index for 1952 to 1977, we derive the real capital stock for our productivity analysis.

2.3.3 Results

Table 2.1 presents the annual growth rate of real capital stock during three time periods, 1978 to 1988, 1989 to 1999 and 2000 to 2009 by region. Physical capital grows faster in the Coastal than other regions before 2000, but becomes slower in 2000-2009. It suggests that the Coastal is shifting its growth driver from physical capital to other factors (such as human capital) after 2000.

Table 2.1 Annual growth rate of real capital stock

Location	1978-1988	1989-1999	2000-2009
Northeast	0.1	0.09	0.16
Coastal	0.16	0.15	0.14
Interior	0.1	0.11	0.16
West	0.09	0.12	0.16

Note: The real capital stock is calculated by the perpetual inventory method.

2.4 Measuring labour composition index in China

2.4.1 Data sources

Macro level data in the China Statistics Yearbooks 1989-2009 are used to investigate the change of labour composition index over long and continuous time period. Notwithstanding, a major limitation of macro level data is that only mean (average) income are reported at the provincial level. Directly using macro level data is equivalent to assuming that all individuals in a group have the same income. This potentially underestimates inequality within each province. Hence, micro level data of the CHNS is also used to improve the data quality of the labour composition index in this sector.

The CHNS dataset is conducted by China's National Institute of Nutrition and Food Safety, the Chinese Centre for Disease Control and Prevention, and the University of North Carolina. It is typically available for isolated years and individual provinces for urban and rural areas, containing accurate information on wages, education, and other demographic information. The survey employs a multistage random-cluster sampling process to draw households from eight provinces during 1989-1997 and nine provinces thereafter.[8] Jorgenson (1990) measures labour quality indices, incorporating

[8] 8 provinces (Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi and Guizhou) for years 1989-1993; 8 provinces in 1997 (replace Liaoning with Heilongjiang, others are the same); 9 provinces for years 2000-2009 (with both Liaoning and Heilongjiang, and other provinces as well). In 1989, the CHNS surveyed 15,917 individuals from 3,795 households. From 1993 onwards, the survey added new households and communities to replace those that were no longer participating. But most households have

both individual data on hours worked and labour compensation from the Censuses of Population. Following his work, this chapter derives the wages from the CHNS dataset, and then incorporate the macro level data to compare the two methods of labour composition index.

2.4.2 Measurement method

First, we need to identify categories to identify workers with different effectiveness. The categories should be workers' demographic characteristics relevant to marginal products, under the assumption of perfect competition. Dension (1962) measures labour quality changes due to the age, sex and education. Chinloy (1980) uses gender, class of worker, age, educational attainment and occupation. And, Jorgenson *et al*. (1987) use gender, age, educational attainment, class of worker, occupation and industry.

In this chapter, workers' education attainment is considered as a proxy for human capital. The China Statistical Yearbooks have only categorized provincial persons employed by education levels. The information of education levels by age and gender is limited in macro level data. In terms of economic theory, formal education is the main source of general human capital, with the basic proposition that investment in education results in higher human capital and productivity (Becker, 1993). Individuals with the same education level are regarded as an isolated island within which all hours worked have the same productivity, but facing different productivities when compared with each other. Hence, different education groups are imperfect substitutes in production (Lindley and Stephen, 2011; Katz and Murphy, 1992).[9]

---

been followed up across the eight waves.

[9] Previous studies also uses only one variable (education) to obtain quality indexes. For example, Barro

From macro level dataset, we get variables such as number of persons employed over 1989-2009, and education levels of persons employed from 1996 to 2009. Following Cheng and Kwan (2000), we construct the education levels of persons employed from 1989 to 1995 based on information of the entire population (the percentages of the population aged 6 and over with primary school, junior secondary school, senior secondary school and college education) by province. Consequently, we compute changes in the aggregate labour inputs as a weighted average of the working hours of each cell and time period, where the weights are given by the average share of compensation attributable to each cell in two adjacent years. We calculate growth in labour composition as the difference between growth in this aggregate labour inputs and growth in a raw measure of hours worked.

Second, we apply two methods, the average approach and the regression approach to measure average wages using the CHNS dataset. We consider urban and rural areas separately and then weight them by the urban-rural ratios of persons employed.[10] The average approach applies the average compensation share attributable to a particular cell (Ho and Jorgenson, 1999). We construct a composition-adjusted measure of labour input based on a cross-classification of hours worked into a number of cells by observed worker characteristics (education levels in this chapter).

The regression approach is applied by the U.S. Bureau of Labor Statistics (BLS) (1993) and Schwerdt and Turunen (2007), using a Mincerian wage regression to estimate cell means. With the regression approach, we can increase the dimensionality

---

and Lee (1996) used actual years of schooling to compare the human capital stock of different countries.

[10] The effect of education is significantly different between the urban and rural areas, which are verified by the sensitivity tests. The huge urban-rural inequality results in significant differences in the accumulation of human capital and their returns.

of factors in the composition adjustment with few observations by incorporating the interactive variables. We estimate wage equations for the persons employed in available provinces and years using the Ordinary Least Square (OLS) regression.[11]

$$\ln w_{it} = \beta_0 + \beta_1 age_{it} + \beta_2 age2_{it} + \beta_3 male_{it} + \sum_{m=1}^{4}\sum_{p=1}^{9}\sum_{u=0}^{1}\beta_{mpu} edu_{mt} * pro_{pt} * urban_{ut} + \varepsilon_{it} \qquad (2.13)$$

where w_{it} is the nominal hourly wage rate for a worker i with education level m in province p in year t;[12] edu_{mt} are dummies for education categories (m=1 - 4): primary school and below, lower middle school, upper school (including upper middle school and vocational school), and college and above; pro_{pt} represents 9 provinces in the surveys; and $urban_{ut}$ represent individual's location (u=0 for rural; 1 for urban). In the regression, the interactive variable "primary school and below*Guizhou province*rural" is the baseline group. Quadratic age and gender are control variables.[13] We run this regression for each year t. Following the BLS method, average values for the control variables for the whole sample are used to calculate measured wages, such that their impact is excluded from the calculation of the labour composition index (BLS, 1993).

Then, we construct measured wages W_{mpt} for education level m, province p and year t based on the coefficients of the interactive variables in the equation as follows:

---

[11] We will correct the endogeneity problem of education returns in Section 3.6, and the Heckman selection bias of education returns in chapter 5.

[12] We divide the nominal annual earning (including wages, subsidy and bonus) by annual hours worked to derive a measure of nominal hourly wage rate for each individual. Different from the aggregate provincial dataset from CSYs, the CHNS micro data provides the individual's annual hours worked.

[13] Age is a proxy for the stock of general experience that embodied in a person. We use age rather than experience because the CHNS dataset does not provide information for experience. Women earn less than males even when controlling for all the other relevant characteristics.

$$W_{mpt} = \exp(\beta_{mpt}) \qquad (2.14)$$

For both the average approach and the regression approach, we then impute the measured wages between the surveyed years. For example, the measured wages in 1994 can be imputed by the annual growth rate g between 1993 and 1997:

$$\begin{aligned} g &= (\frac{W_{mpt}^{1997}}{W_{mpt}^{1993}})\wedge(1/4)-1 \\ W_{mpt}^{1994} &= W_{mpt}^{1993} * (1+g) \end{aligned} \qquad (2.15)$$

2.4.3 Results

Table 2.2 shows the ratio of persons employed who work in the urban area to total persons employed, i.e. urban share for the nine provinces and the four regions from 1989 to 2009. These urban-rural ratios will be used as weights for the labour composition index calculation. After the foundation of P. R. China in 1949, the Northeast (including Liaoning and Heilongjiang provinces) was centrally planned to focus on the secondary industries. Hence, this region had the highest urban share among regions in 1989 (about 56 percent), but declined to about 44 percent in recent years. The Coastal developed quickly over time as its urban share increased from 27 percent in 1989 to 38 percent in recent years. The urban shares of the other two regions (the Interior and the West) are quite stable around 20 percent.

Table 2.2: Urban Share (by province and region)

Urban share	1989-2009	1989-1999	2000-2009
Northeast	**0.49**	**0.55**	**0.43**
Liaoning	0.51	0.56	0.45
Heilongjiang	0.52	0.60	0.43
Coastal	**0.30**	**0.29**	**0.32**
Jiangsu	0.29	0.26	0.31
Shandong	0.24	0.23	0.25
Interior	**0.22**	**0.23**	**0.20**
Henan	0.18	0.19	0.16
Hubei	0.30	0.32	0.28
Hunan	0.19	0.20	0.18
West	**0.21**	**0.21**	**0.21**
Guangxi	0.16	0.17	0.16
Guizhou	0.14	0.15	0.13

Note: Urban share is the ratio of persons employed who work in the urban area to total persons employed

$$\text{Urban share} = \frac{\text{Persons employed who work in the urban area}}{\text{All persons employed}}$$

Table 2.3 presents the nominal hourly wages derived from the average approach by region (results by province are listed in Appendix Table A2.1). Generally, hourly wage rates of all sub-groups increase over time. In 1989, most of the wage rates was nearly 0.55 - 0.65 Yuan per hour, reflecting the national rigid wage-setting irrelevant education level or location. With the deepening wage reforms, for all education levels and locations, the wage rates doubled from 1993 to 1997. And, the wage rates in 2009 doubled the wage level in 1997 again. The difference across education levels and locations mainly happened in the 2000s.

The highest returns to education occurred in both the urban and rural areas of the Coastal and Interior. Nearly in all provinces and regions, workers with upper school and above degrees earned more in the urban area (urban premium), suggesting complementarities between technology in the urban and high skilled workers. Similarly, workers with lower middle school and below degrees earn more in the rural area (rural premium), suggesting complementarities between technology in the rural and medium skilled workers.

Table 2.3: Average wages by region (the average approach)

Average	1989	1991	1993	1997	2000	2004	2006	2009
Primary school and below (urban area)								
Northeast	0.66	0.85	0.93	2.81	3.49	4.5	8.32	6.24
Coastal	0.63	0.99	1.43	2.87	5.3	5.71	5.66	8.27
Interior	0.65	0.95	1.6	2.93	4.09	5.03	5.5	10.85
West	0.57	0.7	1.66	3.08	4.63	3.23	4.67	5.94
Lower middle school (urban area)								
Northeast	0.5	0.65	1.07	3.37	4.53	5.1	6.29	8.27
Coastal	0.65	0.83	1.49	3.36	5.53	6.6	6.81	10.97
Interior	0.69	0.82	1.29	3.13	4.05	6.29	10.03	9.27
West	0.58	0.59	1.3	2.7	5.57	4.24	5.11	7.81
Upper school (urban area)								
Northeast	0.6	0.67	0.86	2.99	5.11	7.92	9.2	10.58
Coastal	0.6	0.83	1.62	3.62	6.01	8.1	8.39	14.26
Interior	0.77	0.8	1.15	3.78	6.44	7.11	9.31	12.88
West	0.53	0.64	1.23	2.64	4.08	8.12	10.03	13.35
College and above (urban area)								
Northeast	0.63	0.75	1.09	3.04	6.7	10.08	13.87	17.66
Coastal	0.65	0.78	1.44	4.16	8.66	9.45	13.22	17.33
Interior	0.71	0.86	2.35	5.27	8.5	11.7	16.08	17.32
West	0.59	0.69	1.41	2.92	5.06	14.29	10.22	16.06
Primary school and below (rural area)								
Northeast	0.79	1.14	1.43	2.63	6.42	4.84	5.91	16.09
Coastal	0.61	0.93	1.28	3.66	4.34	5.08	3.92	8.28
Interior	0.63	0.88	1.39	3.58	5.04	5.09	6.43	11.76
West	0.72	0.89	1.12	2.79	4.15	3.77	4.43	5.58
Lower middle school (rural area)								
Northeast	0.56	0.93	1.39	3.35	4.09	8.03	7.17	8.84
Coastal	0.68	0.76	1.17	3.07	4.27	5.62	5.76	9.73
Interior	0.93	0.79	1.84	2.82	4.16	4.55	6.4	15.16
West	0.55	0.76	1.42	3.18	4.73	5.93	6.43	8.21
Upper school (rural area)								
Northeast	0.47	1.87	1.17	1.86	3.88	6.32	8.1	10.37
Coastal	0.63	0.75	1.23	3.58	5.31	7.29	8.36	10.71
Interior	0.64	0.74	0.89	3.65	5.31	6.29	7.43	12.75
West	0.49	0.67	0.95	2.94	4.84	6.56	6.48	13.03
College and above (rural area)								
Northeast	0.59	0.82	1.02	1.88	4.27	6.26	11.01	13.15
Coastal	0.48	0.65	1.03	2.51	5.01	16.39	11.19	13.44
Interior	0.65	0.77	1.32	3.21	12.36	6.82	8.27	18.08
West	0.53	0.69	0.6	3.48	4.62	5.79	9.92	17.76

Note: The average approach is to calculate the average wages for a particular cell, such as "Northeast * Primary school and below * 1989".

Table 2.4 represents the coefficients of the OLS regression model in equation (2.13) by region, using “primary school and below * the West region * rural area” as the baseline group.[14] These coefficients are regarded as the incremental effects on the baseline group.

In the urban areas, the significantly positive incremental effects are found in higher educated groups (for example College and above) since 1993 as we expect. However, the incremental effects of higher educated workers in the rural areas are only found prominent since 2004. For those medium or low education groups, the wage differentials are significant in the urban areas only after 2000, being similar to the rural areas. It is consistent with what we find in the average approach and suggests that the skill-biased technology, for instance, the Information and Communication Technology (ICT) in O’Mahony *et al*. (2008) was firstly introduced to the urban areas from the advanced western countries with the openness policies, and later the rural areas. Therefore, the significant wage differentials among education levels and locations mainly appear in the 2000s and more prominent for medium and higher education groups such as upper school, and college and above. These results are also consistent with the transition processes of Chinese labour markets.

[14] The coefficients of the OLS regression model by province can be seen in Appendix Table A2.2.

Table 2.4: Measured coefficients of wages by region (OLS regression)

OLS	1989	1991	1993	1997	2000	2004	2006	2009
				Primary school and below (Urban Area)				
Northeast	0.076	0.013	-0.124	-0.059	-0.153	0.151	-0.018	0.023
Coastal	0.047	0.03	0.255	0.031	0.135	0.180*	0.219	0.328**
Interior	0.085	0.107	0.128	0.051	-0.064	0.077	0.178	0.519***
West	-0.1	-0.132*	0.143	-0.022	-0.179	-0.214	0.1	0.029
				Lower middle school (Urban Area)				
Northeast	-0.048	-0.111	-0.064	0.109	0.061	0.168	0.219	0.299**
Coastal	0.173*	0.058	0.249*	0.065	0.105	0.436***	0.322**	0.481***
Interior	0.155	0.106	0.141	0.117	-0.046	0.201	0.421***	0.368***
West	-0.022	-0.191**	0.047	-0.053	0.009	0.075	0.098	0.219*
				Upper school (Urban Area)				
Northeast	0.099	-0.034	-0.141	0.075	0.247**	0.653***	0.589***	0.565***
Coastal	0.095	0.12	0.413***	0.265***	0.299**	0.698***	0.550***	0.775***
Interior	0.191*	0.111	0.069	0.205**	0.308***	0.560***	0.670***	0.741***
West	-0.062	-0.115	0.171	-0.008	0.085	0.680***	0.641***	0.685***
				College and above (Urban Area)				
Northeast	0.131	0.002	0.027	-0.055	0.474***	0.982***	1.042***	1.171***
Coastal	0.215*	-0.004	0.216	0.444***	0.620***	0.888***	1.003***	1.124***
Interior	0.242**	0.116	0.306**	0.550***	0.633***	1.047***	1.119***	1.116***
West	0.117	-0.014	0.249**	0.141	0.249	0.863***	0.949***	1.022***
				Primary school and below (Rural Area)				
Northeast	0.151	0.208	-0.006	-0.041	0.002	0.038	0.181	0.553***
Coastal	-0.045	-0.027	0.062	0.11	0.013	-0.063	-0.069	0.194
Interior	-0.091	-0.092	-0.18	0.07	-0.114	-0.119	0.135	0.347**
				Lower middle school (Rural Area)				
Northeast	-0.088	0.069	0.028	-0.166	-0.125	0.205	0.159	0.253**
Coastal	0.055	-0.018	0.105	-0.034	0.014	0.208*	0.201*	0.326***
Interior	0.048	-0.087	-0.077	-0.051	-0.001	0.187	0.24	0.446***
West	-0.024	-0.036	0.168**	0.099	0.077	0.313***	0.189**	0.263**
				Upper school (Rural Area)				
Northeast	-0.08	0.039	-0.19	-0.331***	0.024	0.456***	0.504***	0.582***
Coastal	0.099	-0.046	0.08	0.159*	0.224*	0.473***	0.507***	0.405***
Interior	-0.098	-0.087	-0.147	0.135	0.083	0.403***	0.454***	0.680***
West	-0.117	-0.104	-0.091	0.08	0.174	0.458***	0.380***	0.568***
				College and above (Rural Area)				
Northeast	0.136	0.08	-0.032	-0.297***	0.111	0.508***	0.848***	0.866***
Coastal	-0.018	-0.058	0.02	-0.047	0.235	1.242***	0.848***	0.924***
Interior	0.11	0.072	0.122	0.189	0.673**	0.633***	0.697***	0.905***
West	-0.136	0.026	-0.570***	0.283***	0.131	0.517***	0.819***	0.891***
R-square	0.092	0.093	0.089	0.081	0.086	0.173	0.191	0.181
N	3325	2981	2498	2562	2555	1841	1988	2277

Notes:

1. The coefficients are incremental effects on the baseline group "primary school and below * the West region * rural area".
2. Notes: Standard errors are in italics. The stars *, ** and *** indicate the significance level at the 10%, 5% and 1%, respectively for two-tail test.

With the nominal hourly wage rates from the average approach and OLS regression approach, we get the labour composition index by region (with the West as the baseline region starting from 100 in 1989) and province (with Guizhou as the baseline province starting from 100 in 1989) in Table 2.5. The detailed labour composition indices per year by province are presented in Appendix Table A2.3 and in Appendix Table A2.4 by region. In general, the labour composition indices increase over time especially after 2000.

The labour composition indices calculated from the regression approach have less variation than from the average approach possibly due to better controlling. In both methods, the Interior (101.61 and 102.33 respectively) always has the highest LCI among four regions. The outstanding growth rates of the LCI in the Interior suggest the catching up processes of this region to the richest Coastal.

Moreover, from the OLS regression approach, Heilongjiang province in the Northeast also has high LCI as in the Interior. For example, in the first survey year 1989, the highest LCI from the average approach is in Henan province (109.76) while the highest LCI from the OLS regression approach is in Heilongjiang province (104.79). Therefore, after two decades, Henan province has become the one with highest LCI (121.20 and 114.18 respectively) among all provinces. The lowest labour composition index is in Liaoning from the average approach and in Guizhou from the regression approach.

Table 2.5: Average labour composition index

Average LCI	Average approach			OLS approach		
	1989-2009	1989-1999	2000-2009	1989-2009	1989-1999	2000-2009
Northeast	**95.60**	**95.40**	**95.81**	**98.95**	**98.33**	**99.64**
Liaoning	94.53	94.34	94.74	101.44	100.94	101.99
Heilongjiang	105.42	104.89	106.00	105.96	105.06	106.96
Coastal	**99.15**	**98.66**	**99.70**	**101.85**	**100.99**	**102.80**
Jiangsu	100.77	99.72	101.92	104.95	103.27	106.80
Shandong	101.82	101.74	101.91	104.30	104.03	104.61
Interior	**102.91**	**101.91**	**104.01**	**104.47**	**102.85**	**106.26**
Henan	115.70	111.83	119.95	108.48	104.36	113.03
Hubei	104.36	104.00	104.76	106.17	104.98	107.48
Hunan	104.65	100.46	109.26	103.64	100.97	106.57
West	**100.49**	**99.54**	**101.54**	**101.20**	**100.23**	**102.25**
Guangxi	98.68	97.31	100.19	101.96	100.35	103.74
Guizhou	99.16	98.75	99.61	100.17	99.91	100.45

Table 2.6 indicates the annual growth rates of labour composition indices derived from both the average and OLS approaches, by region and province over the two periods, 1989 to 1999, and 2000 to 2009. Provinces and regions perform much better in the 2000s, especially in Henan province with the annual growth rates above 1.1 percent. Besides Henan and Hunan, the growth rates of LCI in Jiangsu and Heilongjiang are also outstanding. Gansu has no much progress in LCI in the past two decades. Therefore, the disparities of growth rates of LCI between provinces and regions in the recent years suggest the contribution of human capital formation to decrease the regional disparities in China.

We will use the labour composition index calculated by the OLS regressions in the rest of this thesis, since the OLS method can increase the dimensionality of factors in the composition adjustment with few observations by incorporating the interactive variables. The interactive variables "education level dummies * province dummies * urban dummies" can describe the human capital analysis more precisely, especially for a transition country as China.

Table 2.6: Annual growth rates of Labour composition index

	Average approach			OLS approach		
	1989-2009	1989-1999	2000-2009	1989-2009	1989-1999	2000-2009
Northeast	**-0.02%**	**-0.10%**	**0.07%**	**0.10%**	**-0.06%**	**0.27%**
Liaoning	0.01%	-0.11%	0.16%	0.14%	-0.02%	0.35%
Heilongjiang	0.04%	0.19%	-0.13%	0.09%	0.04%	0.10%
Coastal	**0.06%**	**-0.10%**	**0.19%**	**0.13%**	**0.03%**	**0.19%**
Jiangsu	0.17%	-0.15%	0.52%	0.29%	0.07%	0.55%
Shandong	0.07%	-0.03%	0.17%	0.07%	0.01%	0.10%
Interior	**0.15%**	**0.02%**	**0.19%**	**0.23%**	**0.09%**	**0.27%**
Henan	0.50%	0.31%	0.45%	0.53%	0.29%	0.49%
Hubei	-0.01%	0.16%	-0.19%	0.17%	0.22%	0.03%
Hunan	0.62%	-0.03%	1.10%	0.39%	-0.09%	0.75%
West	**0.10%**	**-0.01%**	**0.18%**	**0.10%**	**0.08%**	**0.07%**
Guangxi	0.18%	0.11%	0.21%	0.19%	0.11%	0.18%
Guizhou	0.00%	-0.15%	0.14%	0.00%	0.02%	-0.03%

2.5 Total factor productivity (TFP)

We calculate the TFP growth according to method referred to O'Mahony and Timmer (2009) which is based on the index number approach.

$$\Delta \ln A_{pt} = \Delta \ln Y_{pt} - (1-\overline{V}_{pt}^{L})\Delta \ln K_{pt} - \overline{V}_{pt}^{L}\Delta \ln L_{pt} \quad (2.17)$$

where Y, K and L are GDP, capital stock and labour inputs. $\overline{V}_{pt}^{L}$ denotes the two-period average labour share, which is defined as the ratio of labour compensation to GDP.

First of all, the labour share V_{pt}^{L} is regarded as the weight for the production factor - labour, reflecting the marginal cost of labour usage in growth accounting decompositions. According to the income approach in the China Statistics Yearbooks

(CSYs), GDP is the sum of labour remuneration, depreciation, operating surplus and net taxes on production[15]. To avoid the potential underestimation of labour shares due to non-reported incomes, we use labour remuneration[16] rather than wage bills to measure labour compensation. Returns to capital are represented by depreciation and the operating surplus. In addition, in the absence of detailed information about the various tax types of net taxes on production, we follow Holz (2006)'s suggestion to split the net taxes on production as follows:

Split ratios for labour = Labour remuneration / (labour remuneration + depreciation + operating surplus)

The imputed labour returns within Net taxes on production = Net taxes on production * Split ratios for labour

Total labour returns = Labour remuneration + the imputed labour returns in net taxes on production

Labour share = Total labour returns / GDP

Then, there are various kinds of price index used here. The implicit GDP deflators are applied as in many previous studies (Rawski, 1993; Maddison, 1998; Woo, 1998; Wu, 2000a) to deflate nominal values into real ones. To transfer the nominal capital stock into real values, we use the "price index of investment in fixed assets" from the

---

[15] Net taxes on production refer to taxes on production less subsidies on production. The taxes on production refers to the various taxes, extra charges and fees levied on the production units on their production, sale and business activities as well as on the use of some factors of production, such as fixed assets, land and labour in the production activities they are engaged in. Subsidies on production refer to the unilateral government transfer to the production units, including subsidies on the loss due to implementation of government policies, price subsidies, etc.

[16] Labour remuneration not only refers to the total payment of various forms to workers including wages, bonuses and allowances earned in cash or other kinds, but also includes all benefits such as free medical services, medicine expenses, transport subsidies, social insurance, and housing fund paid by the employers.

national CSYs as capital deflator. This capital deflator is collected by the urban survey team of National Bureau of Statistics (NBS) since 1991, based on 600 enterprises and expanding to 4500 enterprises after 1998. For years before 1991, we splice the price index of investment in fixed assets to the GDP implicit deflator. All the monetary values are calculated in 1995 price.

Table 2.7 presents the annual growth rates of the TFP indices by region and province during the three time periods, 1978 to 1988, 1989 to 1999 and 1999 to 2009.[17] The main difference between using composition-adjusted labour input or unadjusted labour input to calculate TFP mainly lies during the time period 2000-2009 in the Interior region. In general, the Coastal, Interior and West perform better than the Northeast. The highest annual growth rates are 6.6 percent for Xinjiang during 1978-1988, 6.8 percent for Fujian during 1989-1999 and 5.9 percent in Hubei in the 2000s possibly due to their much lower initial levels. It suggests convergence processes among provinces and regions which will be further discussed in chapter 3 and 4. Only three provinces (Tianjin, Beijing and Shanghai) during 1978-1988 show the negative annual growth rates, possibly associated with the slow processes of political and economic reforms in before 1989 these three "special municipalities/cities" which are directly under control of the Central Government. Moreover, the annual growth rates during 1989-1999 are the highest among the three periods, which is consistent with the dramatic institutional reforms after Deng Xiaoping's south trip's speech about deepening reforms in 1992.

[17] The TFP indices (1995=100) by province and region from 1978 to 2009 can be seen in the Appendix Table A2.4.

Table 2.7: Annual growth rates of Total Factor Productivity

TFP growth	Considering LCI 1989-1999	Considering LCI 2000-2009	Not considering LCI 1978-1988	Not considering LCI 1989-1999	Not considering LCI 2000-2009
Northeast	**0.039**	**0.029**	**0.015**	**0.039**	**0.030**
Liaoning	0.033	0.028	0.022	0.033	0.029
Jilin	0.060	0.032	0.034	0.060	0.034
Heilongjiang	0.036	0.037	0.001	0.036	0.037
Coastal	**0.047**	**0.033**	**0.016**	**0.047**	**0.034**
Beijing	0.034	0.013	-0.011	0.034	0.014
Tianjin	0.046	0.045	-0.006	0.046	0.046
Hebei	0.051	0.024	0.016	0.051	0.025
shanghai	0.024	0.039	-0.040	0.024	0.040
Jiangsu	0.046	0.045	0.002	0.046	0.047
Zhejiang	0.052	0.020	0.049	0.053	0.021
Fujian	0.068	0.030	0.057	0.069	0.031
Shandong	0.051	0.034	0.017	0.051	0.035
Guangdong*	0.054	0.028	0.039	0.054	0.030
Interior	**0.050**	**0.034**	**0.042**	**0.051**	**0.036**
Shanxi	0.046	0.016	0.023	0.046	0.017
Anhui	0.053	0.021	0.033	0.053	0.022
Jiangxi	0.058	0.021	0.027	0.059	0.023
Henan	0.050	0.031	0.059	0.052	0.035
Hubei	0.039	0.059	0.051	0.040	0.059
Hunan	0.054	0.039	0.033	0.054	0.044
West	**0.043**	**0.035**	**0.040**	**0.043**	**0.036**
Inner Mongolia	0.051	0.047	0.057	0.052	0.048
Guangxi	0.067	0.042	0.016	0.068	0.044
Sichuan*	0.035	0.033	0.035	0.036	0.034
Guizhou	0.039	0.024	0.050	0.040	0.024
Yunnan	0.026	0.022	0.048	0.027	0.024
Shaanxi	0.039	0.036	0.053	0.039	0.038
Gansu	0.039	0.026	0.013	0.039	0.027
Qinghai	0.030	0.058	0.018	0.031	0.059
Ningxia	0.021	0.034	0.029	0.021	0.035
Xinjiang	0.047	0.032	0.066	0.047	0.033

Notes:

1. The labour composition index has information from 1989 to 2009.
2. The "Labour input" in the equation 2.17 is calculated by "LCI * Number of employed persons" in the columns "Considering LCI", while only by "Number of employed persons" in the columns "Not considering LCI" imply that the Labour input.

2.6 Contributions of production factors to productivity

According to the growth accounting methodology, we decompose the annual growth rate of GDP into its components: employment (L), LCI, physical capital (K) and factor productivity (TFP). We list two tables (Table 2.8 and 2.9) to consider the contributions of production factors (excluding or including LCI, respectively) to productivity.

Table 2.8 shows the sources of growth (annual percentage rate of change) by region and province during three time periods: 1978 to 1988, 1989 to 1999 and 2000 to 2009. As we expect, the physical capital input is the main contributor to labour productivity growth before 1989 and after 2000. For example, during the period of 1978-1988, the physical capital grows at 11.63 percent for Shanghai and 10.41 percent for Jiangsu, which account for most of growth of labour productivity. Hence, we can find the provinces with more physical investment have higher growth rates, as well as higher contribution proportions from physical capital. The Coastal has the highest growth rate of physical capital (for instance, 7.44 percent over the period 1978-1988), the highest growth rate of GDP (10.5 percent), the highest growth rate of labour productivity (9.04 percent) and the highest contribution of physical capital to labour productivity growth (82.3 percent). Therefore, the disparities of the formation speed of physical capital among regions (provinces) are the dominant factor to understand the regional (provincial) disparities in China. The three negative growth of TFP appear in the three municipal cities (Beijing, Tianjin and Shanghai) which are tightly controlled by the central government during the beginning stage of "Open-up Policy" with cautious optimism.

In 1990s, the TFP growth is much higher than the LP growth, leading to the falling contribution of capital deepening. The highest contribution of TFP occurs in the Interior region, especially the Henan province, consistent with the outstanding performance of LCI in Table 2.9. In contrast, the labour productivity and capital deepening rise simultaneously after 2000, supported by the huge investment of physical capital such as government spending, especially in the Industrial Northeast region may due to the “Revitalize the Northeast” policy implemented in 2003.

Table 2.8: Sources of growth (annual percentage rate of change)

1978-1988	GDP	L	LP	K/L	TFP	Contribution to LP (%) K/L	TFP
Northeast	**8.33**	**2.04**	**6.29**	**4.83**	**1.46**	**76.79**	**23.21**
Liaoning	8.98	1.68	7.3	5.15	2.15	70.55	29.45
Jilin	10.18	3.41	6.77	3.42	3.35	50.52	49.48
Heilongjiang	6.72	1.68	5.04	5.04	0	100.00	0.00
Coastal	**10.5**	**1.46**	**9.04**	**7.44**	**1.60**	**82.30**	**17.70**
Beijing	9.35	0.93	8.42	9.57	-1.15	113.66	-13.66
Tianjin	8.23	0.85	7.38	7.95	-0.57	107.72	-7.72
Hebei	8.6	1.64	6.96	5.39	1.57	77.44	22.56
shanghai	7.98	0.39	7.59	11.63	-4.04	153.23	-53.23
Jiangsu	11.83	1.29	10.54	10.41	0.13	98.77	1.23
Zhejiang	12.95	2.01	10.94	6.03	4.91	55.12	44.88
Fujian	11.59	2.29	9.3	3.61	5.69	38.82	61.18
Shandong	10.49	1.59	8.9	7.25	1.65	81.46	18.54
Guangdong*	11.44	1.8	9.64	5.82	3.82	60.37	39.63
Interior	**9.48**	**2**	**7.48**	**3.34**	**4.14**	**44.65**	**55.35**
Shanxi	8.49	1.52	6.97	4.78	2.19	68.58	31.42
Anhui	9.88	2.5	7.38	4.13	3.25	55.96	44.04
Jiangxi	9.31	2.25	7.06	4.43	2.63	62.75	37.25
Henan	10.58	2.23	8.35	2.51	5.84	30.06	69.94
Hubei	9.9	1.41	8.49	3.34	5.15	39.34	60.66
Hunan	8.18	1.96	6.22	2.96	3.26	47.59	52.41
West	**9.2**	**2.11**	**7.09**	**3.09**	**4.00**	**43.58**	**56.42**
Inner Mongolia	10.2	1.93	8.27	2.53	5.74	30.59	69.41
Guangxi	7.3	2.33	4.97	3.38	1.59	68.01	31.99
Sichuan*	9.1	1.8	7.3	3.76	3.54	51.51	48.49
Guizhou	9.72	2.38	7.34	2.28	5.06	31.06	68.94
Yunnan	9.76	2.21	7.55	2.77	4.78	36.69	63.31
Shaanxi	10.3	2.14	8.16	2.85	5.31	34.93	65.07
Gansu	8.09	3.44	4.65	3.24	1.41	69.68	30.32
Qinghai	7.02	2.14	4.88	3.11	1.77	63.73	36.27
Ningxia	9.48	2.25	7.23	4.35	2.88	60.17	39.83
Xinjiang	10.67	1.26	9.41	2.84	6.57	30.18	69.82

Notes:

1. Annual growth rate of LP = Annual growth rate of GDP – Annual growth rate of L
2. Annual growth rate of LP = Annual growth rate of capital deepening (K/L) + Annual growth rate of TFP

Continue…

1989-1999	GDP	L	LP	K/L	TFP	Contribution to LP (%) K/L	TFP
Northeast	**8.31**	**0.43**	**7.88**	**3.99**	**3.89**	**50.63**	**49.37**
Liaoning	8.24	0.32	7.92	4.67	3.25	58.96	41.04
Jilin	9.34	-0.13	9.47	3.54	5.93	37.38	62.62
Heilongjiang	7.84	0.93	6.91	3.3	3.61	47.76	52.24
Coastal	**12.4**	**0.99**	**11.41**	**6.65**	**4.76**	**58.28**	**41.72**
Beijing	9.86	0.21	9.65	6.45	3.2	66.84	33.16
Tianjin	10.4	0.4	10	5.49	4.51	54.90	45.10
Hebei	11.71	0.87	10.84	5.84	5	53.87	46.13
shanghai	10.81	-0.61	11.42	9.1	2.32	79.68	20.32
Jiangsu	12.62	1.22	11.4	6.79	4.61	59.56	40.44
Zhejiang	13.28	0.22	13.06	7.7	5.36	58.96	41.04
Fujian	14.38	1.38	13	5.95	7.05	45.77	54.23
Shandong	12.46	1.6	10.86	5.73	5.13	52.76	47.24
Guangdong*	13.05	1.21	11.84	6.45	5.39	54.48	45.52
Interior	**10.3**	**1.45**	**8.85**	**3.74**	**5.11**	**42.26**	**57.74**
Shanxi	8.7	0.64	8.06	3.48	4.58	43.18	56.82
Anhui	11	1.23	9.77	4.3	5.47	44.01	55.99
Jiangxi	10.7	1.18	9.52	3.66	5.86	38.45	61.55
Henan	10.43	1.88	8.55	3.44	5.11	40.23	59.77
Hubei	10.8	2.05	8.75	4.62	4.13	52.80	47.20
Hunan	9.48	1.07	8.41	3.02	5.39	35.91	64.09
West	**9.29**	**0.86**	**8.43**	**4.12**	**4.31**	**48.87**	**51.13**
Inner Mongolia	9.12	0.71	8.41	3.27	5.14	38.88	61.12
Guangxi	11.84	1.35	10.49	3.79	6.7	36.13	63.87
Sichuan*	9.17	0.63	8.54	4.99	3.55	58.43	41.57
Guizhou	7.89	1.2	6.69	2.82	3.87	42.15	57.85
Yunnan	9.03	1.11	7.92	5.21	2.71	65.78	34.22
Shaanxi	8.32	1.12	7.2	3.27	3.93	45.42	54.58
Gansu	8.74	-0.14	8.88	4.9	3.98	55.18	44.82
Qinghai	7.35	2.19	5.16	2.16	3	41.86	58.14
Ningxia	7.65	1.75	5.9	3.76	2.14	63.73	36.27
Xinjiang	9.61	0.69	8.92	4.15	4.77	46.52	53.48

Notes:

1. Annual growth rate of LP = Annual growth rate of GDP – Annual growth rate of L
2. Annual growth rate of LP = Annual growth rate of capital deepening (K/L) + Annual growth rate of TFP

Continue…

2000-2009	GDP	L	LP	K/L	TFP	Contribution to LP (%) K/L	TFP
Northeast	**11.3**	**0.28**	**11.02**	**7.76**	**3.26**	**70.42**	**29.58**
Liaoning	11.55	0.37	11.18	8.18	3	73.17	26.83
Jilin	11.9	0.12	11.78	7.77	4.01	65.96	34.04
Heilongjiang	10.57	0.27	10.3	6.44	3.86	62.52	37.48
Coastal	**11.7**	**1.07**	**10.63**	**7.1**	**3.53**	**66.79**	**33.21**
Beijing	11.06	4.07	6.99	5.63	1.36	80.54	19.46
Tianjin	13.72	0.2	13.52	8.6	4.92	63.61	36.39
Hebei	10.74	0.83	9.91	7.14	2.77	72.05	27.95
shanghai	10.71	1.54	9.17	5.11	4.06	55.73	44.27
Jiangsu	12.43	0.15	12.28	7.49	4.79	60.99	39.01
Zhejiang	11.72	1.87	9.85	7.81	2.04	79.29	20.71
Fujian	11.53	1.58	9.95	6.81	3.14	68.44	31.56
Shandong	12.45	0.01	12.44	8.77	3.67	70.50	29.50
Guangdong*	10.98	2.09	8.89	5.9	2.99	66.37	33.63
Interior	**11.1**	**0.33**	**10.77**	**6.92**	**3.85**	**64.25**	**35.75**
Shanxi	10.56	0.65	9.91	7.92	1.99	79.92	20.08
Anhui	10.83	0.56	10.27	7.89	2.38	76.83	23.17
Jiangxi	11.45	0.54	10.91	8.48	2.43	77.73	22.27
Henan	11.45	0.43	11.02	7.16	3.86	64.97	35.03
Hubei	11.08	-0.72	11.8	5.58	6.22	47.29	52.71
Hunan	10.96	0.6	10.36	5.73	4.63	55.31	44.69
West	**11.4**	**0.79**	**10.61**	**6.85**	**3.76**	**64.56**	**35.44**
Inner Mongolia	15.7	0.73	14.97	9.88	5.09	66.00	34.00
Guangxi	11.44	0.88	10.56	5.83	4.73	55.21	44.79
Sichuan*	11.18	0.47	10.71	7.25	3.46	67.69	32.31
Guizhou	10.32	1.45	8.87	6.39	2.48	72.04	27.96
Yunnan	9.65	1.07	8.58	6.17	2.41	71.91	28.09
Shaanxi	11.69	0.35	11.34	7.24	4.1	63.84	36.16
Gansu	10.12	1.07	9.05	6.23	2.82	68.84	31.16
Qinghai	11.37	0.04	11.33	5.38	5.95	47.48	52.52
Ningxia	10.93	1.22	9.71	6.16	3.55	63.44	36.56
Xinjiang	9.65	1.33	8.32	5.01	3.31	60.22	39.78

Notes:

1. Annual growth rate of LP = Annual growth rate of GDP – Annual growth rate of L
2. Annual growth rate of LP = Annual growth rate of capital deepening (K/L) + Annual growth rate of TFP

Since the LCI are calculated by using the CHNS dataset (1989-2009), we only can impute the LCI contributions during the latter two time periods: 1989-1999 and 2000-2009 (see Table 2.9). Human capital formation is becoming more and more important factor in economic growth. The performance of the Interior region (especially Henan province) are outstanding across the two time periods, marked by the lowest contribution of physical capital and highest contribution of LCI. It suggests that human capital formation from technological and institutional shifts is taking place of physical capital formation in the economic growth (Ding and Knight, 2011). Labour composition index has also contributed more than before from about 0.2 percent in the 1990s to about 1.4 percent in the 2000s. The changing growth pattern in the Coastal points out the development direction for the other regions in the future.

Table 2.9: Sources of growth (annual percentage rate of change)

1989-1999	GDP	L	LP	K/L	LCI	TFP	Contribution to LP (%) K/L	LCI	TFP
Northeast	**8.31**	**0.43**	**7.88**	**3.99**	**0**	**3.89**	**50.63**	**0.00**	**49.37**
Liaoning	8.24	0.32	7.92	4.67	-0.01	3.26	58.96	-0.13	41.16
Jilin	9.34	-0.13	9.47	3.54	-0.04	5.97	37.38	-0.42	63.04
Heilongjiang	7.84	0.93	6.91	3.3	0.02	3.59	47.76	0.29	51.95
Coastal	**12.4**	**0.99**	**11.41**	**6.65**	**0.02**	**4.74**	**58.28**	**0.18**	**41.54**
Beijing	9.86	0.21	9.65	6.45	0.02	3.18	66.84	0.21	32.95
Tianjin	10.4	0.4	10	5.49	0.02	4.49	54.90	0.20	44.90
Hebei	11.71	0.87	10.84	5.84	0.02	4.98	53.87	0.18	45.94
shanghai	10.81	-0.61	11.42	9.1	0.01	2.31	79.68	0.09	20.23
Jiangsu	12.62	1.22	11.4	6.79	0.04	4.57	59.56	0.35	40.09
Zhejiang	13.28	0.22	13.06	7.7	0.02	5.34	58.96	0.15	40.89
Fujian	14.38	1.38	13	5.95	0.02	7.03	45.77	0.15	54.08
Shandong	12.46	1.6	10.86	5.73	0.01	5.12	52.76	0.09	47.15
Guangdong*	13.05	1.21	11.84	6.45	0.02	5.37	54.48	0.17	45.35
Interior	**10.3**	**1.45**	**8.85**	**3.74**	**0.06**	**5.05**	**42.26**	**0.68**	**57.06**
Shanxi	8.7	0.64	8.06	3.48	0.05	4.53	43.18	0.62	56.20
Anhui	11	1.23	9.77	4.3	0.05	5.42	44.01	0.51	55.48
Jiangxi	10.7	1.18	9.52	3.66	0.06	5.8	38.45	0.63	60.92
Henan	10.43	1.88	8.55	3.44	0.2	4.91	40.23	2.34	57.43
Hubei	10.8	2.05	8.75	4.62	0.14	3.99	52.80	1.60	45.60
Hunan	9.48	1.07	8.41	3.02	-0.06	5.45	35.91	-0.71	64.80
West	**9.29**	**0.86**	**8.43**	**4.12**	**0.05**	**4.26**	**48.87**	**0.59**	**50.53**
Inner Mongolia	9.12	0.71	8.41	3.27	0.05	5.09	38.88	0.59	60.52
Guangxi	11.84	1.35	10.49	3.79	0.08	6.62	36.13	0.76	63.11
Sichuan*	9.17	0.63	8.54	4.99	0.05	3.5	58.43	0.59	40.98
Guizhou	7.89	1.2	6.69	2.82	0.01	3.86	42.15	0.15	57.70
Yunnan	9.03	1.11	7.92	5.21	0.05	2.66	65.78	0.63	33.59
Shaanxi	8.32	1.12	7.2	3.27	0.06	3.87	45.42	0.83	53.75
Gansu	8.74	-0.14	8.88	4.9	0.05	3.93	55.18	0.56	44.26
Qinghai	7.35	2.19	5.16	2.16	0.05	2.95	41.86	0.97	57.17
Ningxia	7.65	1.75	5.9	3.76	0.05	2.09	63.73	0.85	35.42
Xinjiang	9.61	0.69	8.92	4.15	0.05	4.72	46.52	0.56	52.91

Notes:

1. Annual growth rate of LP = Annual growth rate of GDP – Annual growth rate of L
2. Annual growth rate of LP = Annual growth rate of capital deepening (K/L) + Annual growth rate of LCI + Annual growth rate of TFP

Continue…

2000-2009	GDP	L	LP	K/L	LCI	TFP	Contribution to LP (%) K/L	LCI	TFP
Northeast	**11.3**	**0.28**	**11.02**	**7.76**	**0.14**	**3.12**	**70.42**	**1.27**	**28.31**
Liaoning	11.55	0.37	11.18	8.18	0.18	2.82	73.17	1.61	25.22
Jilin	11.9	0.12	11.78	7.77	0.16	3.85	65.96	1.36	32.68
Heilongjiang	10.57	0.27	10.3	6.44	0.05	3.81	62.52	0.49	36.99
Coastal	**11.7**	**1.07**	**10.63**	**7.1**	**0.1**	**3.43**	**66.79**	**0.94**	**32.27**
Beijing	11.06	4.07	6.99	5.63	0.1	1.26	80.54	1.43	18.03
Tianjin	13.72	0.2	13.52	8.6	0.09	4.83	63.61	0.67	35.72
Hebei	10.74	0.83	9.91	7.14	0.1	2.67	72.05	1.01	26.94
shanghai	10.71	1.54	9.17	5.11	0.08	3.98	55.73	0.87	43.40
Jiangsu	12.43	0.15	12.28	7.49	0.28	4.51	60.99	2.28	36.73
Zhejiang	11.72	1.87	9.85	7.81	0.1	1.94	79.29	1.02	19.70
Fujian	11.53	1.58	9.95	6.81	0.1	3.04	68.44	1.01	30.55
Shandong	12.45	0.01	12.44	8.77	0.05	3.62	70.50	0.40	29.10
Guangdong*	10.98	2.09	8.89	5.9	0.1	2.89	66.37	1.12	32.51
Interior	**11.1**	**0.33**	**10.77**	**6.92**	**0.15**	**3.7**	**64.25**	**1.39**	**34.35**
Shanxi	10.56	0.65	9.91	7.92	0.13	1.86	79.92	1.31	18.77
Anhui	10.83	0.56	10.27	7.89	0.15	2.23	76.83	1.46	21.71
Jiangxi	11.45	0.54	10.91	8.48	0.15	2.28	77.73	1.37	20.90
Henan	11.45	0.43	11.02	7.16	0.29	3.57	64.97	2.63	32.40
Hubei	11.08	-0.72	11.8	5.58	0.02	6.2	47.29	0.17	52.54
Hunan	10.96	0.6	10.36	5.73	0.46	4.17	55.31	4.44	40.25
West	**11.4**	**0.79**	**10.61**	**6.85**	**0.04**	**3.72**	**64.56**	**0.38**	**35.06**
Inner Mongolia	15.7	0.73	14.97	9.88	0.15	4.94	66.00	1.00	33.00
Guangxi	11.44	0.88	10.56	5.83	0.11	4.62	55.21	1.04	43.75
Sichuan*	11.18	0.47	10.71	7.25	0.16	3.3	67.69	1.49	30.81
Guizhou	10.32	1.45	8.87	6.39	-0.02	2.5	72.04	-0.23	28.18
Yunnan	9.65	1.07	8.58	6.17	0.15	2.26	71.91	1.75	26.34
Shaanxi	11.69	0.35	11.34	7.24	0.15	3.95	63.84	1.32	34.83
Gansu	10.12	1.07	9.05	6.23	0.04	2.78	68.84	0.44	30.72
Qinghai	11.37	0.04	11.33	5.38	0.04	5.91	47.48	0.35	52.16
Ningxia	10.93	1.22	9.71	6.16	0.04	3.51	63.44	0.41	36.15
Xinjiang	9.65	1.33	8.32	5.01	0.04	3.27	60.22	0.48	39.30

Notes:

1. Annual growth rate of LP = Annual growth rate of GDP – Annual growth rate of L
2. Annual growth rate of LP = Annual growth rate of capital deepening (K/L) + Annual growth rate of LCI + Annual growth rate of TFP

2.7 Conclusions

This chapter reviews the growth accounting model and measurement methods of its components such as physical capital services, labour inputs, labour composition index (LCI) and Total Factor Productivity (TFP). We apply this model to Chinese empirical studies for regions and provinces from 1978 to 2009.

We use the LCI to adjust labour inputs. Both average approach and Ordinary Least Square (OLS) regression approach are applied to calculate the measured wage rates for employees with different education levels, provinces and years, weighted by urban/rural ratios. The LCI keeps on increasing from 1989 to 2009. Among the provinces and regions, the Interior region especially Henan province has the highest LCI, maybe because it is centre-located between Beijign and Shanghai (two educational and economic centers in China).

After we decompose the annual growth rate of GDP into its components of employment, LCI, physical capital and TFP, we find that Chinese economic growth was mainly pushed by the growth of physical capital. The annual growth rate of labour productivity in the Coastal is the highest among all regions in China, while labour inputs and TFP growth contribute more in the Interior and West regions. It can explain the regional disparities reasonably. The growth rate of physical capital in the Coastal was at about double speed of the other three regions (the Northeast, the Interior and the West) before 2000. During the period of 2000-2009, the growth rates of physical capital in the left-behind regions have caught up with the Coastal. Since there is no significant difference between the Coastal and the other three, with more investment of physical capital, we would find more evidence of convergence on economic growth in the future research.

Moreover, the contribution shares of physical capital in labour productivity have been declining for the most advanced Coastal, while the TFP contributions have been increasing over the same period. It is consistent with findings of Ding and Knight (2011) that both physical and human capital formation contribute to the economic growth in China. Our results show that the human capital formation from technological and institutional shifts (TFP) is becoming more and more important in the Coastal. Labour composition index (education) also contribute to economic growth. Although its contribution is not as dominant as physical capital and TFP in current stage, the LCI is taking more space in the growth accounting model. The new growth pattern of the Coastal suggests that human capital formation including education will be the next potential engine of economic growth for other less developed regions, leaving much more space for them to compete.

In the next chapter, we apply more accurate specifications to analyze the regional disparities and convergence of labour productivity, TFP and wages, using physical capital services, labour inputs, LCI and TFP measured here.

CHAPTER THREE: ECONOMIC REFORM AND PRODUCTIVITY CONVERGENCE

3.1 Introduction

This chapter focuses on the regional disparities and convergence of labour productivity (GDP per worker), Total Factor Productivity (TFP) and wages in China. Regions are defined as in the last chapter. China is one country with the worst regional economic disparities in the world (Yang, 2002; Kanbur and Zhang, 2005; Fleisher *et al.*, 2010). If the increasing regional disparities in China were not corrected in time, the uneven growth in productivity and wages would not only threaten the ultimate success of China's economic reform, but also bring about serious social and political unrest (Chen and Feng, 2000). Understanding the drivers of the increasing economic gap between the rich and poor regions and whether and how the poor regions are catching up with rich regions has become an urgent task for Chinese economists.

Table 3.1 discusses the changes of labour productivity, TFP and wages among the four regions from 1978 to 2009. In 1978, the real GDP per worker of the Northeast was double that of the Coastal and the Interior. Then, the Coastal caught up with the Northeast with annual growth rate at 8.6 percent during 1978-1995. All regions developed very quickly at 9.3 percent to 10 percent per year in 1995-2009. However, in 2009, the real labour productivity in the richer Northeast and Coastal regions (about 50,000 RMB) were still more than twice the poorer Interior and West regions (below 26,000 RMB) due to their low initial levels.

A body of research has shown that TFP growth has played an important role in post-reform growth in China (Chow, 1993; Borensztein and Ostry, 1996; Young, 2003; Wang and Yao, 2003; Islam *et al.*, 2006; Fleisher *et al.*, 2010). In 1978, the Northeast had the higher level of TFP index (73), nearly 17 percent higher than the Coastal, and 54 percent higher than the Interior and West. The annual growth rate of the TFP index was the highest in the Interior at annual rate of 4.4 percent from 1978 to 1995 and 3.9 percent from 1995 to 2009. Therefore, the TFP index of the Interior (173) exceeds the industrial Northeast region in 2009.

In terms of wages, we find the same "gradualism, stagnation and sharp jumps" process of China's economy as described in Fleisher *et al*. (2010). The gradualism of reform brings the slow pace of China's transformation which distinguishes it from most other transition economies, especially those in Central and Eastern Europe and the Former Soviet Union (Fleisher et al., 2005). In the 1980s, the regional wages were similar to each other due to a rigid labour market, until Deng Xiaoping's "South Trip" in 1992 which speeds the pace of transition to a market based economy and changes the wage structure in China.[18] From 1978 to 1995, the annual growth rates of wages in the Coastal (7.4 percent) were much higher than the other three regions, especially the Northeast (4.9 percent) which was suffering the huge laid-off from State Owned Enterprises (SOEs). During 1995-2009, wages increased rapidly with growing labour productivity in all regions at about 10-11 percent per year. With lower initial levels, average wages of the Coastal were about 10 percent higher than those of the Northeast in 2009, 22.6 percent higher than the Interior and 28.3 percent higher than the West.

[18] In the spring of 1992, Deng Xiaoping visited the east region of China (Guangdong and Shanghai). His main idea was "To Get Rich Is Glorious". Hence, we follow the same line of Fleisher *et al*. (2010) to account for the structural break of Chinese market reforms around 1994 in the specification of our empirical models.

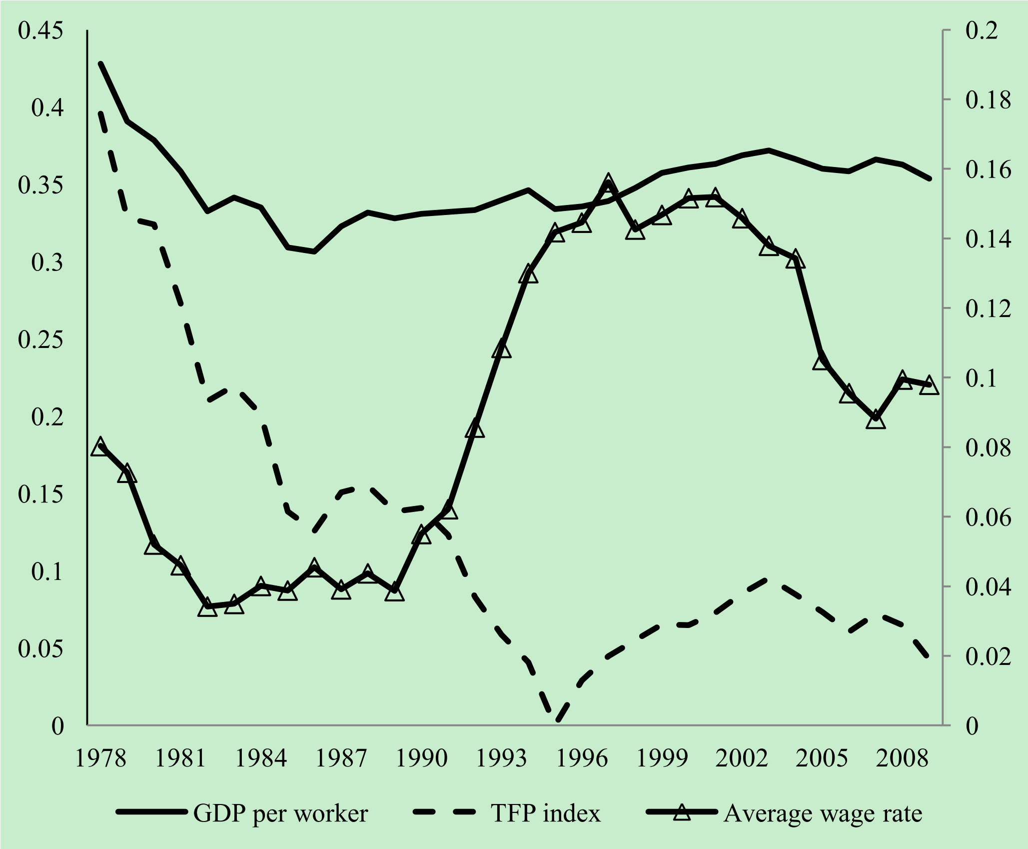
Table 3.1 Changes of labour productivity, TFP and wages, 1978- 2009

	Northeast	Coastal	Interior	West
Real labour productivity				
1978 value	5288	2964	2115	1993
1995 value	12263	12766	6637	5905
2009 value	49728	48818	25657	21644
1978-1995 (growth rate)	0.049	0.086	0.067	0.064
1995-2009 (growth rate)	0.100	0.096	0.097	0.093
Total factor productivity index (1995=100)				
1978 value	73	63	47	50
1995 value	100	100	100	100
2009 value	170	166	173	165
1978-1995 (growth rate)	0.018	0.028	0.044	0.040
1995-2009 (growth rate)	0.038	0.036	0.039	0.036
Real average annual wages				
1978 value	2162	1773	1812	1999
1995 value	4541	6266	4555	4801
2009 value	22431	24662	20116	19222
1978-1995 (growth rate)	0.044	0.074	0.054	0.052
1995-2009 (growth rate)	0.114	0.098	0.106	0.099

Data sources: (Hsueh and Li, 1999)); various years China Statistical Yearbook; National Bureau of Statistics (1999).

Figure 3.1 is a preliminary statistical examination of regional disparities and convergence of labour productivity, TFP and wages. Here regional disparities are measured as the coefficients of variation (CV) of labour productivity (left axis), TFP and wages (right axis) among the four regions. Regional disparities have been decreasing for all three productivity proxies before 1986 which showed a common trend of convergence for all regions. After that, the coefficients of variation for labour productivity become quite stable, while the wages are dramatically diverging in the 1990s and then converging in the 2000s. In contrast to the diverging wages in the 1990s, TFP index keeps on converging among regions and becomes quite stable in the 2000s. Thus, these three productivity proxies show different convergence patterns in the more dynamic economy after 1986.

Figure 3.1: Coefficients of variation, 1978-2009



Data sources: (Hsueh and Li, 1999); various years China Statistical Yearbook (NBS, 1999); National Bureau of Statistics (1999).

The different patterns of regional disparities of labour productivity, TFP and wages demand more comprehensive economic growth models which can take account of determining factors of economic growth such as demographic, social-economic and institutional changes. China need learn lessons from the economic growth path of developed economies. In a cross-country setting, numerous theoretical and empirical studies find that economic growth is determined by factors such as physical and human capital, privatization, international openness and public policy (Barro and Lee, 1993; Barro and Lee, 2001; Chen and Feng, 1996; van Ark *et al.*, 2008). However, effects of these determinants on Chinese economic growth, especially their impacts on different productivity proxies have not been thoroughly analyzed. Thus, this chapter aims to investigate determining factors in production processes, labour productivity, TFP and wages in China. We study the beta-convergence processes in China to check whether the lagging regions would grow faster than the rich regions and eventually catch up with them. We focus on the role of human capital in economic growth and address the associations between human capital formation and ownership reform, One-Child Policy, openness and fiscal expenditures.

The rest of this chapter is organized as follows. The next section is the literature review; in section 3.3 we lay out our baseline empirical specifications for drivers of regional disparities and beta-convergence; Section 3.4 is for data description; Section 3.5 reports empirical results; Section 3.6 solves the endogeneity problem of education; Section 3.7 concludes.

3.2 Literature Review

Regional convergence

The hypothesis of economic convergence is a primary and particularly active area of research in empirical growth economics. The growth-convergence equation originates from the neoclassical growth model (Solow, 1956) and has been developed by long series of growth empirics such as Barro and Sala-i-Martin (1992). In more recent literature, Byrne and Vecchi (2010) examine convergence in a panel of industries between the United States, the United Kingdom and France, providing evidence of conditional convergence. When the partial correlation between economic growth and its initial level is negative, there is beta-convergence (Islam, 2003).

Researchers generally deal with convergence in terms of GDP per capita across Chinese provinces. Jian *et al.* (1996) is a pioneering study proceeding from the neoclassical convergence and use the beta-convergence to analyze GDP per capita of 28 Chinese provinces for the period 1978-1992. They use agriculture share and costal location as conditional variables and report that convergence before 1985 and divergence afterwards, which is consistent with what we find in Figure 3.1. They argue that convergence is a result of provinces in the Coastal (rural area) growing faster as a result of policy advantage.

Raiser (1998) relies on light industry and investment rates as controlling variables and finds “weakening” convergence since 1985, which could be the result of either shifts in the steady state of some provinces in the Coastal or reduction in capital mobility. Chen and Fleisher (1996) find conditional convergence of production across provinces on physical investment share, employment growth, human capital investment, foreign direct investment (FDI) and coastal location from 1978 to 1993. Villaverde *et al.* (2010) find a strong convergence process for the periods 1978-1990 and 2004-2007 but divergence for the period 1990-2004. They argue that provincial inequality in China mainly lies within rather between regions, particularly for provinces in the Coastal.

Labour productivity convergence however can be the joint outcome of the twin processes of capital deepening and technological catch-up, known as issue of TFP convergence. Jorgenson and Nishimizu (1978) initiates the international comparison of relative TFP levels in the United States and Japan during the period 1952-1974. Dollar and Wolff (1994) examine TFP level convergence using time-series growth accounting method, while Dowrick and Nguyen (1989) use a cross-section regression to interpret the coefficients of the initial income variables of the equation as indicative of TFP-convergence.

Unfortunately, there is little literature about Chinese regional TFP convergence. As one of rare cases, Wu (2000b) find that China's regional TFP converges to the same level from 1982 to 1995 using coefficient of variation, but he does not relate his study to convergence theory. In this chapter, we use the following conditional variables to analyze the drivers of regional disparities and beta-convergence of labour productivity, TFP and wages in China.

Human capital

It is widely hypothesized that human capital has an important role in production through the direct generation of worker skills and also facilitate technology spillovers (O'Mahony and Vecchi, 2009; Fleisher *et al.*, 2010). Human capital plays a critical role in the endogenous growth models, which hold that knowledge-driven growth can lead to a constant or even increasing rate of return. Romer (1986; 1990) argues that human capital is the major input to research and development that innovates technologies. Levine and Renelt (1992) and Young (1992) also find that countries with larger initial human capital stock are more likely to have new products and grow faster than other countries. Empirical evidence has revealed a positive relationship between human capital and growth. Fleisher *et al.* (2010) find that human capital positively affects labour productivity, TFP growth and wage growth in China.

This chapter focuses on the effect of human capital on labour productivity, TFP and wages in China. Dearden *et al.* (2006), O'Mahony and Peng (2008) and Carmichael *et al.* (2009) compare the effect of education and training on productivity and wages for European countries in an attempt to pick up external benefits of human capital.

However, China does not have the labour force survey dataset for the whole country, so we apply the labour composition index (calculated by the CHNS dataset in the former chapter) into an economic growth model and address the associations between human capital formation and ownership reform, One-Child Policy, openness and fiscal expenditures.

Physical capital

Mankiw *et al*. (1992) show that an augmented Solow model including physical capital as well as human capital accumulation can describe the cross-country data. Bai *et al.* (2006) estimate average rates of returns on physical capital for Chinese industrial enterprises as 6.1 percent in 1998 and 12.2 percent in 2003. Chapter 2 also verifies a observation in Ding and Knight (2011) that China's exceptional growth performance is most fundamentally a reflection of the high investment rates of physical and human capital that characterised the economy.

Ownership reform

Knight and Song (2001) point out that there are two obvious explanations for the rise in regional disparities in China: economic growth and policies of economic reforms. The Chinese economy has experienced dramatic institutional reforms in last thirty years (Chen and Feng, 2000). Although urban economic reforms began in the period of 1983-85, the Chinese economy was still largely a command and market coordinated economy with rigid wage system over the entire period of our study. [19] The State-Owned

[19] Using data for advanced European countries such as Germany and Italy, Peng and Siebert (2007; 2008) find that the wage rigidity harms the economy of lagging regions by delaying their recovery from disadvantageous shocks. Kang and Peng (2012) analyze the CHNS data and also find similar wage rigidity for lagging private sector in China.

Enterprises (SOEs) account for more than half of gross industrial outputs (Fleisher *et al*., 2010).

After 1992, Chinese reforms aimed to transform the rigid central-planned economy into a flexible market-oriented economy. Chen and Feng (2000) suggest that a larger share of production by non-state-owned enterprises (including collective and private units) results in higher economic growth in the Coastal region of China.[20] Consequently, curtailing the widening Coastal-Inner regional gaps can be effectively achieved by promoting collective-owned or private enterprises.

Fleisher *et al*. (2010) measure the degree of market reform in the local economy using the proportion of urban labour employed in private firms. We categorize staff and workers into three kinds of enterprises: SOEs, collective-owned units and private units, and assess the effect of privatization on labour productivity, TFP and wages. Under the rigid wage system until the early 1990s, the superior labour compensation in joint ventures and foreign firms attracted many talented workers to transfer from SOEs into the private sector which was well known as "jumping into the sea". It brought about a much more efficient allocation of human capital in the production processes.

However, the wages in the public sector began to increase sharply in the late 1990s and reached 16,227 Yuan in 2003 which finally surpassed the private sector wages and attracted Chinese professionals back to the public sector known as "coming back to shore" (Yang *et al.*, 2010). These new changes could be from the capital deepening processes through the global value chain which make the economic scale more important than before and also improve human capital formation. Therefore, the

---

[20] "Private units" include cooperative enterprises, Joint enterprises, Limited liability enterprises, share-holding enterprises, private enterprises, self-employed individual, Funds from Hong Kong, Macro and Taiwan, Foreign funded enterprises.

ownership structure is a very important institutional factor in our study.

<u>Openness</u>

Levine and Renelt (1992) systematically study numerous economic factors that may account for long-run aggregate economic growth. They argue that government policies reducing protectionism and liberalising trade are major inputs for growth. Chen and Feng (2000) also argue that international trade is encouraged by geographical and political factors such as proximity to major ports, decisions to create special economic zones and free trade areas, local institutional characteristics such as laws and regulations, contract enforcement, local expenditures on infrastructure, and by labour market conditions. Trade also has facilitated the transformation of the state-owned and the collective sectors, and potentially bring in new production and managerial technologies with their attendant spillovers (Liu, 2008; O'Mahony *et al.*, 2008). Thus, we also account for the regional disparities with trade by measuring an openness variable as the share of international trade (export and import) to GDP, and assess its effect on regional productivity and wages.

<u>One-Child Policy</u>

Birth rate is regarded as an important variable representing human capital formation in the productivity model, but no conclusion that birth rate has positive or negative effect on productivity in the theoretical or empirical literatures. On the one hand, there is "population pessimism" which claims population growth will bring negative effect on economic growth. Malthus (1798 [1986]) claimed that large population will decrease the productivity because of diminishing marginal productivity. For a natural resource (land, water, etc.) augmented economy, such as rural economy, as population grows the per capita share of natural resource decreases. Hence, the marginal product of labour goes down.

On the other hand, there is "population optimism" which claims population growth will bring positive effect on economic growth. The neo-Boserupian school of thought (Boserup, 1981) mentions that population may have a scale effect that is beneficial to economic growth. Becker, Glaeser and Murphy (1999) argue that in modern urban economies with small agricultural and natural-resource sectors, the increased density that comes with higher population and greater urbanization promotes specialization and investment in human capital and more rapid accumulation of new knowledge, which would raise per capita incomes.

Therefore, Becker, Glaeser and Murphy (1999) combine both negative effect (diminishing marginal productivity) and the positive effect (human capital accumulation, spillover effect, etc.) and conclude that "the net relation between greater population and labour productivity depends on whether the inducements to human capital and expansion of knowledge are stronger than diminishing returns to natural resources.

China started the "One-Child Policy" in 1979 which only be applied to the Han Chinese[21] and by way of affirmative policies, all ethnic minorities in China are allowed to have two or more children until the end of the 1980s (Qian, 1997). In this chapter, I will study the net effect of birth rate on labour productivity, Total factor productivity and average wages in the transition of rural economy to urban economy by urbanization reform.

[21] Han Chinese is an ethnic group native to China and constitutes about 92 percent of the population of the People's Republic of China.

Regional growth policies

The cross-country growth literature addresses the political roles that the central government can play in improving the lagging regions' economic growth. Since the widening productivity and wage gap between the Coastal and the other regions can lead to political unrest and polarization, the Chinese central government has emphasized the importance of the inner areas' growth and development.

Ma (1995), Ma and Norregaard (1998) and Chen and Feng (2000) argue that the central government policies should not be biased in favour of the Coastal. The central government led by Premier Zhu Rongji launched the "Western Development Strategy" in 1999 to boost the lagging Interior and West regions. The main components of the strategies include the development of infrastructure, enticement of foreign investment, increased efforts on ecological protection (such as reforestation), as well as human capital formation such as promotion of education and retention of talent flowing to richer provinces. As of 2006, a total of 1 trillion Yuan has been spent on building infrastructure in western China (Goodman, 2004).

Moreover, the Northeast was one of the earlier regions to industrialize in China, focusing mainly on equipment manufacturing including the steel, automobile, shipbuilding, aircraft manufacturing, and petroleum refining industries. Recent years, however, have seen the stagnation of the Northeast's heavy-industry-based economy, as economy continues to liberalize and privatize. Hence, the central government led by Premier Wen JiaBao has initialized the "Revitalize the Northeast" campaign in 2003. These policy factors should be considered in an economic growth model for China by the sensitivity test of different development patterns of the four regions.

Fiscal expenditures on human capital

Not only individuals but also government benefit from increasing wages. Heckman (2005) notes that China's government investment in human capital beyond the junior high school level (the compulsory 9-year education) has been very small and dispersed, in contrast to nations at similar levels of socio-economic development. Chinese government has increased education expenditures sharply aiming for 4 percent of GDP before 2010. In 2007, however, the government expenditures on education are still only 2.43 percent of GDP and have been below 3 percent in most years since 1992, which are much lower than the average of 5.1 percent in developed countries (Fleisher *et al.*, 2010). Hence, we investigate the effect of provincial "fiscal expenditures on human capital (culture, education, scientific and health)" on labour productivity, TFP and wages in this chapter.

Structural breaks in 1994

The year 1994 marks the fiscal decentralization processes beginning from withdrawal of government subsidies for loss-incurring SOEs, and the hardening of SOEs' budget constraints become much more earnest in 1997 (Appleton *et al.*, 2002).[22] The shift toward fiscal federalism is also through separating central and local government taxation and relaxing ties between provincial and sub-provincial treasuries and the centre, reinforced imposition of hard budget constraints on SOEs (Su and Zhao, 2004). Therefore, We will follow the suggestion of Fleisher *et al.* (2010) to use the year 1994

[22] The decentralization of fiscal revenue raising and spending decisions can improve the efficiency of the public sector, cut the budget deficit and promote economic growth because local governments are better positioned than the central government to locate and monitor the fiscal expenditure more efficiently, which reinforced imposition of hard budget constraints on SOEs (Qian and Weingast, 1997; Ma and Norregaard, 1998; Oates, 1972). It is also confirmed by numerous studies on intergovernmental fiscal relations in China (Agarwala, 1992).

as a structural break for the economic transition process in China.

3.3 Empirical specifications

3.3.1 Baseline empirical Specifications

Firstly, we estimate a regional aggregate production function, in which inputs include physical and human capital. We measure human capital as the composition-adjusted labour inputs (= Number of employed persons * LCI[23]). The standard regional fixed effects (FE) specification is as follows:

$$\ln Y_{pt} = \alpha_0 + \alpha_1 \ln K_{pt} + \alpha_2 \ln(L_{pt} * LCI_{pt}) + \sum_{r=1}^{4} \varphi_r R_r + \sum_{t=1}^{32} \lambda_t T_t + \varepsilon_{pt} \tag{3.1}$$

where Y_{pt} is the real GDP for province p (=1 ,…, 28) in year t (=1978, …, 2009); K_{pt} is real capital inputs; L_{pt} is the number of employed persons; LCI_{pt} is the labour composition index calculated with the micro CHNS dataset; R_r and T_t are region (=1,…,4) and time dummies; and ε_{it} is a random error term.

As discussed in above section, we apply two sensitivity tests to test the 1994 structural break, and the disparities in different development patterns in the four regions:

(1) Adding variables interacted with the structural break year dummy S_{pt} (0 = before 1994, 1 = 1994 and thereafter);

(2) Adding variables interacted with the regional dummies *rd* to capture the

[23] The Labour composition index used in this chapter is calculated from the Chapter 2 for 1989 - 2009. We assume that the LCI indices during 1978-1988 are the same as 1989 for every region and province. This assumption is reasonable because the contributions of LCI to labour productivity increase mainly in 2000s (see Table 2.9) and are very likely to be quite constant in the early stage of reforms (1980s).

different growth paths of regions. The *rd1 – rd3* dummies are for the Northeast, Coastal and Interior regions, leaving the West as the baseline region. Hence, the coefficients of interactions are the incremental effect of specific period/region on the baseline period/region.

Secondly, the fixed effect (FE) models are applied to examine the impact of LCI and institutional variables on labour productivity, TFP and wages. We present the basic FE specification as follows:

$$\begin{aligned}\ln LP_{pt} &= \beta_0 + \beta_1 \ln KL_{pt} + \beta_2 LCI_{pt} + \delta_1 O1_{pt} + \delta_2 O3_{pt} + \beta_3 BR_{pt} \\ &+ \beta_4 \ln OP_{pt} + \beta_5 Fis_{pt} + \sum_{r=1}^{4} \chi_r R_r + \sum_{t=1}^{30} \lambda_t T_t + \varepsilon_{pt}\end{aligned}$$

$$\begin{aligned}\ln TFP_{pt} &= \beta_0 + \beta_2 LCI_{pt} + \delta_1 O1_{pt} + \delta_2 O3_{pt} + \beta_3 BR_{pt} + \beta_4 \ln OP_{pt} \\ &+ \beta_5 Fis_{pt} + \sum_{r=1}^{4} \chi_r R_r + \sum_{t=1}^{30} \lambda_t T_t + \varepsilon_{pt}\end{aligned}$$

$$\begin{aligned}\ln AW_{pt} &= \beta_0 + \beta_1 \ln KL_{pt} + \beta_2 LCI_{pt} + \delta_1 O1_{pt} + \delta_2 O3_{pt} + \beta_3 BR_{pt} \\ &+ \beta_4 \ln OP_{pt} + \beta_5 Fis_{pt} + \sum_{r=1}^{4} \chi_r R_r + \sum_{t=1}^{30} \lambda_t T_t + \varepsilon_{pt} \qquad (3.2)\end{aligned}$$

where LP_{pt} is the GDP per worker for province p in year t; KL_{pt} is real capital stock per worker; TFP_{pt} is the total factor productivity index; AW_{pt} is the real annual earnings per worker; $O1_{pt}$ and $O3_{pt}$ represent the ratios of staff and workers worked in the public sector and private enterprises respectively; BR_{pt} is the birth rate of population to measure the human capital formation from One-Child Policy on productivity; OP_{pt} is the share of trade (export and import) of GDP to capture the effect of openness and potential skilled-biased technology spillovers; Fis_{pt} is the share of fiscal expenditures on human capital; R_r and T_t are region and time dummies; and ε_{pt} is a random error term.

Following the same vein of the sensitivity tests in the production function in equation (3.2), we also apply sensitivity tests for structural break (year 1994) in labour productivity, TFP and wage functions (use LP as example) as follows:

$$
\begin{aligned}
\ln LP_{pt} &= \beta_0 + \beta_1 \ln KL_{pt} + \beta_2 LCI_{pt} + \delta_1 O1_{pt} + \delta_2 O3_{pt} + \beta_3 BR_{pt} + \beta_4 \ln OP_{pt} \\
&+ \beta_5 Fis_{pt} + \beta_6 \ln KL_{pt} * S_{pt} + \beta_7 LCI_{pt} * S_{pt} + + \delta_3 O1_{pt} * S_{pt} + \delta_4 O3_{pt} * S_{pt} \\
&+ \beta_8 BR_{pt} * S_{pt} + \beta_9 \ln OP_{pt} * S_{pt} + \beta_{10} Fis_{pt} * S_{pt} + \sum_{r=1}^{4} \chi_r R_r + \sum_{t=1}^{30} \lambda_t T_t + \varepsilon_{pt}
\end{aligned}
\tag{3.3}
$$

And the sensitivity tests for regional disparities in GDP per worker are just replacing the structural break dummy with the regional dummies $rd1$ - $rd3$ for the Northeast, Coastal and Interior regions.

3.3.2 Empirical specifications for beta-convergence

Following Sala-i-Martin (1996), we postulate that beta-convergence holds for provinces *p* in a region. Log form labour productivity in the province *p* can be approximated by

$$\ln LP_{pt} = \alpha + (1-\beta)\ln LP_{p,t-1} + \mu_{pt} \tag{3.4}$$

where 0< β <1 and $\mu_{pt} \sim (0, \sigma_{\mu}^2)$, and is independent over province *p* and year *t*. Manipulating the equation (3.4) yields,

$$\ln\left(\frac{LP_{pt}}{LP_{p,t-1}}\right) = \alpha - \beta \ln LP_{p,t-1} + \mu_{pt} \tag{3.5}$$

Thus, β>0 implies a negative correlation between growth and initial level of labour productivity.

$$\beta = -(1 - e^{-\lambda T}) \quad (3.6)$$

λ is the measure of speed at which a region proceeds towards its own steady state level, Hence, λ from cross-section data is often interpreted as the speed at which poorer regions are closing their productivity gap with richer countries.

The beta-convergence regression of provincial labour productivity for region *r* (=1, … ,4) are as follows:

$$\ln(\frac{LP_{pt}}{LP_{p,t-1}}) = \alpha + \beta \ln LP_{p,t-1} + \delta_1 \ln KL_{pt} + \delta_2 LCI_{pt} + \delta_3 O1_{pt} + \delta_4 O3_{pt} + \delta_5 BR_{pt} + \delta_6 OP_{pt} + \delta_7 Fis_{pt} + \delta_8 S_{pt} \quad (3.7)$$

where $LP_{p,t-1}$ is the lagged labour productivity for province *p*. The beta-convergence regression of provincial TFP and wages for region r are similar.

$$\ln(\frac{TFP_{pt}}{TFP_{p,t-1}}) = \alpha + \beta \ln TFP_{p,t-1} + \delta_2 LCI_{pt} + \delta_3 O1_{pt} + \delta_4 O3_{pt} + \delta_5 BR_{pt} + \delta_6 OP_{pt} + \delta_7 Fis_{pt} + \delta_8 S_{pt}$$

$$\ln(\frac{AW_{pt}}{AW_{p,t-1}}) = \alpha + \beta \ln AW_{p,t-1} + \delta_1 \ln KL_{pt} + \delta_2 LCI_{pt} + \delta_3 O1_{pt} + \delta_4 O3_{pt} + \delta_5 BR_{pt} + \delta_6 OP_{pt} + \delta_7 Fis_{pt} + \delta_8 S_{pt}$$

(3.8)

3.4 Data Description

Table 3.2 describes the variables used in this chapter. In 1978, the real GDP in the Northeast (51.2 billion RMB) is higher than that of the Coastal (48 billion RMB) and Interior (39.1 billion RMB), and above twice that of the West (22.5 billion RMB). Hence, the industrial Northeast was the growth engine and the richest region.

From 1978 to 1994, the GDP in the Coastal increases about 6 fold, compared with about 4 fold in the other three regions so that the Coastal took the No.1 position of the Northeast gradually. From 1994 to 2009, all regions increase 5 fold, suggesting a convergence trend among regions. Hence, over the last 32 years, the Coastal has the highest annual growth rate of GDP at 11.9 percent, while the Northeast grows slower than the Coastal at 8.7 percent per year.

The capital inputs have the similar pattern to GDP. The Northeast had the highest capital inputs (65 billion RMB) in 1978. Then, the capital inputs in the Coastal increased rapidly so that they were 50 percent higher than the Northeast in 2009. The annual growth rate is the highest in the Coastal (14.2 percent) and lowest in the Northeast (10.9 percent).

TFP index has been increasing in all four regions, but the growth is most prominent in the Interior. TFP index in the Interior (50) was the lowest among the four regions in 1978 which increased to 94 in 1994, and finally achieved the second highest level (173) among four regions in 2009. As average wage rates are concerned, the Coastal has the lowest wages (1,766 Yuan, about 211 US$ in 1995) among the four regions in 1978. However, its growth rate was the fastest at 8.6 percent per year and increased 16 fold from 1978 to 2009. Hence, the average wages of the Coastal (27,697 Yuan, about 4,054 US$) became the highest among the four regions in 2009. The labour composition index is normally higher in the Interior than in the other three regions, which may be because the Interior is closer to the municipal cities with rich education resources, such as Beijing and Shanghai (see more details in Appendix Table A3.1).

We also compare several relevant factors that may affect growth, such as ownership (the share of persons employed in SOEs or private enterprises), birth rate, openness and fiscal expenditures on human capital. First of all, the share of private enterprise has been increasing over time, and now is higher than SOEs in the Coastal (88 percent). In 1978, all four regions had a share of SOEs more than 70 percent (86 percent in the West). Thereafter, the SOEs share of staff employed persons has declined to the range of 16-24 percent in the three inner regions and even lower in the Coastal (only 11 percent) in 2009.

The birth rate keeps on decreasing for all regions resulting from the One-Child Policy, and in 2009, the Northeast had the lowest birth rate (7.07‰) while the West had the highest rate (12.75‰). The provinces in the Coastal tend to be more engaged in international trade because of their geographic, historical and institutional advantages, while inner provinces tend to be less open to international trade. The openness ratio (5 percent) in the Coastal was much higher than the second most open region - the Northeast (2 percent) in 1978. From 1994, the openness ratios were quite stable in the four regions: the Coastal (9 percent), the Northeast (3 percent) and the other two lagging regions (1 percent). As noted above, the openness of these provinces in the Coastal is likely to be an important factor conducive to higher growth.

Finally, the proportion of fiscal expenditures on human capital in the Interior was the highest among the four regions in 1978 (18 percent), as the other regions are nearly the same (16 percent). Human capital expenditures have been increasing very fast in both absolute and relative sense over the period 1978-1994. The West region even achieved a peak proportion as 59 percent in 1994 because the central government transfer huge investment on human capital to the Xinjiang province of the West region. After 1994, this expenditures share slowly has been decreasing in all regions, possibly due to the dramatic process of fiscal decentralization in 1994, possible due to the substitution effect of infrastructural investment of local government (Fleisher *et al.*, 2010; Zhang and Zou, 1998).

Table 3.2: Data description of economic growth in China

Region	GDP	Capital input	Labour input	TFP index	Average wage	Labour composition index	Public sector	Private Firms	Birth rate (‰)	Openness	Fiscal expenditures on human capital
						1978					
Northeast	512	650	969	70	2148	101.64	0.78	0	16.93	0.02	0.16
Coastal	480	377	1620	71	1766	101.37	0.74	0	17.63	0.05	0.16
Interior	391	509	1848	50	1786	102.50	0.81	0	20.19	0.01	0.18
West	225	308	1127	54	2147	100.92	0.86	0	22.75	0.01	0.15
						1994					
Northeast	1825	3030	1592	96	4128	101.39	0.47	0.37	11.46	0.03	0.27
Coastal	2866	4353	2445	96	5646	101.66	0.35	0.54	12.66	0.08	0.3
Interior	1751	2324	2929	94	4059	103.23	0.36	0.55	16.83	0.01	0.31
West	953	1329	1793	94	4521	101.24	0.53	0.37	20.04	0.02	0.59
						2009					
Northeast	8391	21113	1687	178	21919	103.90	0.24	0.75	7.07	0.03	0.24
Coastal	15538	35817	3183	167	27697	104.36	0.11	0.88	10.38	0.09	0.29
Interior	8729	21366	3402	173	19799	108.82	0.16	0.82	11.97	0.01	0.27
West	4474	12707	2067	170	18632	104.10	0.22	0.77	12.75	0.01	0.25

Data sources: (Hsueh and Li, 1999); various years China Statistical Yearbook; National Bureau of Statistics (1999).

Notes:
1. "GDP": 100 million Yuan. "Capital input": 100 million Yuan. "Labour input": Number of employed persons, 10,000 persons. "TFP index", "Labour composition index": 1995=100. Average wage: annual wage rate (Yuan per worker).
2. The value of the labour composition index in 1978 is assumed to equal those in 1989, since the LCI is calculated by the Chinese Household Nutrition Survey (CHNS) (1989-2009).

3.5 Empirical results

3.5.1 Results of baseline regressions

This section reports statistical results estimating cross-region productivity and wages from 1978 to 2009 in China. Table 3.3 presents the estimation results from the simple production function using equation (3.1). The estimated output elasticises of capital services, adjusted labour inputs are positive and significant, which is consistent with the literature. For the overall regression (1), the contribution of adjusted labour inputs is slightly higher than capital services.

For the sensitivity test on structural break in 1994, regression (2) shows that significantly positive incremental effect in physical capital (14.7 percent) and significantly negative incremental effect in adjusted labour inputs (-12.9 percent), confirming the structural break in China's economy in 1994. Regression (3) shows the sensitivity tests on regional heterogeneity that the adjusted labour inputs mainly benefits output in the West (1.14) and the Interior (0.785), while the capital inputs are more important in the Northeast (0.81) and the Coastal (0.69) than others.

Table 3.3: Production function and sensitivity tests, fixed effect model using equation (3.1)

	Reg (1)	Reg (2)		Reg (3)			
Dep. Variable: Ln (GDP)	Overall effect	Before 1994	After 1994 (Incremental)	Northeast (Incremental)	Coastal (Incremental)	Interior (Incremental)	West
Ln (Capital)	0.681***	0.510***	0.147***	0.213***	0.091***	0.080***	0.599***
	0.007	*0.011*	*0.01*	*0.029*	*0.02*	*0.026*	*0.018*
Ln (adjusted labour input)	0.696***	0.998***	-0.129***	-0.905***	-0.563***	-0.355**	1.140***
	0.044	*0.043*	*0.01*	*0.175*	*0.126*	*0.148*	*0.111*
R-squared	0.986	0.991		0.987			
N	832	832		832			

Notes: Standard errors are in italics. The stars *, ** and *** indicate the significance level at the 10%, 5% and 1%, respectively for two-tail test.

Significant coefficients table:

	Reg (1)	Reg (2)		Reg (3)			
Dep. Variable: Ln (GDP)	Overall effect	Before 1994	After 1994	Northeast	Coastal	Interior	West
Ln (Capital)	0.681	0.51	0.657	0.812	0.69	0.679	0.599
Ln (Adjusted labour input)	0.696	0.998	0.869	0.235	0.577	0.785	1.14

Table 3.4 displays estimation results of the baseline specification for effect of human capital on labour productivity, TFP and wages. We find that capital deepening improves labour productivity and wages. The labour composition index improves all three productivity proxies and benefits workers' earnings (3.6 percent) more than TFP (3 percent) and labour productivity (1.1 percent).

Other variables include the market reform factors such as ownership, birth rate, openness and fiscal expenditures on human capital. Compared to collective-owned enterprises, the private firms have much higher productivity and wages; while the public sector has lower productivity but similar wages. The birth rate is negatively associated with the three productivity proxies, which is consistent with Li and Zhang (2007). Openness can increase TFP (45 percent) and the labour productivity (29 percent), but not for wages. Fiscal expenditures on human capital have no significant effect on the labour productivity and TFP, but decrease wage (-12.4 percent).

We conclude that capital deepening as well as human capital formation, privatization and openness significantly improve economic growth, while higher birth rate and the relatively inefficient public sectors harm productivity growth. Fiscal expenditures on human capital have no significant positive effect on economic growth, and are even harmful for wages, verifying Zhang and Zou (1998)'s argument that central government spending (such as in highways, railways, power stations, telecommunications and energy) benefits economic growth, while a high degree of provincial government spending is associated with lower provincial economic growth.

Table 3.4: Baseline model, fixed effect models using equation (3.2), 1978-2009

Dependent variable	Ln (Labour productivity)	Ln (TFP index)	Ln (Average wage)
Ln (Capital per worker)	0.564***		0.568***
	0.01		*0.01*
Labour composition index	0.011***	0.030***	0.036***
	0.00	*0.00*	*0.00*
Public sector (%)	-0.343***	-0.498***	0.19
	0.12	*0.15*	*0.17*
Private sector (%)	0.296***	0.515***	0.547***
	0.10	*0.11*	*0.14*
Birth rate	-3.505***	-5.585***	-0.87
	1.04	*1.28*	*1.49*
Openness	0.290**	0.446***	-0.17
	0.14	*0.16*	*0.19*
Fiscal expenditures on human capital	-0.05	-0.03	-0.124***
	0.03	*0.04*	*0.05*
R-squared	0.99	0.89	0.97
N	832	832	832

Notes: Standard errors are in italics. The stars *, ** and *** indicate the significance level at the 10%, 5% and 1%, respectively for two-tail test.

Significant coefficients table

Dependent variable	Ln (Labour productivity)	Ln (TFP index)	Ln (Average wage)
Ln (Capital per worker)	0.56		0.57
Labour composition index	0.01	0.03	0.04
Public sector (%)	-0.34	-0.50	-
Private sector (%)	0.30	0.52	0.55
birth rate	-3.51	-5.59	-
Openness	0.29	0.45	-
Fiscal expenditures on human capital	-	-	-0.12

As the dramatic fiscal reform happens during in 1994, we argue that the structural break may produce biases in our estimation. Hence, we next have the sensitivity tests on disparities in the two time periods (1978-1993 and 1994-2009) and four regions using the equation (3.3). The results are reported in Table 3.5 and 3.6. In Table 3.5, economic growth mainly benefits from the capital services (48 percent) and openness (33 percent) before 1994, but mainly from the birth rate (1.642), the capital inputs (60.5 percent) and the fiscal expenditures on human capital (12.8 percent) after 1994. The public sector harms labour productivity overall for the whole time period, but it improves TFP and wages after 1994. These results confirm our postulation on structural break in 1994. Especially for fiscal expenditures on human capital, the positive effect on productivity is found after 1994, as well as positive effect on wages before 1994.

Openness has significantly positive effect on labour productivity and TFP. The LCI accelerate both TFP and wage growth from 1978 to 2009. Among other variables, the privatization is the most important institutional change for the three productivity proxies after 1994.

Since the One-Child Policy was implemented after late 1970s, people who born under this policy have not join the labour market before 1994, supporting the negative effect of birth rate on labour productivity due to the dominant diminishing marginal productivity. However, after 1994, the birth rate has positive effect on labour productivity due to the human capital accumulation in the One-Child family, the development of urban area and the gradual process of urbanization. For the whole time period 1978-2009, the birth rate has negative effect on TFP mainly due to the still low technology level across the population. The effects of birth rate on labour productivity and average wages are inconsistent, maybe because Chinese labour market is still rigid in the transition process.

Overall, this table shows that the post-1994 period is different from the pre-1994, supporting that year 1994 is a structural break year for Chinese productivity analysis.

Table 3.5: Sensitivity tests for structural break (Y1994), fixed effect models using equation (3.3), 1978-2009

Dependent variable	Log (Labour productivity)		Log (TFP index)		Log (Average wage)	
	Before 1994	After 1994 (Incre.)	Before 1994	After 1994 (Incre.)	Before 1994	After 1994 (Incre.)
Ln (Capital per worker)	0.483***	0.122***			0.383***	0.223***
	0.01	*0.01*			*0.01*	*0.01*
Labour composition index	0.01	0.00	0.034***	-0.012***	0.033***	-0.016***
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Public sector (%)	-0.595***	-0.06	-0.554***	1.145***	-0.20	1.911***
	0.12	*0.28*	*0.15*	*0.33*	*0.14*	*0.32*
Private sector (%)	0.13	0.17	0.309**	1.375***	0.404***	1.847***
	0.10	*0.22*	*0.12*	*0.25*	*0.12*	*0.26*
birth rate	-4.763***	6.405***	-6.906***	6.067***	2.275*	-4.666**
	1.11	*1.90*	*1.42*	*2.20*	*1.31*	*2.23*
Openness	0.327**	-0.298**	0.549***	-0.421***	-0.11	-0.524***
	0.14	*0.14*	*0.18*	*0.16*	*0.16*	*0.16*
Fiscal expenditures on human capital	-0.07	0.128**	-0.135**	0.196***	0.155***	-0.182***
	0.05	*0.05*	*0.06*	*0.07*	*0.05*	*0.06*
R-squared	0.99		0.90		0.98	
N	832		832		832	

Notes: Standard errors are in italics. The stars *, ** and *** indicate the significance level at the 10%, 5% and 1%, respectively for two-tail test.

Significant coefficients table

Dependent variable	Log (GDP per worker)		Log (TFP index)		Log (Average wage)	
	Before 1994	After 1994	Before 1994	After 1994	Before 1994	After 1994
Ln (Capital per worker)	0.48	0.61			0.38	0.61
Labour composition index	0.01	0.01	0.03	0.02	0.03	0.02
Public sector (%)	-0.60	-0.60	-0.55	0.59	-	1.91
Private sector (%)	-	-	0.31	1.68	0.40	2.25
birth rate	-4.76	1.64	-6.91	-0.84	2.28	-2.39
Openness	0.33	0.03	0.55	0.13	-	-0.52
Fiscal expenditures on human capital	-	0.13	-0.14	0.06	0.16	-0.03

Table 3.6 shows the different growth patterns for the four regions. Capital accumulation benefits the labour productivity and TFP growth in all four regions, especially in the Northeast and Interior. The labour composition index is more important in the Coastal, mainly possibly due to 56 percent of top universities in China are located in this region (see Appendix Table A3.1). The public sector only improves labour productivity and TFP in the Northeast and Coastal, and wages in the Interior. The Northeast and Coastal also benefit from more private firms. The birth rate has no effect on labour productivity, but harms the TFP in all the four regions which is consistent with quality and quantity argument of human capital formation. Openness has huge positive effect on all three productivity proxies, except in the Northeast for the labour productivity, and in the Coastal for wages. The fiscal expenditures on human capital are also significantly positive in the Coastal for wages, suggesting a new growth pattern in this advanced region.

Table 3.6: Sensitivity tests for 4 regions, fixed effect models, 1978-2009

Dependent variable	Ln (Labour productivity)			
	Northeast (Incre.)	Coastal (Incre.)	Interior (Incre.)	West
Ln (Capital per worker)	0.028	-0.053*	0.029	0.568***
	0.048	*0.028*	*0.032*	*0.025*
Labour composition index	0.017	0.035***	0.003	0.008
	0.017	*0.011*	*0.01*	*0.009*
Public sector (%)	2.336***	1.954***	0.319	-2.350***
	0.647	*0.346*	*0.452*	*0.314*
Private sector (%)	1.985***	1.748***	0.365	-1.395***
	0.419	*0.278*	*0.353*	*0.253*
birth rate	-0.55	-3.891	2.779	-2.924
	3.525	*2.537*	*3.237*	*2.199*
Openness	-4.895***	-4.430***	-2.856	4.583***
	1.314	*1.219*	*1.956*	*1.211*
Fiscal expenditures on human capital	-0.275	-0.173	0.069	0.017
	0.309	*0.121*	*0.196*	*0.031*
R-squared	0.989			
N	832			
Dependent variable	**Ln (TFP index)**			
	Northeast (Incre.)	Coastal (Incre.)	Interior (Incre.)	West
Labour composition index	-0.002	-0.002	-0.014	0.037***
	0.02	*0.012*	*0.011*	*0.01*
Public sector (%)	1.618**	2.581***	-0.26	-2.459***
	0.811	*0.456*	*0.597*	*0.415*
Private sector (%)	1.544***	1.943***	0.04	-1.071***
	0.551	*0.357*	*0.462*	*0.33*
birth rate	5.23	-2.324	6.579	-6.969**
	4.488	*3.317*	*4.25*	*2.871*
Openness	-3.654**	-4.485***	-0.502	4.912***
	1.699	*1.57*	*2.469*	*1.56*
Fiscal expenditures on human capital	-0.773*	-0.553***	-0.42	0.044
	0.407	*0.153*	*0.257*	*0.04*
R-squared	0.904			
N	832			

Notes: Standard errors are in italics. The stars *, ** and *** indicate the significance level at the 10%, 5% and 1%, respectively for two-tail test.

Continue...

Dependent variable	**Ln (Average wage)**			
	Northeast (Incre.)	Coastal (Incre.)	Interior (Incre.)	West
Ln (Capital per worker)	-0.022	-0.039	0.118**	0.538***
	0.072	*0.043*	*0.049*	*0.038*
Labour composition index	0.034	0.037**	-0.02	0.047***
	0.026	*0.016*	*0.015*	*0.014*
Public sector (%)	0.946	0.772	2.162***	-1.395***
	0.969	*0.519*	*0.678*	*0.471*
Private sector (%)	1.415**	0.924**	1.559***	-0.812**
	0.628	*0.417*	*0.529*	*0.379*
birth rate	7.386	4.967	4.267	-5.336
	5.281	*3.801*	*4.849*	*3.295*
Openness	-3.238	-3.515*	-0.399	3.356*
	1.969	*1.826*	*2.931*	*1.815*
Fiscal expenditures on human capital	-0.781*	0.404**	-0.193	-0.077*
	0.463	*0.181*	*0.293*	*0.046*
R-squared	0.974			
N	832			

Notes: Standard errors are in italics. The stars *, ** and *** indicate the significance level at the 10%, 5% and 1%, respectively for two-tail test.

Significant coefficients table:

	Northeast	Coastal	Interior	West
Dependent variable	**Ln (Labour productivity)**			
Ln (Capital per worker)	0.568	0.515	0.568	0.57
Labour composition index	-	0.035	-	-
Public sector (%)	-0.014	-0.396	-2.35	-2.35
Private sector (%)	0.59	0.353	-1.395	-1.40
birth rate	-	-	-	-
Openness	-0.312	0.153	4.583	4.58
Fiscal expenditures on human capital	-	-	-	-
Dependent variable	**Ln (TFP index)**			
Labour composition index	0.037	0.037	0.037	0.04
Public sector (%)	-0.841	0.122	-2.459	-2.46
Private sector (%)	0.473	0.872	-1.071	-1.07
birth rate	-6.969	-6.969	-6.969	-6.97
Openness	1.258	0.427	4.912	4.91
Fiscal expenditures on human capital	-0.773	-0.553	-	-
Dependent variable	**Ln (Average wage)**			
Ln (Capital per worker)	0.538	0.499	0.656	0.54
Labour composition index	0.047	0.084	0.047	0.05
Public sector (%)	-1.395	-1.395	0.767	-1.40
Private sector (%)	0.603	0.112	0.747	-0.81
birth rate	7.386	-	-	-
Openness	3.356	-0.159	3.356	3.36
Fiscal expenditures on human capital	-0.858	0.327	-0.077	-0.077

3.5.2 Results of beta-convergence regressions

Table 3.7 presents estimation results for conditional beta-divergence. The dependent variables are growth rates of labour productivity, TFP or average wages. We control relevant condition variables such as capital deepening, LCI, ownership, birth rate, openness, fiscal expenditures on human capital and structural break in year 1994 as above. The conditional beta-convergence is present if the coefficient on lagged dependent variable is significantly less than 0.

The main difference between the OLS and GLS specifications appears on the coefficients of the controlled variables. For example, regarding to the labour productivity regressions, GLS method finds upwards bias of OLS estimators on capital deepening and ownership variables, and GLS method verify the significant positive effect of LCI on labour productivity in the Interior region which is consistent with our discuss about LCI indices in the Chapter 2.

The convergence speeds are similar in the two specifications, and both methods confirm that only provincial within the Northeast region do not show evidence of convergence for average wages. The provinces within the richest Northeast and Costal regions have the highest speed (above 2) converging to their steady states of labour productivity and TFP growth, while the provinces within the poorest West region have the lowest convergence speed (1.89). For the convergence trends of average wages, the provinces within the Coastal regions still have highest speed (2.03) while the provinces within the West region has the lowest speed (1.99). From the convergence analyse, we can see that the poorest West region not only suffer from the severe regional inequality, but also suffer from the relative slower convergence speed across provinces within this region.

Table 3.7: Regressions to test for beta-convergence in China using equations (3.7 and 3.8), 1978-2009

Dependent: LP growth	**OLS regression**				**GLS regression**			
	Northeast	Coastal	Interior	West	Northeast	Coastal	Interior	West
Lagged labour productivity	-0.269***	-0.151***	-0.152***	-0.033*	-0.233***	-0.134***	-0.122***	-0.034**
	0.068	0.024	0.036	0.017	0.057	0.023	0.03	0.015
Capital deepening	0.168***	0.105***	0.081***	0.027**	0.154***	0.091***	0.058***	0.030***
	0.042	0.017	0.022	0.011	0.037	0.017	0.017	0.01
Labour composition index	0.007**	0	0.002	0	0.006**	-0.002	0.002**	0
	0.003	0.002	0.001	0.002	0.002	0.002	0.001	0.002
Public sector	-0.092	-0.218***	-0.109	-0.300***	0.024	-0.236***	-0.088	-0.244***
	0.214	0.074	0.148	0.096	0.203	0.067	0.116	0.092
Private enterprises	0.187	-0.130**	0.102	-0.181**	0.237	-0.140**	0.118	-0.162**
	0.16	0.066	0.12	0.078	0.15	0.058	0.094	0.077
Birth rate	-2.497**	-3.980***	1.021	-1.068	-2.450**	-3.760***	1.426*	-1.548**
	1.123	0.859	1.096	0.7	1.01	0.845	0.851	0.658
Openness	-0.386***	0.120**	2.090***	0.556	-0.355***	0.143**	1.255**	0.725**
	0.121	0.055	0.688	0.398	0.122	0.057	0.555	0.331
Fiscal expenditures on human capital	0.230**	0.001	0.178*	0.014	0.295***	0.004	0.122	0.011*
	0.109	0.081	0.102	0.009	0.1	0.079	0.081	0.006
Year1994 dummy	-0.026	-0.005	-0.009	-0.01	-0.033*	-0.001	-0.012	-0.008
	0.02	0.015	0.022	0.014	0.018	0.014	0.016	0.012
R-squared	0.53	0.178	0.278	0.236				
N	93	279	186	248	93	279	186	310
Wald chi2 (Prob>chi2)					132.4	68.9	104.9	72.3
Beta	-0.27	-0.15	-0.15	-0.03	-0.23	-0.13	-0.12	-0.03
Lambda	2.07	2.04	2.04	1.89	2.06	2.04	2.03	1.91

Notes: Standard errors are in italics. The stars *, ** and *** indicate the significance level at the 10%, 5% and 1%, respectively for two-tail test.

Dependent: TFP growth	OLS regression				GLS regression			
	Northeast	Coastal	Interior	West	Northeast	Coastal	Interior	West
Lagged TFP	-0.116***	-0.119***	-0.121***	-0.055***	-0.124***	-0.112***	-0.114***	-0.048***
	0.038	*0.014*	*0.023*	*0.015*	*0.037*	*0.011*	*0.021*	*0.013*
Labour composition index	-0.001	0.001	0.001	-0.001	-0.001	0	0	-0.001
	0.001	*0.002*	*0.001*	*0.002*	*0.001*	*0.002*	*0.001*	*0.001*
Public sector	0.159	0.047	0.045	-0.092	0.176	0.021	-0.025	-0.091
	0.188	*0.049*	*0.114*	*0.07*	*0.176*	*0.051*	*0.106*	*0.068*
Private enterprises	0.22	0.160***	0.200**	-0.012	0.254*	0.133***	0.152*	-0.042
	0.152	*0.043*	*0.09*	*0.056*	*0.143*	*0.043*	*0.084*	*0.056*
Birth rate	-2.028**	-2.538***	0.867	-1.02	-1.449*	-2.204***	1.237	-1.392**
	0.956	*0.603*	*0.903*	*0.619*	*0.841*	*0.571*	*0.788*	*0.575*
Openness	-0.154	0.081**	0.76	0.357	-0.124	0.078**	0.103	0.587**
	0.108	*0.037*	*0.558*	*0.319*	*0.108*	*0.036*	*0.477*	*0.242*
Fiscal expenditures on human capital	0.188**	-0.026	0.098	0.013*	0.185**	-0.009	0.056	0.009**
	0.092	*0.058*	*0.087*	*0.008*	*0.088*	*0.056*	*0.074*	*0.004*
Year1994 dummy	0.011	-0.016	-0.009	-0.009	0.006	-0.01	-0.01	0.001
	0.018	*0.011*	*0.018*	*0.012*	*0.017*	*0.01*	*0.014*	*0.01*
R-squared	0.25	0.303	0.177	0.037				
N	93	279	186	248	93	279	186	310
Wald chi2 (Prob>chi2)					42.5	175.4	54.4	25.9
Beta	-0.12	-0.12	-0.12	-0.06	-0.12	-0.11	-0.11	-0.05
Lambda	2.03	2.03	2.03	1.99	2.03	2.03	2.03	1.98

Notes: Standard errors are in italics. The stars *, ** and *** indicate the significance level at the 10%, 5% and 1%, respectively for two-tail test.

Dependent: Average wages growth		**OLS regression**				**GLS regression**		
	Northeast	Coastal	Interior	West	Northeast	Coastal	Interior	West
Lagged average wages	-0.039	-0.121***	-0.057**	-0.058***	-0.05	-0.118***	-0.055**	-0.056***
	0.04	0.02	0.025	0.02	0.036	0.02	0.024	0.019
Capital deepening	-0.033	0.053***	0.019	0.004	-0.014	0.053***	0.016	0.002
	0.033	0.011	0.017	0.01	0.028	0.011	0.015	0.009
Labour composition index	0.006**	0	0.002	-0.001	0.004*	0	0.002	-0.002
	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.002
Public sector	-0.43	-0.115	-0.243	-0.097	-0.356	-0.135*	-0.244	-0.079
	0.328	0.086	0.175	0.134	0.293	0.081	0.165	0.126
Private enterprises	0.014	0.025	-0.023	0.019	0.009	0.011	-0.033	0.048
	0.245	0.076	0.15	0.116	0.217	0.071	0.139	0.113
Birth rate	-1.501	-3.071***	0.521	-2.480**	-2.453*	-2.964***	0.9	-1.626
	1.478	0.984	1.44	1.158	1.336	0.931	1.221	1.133
Openness	-0.257	0.118*	1.421*	1.029	-0.302*	0.107	1.263*	0.8
	0.169	0.066	0.855	0.624	0.164	0.072	0.761	0.572
Fiscal expenditures on human capital	0.095	0.079	-0.142	0.007	0.062	0.121	-0.16	0.007
	0.137	0.094	0.128	0.016	0.115	0.089	0.117	0.015
Year1994 dummy	0.006	0.021	-0.007	0.048**	0.012	0.02	-0.005	0.047**
	0.03	0.018	0.029	0.023	0.028	0.017	0.026	0.021
R-squared	0.464	0.216	0.226	0.208				
N	93	279	186	248	93	279	186	310
Wald chi2 (Prob>chi2)					98.4	94.8	69.1	70.3
Beta	no convergence	-0.12	-0.06	-0.06	no convergence	-0.12	-0.06	-0.06
Lambda		2.03	1.99	1.99		2.03	1.99	1.99

Notes: Standard errors are in italics. The stars *, ** and *** indicate the significance level at the 10%, 5% and 1%, respectively for two-tail test.

3.6 Endogeneity of education

This section focuses on finding and testing valid instrumental variables to overcome the well-known endogeneity problem of schooling in education returns over the early and later transition periods and speculate on the likely institutional and structural factors underpinning these results. It assesses whether the OLS estimates (assuming schooling an exogenous variable) significantly differ from the Generalized Instrumental Variables (GIV) estimates that consider this bias.

3.6.1 Empirical specifications and choice of instruments

The Ordinary Least Square estimation is given by:

$$\ln W_i = \beta_0 + \beta_1 E_i + \beta_2 X_i + \varepsilon_i \qquad (3.9)$$

where W_i is the hourly wage rate of individual i, E_i represent years of schooling, X_i is a vector of control variables including experience and its square, dummies of urban(=1), year dummies and provincial dummies; ε_i is an error term with $\varepsilon \sim N(0, \sigma^2)$.

Recent work provides evidence that OLS estimates of returns to schooling in China are biased if years of schooling are endogenous. However, the literature has emphasized the biases that may be caused principally by the endogenous nature of schooling (Dearden, 1999; Card, 1999; Blundell *et al.*, 2005). In our CHNS sample, endogeneity can arise because of omitted ability. That is, the coefficient of returns to schooling β_1 is upwardly biased because the chosen schooling levels are positively correlated with omitted ability, while ability is positively correlated with the wage rate (Chen and Hamori, 2009). However, Card (1999) argues that OLS estimates of β_1 are biased downwards because individuals with high discount rates choose low levels of schooling, that is, schooling with higher marginal rates of return. In addition, Li and Luo (2004) argue that OLS estimators will be biased downwards caused by measurement error in schooling. Our study will check out which one of the upwards and downwards bias dominates in the gender samples.

Heckman and Li (2004) recommend using the Instrumental Variable (IV) methodology to cope with the endogeneity problem in China. They use parental education and year of birth as instrumental variables to identify the returns to higher education for young people in the urban areas of the six provinces in 2000. The IV estimator of average return to four-year college attendance is 43 percent (on average, 11 percent annually). Harmon and Walker (2000) use the family background as instrument and find the IV result (9.9 percent) is higher than the OLS estimation (5 percent) for males in UK. Uusitalo (1999) apply the instruments (parental income and education and location of resident) for the Finnish sample with IV result (12.9 percent) which is higher than OLS (8.9 percent). Chen and Hamori (2009) examines economic returns to education in urban China using OLS and IV methodologies for women and men with the CHNS 2004 and 2006 pooled data with spouse education as instrument. Moreover, Fleisher and Wang (2005) use an IV approach in which schooling is endogenous and the instruments are birth year, location dummies of elementary school, namely, a dummy variable for whether any normal high-school years occurred during the cultural revolution, and interaction terms between the location and Culture Revolution year variables. Their IV estimators are exceeding 10 percent in every year in 1984, 1987 and 1990.

Even with the above trials, valid instruments for education still seem a big problem in studies of education returns. To be a valid instrumental variable for the endogenous years of schooling, the potential exogenous instruments should be only correlated with years of schooling, and not correlated with the unobserved errors in the wage equation, $\varepsilon_{i,}$ (such as the unobservable ability variable). The instrumental above (family background, parental income and parental education, birth year and spouse's education) are questioned in the literatures.

Belley and Lochner (2007) argue that family background (such as parental income) is correlated with children's cognitive skill and hence is not a valid instrumental variable for education. Heckman and Li (2004) use parental income as the proxy for ability which should be put into the wage equation directly rather than used as an instrument. Furthermore, parental income is correlated with parental education, so parental education would not be a valid instrument too. Following the same line of reasoning, although year of birth of individuals may reflect the cohort effect on education, it is possible that the cohort effect is correlated with wage through different channels such as experience. Spouse's education would be highly correlated with his/her family background which is generally similar and correlated with the individual's education, hence not exogenous.

Therefore, we try three potential instrumental variables: number of brothers, number of sisters and whether the household has access to tap water. The justification is as follows. Firstly, there is an extensive theoretical literature that postulates a trade-off between child quantity and quality within a family, introduced by Becker (1960) and expanded in Becker and Lewis (1973) and Becker and Tomes (1976). A key element of the quantity-quality model is an interaction between quantity and quality in the budget constraint that leads to rising marginal costs of quality with respect to family size. It may be a consequence of low substitution elasticity in a family's utility function between parents' consumption or level of living and that of their children (Duesenberry 1960, Willis 1969). Becker and Lewis (1979) argue that the shadow price of children is greater the higher their quality is, and the shadow price of children with respect to their quality is greater, the greater the number of children.

Recent evidence suggests that children from larger families have lower average education levels, and yet family size does not affect an individual's wage – a requirement for a valid IV. Black et al. (2005) use a rich dataset on the entire population of Norway and find a negative correlation between family size and children's education. Silles (2010) finds that sibling size has an adverse causal effect on test scores and behavioural development. Li and Luo (2004) use the CHIP 1995 data and apply OLS and various IV estimations with number of siblings as the IV to estimate returns to education for young workers in urban China. They find the IV results are around 15-17 percent while the OLS estimators are 7-8 percent per year of schooling. Li (2007) find that student who is the single child or has only one sibling in the family is more likely to be enrolled in elite universities in China.

The effect of number of siblings on returns to education is likely to be different for males and females, since a child's education may be affected by the size and composition of brothers or sisters if the family faces borrowing constraints, especially in the developing countries such as China. Girls and boys have different earnings potentials during the period in which they contribute to household income. Women historically spent less time in the labour force than men and for this reason the return to investment in education may have been lower for daughters than for sons. If boys receive a higher return to each level of schooling, we should expect to see not only boys receive more education, but also that the presence of sons reduces the educational attainment of daughters. A girl with only sisters would receive more education than a girl with brothers, under the assumption of borrowing constraints and not upon the exact shape of the parents' utility function (Butcher and Case, 1994). Empirical literatures also find patterns of discrimination in favour of boys in the allocation of household resources, including nutrients, health care, and education (Behrman, 1988; Deaton, 1989). Parish and Wills (1992) verify that a brother reduces siblings' education in Taiwan. Butcher and Case (1994) examine the effect of the number and sex composition of a boy or girl's siblings on that child's educational attainment. They find that in the United States between 1920 and 1965, women's educational choices have been systematically affected by the sex composition of her siblings, and that men's choices have not. So we expect the number of brothers will have higher negative effect on individual's education than the number of sisters. Hence we will distinguish between girl and boy siblings when constructing the instruments.

Second, as regards household access to tap water as an IV, the argument is simply that such access improves a child's schooling, but does not affect later earnings. In other words, we follow Fleisher et al. (2010), Pal (2010) and Maimaiti and Siebert (2009) in arguing that education is improved by local investment in public facilities such as water supply. Even though good education facilities are located in large urban areas and provincial capitals, their locations are determined by historical factors, geographic characteristics, fiscal policy, political considerations, defence goals, and the like. Thus it is reasonable to assume that public facilities tend to generate exogenous impacts on people' earnings through education rather than that their locations have been the result of earnings of people who live there.

Pal (2010) verifies that access to public infrastructure plays a crucial role on the presence of private schools in a community in India. He highlights the role of village-level public infrastructure (as reflected in the access to concrete road, electricity, piped water, phone and post office). Maimaiti and Siebert (2009) argue that access to water is especially important for girls, since a girl's education suffers when her larger water need for female hygiene purposes after menarche is not met because her household has poor access to water. Using the same data source as our chapter, they find that menarche is associated with an increase in the school dropout rate, and indeed the effect is weaker for girls who have good access to water. Hence, they conclude that water engineering can thus contribute significantly to increasing girls' education in rural areas. On the other hand, Oster and Thornton (2011) address sanitary product provision and argue that access to tap water affects education of both males and females, and that menarche is possibly irrelevant. Thus, we use access to tap water as a potential instrumental variable for education of both males and females.

Overall, we adopt an IV approach and using the "numbers of brothers", "numbers of sisters" and "piped / tap water in house or courtyard" variables as instruments. The following two-equation model describes the natural logarithm of hourly wage and years of schooling are normally applied to cope with the endogeneity of schooling:

$$YS_i = \delta Z_i^{'} + v \qquad (3.10)$$

$$\ln W_i = \alpha X_i^{'} + \beta YS_i + \mu_i \qquad (3.11)$$

where Z_i denotes the vector of observed instrumental variables with the properties suggested above and the other exogenous variables, same as the variables in the OLS regression. Our dataset contain two potential instruments for years of schooling YS_i: number of brothers, number of sisters and tap water.

3.6.2 Composition bias of age

The aggregated estimates of repeated cross-section regressions may be mix-ups of many heterogeneous cohorts and hence may suffer serious composition biases (Solon *et al.*, 1994). Li (2003) uses the 1988 CHIP data to classify workers into three cohorts depending on when they started working: prior to economic reform, up to 1979; in the early stage of urban reforms (1980 to 1987); or during the advanced stage of urban reform (1988 to 1995). The average annual rates of returns to college education were 7.7 percent for the pre-1979 cohort, 14.1 percent for the 1980–1987 cohort, and 14.8 percent for the 1988–1995 cohort. Maurer-Fazio (1999) finds higher annual rates of education returns for the young (under age 30, 6.6 percent) than for their elders (above age 50, 3.4 percent) in 1989. Fleisher and Wang (2005) estimate education returns in the first and subsequent jobs, with workers grouped by the year of the first job, in order to observe the impact of the "Cultural Revolution". Their OLS estimators find that annual rates of education returns to the younger cohorts (whose first jobs were in 1984, 1987 and 1990) have received smaller returns to education than did the older cohorts (whose first jobs occurred prior to 1970 and 1975, and were affected by the Cultural Revolution). These cohort analyses reveal different views of education returns, compared to traditional aggregated analysis. Hence, we estimate wage equations for four age groups which can provide insights into the nature of labour markets changes and the fluctuations in returns to schooling over time.

We estimate the regressions with separated age group samples. The three age groups are people born before 1961, during 1962-1980 and in 1981 or after. The cut-off time choice of groups is based on the widely accepted structural break points in Chinese modern history to allow heterogeneity of groups in our study. The age group (born before 1961) marks the history periods of the foundation of People's Republic of China (1949) and the "Great Leap Forward" (1958-1961), and the second age group (1962-1980) is the second baby boom period. Finally, the full enforcement of the "One Child Policy" in 1981 defines the last group.

These structural break points can be clearly observed in a birth rate graph over the period of 1949-2009 (see Figure A3.1). The birth rate was above 30 per thousand in the 1950s. The economic crisis from the "Great Leap Forward" and famine during the period 1958-1961 resulted in 30 million extra deaths (Lin, 1990), and the lowest birth rate at 18.02 per thousand in 1961. Afterwards, with the economic recovery, China experienced the largest baby boom, with the birth rate peaking at 43.37 per thousand in 1963. From 1961 to 1980, the newborns were about 310 million and comprised 23.5 percent of the total population in 2009.[24] The large number of children born caused China's leaders to be very concerned about the growth potential of this extraordinarily large age group. The "One Child Campaign" was launched in December 1979. In Feb 1980, Guangdong province was the first province to make regulations for implementation, followed by other provinces. The full enforcement of "One-Child policy" across country started from 1981. There were two small peaks of the birth rate; between 1980 and 1982, due to the implementation of China's new Marriage Law in 1981; and the consequent baby boom during 1984 and 1987. After that, the birth rate

[24] Data are from the Chinese Statistics Yearbook 2010.

continued to decline to be as low as 12.13 per thousand in 2009.

3.6.3 Data description

We use all eight waves of the CHNS dataset (1989, 1991, 1993, 1997, 2000, 2004, 2006 and 2009) to compare returns to education over time. Our sample is selected based on employees (age 16-60 for males and 16-52 for females[25]) who work in sectors besides "Agriculture, forestry, animal husbandry, fishery and water conservancy". It only includes employees with positive annual gross income. Self-employed and owners of private or individual enterprises have been excluded, because it is difficult to separate their wages from the profit income. Observations with missing values on years of schooling, experience, etc. have been dropped. Nominal annual earnings include regular wages, bonuses, all kinds of subsidies and in-kind wages from the work unit. Nominal annual earnings are converted into real annual earnings by deflating by provincial urban/rural Consumer Price Index with year 1995 as 100. In the CHNS dataset, the numbers of brother and numbers of sister variables are only surveyed on once married women under age 53 and their husbands in 2000, 2004, 2006 and 2009. To impute sibling numbers for every individual i in our sample, we run regression as follows:

$$Sib_i = f(B_i, \Pr_i, Urban_i, Male_i) \qquad (3.12)$$

where Sib_i is the number of brothers or number of sisters, B_i is the birth year, $Urban_i$ is the urban dummy, $Male_i$ is the gender dummy.

[25] In China, the retirement age is 60 for male and 55 for female. The CHNS dataset provide the sibling information for once married female under age 53, so we use the cut-off age of 53 for our female sample.

Table A3.2 describes the variables by gender and three age groups in the pooled dataset of all eight waves. The youngest age group has the highest real hourly wage rates at 6.8 Yuan for males and 5.92 Yuan for females. They also have the highest years of schooling at 10.59 years for males and 11.18 years for females. But they have the shortest potential labour markets experience. The older age group, the more brothers and sisters are for both genders. Nearly 79 - 89 percent of households have piped/tap water in house or courtyard across the surveyed period. The average experience of employees are more than 25 years for the oldest group while only 4-5 years for the One-child group. Less than half of the employees are from urban area except the female group born before 1961, since urban females may have the chance to postpone their retirement age.

3.6.4 Empirical Results

Table A3.3 shows the OLS estimators for the years of schooling by interacting schooling and wave dummies for the pooled data, with the logarithm of real hourly wage rate as the dependent variable by gender and age group. Experience, experience squared, urban dummy, time dummies and provincial dummies are the controlled variables. In general, females' returns to schooling are higher than males' returns to schooling. The returns to schooling for females are higher than males in most cases. And, returns are highest around 2004-2006 then decline in 2009 for both gender.

For the oldest age group (born before 1961), the returns to schooling are nearly constant in 1989, 1991 and 1997 at around 2 percent for males and 3.6 for females. For both gender, the returns are tripled from 1997 to 2000, increase to the peak at 9.8 percent for males in 2006 and at 10.7 percent for females in 2004, then decline in 2009 especially for females. For the baby boom group (born 1962-1980), males' returns to schooling only appear from 2000 at 3.2 percent, which may be affected by political unrest in 1989, then rise at 8.7 percent in 2006. Females have positive returns from 1991 to 2009 and the highest returns are 12.9 percent in 2004. Employees born in 1981 or after have highest returns to schooling than other age groups, especially at 19.8 percent in 2006 for females.

To overcome the endogeneity problem of years of schooling, we apply the Generalized Instrumental Variables (GIV) method by gender and age group which also avoid the possible over-identification and heteroscedasticity problems. This is a 2 Stage Least Square (2SLS) procedure. In the first step (using equation 3.10, results in Table A3.4), we regress years of schooling on instruments and get the 1SLS estimator by age group. Then we calculate the predicted values of years of schooling for each group. Hence, the variable of years of schooling can be decomposed into two components: a linear combination of instruments (predicted years of schooling) and a random component. In step 2, we estimate equation 3.11 using the predicted years of schooling. This is the GIV estimator and the results are in Table A3.5.

In Table A3.4, we test the endogeneity of years of schooling and the validity of the instruments (number of brothers, number of sisters, and tap water) with the instrumental variables estimation, and present the estimators for the years of schooling. When the excluded instruments are correlated with the endogenous regressors and valid, we check whether the equation is weakly identified (Angrist and Pischke, 2009). Estimators can perform poorly when instruments are weak. When errors are assumed to be i.i.d., the test for weak identification reports an F version of the Cragg-Donald Wald statistic (Cragg and Donald, 1993). Stock and Yogo (2002) have compiled critical values for the

Cragg-Donald F statistic for several different estimators, several different definitions of "perform poorly" (based on bias and test size), and a range of configurations (up to 100 excluded instruments and up to 2 or 3 endogenous regressors, depending on the estimator). The instruments are valid except the males born in 1981 and after (F-value=5.19 here). With the GIV method, the chi-2 statistics are 308.14 between males and females, 274.4 among the male groups and 240.39 among the female groups.

First, children born before 1961 appear mainly to compete with their same sex siblings, i.e. losing 0.199 years of schooling for males and 0.123 years of schooling for females. Second, children born in the largest baby boom period 1962-1980 compete with both brothers and sisters, and present the consistent findings as literatures, i.e., girls suffer more from siblings (losing more than 0.20 years of schooling) than boys (losing less than 0.175 schooling), and girl with brothers would suffer more education (losing 0.214 years) than with sister (losing 0.202 years). Under the One-Child Policy, girls appear to compete strongly with their sisters, losing 0.379 years of schooling. Having tap water always favours the years of schooling for the three age groups and both genders (more for girls, as expected).

Table A3.5 shows the second-step GIV regressions by gender and age groups. By eliminating the endogeneity problem, males' returns to schooling are higher than females' for the two older age groups, in contrast with the higher returns for females in the OLS estimation. The returns from the GIV estimators are higher than the OLS estimators, supporting the domination of downwards bias due to the endogeneity problem.

The returns for females born before 1961 are constant from 1989 to 2006 at 6.8 percent, and then increase to 12.1 percent, while the males in the same group get the returns more than 10 percent in 2000s. For both genders, the education returns appear after 2004 at more than 10 percent. The One-Child Policy group has the highest returns (about 25 percent for males and 33 percent for females) from 2006. We will discuss the characteristics of returns for the age groups in details in the chapter 5.

3.7 Conclusions

China's spectacular economic growth is from unequal economic performance of provinces and regions. This chapter examines effects of the physical and human capital on labour productivity, Total factor productivity (TFP) and wages incorporating the market reform factors such as ownership types, birth rate, openness and fiscal expenditures on human capital.

We find that, in a simple production function, the human capital (measured as composition-adjusted labour inputs) is more important than physical capital for GDP. And, the returns to adjusted labour inputs in the West which has the poorest education resources are the highest among the four regions, while the returns to capital inputs are the highest in the traditional industrial Northeast region.

In more accurate specifications for labour productivity, TFP and wages, Chinese economic miracle mainly pushed by the (physical) capital service per capita rather than labour composition index, possibly due to that the effect of human capital has been reflected into market reform variables such as privatization, One-Child Policy, openness, and fiscal expenditures on human capital. The share of persons employed in the private sector and openness (competing with the foreign companies to the globalization processes) are very important for labour productivity and TFP growth, which allow a more efficient allocation of human capital based on market demand rather than central planning. The higher birth rate is harmful for human capital formation within the families and negative for productivity. The average wage rate is harmed by the fiscal expenditures on human capital, possible due to the substitution effect of infrastructural investment of local government (Zhang and Zou, 1998).

The structural break between the pre-1994 and post-1994 periods illustrates significant difference on economic growth patterns, indicating that the more radical market reforms after 1994 improve productivity and wages. The capital inputs contribute more after 1994, while the returns to Labour composition index (LCI) decrease with the education expansion and increasing tuition fees since the late 1990s (Wang et al. 2010).

The four regions also show different patterns in economic growth paths. The capital inputs mostly help the labour productivity growth in the West as well as the wages growth in the Interior. LCI contributes to the TFP in all four regions. The privatization processes improve labour productivity and TFP in the Northeast and Coastal, as well as wage growth in all four regions except the West. The collective ownership seems a better choice than the pure private or public organisation for the West because its economy is still based on agriculture. Openness is good for three productivity proxies in all four regions, except labour productivity in the Northeast and wages in the Coastal. It is consistent with two phenomenal economic issues in China: the declining production power of the Northeast under the international and internal competition and the great migration of unskilled workers from the rural areas around the country to the coastal region after 1994.

Moreover, provinces within each region present strong evidence of beta-convergence for all three productivity proxies. The highest convergence speed is found in the provinces in the Northeast and Coastal regions for labour productivity and TFP growth, suggesting fast technology spillover within these regions. The provinces in the Coastal, as the most advanced region in China have the highest convergence speed for average wages, while the provinces in the Northeast region do not show convergence in both Ordinary Least Square (OLS) and Generalized Least Square (GLS) regressions.

Finally, we overcome the endogeneity problem of education by the Generalized Instrumental Variables (GIV) method using the CHNS dataset (1989, 1991, 1993, 1997, 2000, 2004, 2006 and 2009), considering the composition bias of gender and age groups.

We argue the validity of instruments applied in the past literatures, and try three instruments (number of brothers, number of sisters and tap water). These IVs pass the required tests (F tests and Chi-square tests). Results of the first step of GIV regressions show that, children born before 1961 appear mainly to compete with their same sex siblings, while children born in the largest baby boom period 1962-1980 compete with both brothers and sisters, and girls suffer from siblings than boys. For the youngest group born in 1981 and after, girls appear to compete strongly with their sisters. Having tap water always favours the years of schooling for the three age groups and both genders (more for girls, as expected).

By eliminating the endogeneity problem, males' returns to schooling are higher than females' for the two older age groups, in contrast with the higher returns for females in the OLS estimation. The returns from the GIV estimators are higher than the OLS estimators, supporting the domination of downwards bias due to the endogeneity problem. We will discuss the returns for age groups in details when we deal with another well-known problem of education, Heckman selection bias in the chapter 5.

CHAPTER FOUR: COST COMPETITIVENESS COMPARISONS AND CONVERGENCE

4.1 Introduction

Chapter 2 and 3 discuss Chinese provincial disparities and convergence of labour productivity, TFP and wages using the growth accounting method and regression method. In this chapter, we examine international and internal provincial disparities and convergence of sectors (industries) from a labour cost perspective. And then, we investigate which sectors have comparative competitiveness advantage in international and internal senses.

Unit labour costs are widely used as a straightforward yard-stick for international comparisons (van Ark *et al.*, 2005). An analysis on the factors driving the disparities of unit labour costs between regions and industries would continuously induce great interest of both academy and practitioners, especially as the information is to be useful in a policy context (Peneder, 2009). Thus, we focus on the drivers of unit labour costs and decomposition of cost competitiveness in this chapter.

It is well known that China has a competitive edge in manufacturing subsectors because Chinese labour costs were so cheap that China easily became “the world factory” in the 1990s (Chen *et al.*, 2009). However, over recent years, Chinese competitive advantage has been weakened by raised nominal wages, the relative slower productivity growth and appreciated Chinese currency. Thus, this chapter, on the one hand examines the change in the competitive position of Chinese 12 manufacturing subsectors related to 19 countries (including the USA, many EU countries and China neighbouring countries) during the long-run time periods 1978-2007.[26] On the other hand, we investigate the Chinese internal provincial unit labour costs and its two components, i.e. labour productivity and labour compensation across nine one-digit sectors from 1978 to 2009, to figure out provincial development strategies according to their comparative advantage.

Unfortunately, previous studies related to China's international and internal provincial competitive positions are very rare. Even in these scarce cases, on one has tried to study so many countries, provinces and sectors, leaving alone so long time period as in this chapter. Notable studies include UNCTAD (2002) computing unit labour costs in manufacturing for China relative to the US, Sweden and some non-EU countries, but only for one year (1998). Cox and Koo (2003) calculate comparative labour productivity for China relative to the US and Mexico, also only for one year (2001), and without comparisons of unit labour costs. Banister (2005) report on labour costs in Chinese manufacturing but does not include productivity or unit labour costs analysis and only for 2002. Szirmai *et al*. (2005) provide long-run series of China's labour productivity relative to the US for 21 manufacturing subsectors from 1980 to 2002. However, they do not consider unit labour costs either.

In more recent literature, Ceglowski and Golub (2007) analyze China's labour productivity and unit labour costs in aggregate manufacturing over the period 1980-2002. They find that China's unit labour costs are very low relative to the US, the EU countries, Japan and most newly industrialized countries. However, their investigation is only for aggregated manufacturing and cannot provide any information at more detailed levels such as subsectors and provinces. Chen *et al.* (2009) concentrate on comparisons

[26] The time periods for Portugal and Japan are 1978-2006 due to data limitation.

of relative levels of productivity, labour compensation, unit labour costs and convergence trends for 28 manufacturing subsectors and 30 provinces for only two years (1995 and 2004). They argue that unit labour costs decline at the aggregated level, because labour productivity growth is faster than the labour compensation growth. Labour-intensive industries are more likely to converge, whereas capital-skill intensive industries tended to diverge in China. However, they do not consider the fast developing service sectors in China, which is our contribution in this chapter.

This chapter is structured as follows: in section 4.2 we consider the method of relative unit labour costs, relative labour productivity and relative nominal labour costs for comparisons across countries or provinces; Section 4.3 discusses the construction of the dataset; in section 4.4 we outline findings in relation to measures of relative unit labour costs averaged over periods, and examine what's driving competitive differences among different countries (provinces) across sectors; Section 4.5 provides a decomposition of unit labour costs growth into relative changes of productivity, nominal labour costs and exchange rates; Section 4.6 shows the convergence taken place across countries (provinces) by sector. Finally, we outline the key findings of this chapter.

4.2 Measurement method of unit labour cost

In order to calculate unit labour costs, we need information of value added, price deflators of value added, labour compensation, working hours, numbers of employees (or staff and workers in China), exchange rate and purchasing power parity.[27] For cross-country comparisons, unit labour costs in domestic prices in sector *j* and country *b*

[27] The staff and workers refer to persons working in, and receive payment from units of state ownership, collective ownership, joint ownership, and share holding ownership, foreign ownership, and ownership by entrepreneurs from Hong Kong, Macao, and Taiwan, and other types of ownership and their affiliated units. This definition is similar to the employee in the EU KLEMS dataset.

(baseline country is China in this study), i.e. $ULC_j^{b(b)}$ can be calculated by:

$$ULC_j^{b(b)} = \frac{LC_j^{b(b)}}{Y_j^{b(b)}} \tag{4.1}$$

where $LC_j^{b(b)}$ is labour compensation of sector *j* in country *b* in domestic prices; similarly, $Y_j^{b(b)}$ is value added in domestic prices in sector *j* and country *b* . Using estimates of price ratios, the unit labour costs of country *a* can be expressed in prices of country *b* as follows:

$$ULC_j^{a(b)} = \frac{LC_j^{a(a)} / ER^{ab}}{Y_j^{a(a)} / PPP_j^{ab}} \tag{4.2}$$

where ER^{ab} is the exchange rate between country *a* and *b*; and PPP^{ab} is the purchasing power parity between country *a* and *b*. Relative unit labour costs between country *a* and *b* ($RULC^{ab}$) for a particular benchmark year are then defined as:

$$RULC_j^{ab} = \frac{ULC_j^{a(b)}}{ULC_j^{b(b)}} \tag{4.3}$$

Next, labour productivity in domestic prices in sector *j* and country *b*, i.e. $LP_j^{b(b)}$ can be calculated by:

$$LP_j^{b(b)} = \frac{Y_j^{b(b)}}{H_j^b} \qquad (4.4)$$

where H_j^b is hours worked of employees in sector *j* and country *b*. Using PPP, the labour productivity of country *a* can be expressed in prices of country *b* ($LP_j^{a(b)}$) as follows:

$$LP_j^{a(b)} = (\frac{Y_j^{a(a)}}{H_j^a}) / PPP_j^{ab} \qquad (4.5)$$

Relative labour productivity in sector *j* between countries *a* and *b* (RLP_j^{ab}) for a particular benchmark year are then defined as:

$$RLP_j^{ab} = \frac{LP_j^{a(b)}}{LP_j^{b(b)}} \qquad (4.6)$$

Finally, nominal labour costs in domestic prices in sector *j* and country *b* ($NLC_j^{b(b)}$) can be calculated by:

$$NLC_j^{b(b)} = \frac{LC_j^{b(b)}}{H_j^b} \qquad (4.7)$$

Nominal labour costs in prices of country b in sector j and country a ($NLC_j^{a(b)}$) can be calculated by:

$$NLC_j^{a(b)} = (\frac{LC_j^{a(a)}}{H_j^{a(a)}}) / ER^{ab} \qquad (4.8)$$

Relative nominal labour costs between countries a and b ($RNLC^{ab}$) for a particular benchmark year are then defined as:

$$RNLC_j^{ab} = \frac{NLC_j^{a(b)}}{NLC_j^{b(b)}} \qquad (4.9)$$

Similarly, for cross-provincial comparisons within China, the formulas for unit labour costs, labour productivity and nominal labour costs in province p, relative to baseline Chinese national level b are as follows:

$$RULC_j^{pb} = \frac{ULC_j^p}{ULC_j^b} = \frac{LC_j^p / Y_j^p}{LC_j^b / Y_j^b} \qquad (4.10)$$

$$RLP_j^{pb} = \frac{LP_j^p}{LP_j^b} = \frac{Y_j^p / H_j^p}{Y_j^b / H_j^b} \qquad (4.11)$$

$$RNLC_j^{pb} = \frac{NLC_j^p}{NLC_j^b} = \frac{LC_j^p / H_j^p}{LC_j^b / H_j^b} \qquad (4.12)$$

4.3 Construction of the dataset

For cross-country comparisons, data are now readily available in harmonised form and at a detailed industry breakdown from the EU KLEMS productivity accounts database (O'Mahony and Timmer, 2009).[28] We also extract annual market exchange rates and purchasing power parity (PPP) for each country over the time period of consideration from the Penn World Table (PWT) 7.0 dataset.[29] Since unit labour costs are all relative to the China's average national level, figures greater than one indicate relative labour costs advantage for China overall, while figures lower than one indicate relative labour costs advantage for other countries over the China's average national level.

For cross-provincial comparisons within China, it is more difficult to construct national and provincial dataset from 1978 to 2009. Our Chinese dataset is constructed from two sources, Hsueh and Li (1999) and Chinese Statistics Yearbooks (CSYs). Hsueh and Li (1999) provide information for fourteen sectors for 1978-1995.[30] And, CSYs have information for five sectors in 1996 and 1997, fifteen sectors from 1997 to

[28] The efforts of the EU KLEMS consortium in producing these data and making them publicly available are gratefully acknowledged. The November 2009 release is used.

[29] The construction methods can be found in Penn World Table (2011). The Penn World Table 7.0 http://pwt.econ.upenn.edu/php_site/pwt_index.php is released in May 2011. We also try other two kinds of PPP exchange rate: adjusted PPP also from the Penn World Table 7.0; and the unit value ratios from the International Comparison of Output and Productivity (ICOP) project. Our basic conclusions do not change much, so the sensitivity tests of PPP are only available if requested.

[30] The fourteen sectors are total economy; primary sector; total manufacturing; construction; transportation, post and telecommunications; wholesale and retail trade; banking and insurance; real estate; social service; health, sports and welfare; education, culture, arts and television broadcasting; science research and general technical services; government agencies, party agencies and social organization.

2003, and nine sectors information during 2004-2009.[31] On the one hand, we construct China's national dataset of 12 manufacturing subsectors, consistent with the industry code of EU KLEMS dataset (see Appendix Table A4.1) for international comparisons. The missing values are imputed by the manufacturing sector ratios calculated from subsectors' gross value added in the seven input-output (IO) tables. The industrial classifications in the seven IO tables were adjusted with the China's system of industrial classification (GB), changing from 33 subsectors in 1987, 1990, 1992 and 1995, then to 40 subsectors in 1997, and finally to 42 subsectors in 2002 and 2007. [32]

First, we recode these three kinds of industrial classifications into EU KLEMS codes according to their descriptions (see Table A4.1 in Appendix). Second, we calculate the ratios of manufacturing subsector to the total manufacturing in the seven years. To get the whole time series of the ratios from 1978 to 2009, we assume the subsector ratios before 1987 are the same as the 1987 ratios. And the 1988-1989 ratios, 1991 ratios, 1993-1994 ratios, 1996 ratios, 1998-2001 ratios and 2003-2006 ratios are filled by assuming they follow the same exponential growth rate of two adjacent years. For example, the 1998-2001 subsector ratios are filled by assuming they follow the same growth rate, that is $ln(R_{2002}/R_{1997})/5$. Finally, we separate the total manufacturing's gross value added, labour compensation and hours worked of staff and workers into

[31] The five sectors in 1996 and 1997 are total economy; primary sector; total manufacturing; construction; transportation, post and telecommunications; wholesale and retail trade. The fifteen sectors in 1997-2003 are total economy; primary sector; total manufacturing; construction; service for farming, forestry, animal husbandry and fishery; geological prospecting and water management (conservancy); transportation, post and telecommunications; wholesale and retail trade; banking and insurance; real estate; social services; health care, sports and social welfare; education, culture and arts, radio, film and television; scientific research and polytechnic services; government agencies, party agencies, and social organization. The nine sectors in 2004-2009 are total economy; primary sector; total manufacturing; construction; transportation, post and telecommunications; wholesale and retail trade; accommodation; banking and insurance and real estate.

[32] The system of industrial classification is firstly issued in 1984 ("GB1984"), changed in 1994 ("GB1994") and revised in 2002 ("GB2002").

their subsector components by applying subsector ratios over 1978-2009 (see Appendix Table A4.2), and combine them into 12 manufacturing subsectors which are consistent with industry code of the EU KLEMS dataset (see Table 4.1).

Table 4.1 EU KLEMS code of industries

code	Description
AtB	AGRICULTURE, HUNTING, FORESTRY AND FISHING
D	TOTAL MANUFACTURING
15t16	FOOD , BEVERAGES AND TOBACCO
17t19	TEXTILES, TEXTILE , LEATHER AND FOOTWEAR
20	WOOD AND OF WOOD AND CORK
21t22	PULP, PAPER, PAPER , PRINTING AND PUBLISHING
23	Coke, refined petroleum and nuclear fuel
24	Chemicals and chemical products
26	Other non-metallic mineral products
27t28	BASIC METALS AND FABRICATED METAL
29	MACHINERY, NEC
30t33	ELECTRICAL AND OPTICAL EQUIPMENT
34t35	TRANSPORT EQUIPMENT
36t37	MANUFACTURING NEC; RECYCLING
F	CONSTRUCTION
G	WHOLESALE AND RETAIL TRADE
I	TRANSPORT AND STORAGE AND COMMUNICATION
J	FINANCIAL INTERMEDIATION
K	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES
M	EDUCATION
N	HEALTH AND SOCIAL WORK

Data source: EU KLEMS http://www.euklems.net/

There are many missing values in the nine one-digit tertiary sectors after 1995. We have to fill up these missing values using data of tertiary sector in the 1995 such as gross value added, number of staff and workers and labour compensation from Hsueh and Li (1999). We derive the implicit prices of gross value added from the ratios of value added at current prices and constant prices. The price deflators of gross value added for missing manufacturing subsectors and tertiary sectors are assumed to be the same as the respective price deflators of the total manufacturing or total tertiary.

Annual working hours are not available in Chinese official statistics. So we follow the calculation of Jefferson *et al.* (2000). They derive working hours from labour regulation which changes three times over 1978-2009. Until 1994, a 6-day and 48-hour a week is the norm for workers throughout Chinese industry. Then, staff and workers work 8 hours a day and 44 hours a week from March 1st, 1994 and work 8 hours a day and 40 hours a week from May 1st, 1995. Hence, during the period of 1978-1993, the standard annual working time is 2400 hours a year (= 48 hours/week*50 weeks). The standard annual working time in 1994 is 2233 hours, and 2067 hours in 1995.[33] And then, the standard annual working time declines to 2000 hours (= 40 hours/week*50 weeks) since 1996. By assuming the individual annual working hours do not vary across industries, the total working hours are imputed using the number of staff and workers.

4.4 Results

We firstly present the findings of average relative unit labour costs, and then the drivers of cost competition – relative nominal labour costs (RNLC) and relative labour productivity (RLP). Because of the structural break in 1994 discussed in the last chapter and the baseline year choice of 1995 in the EU KLEMS, we divide the entire time period into two parts: before 1995 and afterwards, and also compare results for these two periods. Finally, results of cross-country comparisons and cross-provincial comparisons have been presented separately, even though both comparisons are based on China's average national level.

[33] The standard annual working time in 1994: 2233 hours =2400*(2/12)+2200*(10/12); The standard annual working time in 1995: 2067 hours =2200*(4/12)+2000*(8/12), Jefferson *et al.* (2000).

4.4.1 International comparisons of relative unit labour costs and drivers

Here we present the results by six main economies groups: the USA, Large EU countries (the UK, France and Germany), Scandinavian countries (Denmark, Finland and Sweden), Mediterranean countries (Spain, Greece, Italy and Portugal), other EU countries (Austria, Belgium, Ireland, Luxembourg and Netherlands), and neighbouring countries (Australia, Korea and Japan). And we divide the 12 manufacturing subsectors into low-tech and high-tech manufacturing subsectors. The low-tech manufacturing subsectors include Food and Tobacco (15t16), Textiles (17t19), Wood (20), Paper (21t22) and other non-metallic products (26). And, the high-tech manufacturing subsectors include Petroleum (23), Chemicals (24), Metals (27t28), Machinery (29), Electrical equipment (30t33), Transport equipment (34t35) and Manufacturing nec (36t37).

Table 4.2 displays the average RULC in 12 manufacturing subsectors over two periods. The average RULCs declines by about 80 percent after 1995 for all subsectors in all countries. It suggests that the labour cost advantages of China are declining over time. Hence, we will concentrate on the more recent period of 1995-2007. The bold values in Table 4.2 represent China's largest cost advantage on unit labour costs for each manufacturing sub-sector after 1995, compared with other countries. It is not surprising to find that China's labour cost advantages are most prominent in many manufacturing subsectors against Denmark and Germany. For example, unit labour costs in Petroleum (23) of Denmark are about 5.8 times those in China. For other manufacturing subsectors, unit labour costs in Denmark are about 2-3 times those in China. The only exception is Chemicals (24), but still 58 percent higher than in China. Germany, Sweden, Spain and Japan also show cost disadvantages in many manufacturing subsectors.

In contrast to widely believed statement that China has labour cost advantages for all manufacturing subsectors, China actually has many disadvantaged industries in unit labour cost term. China have no competitiveness which have lower unit labour costs (<1, italic bold values in Table 4.2). For example, unit labour costs in Food and Tobacco (15t16), Metals (27t28) and Electrical equipment (30t33) in China are too high compared with Korea. These labour cost disadvantages are also prominent in Textiles (17t19) against Spain and Luxembourg, in Woods (20) against Greece and Italy, in Paper and Publishing (21t22) against Spain and Ireland, in Petroleum (23) against Japan, Korea, Greece, France, Italy and the USA, in Chemicals (24) against Ireland, Spain, Korea, Netherlands, Luxembourg, Sweden and Portugal, in other non-metallic products (26) against Portugal and in Manufacturing nec (36t37) with Greece.

Therefore, in a broad brush way, China has general cost advantages over the USA and the three large EU countries, and can competes in high-tech subsectors with Mediterranean countries and low-tech subsectors with neighbouring countries. For other countries and manufacturing sub-sectors, China's labour cost advantages are much weaker.

Table 4.2 Unit labour costs relative to China across 19 countries, manufacturing subsectors

Country	Period	15t16	17t19	20	21t22	23	24	26	27t28	29	30t33	34t35	36t37
USA	78-95	8.63	12.78	8.61	7.27	9.72	6.93	10.59	11.31	11.17	23.52	11.93	11.16
	95-07	1.53	1.78	1.79	1.62	***0.98***	1.12	1.48	1.68	1.9	1.13	1.89	1.87
UK	78-95	6.9	8.24	6.64	6.64	6.42	7.82	6.53	7.39	7.77	8.86	10.59	4.65
	95-07	1.59	1.89	1.91	1.66	1.69	1.35	1.59	1.82	1.77	1.39	1.86	1.79
France	78-95	7.27	9.55	11.63	8.58		9.05	9.05	7.05	15.58	11.67	10.3	7.98
	95-07	1.48	1.68	1.46	1.79		1.47	1.63	1.86	1.98	1.64	1.75	1.46
Germany	78-95	7.73	12.38	10.75	9.1	2.13	12.24	10.1	12.27	11.09	13.12	10.76	9.8
	95-07	1.72	**2.02**	1.71	1.77	**3.01**	1.66	1.64	**2.02**	**2.23**	**2.17**	**2.23**	**2.29**
Denmark	78-95	10.23	12.53	10.03	10.54	10.4	10.17	9.42	11.6	11.56	17.28	15.38	10.24
	95-07	**2.44**	**2.34**	**2.57**	**2.49**	**5.78**	1.58	**2.23**	**2.67**	**2.74**	**2.18**	**3.3**	**2.54**
Finland	78-95	10.7	12.1	11.09	8.17	10.41	7.9	10.18	9.86	10.28	13.09	12.78	10.6
	95-07	1.49	1.97	1.53	1.17	1.32	1.28	1.83	1.54	2.25	1.11	**2.33**	1.97
Sweden	78-95	9.82	14.53	11.69	7.33	12.38	5.89	9.54	10.14	11.82	15.56	11.63	26.78
	95-07	1.83	**2.33**	1.94	1.4	1.16	***0.92***	**2.13**	1.64	**2.01**	1.2	1.62	3.51
Spain	78-95	4.3	1.25	12.76	***0.8***	13.66	1.89	5.21	4.21	6.06	6.41	6.65	5.55
	95-07	1.23	***0.45***	**4.34**	***0.12***	**5.52**	***0.59***	1.17	1.21	1.39	1.27	1.35	1.44
Greece	78-95	1.99	2.04	1.54	2.33	1.38	2.63	2.96	2.74	3.6	2.77	4.18	1.84
	95-07	1.07	1.04	***0.91***	1.5	***0.51***	1.41	1.27	1.18	1.61	1.09	1.7	***0.87***
Italy	78-95	4.74	6.03	4.34	5.66	2.56	6.35	5.75	6.06	6.3	7.19	7.71	5.4
	95-07	1.14	1.37	***0.96***	1.26	0.97	1.22	1.25	1.25	1.64	1.48	1.93	1.26
Portugal	78-95	2.65	3.57	3.89	2.17	15.42	2.08	2.73	3.84	4.16	3.99	5.24	4.09
	95-06	1.26	1.57	1.45	1.05	**4.69**	***0.93***	***0.98***	1.44	1.71	1.16	1.18	1.73
Australia	78-95	8.07	9.23	7.35	8.21	14.11	7.47	7.33	8.06	11.81	11.46	10.16	9.33
	95-07	1.28	1.54	1.28	1.5	1.77	1.29	1.1	1.18	1.89	1.46	1.36	1.56
Austria	78-95	9.37	9.55	7.4	10.29	14.35	10.23	7.34	10.72	9.72	11.84	7.88	11.01
	95-07	1.39	1.57	1.43	1.42	1.02	1.34	1.51	1.63	1.78	1.74	1.54	1.63
Belgium	78-95	7.9	10.72	13.64	9.21	6.36	9.94	9.03	9.97	9.6	8.74	9.73	8.99
	95-07	1.51	1.59	1.66	1.6	**2.06**	1.32	1.66	1.71	1.78	1.62	1.71	1.79
Ireland	78-95	5.13	9.01	6.44	4.72	6.74	2.69	6.47	7.43	7.78	7.07	10.4	9.47
	95-07	1.03	2.01	1.5	***0.75***	1.2	***0.31***	1.29	1.62	1.67	***0.9***	**2.25**	2.17
Luxembourg	78-95	6.16	14.14	11.61	6.87		5.6	7.65	14.45	8.99	8.48	10.48	8.55
	95-07	1.93	***0.93***	1.32	1.8		***0.88***	1.37	**2**	2.06	1.71	1.85	1.58
Netherlands	78-95	8.74	10.77	11.05	9.59	6.57	7.26	7.62	9.86	12.07	16.29	12.85	11.98
	95-07	1.27	1.46	1.84	1.56	1.43	***0.88***	1.48	1.64	1.86	**2.01**	1.62	**2.21**
Korea	78-95	3.06	3.46	2.94	3.78	2.25	3.04	3.97	2.92	5.05	4.9	4.96	3.71
	95-07	***0.98***	1.22	1.07	1.27	***0.48***	***0.65***	1	***0.87***	1.31	***0.69***	1.11	1.35
Japan	78-95	7.7	11.19	11.3	11.39	1.02	10.6	11.27	10.28	15.19	24.52	13.4	10.19
	95-06	1.46	**2.56**	**2.19**	**2.06**	***0.23***	1.12	1.84	1.81	**2.09**	1.7	**2**	1.86

Notes:

1. The subsectors represent Food and Tobacco (15t16), Textiles (17t19), Wood (20), Paper and publishing (21t22), Petroleum (23), Chemicals (24), other non-metallic products (26), Metals (27t28), Machinery (29), Electrical equipment (30t33), Transport equipment (34t35) and Manufacturing nec (36t37).
2. The bold values represent China's large advantage on unit labour costs relative to other countries (RULC>2) during 1995-2007.
3. The italic bold values represent China's disadvantage on unit labour costs relative to other countries.

We investigate the extent to which competitiveness, defined by relative unit labour costs, is determined by nominal labour cost advantage or a relative productivity advantage. Similarly, a relative unit labour costs larger than one with respect to China indicates a relatively competitive situation for China. It implies that labour costs are considerably lower in China, or that China's labour productivity is considerably higher. Each of these outcomes is likely to have different policy implications and from this perspective, it is useful to have a better understanding of which component of relative unit labour costs measurement is driving the level. From the perspective of understanding the disparities, the most interesting subsectors are those where there is the greatest gap between nominal labour costs and labour productivity.

Table 4.3 and 4.4 illustrate cross-country comparisons of average relative labour productivity and relative nominal labour costs over the two periods. In Table 4.3, the RLPs are quiet stable except one high-tech manufacturing subsector – Petroleum (23). China narrows the relative labour productivity gap in Petroleum with the USA, the three large EU countries and Mediterranean countries, but still has largest gap with Japan. During 1995-2009, China's advantages on labour productivity relative to other countries only appear in Textiles (17t19) with Portugal and Korea, and in Woods (20) with Portugal (see the bold values in Table 4.3), both are low-tech manufacturing subsectors.

We find China compete against all countries in all subsectors in terms of relative nominal labour costs over time in Table 4.4. The relative nominal labour costs gap decreases about 80 percent from 1978-1995 to 1995-2007, which explains the sharp decrease of relative unit labour costs over time. Therefore, the unit labour costs advantages of China are mainly from nominal labour costs rather than increasing labour productivity.

Table 4.3 Relative labour productivity 1978-1995 and 1995-2007, by 19 countries, relative to China, 12 manufacturing subsectors

Country	Period	15t16	17t19	20	21t22	23	24	26	27t28	29	30t33	34t35	36t37
USA	78-95	4.01	1.98	3.27	4.91	7.79	7.14	3.73	3.62	3.86	2.37	4.4	2.74
	95-07	3.07	2.11	2.09	3.23	9.52	7.01	3.32	3.07	3.02	9.03	3.75	2.34
UK	78-95	4.88	2.64	3.17	5	13.47	5.37	3.84	3.46	3.68	3.17	3.61	3.72
	95-07	3.34	2.16	1.76	3.47	8.22	5.83	3.28	2.73	2.83	4.07	3.37	2.04
France	78-95	4.73	2.71	2.43	4.78		7.78	4.01	6.29	2.62	3.81	3.69	3.46
	95-07	3.42	2.84	3.26	3.8		7.92	3.93	3.17	3.49	4.59	4.34	3.24
Germany	78-95	3.43	2.21	3.15	3.59	28.2	4.54	3.68	3.73	3.91	3.42	4.78	3.33
	95-07	2.63	2.73	3.22	3.48	5.54	6.39	4.07	3.7	3.69	4.08	4.54	2.66
Denmark	78-95	3.79	2.55	3.37	3.92	8.51	4.44	4.11	2.97	3.29	2.52	2.55	3.31
	95-07	2.51	2.32	2.18	2.7	2.2	5.31	2.88	2.19	2.29	3.13	1.87	2.15
Finland	78-95	3.16	2.2	2.87	5.28	4.52	5.04	3.34	3.79	3.55	3.02	2.98	2.74
	95-07	3.82	2.22	3.37	6.15	6.83	5.23	3	3.71	2.7	8.36	2.56	2.37
Sweden	78-95	3.7	2.8	3.28	6.09	3.78	8.83	4.55	3.89	3.46	3.1	3.64	1.34
	95-07	2.78	2.06	2.69	4.49	7.87	8.61	2.58	3.16	2.84	11.22	3.9	1.45
Spain	78-95	4.93	3.35	2.32	3.43	3.32	15.14	4.72	6.12	4.67	4.56	4.57	2.96
	95-07	2.7	1.72	0.96	2.45	1.01	6.88	3.47	3.03	3.02	3.25	3.13	1.72
Greece	78-95	6.08	10.16	10.62	6.4	14.75	7.57	7.22	7.05	10.5	16.23	13.9	18.89
	95-07	1.72	1.51	1.46	1.52	6.02	2.13	1.87	1.74	1.18	2.09	1.67	2.03
Italy	78-95	6.52	4.1	5	6.12	21.33	6.64	5.57	4.86	5.36	4.6	4.48	5.36
	95-07	3.86	2.5	3.44	3.95	7.91	5.32	3.55	3.34	2.95	3.27	2.66	2.79
Portugal	78-95	3.48	1.83	1.67	5.08	**0.87**	7.29	3.08	3.26	3.19	2.96	1.69	1.5
	95-06	1.29	**0.78**	**0.95**	2.25	8.72	3.52	1.89	1.29	1.28	2.27	2.39	0.76
Australia	78-95	4.21	2.77	3.55	4.11	4.07	5.28	4.05	3.94	2.38	2.75	3.27	3.04
	95-07	3.2	1.84	2.52	2.87	3.5	3.62	4.12	3.22	1.97	2.74	2.86	1.64
Austria	78-95	2.86	2.61	3.38	3.57	5.78	3.86	4.71	3.27	3.3	3.12	4.32	2.21
	95-07	3.33	2.97	3.19	4.84	20.79	5.77	3.99	3.54	3.38	3.9	4.39	2.73
Belgium	78-95	5.13	2.77	3.35	4.93	13.98	6.29	4.39	4.32	4.93	4.87	5.09	3.45
	95-07	4.37	3.61	3.56	4.79	7.37	7.94	4.37	4.4	4.26	5.32	4.83	3.06
Ireland	78-95	4.21	2.24	2.52	5.25	2.79	9.75	4.19	2.92	2.66	2.83	3.13	2.07
	95-07	3.7	1.54	2.02	6.87	2.73	17.12	3.01	2.1	2.13	4.66	2.12	1.55
Luxembourg	78-95	4.51	10	2.92	5.25		8.22	4.82	3.34	6.76	3.83	3.97	2.78
	95-07	2.24	9.37	4.37	3.65		7.84	4.24	3.79	4.45	3.09	2.83	3.17
Netherlands	78-95	4.77	3.67	1.31	4.02	13.26	7.69	4.23	3.82	3.42	2.84	2.78	3.57
	95-07	4.83	3.7	1.14	4.02	7.35	9.98	3.01	3.56	3.42	3.35	3.89	2.85
Korea	78-95	2.77	**0.96**	1.62	1.99	5.04	3.61	1.96	2.23	**0.7**	1.32	1.69	1.41
	95-07	1.71	**0.74**	1.35	1.41	5.77	4.6	1.78	2.15	0.8	4.05	1.97	1.06
Japan	78-95	3.11	1.6	1.93	2.93	46.56	6.27	2.47	3.28	2.49	1.82	3.27	2.29
	95-06	2.86	1.39	1.97	2.78	48.75	9.36	3.03	3.49	3.36	5.07	3.61	2.61

Notes:

1. The subsectors represent Food and Tobacco (15t16), Textiles (17t19), Wood (20), Paper and publishing (21t22), Petroleum (23), Chemicals (24), other non-metallic products (26), Metals (27t28), Machinery (29), Electrical equipment (30t33), Transport equipment (34t35) and Manufacturing nec (36t37).
2. The bold values represent China's advantage on labour productivity relative to other countries.

Table 4.4 Relative Nominal labour costs 1978-1995 and 1995-2007, by 19 countries, relative to China, 12 manufacturing subsectors

Country	Period	15t16	17t19	20	21t22	23	24	26	27t28	29	30t33	34t35	36t37
USA	78-95	33.97	23.91	27.46	35.58	62.22	47.75	37.66	39.39	41.85	41.41	51.21	29.77
	95-07	5.22	4.01	4.14	5.78	9.45	8.3	5.41	5.74	6.17	7.83	7.6	4.74
UK	78-95	33.88	21.83	21.04	33.12	85.23	40.51	24.93	25.52	28.33	27	36.74	17.08
	95-07	5.91	4.27	3.7	6.33	15.12	8.52	5.63	5.34	5.35	5.86	6.89	4.01
France	78-95	34.31	25.92	27.01	40.95		64.45	36.18	38.7	38.37	43.71	37.99	27.76
	95-07	5.82	5.03	4.91	7.57		13.01	6.96	6.7	7.31	7.76	8.29	5.22
Germany	78-95	26.53	26.14	33.33	32.35	42.19	53.13	36.11	44.84	43.23	42.96	51.26	32.87
	95-07	5.13	5.96	6.03	7.03	11.95	11.11	7.32	8.46	9.22	9.17	10.88	6.93
Denmark	78-95	38.9	31.83	33.48	41.17	55.96	45	38.92	34.09	38	40.61	38.35	34.03
	95-07	6.95	6	6.23	7.62	10.72	8.81	7.14	6.69	7.16	7.4	7.02	6.16
Finland	78-95	32.96	25.93	30.45	42.11	45.4	39.01	33.84	36.02	36.77	34.89	37.73	29.02
	95-07	6.07	4.86	5.63	7.81	8.44	7.37	6.2	6.48	6.93	6.89	6.8	5.31
Sweden	78-95	36.14	40.5	38.6	44.67	45.45	51.49	43.19	38.85	40.76	47.35	42.03	35.35
	95-07	5.67	5.43	5.67	6.96	7.33	8.21	6.09	5.88	6.31	7.51	6.53	5.4
Spain	78-95	21.4	4.16	28.38	2.69	34.65	27.94	24.9	25.71	28.55	29.26	30.14	16.5
	95-07	3.87	0.84	4.85	0.33	6.3	4.79	4.68	4.28	4.82	4.78	4.9	2.85
Greece	78-95	9.05	14.37	10.18	11.04	15.39	15.11	15.04	14.18	24.72	29.43	38.01	22.79
	95-07	2.08	1.77	1.51	2.57	3.2	3.35	2.58	2.28	2.11	2.46	3.19	1.94
Italy	78-95	30.69	24.28	21.77	34.64	47.29	42.1	31.11	29.57	33.01	33.37	34.82	27.64
	95-07	5.05	3.92	3.74	5.69	7.82	7.38	5.01	4.77	5.54	5.51	5.85	4.02
Portugal	78-95	7.36	5.77	5.59	9.65	36.7	13.54	7.92	10.42	9.75	10	7.89	5.71
	95-06	1.8	1.37	1.46	2.61	10.37	3.61	2.02	2.13	2.4	2.66	2.6	1.5
Australia	78-95	33.59	25.53	26.01	33.24	45.14	39.69	29.34	30.9	27.45	30.08	32.48	28.31
	95-07	4.53	3.18	3.7	4.84	6.83	5.19	4.61	4.14	3.94	4.56	4.37	3.16
Austria	78-95	26.03	24.91	25.22	35.13	70.84	36.56	34.68	33.02	31.48	35.3	34.1	23.55
	95-07	4.97	4.71	4.92	7.02	16.32	7.65	6.6	6.34	6.54	7.25	7.11	4.62
Belgium	78-95	39.56	27.97	40.94	43.54	86.95	54.53	37.55	41.64	46.69	41.77	48.26	31.14
	95-07	7.59	6.2	6.5	8.6	16.52	11.55	8.39	8.39	8.33	9.18	9.11	6.09
Ireland	78-95	21.92	19.96	16.3	24.95	18.77	24.39	26.47	21.69	20.93	19.83	32.22	19.12
	95-07	4.19	3.36	3.29	5.02	3.07	5.39	4.48	3.79	4.02	4.29	5.39	3.63
Luxembourg	78-95	28.03	59.51	33.02	36.22		43.04	35.48	45.9	61.45	31.3	39.27	22.95
	95-07	5.02	10.69	5.26	7.63		7.44	6.67	8.16	10.86	5.66	5.8	5.49
Netherlands	78-95	39.3	36.63	13.72	36.42	81.56	51.21	31.44	35.75	38.58	41.02	33.18	41.44
	95-07	6.88	5.85	2.41	7.03	12.09	9.38	5.13	6.57	7.1	7.45	6.71	7.07
Korea	78-95	8.5	3.36	5	7.68	10.64	10.9	7.94	6.62	3.52	5.92	8.29	5.42
	95-07	1.91	0.98	1.58	2.06	3.06	2.93	1.91	2.08	1.14	2.31	2.34	1.61
Japan	78-95	23.95	17.77	21.81	32.97	51.43	51.41	27.09	33.38	34.66	30.46	41.4	23.09
	95-06	4.77	3.99	4.88	6.54	12.43	11.36	6	7.06	7.47	7.68	8.01	5.31

Note: The subsectors represent Food and Tobacco (15t16), Textiles (17t19), Wood (20), Paper and publishing (21t22), Petroleum (23), Chemicals (24), other non-metallic products (26), Metals (27t28), Machinery (29), Electrical equipment (30t33), Transport equipment (34t35) and Manufacturing nec (36t37).

4.4.2 Relative provincial unit labour costs within China

Table 4.5 shows the average relative unit labour costs in nine one-digit sectors for the cross-provincial comparisons within China. The average RULCs decrease from 1978-1995 to 1995-2009 in most cases as we expect. The structural changes of RULCs highlight the industrialization process of each province in China. Across sectors, the highest relative unit labour costs occur in Finance (J) for most provinces, especially in the provinces in the West region (such as Shanxi and Gansu), while the rich provinces such as Shanghai and Jiangsu have relatively lower labour costs in Finance. The Finance sector is easy to be prosperous in the provinces in the Coastal region associated with their special features in the Chinese financial history. Shanghai and Beijing are the finance centres attracting funds worldwide. In addition to huge foreign investments and advanced banking system, Zhejiang, Jiangsu and Fujian also have traditional informal finance from citizens and foreign remittances.

On the contrary, the relative unit labour costs in Education (M) and Health (N) sectors are quite high in the rich provinces in the Coastal region (Shanghai, Jiangsu and Guangdong), while relatively lower in the Anhui, Guangxi, Guizhou and Hunan provinces, which locate in the Interior and West regions. It suggests a labour cost advantage for these provinces in the Interior and West regions to accumulate human capital for further economic growth and catching-up with the provinces in the Coastal region. Thus, provinces should develop the specific industries according to their comparative advantage (see the bold values in Table 4.5). The Primary sector (AtoB), Construction (F) and Real estate (K) sectors are the most advantageous sectors for the provinces in the Interior and West regions (such as, Guangxi, Guizhou, Henan and Qinghai). The provinces in the Northeast and Coastal regions (such as Heilongjiang, Shandong and Hubei) should encourage the Manufacturing (D) sector. The Trade (G) sector has lower unit labour costs in Shanxi, Heilongjiang, Fujian and Shandong than those in other provinces. The three richest provinces (Beijing, Shanghai and Guangdong*) and some provinces in the Interior region (such as Shanxi, Anhui, Jiangxi and Sichuan* provinces) have cost advantages in transportation (I) sector possibly due to rich capital endowment and geographical advantages of central location.

Table 4.5 Unit labour costs 1978-1995 and 1995-2009, by 28 provinces, relative to China national level, nine one-digit sectors

Province	Period	AtoB	D	F	G	I	J	K	M	N
Beijing	78-95	1.13	2.54	2.36	1.24	1.42	6.22	3.54	2.94	2.37
	95-09	**0.97**	1.63	1.89	1.6	**0.87**	**0.44**	2.04	1.02	1.52
Tianjin	78-95	1.35	2.49	2.96	1.67	2.01	13.64	5.43	3.22	3.09
	95-09	1.49	1.37	2.06	1.48	1.62	**0.93**	2.38	1.09	1.17
Hebei	78-95	1.49	3.5	2.6	2.1	2.41	2.64	5.97	2.95	3.42
	95-09	**0.96**	1.03	1.16	1.85	1.15	1.37	1.26	1.1	1.13
Shanxi	78-95	1.46	3.99	3.35	2.47	2.86	3.95	5.64	3.17	3.27
	95-09	**0.87**	1.34	1.37	**0.88**	**0.98**	1.04	1.44	**0.99**	**0.82**
Inner Mongolia	78-95	1.27	3.86	2.85	2.81	2.78	7.06	4.96	3.15	3.26
	95-09	1	1.31	1.57	1.25	**0.93**	3.69	1.51	1.27	1.1
Liaoning	78-95	1.53	2.72	2.8	1.79	2.22	2.07	5.68	2.7	2.58
	95-09	1	1.08	1.46	1	**0.86**	1.8	1.45	1.14	1.53
Jilin	78-95	1.43	4	3.37	5.07	2.98	9.75	4.27	2.99	3.1
	95-09	**0.96**	1.15	**0.9**	1.08	1.08	2.37	1.21	1.09	1.09
Heilongjiang	78-95	1.47	3.21	3.03	4	2.71	9.7	6.29	3.21	3.26
	95-09	1.19	**0.85**	1.05	**0.98**	1.41	2.66	1.52	1.01	1.46
shanghai	78-95	1.32	2.43	2.63	1.32	2.08	1.13	2.26	3.23	3.22
	95-09	1.3	1.52	1.85	1.42	**0.86**	**0.38**	1.8	1.37	1.44
Jiangsu	78-95	1.56	3.05	2.44	2.39	2.81	1.45	2.74	2.67	2.94
	95-09	1.25	1.25	1.21	1.17	1.52	**0.79**	1.28	1.23	1.28
Zhejiang	78-95	1.4	3.87	2.97	1.58	3.52	2.41	5.54	3.16	2.68
	95-09	1.3	1.14	1.82	1.44	1.57	**0.62**	1.1	1.02	**0.81**
Anhui	78-95	1.56	3.62	3.17	2.5	2.91	8.08	2.8	3.5	3.57
	95-09	1.05	1.05	1.08	1.05	**0.46**	1.25	**0.87**	**0.74**	**0.63**
Fujian	78-95	1.61	4.76	3.08	3.62	3.19	3.8	4.89	2.92	2.89
	95-09	1.16	1.21	1.76	**0.98**	1	**0.8**	1.06	1.15	1.11
Jiangxi	78-95	1.55	3.8	3.27	2.84	3.86	11.72	3.39	1.83	1.74
	95-09	**0.98**	1.14	**0.89**	1.16	**0.86**	1.5	**0.83**	1.23	1.36

Continue...

Province	Period	AtoB	D	F	G	I	J	K	M	N
Shandong	78-95	1.45	3.53	2.53	2.79	2.11	3.89	2.33	2.57	2.37
	95-09	1.25	**0.98**	1.28	**0.99**	1.21	2.58	**0.99**	1.21	**0.93**
Henan	78-95	1.55	3.7	2.78	2.33	2.06	4.96	3.03	2.85	3.07
	95-09	**0.92**	1.31	**0.92**	1.18	1.05	1.21	1.06	**0.93**	1.16
Hubei	78-95	1.49	3.32	2.95	2.6	3.4	5.59	4.31	3.26	3.16
	95-09	**0.99**	**0.82**	1.35	1.43	1.45	**0.91**	1.57	1.02	1.07
Hunan	78-95	1.67	3.43	3.44	2.35	3.09	6.64	2.82	3.29	3.25
	95-09	**0.84**	1.22	1.2	1.14	1.37	1.25	**0.79**	**0.81**	**0.74**
Guangdong*	78-95	1.33	4.8	2.25	3.77	2.28	4.07	4.84	2.19	2.47
	95-09	1.24	1.17	2.46	1.08	**0.95**	1.34	1.28	1.71	1.29
Guangxi	78-95	1.54	3.17	3.27	3.11	2.47	5.59	4.26	2.68	2.93
	95-09	**0.77**	1.27	**0.86**	**0.75**	1.14	8.27	1.26	**0.79**	**0.86**
Sichuan*	78-95	1.57	3.72	2.94	1.68	2.19	6.84	4.03	3.02	3.21
	95-09	**0.91**	1.1	1.33	**0.8**	**0.8**	1.29	**0.96**	**0.97**	**0.86**
Guizhou	78-95	1.57	3.82	2.99	2.4	2.14	6.47	6.25	3.65	3.49
	95-09	**0.79**	1.07	**0.88**	**0.84**	1.19	1.3	**0.94**	**0.81**	**0.67**
Yunnan	78-95	1.66	2.25	2.75	3.43	2.15	3.62	5.76	2.44	2.33
	95-09	1.95	6.12	1.96	1.77	2.78	4.86	2.88	2.26	1.5
Shaanxi	78-95	1.56	4.18	3.14	2.71	2.53	19.11	6.29	3.4	3.6
	95-09	**0.93**	1.06	**0.7**	1.46	1.16	1.78	2.06	1	1.23
Gansu	78-95	1.5	4.54	4.07	1.82	3.53	10.59	7.69	3.03	3.56
	95-09	**0.86**	1.52	**0.94**	1.49	1.24	1.88	2.34	1.16	1.56
Qinghai	78-95	1.61	4.83	3.3	1.65	4.46	8.2	7.27	2.77	3.31
	95-09	**0.84**	1.13	1.26	**0.84**	1.27	1.59	2.22	1.09	1.13
Ningxia	78-95	1.78	3.77	3.16	1.74	2.31	3.58	4.32	3.02	2.9
	95-09	1.05	1.12	1.01	**0.81**	**0.86**	1.41	1.41	**0.82**	0.82
Xinjiang	78-95	1.58	3.57	3.09	1.5	2.67	6.4	9.62	3.62	3.74
	95-09	**0.86**	**0.66**	1.34	1.44	1.93	2.02	3.61	1.64	1.84

Notes:

1. The sectors are Primary sector (AtoB), Manufacturing (D), Construction (F), Trade (G), Transportation (I), Finance (J), Real estate (K), Education (M) and Health (N)
2. The bold values represent these provinces' advantage on unit labour costs relative to national level.

Similar to the cross-country comparisons, Table 4.6 and 4.7 try to dig out the drivers of cost competitiveness: the average relative labour productivity and relative nominal labour costs by province, compared with Chinese national level over two time periods. We find that the decrease of relative unit labour costs in Table 4.6 occurs mainly because the growth rate of relative labour productivity is higher than the growth rate of relative nominal labour costs in most cases.

In Table 4.7, the bold values show the provinces' labour productivity advantage on national levels. Normally, the provinces in the Coastal region (such as Shanghai, Jiangsu, Fujian, Shandong and Guangdong) have higher relative labour productivity than other provinces. The provinces in the West region (Guangxi, Guizhou and Shaanxi) only have higher relative labour productivity in the Primary sector (AtoB) than other provinces. As expected, the provinces in the Northeast region (Liaoning, Jilin and Heilongjiang) and the West region (Inner Mongolia, Guangxi, Sichuan*, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang) have lower relative nominal labour costs than national level (see the bold values in Table 4.7).

Table 4.6 Relative labour productivity 1978-1995 and 1995-2009, by provinces, relative to China national level, 9 sectors

Province	Period	AtoB	D	F	G	I	J	K	M	N
Beijing	78-95	0.7	0.47	0.33	0.68	0.66	**1.02**	0.29	0.47	0.82
	95-09	0.87	0.62	0.49	0.55	0.63	2.35	0.38	**1.91**	**1.1**
Tianjin	78-95	**1.16**	0.38	0.42	0.52	0.58	0.83	0.26	0.51	0.38
	95-09	**1.95**	0.72	0.79	0.91	**1.04**	**1.52**	0.76	**1.42**	**1.05**
Hebei	78-95	**1.66**	0.43	0.4	0.56	0.61	0.42	0.51	0.42	0.45
	95-09	**2.57**	**1.13**	0.88	0.78	**1.3**	0.64	0.84	0.75	0.8
Shanxi	78-95	**1.52**	0.37	0.39	0.37	0.44	0.41	0.28	0.45	0.46
	95-09	**1.58**	0.77	0.58	0.44	0.76	0.62	0.53	0.84	0.73
Inner Mongolia	78-95	0.28	0.25	0.33	0.42	0.36	0.25	0.27	0.43	0.38
	95-09	0.34	0.68	0.73	0.88	0.79	0.27	0.52	0.8	0.87
Liaoning	78-95	0.37	0.33	0.27	0.54	0.62	0.44	0.22	0.51	0.55
	95-09	0.48	0.83	0.77	**1.51**	0.83	0.59	0.83	**1.09**	**1.15**
Jilin	78-95	0.51	0.25	0.29	0.27	0.3	0.26	0.23	0.44	0.37
	95-09	0.61	0.64	0.8	0.76	0.47	0.29	0.47	0.75	0.67
Heilongjiang	78-95	0.16	0.4	0.33	0.3	0.36	0.41	0.24	0.49	0.51
	95-09	0.22	1	0.52	0.61	0.49	0.37	0.47	0.83	0.85
shanghai	78-95	0.57	0.77	0.78	0.89	0.68	**1.12**	0.55	0.55	0.42
	95-09	**1.72**	**1.38**	**1.69**	**1.33**	0.92	2.46	1.03	**2.17**	**1.42**
Jiangsu	78-95	**1.22**	0.47	0.85	0.56	0.47	0.62	0.59	0.5	0.46
	95-09	**1.58**	**1.12**	**1.77**	**1.26**	**1.04**	**1.29**	**1.37**	**1.13**	**1.02**
Zhejiang	78-95	**3.05**	0.56	0.54	1.12	0.72	0.42	0.65	0.49	0.51
	95-09	**5.54**	**1.44**	0.71	**1.96**	**1.53**	0.96	**1.18**	**1.3**	**1.23**
Anhui	78-95	**1.6**	0.35	0.45	0.53	0.44	0.38	0.4	0.39	0.37
	95-09	**1.82**	0.92	0.8	0.67	0.81	0.54	0.89	0.75	0.88
Fujian	78-95	**1.12**	0.36	0.65	0.95	0.94	0.52	0.55	0.53	0.47
	95-09	**2.04**	0.7	0.93	**1.6**	**2.07**	**1.06**	**1.33**	**1.02**	**1.11**
Jiangxi	78-95	0.57	0.25	0.57	0.33	0.39	0.32	0.61	0.51	0.48
	95-09	0.77	0.59	**1.02**	0.69	0.87	0.54	0.85	0.68	0.55

Continue...

Province	Period	AtoB	D	F	G	I	J	K	M	N
Shandong	78-95	**3.68**	0.5	**1.06**	0.76	0.88	0.57	0.69	0.56	0.63
	95-09	**4.65**	0.93	**1.22**	**1.04**	**1.48**	**1.08**	**1.37**	**1.15**	**1.2**
Henan	78-95	**3.15**	0.38	0.45	0.39	0.6	0.32	0.55	0.49	0.48
	95-09	**3.11**	0.93	0.56	0.41	0.93	0.4	0.74	0.62	0.79
Hubei	78-95	0.51	0.32	0.45	0.45	0.32	0.31	0.34	0.36	0.37
	95-09	0.66	0.71	0.64	0.71	0.6	0.72	0.72	0.83	0.86
Hunan	78-95	0.7	0.33	0.55	0.54	0.43	0.37	0.46	0.5	0.44
	95-09	**1.68**	0.85	0.73	0.93	0.83	0.55	0.78	**1.03**	**1.06**
Guangdong*	78-95	0.59	0.52	0.61	0.72	0.68	0.39	0.61	0.59	0.66
	95-09	0.96	**1.11**	**1**	**1.37**	**1.46**	0.89	**1.38**	0.98	0.96
Guangxi	78-95	0.86	0.37	0.35	0.82	0.48	0.3	0.41	0.4	0.42
	95-09	**1.11**	0.88	0.87	1.09	0.86	0.41	0.69	0.71	0.84
Sichuan*	78-95	**3.5**	0.43	0.56	0.77	0.47	0.45	0.61	0.58	0.57
	95-09	**2.93**	0.7	0.52	0.9	0.79	0.8	0.82	0.86	0.87
Guizhou	78-95	**1.65**	0.29	0.37	0.42	0.36	0.25	0.31	0.33	0.38
	95-09	**2.26**	0.61	0.37	0.5	0.63	0.59	0.6	0.74	0.98
Yunnan	78-95	0.54	0.48	0.4	0.69	0.37	0.35	0.29	0.51	0.66
	95-09	0.65	**1.01**	0.83	0.71	0.56	0.58	0.6	0.61	0.88
Shaanxi	78-95	**1.43**	0.26	0.38	0.34	0.44	0.35	0.28	0.45	0.45
	95-09	**1.32**	0.51	0.82	0.46	0.67	0.41	0.4	0.87	0.77
Gansu	78-95	0.61	0.31	0.38	0.69	0.36	0.29	0.28	0.42	0.34
	95-09	0.69	0.52	0.7	0.56	0.4	0.4	0.4	0.48	0.64
Qinghai	78-95	0.4	0.27	0.44	0.65	0.27	0.32	0.43	0.64	0.53
	95-09	0.58	0.77	0.87	0.71	0.49	0.65	0.36	0.97	0.66
Ningxia	78-95	0.26	0.3	0.63	0.5	0.41	0.4	0.31	0.45	0.38
	95-09	0.4	0.73	**1.06**	0.78	0.84	0.81	0.57	**1.14**	0.97
Xinjiang	78-95	0.08	0.35	0.42	0.61	0.39	0.35	0.3	0.43	0.36
	95-09	0.12	**1.2**	0.93	0.73	0.72	0.61	0.47	0.82	0.62

Notes:

1. The sectors are Primary sector (AtoB), Manufacturing (D), Construction (F), Trade (G), Transportation (I), Finance (J), Real estate (K), Education (M) and Health (N)
2. The bold values represent these provinces' advantage on labour productivity relative to national level.

Table 4.7 Relative Nominal Labour costs 1978 to 1995 and 1995 to 2009, 28 provinces, relative to China national level, 9 sectors

Province	Period	AtoB	D	F	G	I	J	K	M	N
Beijing	78-95	**0.64**	1.01	**0.63**	**0.72**	**0.86**	2.31	**0.66**	**0.84**	1.59
	95-09	**0.80**	**0.98**	**0.92**	**0.78**	**0.52**	1.03	**0.76**	1.94	1.65
Tianjin	78-95	1.42	**0.76**	**0.88**	**0.75**	**0.94**	**0.66**	**0.95**	1.41	**0.85**
	95-09	2.89	**0.97**	1.62	1.32	1.64	1.25	1.77	1.52	1.20
Hebei	78-95	2.30	1.07	**0.81**	**0.95**	1.21	**0.55**	2.07	**0.90**	1.12
	95-09	2.47	1.17	1.01	1.40	1.49	**0.83**	1.04	**0.82**	**0.89**
Shanxi	78-95	2.14	1.17	**0.94**	**0.70**	**0.92**	**0.62**	1.06	1.17	1.32
	95-09	1.36	1.03	**0.79**	**0.38**	**0.73**	**0.59**	**0.73**	**0.79**	**0.56**
Inner Mongolia	78-95	**0.33**	**0.70**	**0.76**	**0.89**	**0.77**	**0.90**	**0.82**	1.02	**0.85**
	95-09	**0.33**	**0.90**	1.13	1.09	**0.74**	**0.91**	**0.78**	1.01	**0.93**
Liaoning	78-95	**0.51**	**0.72**	**0.57**	**0.70**	**0.85**	**0.51**	**0.56**	**0.96**	1.06
	95-09	**0.48**	**0.89**	1.12	1.50	**0.72**	**0.99**	1.20	1.24	1.75
Jilin	78-95	**0.69**	**0.74**	**0.64**	**0.76**	**0.77**	1.04	**0.64**	1.03	**0.87**
	95-09	**0.58**	**0.74**	**0.73**	**0.80**	**0.50**	**0.51**	**0.57**	**0.81**	**0.73**
Heilongjiang	78-95	**0.22**	**0.97**	**0.72**	**0.72**	**0.86**	1.76	**0.88**	1.22	1.17
	95-09	**0.26**	**0.84**	**0.55**	**0.60**	**0.68**	**0.64**	**0.70**	**0.83**	1.23
shanghai	78-95	**0.69**	1.53	1.35	1.04	1.06	**0.65**	**0.70**	1.11	**0.84**
	95-09	2.28	2.07	3.09	1.84	**0.75**	**0.88**	1.82	2.95	2.02
Jiangsu	78-95	1.76	**0.99**	1.59	**0.88**	**0.98**	**0.63**	1.00	**0.99**	**0.91**
	95-09	1.97	1.37	2.14	1.46	1.55	1.00	1.74	1.38	1.29
Zhejiang	78-95	3.92	1.34	1.12	1.31	1.63	**0.48**	1.71	1.08	**0.95**
	95-09	7.44	1.58	1.23	2.73	2.24	**0.57**	1.30	1.28	**0.96**
Anhui	78-95	2.39	**0.88**	1.11	1.04	**0.89**	1.51	**0.73**	**0.94**	**0.94**
	95-09	1.91	**0.96**	**0.86**	**0.70**	**0.36**	**0.64**	**0.77**	**0.54**	**0.52**
Fujian	78-95	1.60	1.02	1.25	2.10	1.84	**0.99**	1.23	1.03	0.86
	95-09	2.37	**0.81**	1.51	1.56	1.99	**0.83**	1.36	1.14	1.21
Jiangxi	78-95	**0.83**	**0.69**	1.66	**0.86**	1.14	**0.91**	1.38	**0.74**	**0.66**
	95-09	**0.75**	**0.67**	**0.91**	**0.79**	**0.75**	**0.70**	**0.69**	**0.81**	**0.74**

Continue...

Province	Period	AtoB	D	F	G	I	J	K	M	N
Shandong	78-95	4.96	1.28	2.04	**0.93**	1.41	1.12	1.07	1.02	1.08
	95-09	5.85	**0.89**	1.46	1.02	1.77	2.64	1.34	1.37	1.11
Henan	78-95	4.65	1.03	1.06	**0.77**	1.07	**0.75**	1.03	1.13	1.09
	95-09	2.87	1.23	**0.51**	**0.49**	**0.96**	**0.46**	**0.76**	**0.57**	**0.91**
Hubei	78-95	**0.71**	**0.72**	1.09	**0.94**	**0.77**	1.19	**0.84**	**0.8**	**0.74**
	95-09	**0.65**	**0.58**	**0.87**	1.01	**0.86**	0.62	1.12	**0.85**	**0.91**
Hunan	78-95	1.09	**0.87**	1.44	**0.92**	1.04	1.16	**0.83**	1.27	1.07
	95-09	1.36	1.03	**0.87**	1.06	1.14	**0.66**	**0.61**	**0.83**	**0.78**
Guangdong*	78-95	**0.72**	1.49	**0.98**	2.01	1.08	0.69	1.19	**0.9**	1.07
	95-09	1.19	1.26	2.04	1.46	1.28	1.11	1.71	1.52	1.18
Guangxi	78-95	1.24	**0.84**	**0.83**	1.42	**0.88**	1.77	1.12	**0.82**	**0.89**
	95-09	**0.86**	1.11	**0.75**	**0.81**	**0.98**	2.7	**0.87**	**0.55**	**0.71**
Sichuan*	78-95	5.17	1.15	1.25	1.07	**0.84**	1.32	1.55	1.22	1.25
	95-09	2.66	**0.75**	**0.65**	**0.72**	**0.62**	1.01	**0.78**	**0.83**	**0.75**
Guizhou	78-95	2.36	**0.72**	**0.68**	**0.84**	**0.72**	**0.77**	**0.93**	**0.79**	**0.86**
	95-09	1.78	**0.61**	**0.31**	**0.37**	**0.65**	**0.63**	**0.46**	**0.51**	**0.56**
Yunnan	78-95	**0.82**	**0.65**	**0.92**	1.31	**0.63**	**0.99**	**0.9**	**0.83**	**0.71**
	95-09	**0.69**	**0.7**	**0.96**	**0.65**	**0.71**	1.51	0.79	**0.72**	**0.63**
Shaanxi	78-95	2.1	**0.81**	**0.92**	**0.78**	**0.88**	2.31	1.02	1.06	1.15
	95-09	1.23	**0.54**	**0.56**	**0.65**	**0.72**	**0.58**	**0.74**	**0.81**	**0.88**
Gansu	78-95	**0.85**	1.15	**0.89**	1.03	1.16	1.36	1.23	**0.99**	**0.8**
	95-09	**0.5**	**0.67**	**0.6**	**0.7**	**0.42**	**0.66**	**0.85**	**0.48**	**0.84**
Qinghai	78-95	**0.59**	**0.88**	1.11	**0.88**	**0.84**	1.44	2.39	1.41	1.61
	95-09	**0.49**	**0.88**	1.09	**0.59**	**0.61**	**0.97**	**0.76**	1.03	**0.74**
Ningxia	78-95	**0.42**	**0.82**	1.53	0.72	**0.81**	**0.73**	**0.93**	**0.98**	**0.86**
	95-09	**0.32**	**0.74**	**0.8**	**0.49**	**0.57**	**0.83**	**0.63**	**0.75**	**0.63**
Xinjiang	78-95	**0.12**	**0.86**	**0.95**	**0.69**	**0.72**	1.1	1.35	1.03	**0.9**
	95-09	**0.11**	**0.77**	1.23	**0.73**	**0.93**	**0.8**	1.07	**0.91**	**0.71**

Notes:

1. The sectors are Primary sector (AtoB), Manufacturing (D), Construction (F), Trade (G), Transportation (I), Finance (J), Real estate (K), Education (M) and Health (N)
2. The bold numbers presents these provinces' advantage on nominal labour costs relative to national level.

4.5 Decompositions of relative unit labour costs

Changes in relative unit labour costs can be decomposed into three component parts: the changes of relative nominal labour costs per hour (*rnlc*), relative productivity (*rlp*) and market exchange rates (*er*) as follows:

$$\Delta \ln(rulc) = \Delta \ln(rnlc) - \Delta \ln(rlp) - \Delta \ln(er) \qquad (4.13)$$

It is perhaps worth spelling out that a positive change in *dulc* (unit labour costs) indicates gain of China competitiveness, and a positive change in *dnlc* (nominal labour costs) indicates a relative decrease in China nominal labour costs. A negative change in *dlp* (labour productivity) indicates a relative improvement in China labour productivity and a negative change in *de* (market exchange rates) shows depreciation in China currency relative to foreign currency in the cross-country comparisons.

Similarly, for the cross-provincial comparisons, the formula becomes:

$$\Delta \ln(rulc) = \Delta \ln(rnlc) - \Delta \ln(rlp) \qquad (4.14)$$

where a negative change in *dulc* (unit labour costs) indicates gain of province competitiveness, and a negative change in *dnlc* (nominal labour costs) indicates a relative decrease in province nominal labour costs. A positive change in *dlp* (labour productivity) indicates a relative improvement in province labour productivity.

This country by country analysis decomposes the competitiveness gains or losses of the nineteen countries and twelve sectors in Table 4.8 and Table 4.9. During 1978-

1995, China has cost competitiveness gains only relative to the Mediterranean countries (Spain, Greece, Italy and Portugal), mainly relying on the negative changes of labour productivity in these countries and depreciation in China currency relative to foreign currencies. After 1995, China loses its cost competitiveness relative to all countries, because the negative changes of labour productivity in these countries have been offset by the appreciation of China currency.

Table 4.8 Decomposition of relative unit labour costs, 19 countries compared with China, 1978-1995 (Values have been timed 100)

Country	78-95	15t16	17t19	20	21t22	23	24	26	27t28	29	30t33	34t35	36t37
USA	RULC	-5	-6	-4	-2	-10	-4	-5	-5	-3	-11	-3	-4
	NLC	-11	-11	-12	-11	-12	-11	-12	-12	-12	-11	-11	-12
	RLP	3	4	1	0	7	3	2	2	0	10	1	2
	EXCH	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**
UK	RULC	**0**	**0**	**1**	**1**	-1	-2	**0**	**0**	-1	-3	-2	**5**
	NLC	-7	-8	-9	-8	-9	-6	-7	-8	-9	-6	-7	-6
	RLP	1	1	-1	0	**-1**	4	2	1	0	5	4	**-3**
	EXCH	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**
France	RULC	-2	-1	-5	**1**	-29	-6	-1	**7**	-5	-2	-1	-2
	NLC	-10	-8	-8	-8	-9	-8	-8	-8	-8	-9	-7	-8
	RLP	1	2	5	0	29	7	1	**-6**	6	2	3	3
	EXCH	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**
Germany	RULC	-2	-4	-3	-2	**10**	-4	-4	-3	-2	-4	-2	-1
	NLC	-11	-10	-11	-10	-10	-10	-11	-11	-10	-10	-11	-10
	RLP	2	6	3	4	-9	6	5	4	3	5	3	2
	EXCH	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**
Denmark	RULC	-1	-3	-1	**0**	**7**	-3	-1	-2	-1	-6	-2	-2
	NLC	-10	-10	-9	-9	-9	-9	-10	-9	-10	-10	-10	-10
	RLP	0	3	1	0	**-7**	3	0	2	1	6	2	1
	EXCH	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**
Finland	RULC	-2	-2	-3	-3	-1	-3	-2	-4	-1	-6	-1	-2
	NLC	-8	-8	-8	-8	-7	-8	-8	-8	-8	-8	-8	-8
	RLP	4	4	4	4	3	4	3	5	2	7	2	3
	EXCH	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**	**-9**
Sweden	RULC	-3	-4	-3	-3	-5	-3	-2	-5	-4	-6	-4	-6
	NLC	-9	-10	-10	-9	-8	-9	-10	-9	-9	-9	-9	-11
	RLP	0	0	0	0	4	1	**-1**	2	2	3	2	2
	EXCH	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**
Spain	RULC	**2**	**3**	**4**	-1	**10**	**3**	-1	**1**	**0**	-1	**0**	**1**
	NLC	-5	-6	-6	-7	-5	-6	-5	-7	-6	-7	-7	-6
	RLP	**-1**	**-2**	**-4**	1	**-9**	**-2**	2	**-2**	0	1	**-1**	**-1**
	EXCH	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**
Greece	RULC	**10**	**9**	**10**	**12**	**10**	**10**	**10**	**9**	**9**	**9**	**9**	**9**
	NLC	**2**	-3	-3	**4**	**2**	**2**	-1	-1	-6	-6	-6	-6
	RLP	**-9**	**-14**	**-15**	**-10**	**-10**	**-10**	**-12**	**-11**	**-17**	**-17**	**-17**	**-17**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Italy	RULC	**1**	**1**	**1**	**1**	**2**	-3	**2**	-1	**2**	-1	**2**	**2**
	NLC	-5	-6	-5	-5	-6	-6	-6	-6	-5	-5	-5	-7
	RLP	**-1**	**-1**	0	0	**-2**	3	**-2**	1	**-2**	2	**-1**	**-3**
	EXCH	**-6**	**-6**	**-6**	**-6**	**-6**	**-6**	**-6**	**-6**	**-6**	**-6**	**-6**	**-6**

Continue…

Country	78-95	15t16	17t19	20	21t22	23	24	26	27t28	29	30t33	34t35	36t37
Portugal	RULC	**9**	**7**	**8**	**9**	**0**	**9**	**6**	**8**	**11**	**7**	**5**	**8**
	NLC	-1	-1	-1	1	1	1	-1	-1	-1	-1	-1	2
	RLP	**-8**	**-6**	**-7**	**-6**	4	**-6**	**-4**	**-7**	**-9**	**-5**	**-4**	**-4**
	EXCH	**-2**	**-2**	**-2**	**-2**	**-2**	**-2**	**-2**	**-2**	**-2**	**-2**	**-2**	**-2**
Australia	RULC	-4	-4	-3	-3	-4	-4	-3	-5	-4	-5	-4	-2
	NLC	-10	-11	-9	-9	-9	-10	-7	-10	-10	-8	-9	-10
	RLP	1	0	0	1	3	0	3	2	1	4	2	-1
	EXCH	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**
Austria	RULC	-4	-3	-2	-5	-8	-6	-2	-6	-3	-4	-1	-4
	NLC	-11	-11	-11	-11	-10	-11	-12	-11	-11	-11	-11	-11
	RLP	4	3	2	6	10	7	2	6	4	5	2	4
	EXCH	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**	**-12**
Belgium	RULC	-4	-5	-7	-5	-4	-8	-5	-5	-4	-4	-4	-2
	NLC	-10	-9	-11	-10	-7	-9	-9	-9	-11	-10	-10	-9
	RLP	4	6	7	5	7	9	6	5	3	4	4	3
	EXCH	**-10**	**-10**	**-10**	**-10**	**-10**	**-10**	**-10**	**-10**	**-10**	**-10**	**-10**	**-10**
Ireland	RULC	-1	-1	0	**1**	-2	-3	-2	-1	-1	-4	0	-2
	NLC	-6	-10	-7	-6	-10	-4	-8	-8	-5	-2	-9	-9
	RLP	3	-1	1	1	0	8	3	1	4	11	0	2
	EXCH	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**	**-8**
Luxembourg	RULC	-1	-12	-4	-1	0	-4	-4	-4	-1	-2	-4	-4
	NLC	-11	-10	-11	-9	0	-11	-10	-10	-10	-11	-11	-9
	RLP	0	12	3	2	0	3	4	4	1	1	3	5
	EXCH	**-10**	**-10**	**-10**	**-10**	**0**	**-10**	**-10**	**-10**	**-10**	**-10**	**-10**	**-10**
Netherlands	RULC	-6	-7	-6	-6	-5	-8	-5	-6	-6	-8	-6	-5
	NLC	-12	-14	-12	-12	-14	-12	-13	-12	-12	-13	-11	-13
	RLP	5	5	5	5	2	7	3	5	5	6	7	3
	EXCH	**-11**	**-11**	**-11**	**-11**	**-11**	**-11**	**-11**	**-11**	**-11**	**-11**	**-11**	**-11**
Korea	RULC	**4**	**5**	**6**	**3**	**2**	**1**	**3**	**2**	**1**	-2	-1	5
	NLC	-3	-3	2	-2	-2	-3	-2	1	-2	0	-3	**2**
	RLP	0	**-1**	3	3	2	3	2	5	4	9	4	4
	EXCH	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**	**-7**
Japan	RULC	-3	-3	-3	-3	0	-9	-4	-4	-7	-12	-5	-3
	NLC	-13	-13	-12	-13	-11	-12	-12	-13	-12	-13	-13	-12
	RLP	3	5	5	4	3	12	6	5	9	14	7	6
	EXCH	**-14**	**-14**	**-14**	**-14**	**-14**	**-14**	**-14**	**-14**	**-14**	**-14**	**-14**	**-14**

Notes:

1. The subsectors represent Food and Tobacco (15t16), Texiles (17t19), Wood (20), Paper and publishing (21t22), Petroleum (23), Chemicals (24), other non-metallic products (26), Metals (27t28), Machinery (29), Electrical equipment (30t33), Transport equipment (34t35) and Manufacturing nec (36t37).
2. The bold value represent China's advantage (dulc>0, dnlc>0, dlp<0 and de<0)

Table 4.9 Decomposition of relative unit labour costs, 19 countries compared with China, 1995-2007 (Values have been timed 100)

Country	95-07	15t16	17t19	20	21t22	23	24	26	27t28	29	30t33	34t35	36t37
USA	RULC	-15	-17	-15	-15	-13	-17	-15	-16	-17	-27	-19	-16
	NLC	-20	-18	-19	-19	-16	-18	-20	-20	-19	-17	-20	-19
	RLP	**-6**	**-2**	**-5**	**-5**	**-4**	**-2**	**-5**	**-5**	**-3**	9	**-2**	**-3**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
UK	RULC	-12	-13	-11	-13	-10	-14	-13	-14	-14	-17	-15	-13
	NLC	-19	-15	-18	-19	-17	-18	-18	-18	-18	-18	-20	-19
	RLP	**-5**	**-1**	**-6**	**-5**	**-6**	**-3**	**-3**	**-3**	**-3**	0	**-4**	**-5**
	EXCH	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**	**-1**
France	RULC	-15	-18	-19	-17	-19	-17	-17	-16	-19	-20	-17	-16
	NLC	-20	-19	-19	-20	-18	-20	-19	-20	-20	-20	-20	-19
	RLP	**-5**	**-1**	**-1**	**-3**	0	**-3**	**-3**	**-5**	**-1**	0	**-4**	**-4**
	EXCH	0	0	0	0	0	0	0	0	0	0	0	0
Germany	RULC	-17	-20	-20	-20	-8	-21	-20	-19	-18	-22	-18	-18
	NLC	-21	-20	-22	-23	-17	-20	-21	-22	-21	-20	-19	-22
	RLP	**-5**	**-1**	**-3**	**-4**	**-10**	0	**-2**	**-4**	**-4**	1	**-2**	**-5**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Denmark	RULC	-13	-14	-16	-16	-4	-17	-16	-14	-14	-18	-14	-15
	NLC	-19	-18	-19	-20	-18	-18	-19	-19	-19	-19	-19	-19
	RLP	**-6**	**-5**	**-4**	**-4**	**-14**	**-3**	**-3**	**-6**	**-5**	**-1**	**-6**	**-5**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Finland	RULC	-20	-17	-17	-19	-18	-16	-17	-17	-16	-28	-16	-17
	NLC	-20	-19	-20	-20	-20	-19	-20	-20	-19	-18	-21	-20
	RLP	**-1**	**-3**	**-4**	**-2**	**-2**	**-4**	**-4**	**-4**	**-4**	9	**-6**	**-4**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Sweden	RULC	-15	-15	-18	-16	-29	-18	-15	-15	-16	-32	-18	-18
	NLC	-19	-19	-19	-19	-20	-18	-19	-19	-19	-18	-19	-19
	RLP	**-4**	**-5**	**-2**	**-4**	9	**-1**	**-4**	**-5**	**-3**	14	**-1**	**-1**
	EXCH	0	0	0	0	0	0	0	0	0	0	0	0
Spain	RULC	-12	-9	-13	-15	-10	-13	-14	-13	-13	-15	-15	-14
	NLC	-20	-16	-20	-20	-19	-20	-19	-20	-19	-20	-20	-20
	RLP	**-9**	**-7**	**-8**	**-6**	**-10**	**-8**	**-6**	**-8**	**-7**	**-6**	**-6**	**-6**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Greece	RULC	-10	-9	-9	-11	-22	-10	-15	-15	-14	-15	-14	-13
	NLC	-17	-18	-17	-17	-19	-17	-17	-17	-17	-17	-18	-17
	RLP	**-8**	**-11**	**-10**	**-7**	2	**-8**	**-3**	**-3**	**-4**	**-3**	**-6**	**-5**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Italy	RULC	-13	-13	-14	-14	-2	-13	-14	-13	-12	-13	-14	-13
	NLC	-21	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20
	RLP	-7	-7	-6	-6	-17	-6	-6	-7	-8	-7	-6	-7
	EXCH	0	0	0	0	0	0	0	0	0	0	0	0

Continue…

Country	95-07	15t16	17t19	20	21t22	23	24	26	27t28	29	30t33	34t35	36t37
Portugal*	RULC	-13	-13	-15	-13	-47	-15	-14	-16	-15	-18	-19	-12
	NLC	-19	-19	-17	-18	-17	-19	-18	-21	-19	-17	-16	-20
	RLP	**-7**	**-7**	**-4**	**-7**	29	**-6**	**-5**	**-7**	**-5**	0	2	**-9**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Australia	RULC	-13	-13	-11	-13	-9	-12	-18	-15	-14	-16	-17	-15
	NLC	-18	-19	-19	-18	-15	-16	-18	-18	-17	-21	-21	-23
	RLP	**-5**	**-5**	**-8**	**-5**	**-6**	**-4**	**0**	**-3**	**-2**	**-5**	**-4**	**-7**
	EXCH	0	0	0	0	0	0	0	0	0	0	0	0
Austria	RULC	-19	-22	-19	-21	-28	-21	-18	-18	-18	-18	-20	-20
	NLC	-20	-20	-20	-20	-18	-19	-20	-20	-20	-20	-19	-20
	RLP	**-2**	1	**-2**	0	10	2	**-3**	**-3**	**-2**	**-2**	0	0
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Belgium	RULC	-16	-19	-19	-18	-14	-17	-15	-17	-18	-19	-16	-18
	NLC	-20	-20	-21	-21	-18	-20	-20	-20	-20	-20	-19	-20
	RLP	**-5**	**-2**	**-3**	**-3**	**-6**	**-4**	**-6**	**-4**	**-3**	**-2**	**-4**	**-3**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Ireland	RULC	-16	-15	-12	-22	-18	-16	-11	-13	-15	-18	-16	-12
	NLC	-19	-18	-17	-18	-15	-18	-21	-19	-19	-18	-20	-16
	RLP	**-3**	**-3**	**-5**	4	2	**-2**	**-10**	**-6**	**-4**	0	**-4**	**-5**
	EXCH	0	0	0	0	0	0	0	0	0	0	0	0
Luxembourg	RULC	-11	-15	-22	-14	0	-23	-16	-16	-19	-18	-22	-15
	NLC	-21	-26	-20	-20	0	-22	-20	-20	-22	-19	-22	-20
	RLP	**-11**	**-11**	2	**-7**	0	1	**-5**	**-4**	**-4**	**-1**	**-1**	**-5**
	EXCH	1	1	1	1	0	1	1	1	1	1	1	1
Netherlands	RULC	-16	-18	-15	-16	-15	-19	-16	-16	-17	-17	-18	-16
	NLC	-19	-19	-20	-19	-20	-19	-21	-19	-20	-19	-19	-20
	RLP	**-4**	**-2**	**-6**	**-4**	**-6**	**-1**	**-6**	**-5**	**-4**	**-3**	**-1**	**-5**
	EXCH	1	1	1	1	1	1	1	1	1	1	1	1
Korea	RULC	-15	-16	-16	-11	-12	-18	-15	-14	-15	-24	-16	-14
	NLC	-16	-15	-16	-17	-13	-13	-14	-16	-13	-15	-15	-15
	RLP	**-4**	**-1**	**-3**	**-8**	**-4**	2	**-1**	**-5**	0	7	**-1**	**-3**
	EXCH	2	2	2	2	2	2	2	2	2	2	2	2
Japan*	RULC	-21	-19	-21	-23	-20	-23	-24	-21	-27	-30	-25	-23
	NLC	-23	-21	-23	-25	-24	-23	-23	-23	-25	-22	-25	-23
	RLP	**-5**	**-5**	**-4**	**-5**	**-6**	**-3**	**-2**	**-4**	0	6	**-2**	**-2**
	EXCH	2	2	2	2	2	2	2	2	2	2	2	2

Notes:

1. *The time periods for Portugal and Japan are 1995-2006.
2. The subsectors represent Food and Tobacco (15t16), Texiles (17t19), Wood (20), Paper and publishing (21t22), Petroleum (23), Chemicals (24), other non-metallic products (26), Metals (27t28), Machinery (29), Electrical equipment (30t33), Transport equipment (34t35) and Manufacturing nec (36t37).
3. The bold value represent China's advantage (dulc>0, dnlc>0, dlp<0 and de<0)

Table 4.10 and 4.11 decompose the competitiveness gains or losses of the 28 provinces and the nine one digit sectors. Overall, there are much more cost competitiveness gains through decreasing relative nominal labour costs and increasing labour productivity before 1995 than afterwards. During 1978-1995, cost competitiveness gains still exist after labour productivity improvement offset increase of nominal labour costs for provinces in the Coastal region (such as Beijing, Shanghai, Jiangsu, Zhejiang and Fujian). In 1995-2009, Primary sector (AtoB), Construction (F) and Transportation (I) experience more cost competitiveness gains than other sectors. Among provinces, only one province – Guangxi in the West region appears cost competitiveness gains in all sectors due to the sharp relative decrease of nominal labour costs over the whole time period.

Table 4.10 Decomposition of relative unit labour costs, 28 provinces compared with national level, 1978-1995 (Values have been timed 100)

Province	78-95	AtoB	D	F	G	I	J	K	M	N
Beijing	RULC	-8	-9	-8	-6	-5	-21	-9	-10	-9
	NLC	-1	-2	1	2	-1	-3	0	4	-3
	RLP	6	7	9	8	4	18	9	15	7
Tianjin	RULC	-5	-10	-14	-4	-9	-31	-13	-12	-11
	NLC	2	-1	-1	1	2	-1	-5	-5	1
	RLP	7	10	13	5	10	30	9	7	12
Hebei	RULC	-4	-12	-11	-7	-8	-12	-15	-10	-10
	NLC	1	0	0	4	-1	3	-7	1	0
	RLP	5	12	10	10	7	15	9	11	10
Shanxi	RULC	-6	-12	-12	-11	-10	-12	-13	-12	-13
	NLC	-3	-3	-1	-4	2	1	-4	-5	-8
	RLP	3	9	11	7	12	14	9	7	4
Inner Mongolia	RULC	-5	-13	-9	-8	-10	-14	-12	-10	-11
	NLC	0	-3	-2	-1	-1	-2	-1	-2	1
	RLP	5	10	7	7	9	12	12	8	11
Liaoning	RULC	-6	-10	-9	-8	-9	-11	-14	-9	-8
	NLC	-1	-2	2	0	-3	5	7	4	4
	RLP	6	8	11	8	6	16	21	13	12
Jilin	RULC	-4	-12	-15	-15	-9	-17	-12	-10	-11
	NLC	1	-3	-2	-3	-2	-4	-3	-3	-2
	RLP	5	9	13	12	7	13	9	8	8
Heilongjiang	RULC	-6	-13	-11	-14	-9	-18	-14	-11	-11
	NLC	-1	-3	-1	-3	-4	-6	-1	-4	0
	RLP	5	10	10	11	5	12	13	8	11
shanghai	RULC	-6	-10	-13	-6	-14	-13	-10	-12	-11
	NLC	-2	-1	5	1	-5	2	2	2	2
	RLP	4	9	18	7	9	15	12	13	14
Jiangsu	RULC	-6	-11	-11	-7	-8	-11	-12	-10	-11
	NLC	0	3	0	3	3	0	0	-1	0
	RLP	6	14	11	10	11	11	12	10	11
Zhejiang	RULC	-4	-13	-11	-7	-12	-13	-7	-10	-11
	NLC	0	4	3	7	4	3	3	1	0
	RLP	4	17	14	14	16	15	11	12	11
Anhui	RULC	-5	-12	-10	-9	-15	-17	-10	-13	-13
	NLC	-1	2	1	-4	-7	-2	3	-3	-4
	RLP	4	14	11	5	8	15	13	10	9
Fujian	RULC	-5	-15	-9	-15	-14	-17	-16	-12	-11
	NLC	3	3	3	1	3	-3	3	2	4
	RLP	8	17	12	16	16	14	20	14	15
Jiangxi	RULC	-4	-11	-12	-6	-11	-21	-13	-8	-6
	NLC	-1	0	-7	0	-1	-6	-7	1	1
	RLP	4	11	5	6	10	16	7	8	7

Shandong	RULC	**-5**	**-12**	**-11**	**-14**	**-9**	**-10**	**-10**	**-10**	**-11**
	NLC	0	**-1**	0	4	1	5	4	2	0
	RLP	**5**	**12**	**11**	**18**	**10**	**15**	**13**	**12**	**11**
Henan	RULC	**-4**	**-10**	**-9**	**-8**	**-6**	**-17**	**-10**	**-10**	**-10**
	NLC	**-1**	3	**-2**	0	3	**-5**	1	**-1**	0
	RLP	**3**	**12**	**7**	**8**	**8**	**12**	**12**	**8**	**10**
Hubei	RULC	**-5**	**-14**	**-10**	**-8**	**-9**	**-17**	**-12**	**-12**	**-8**
	NLC	**-1**	**-1**	**-4**	0	0	**-6**	1	**-1**	6
	RLP	**4**	**13**	**7**	**9**	**10**	**10**	**13**	**11**	**14**
Hunan	RULC	**-5**	**-10**	**-11**	**-9**	**-8**	**-12**	**-11**	**-12**	**-11**
	NLC	**-1**	1	**-2**	**-1**	1	1	1	**-2**	**-1**
	RLP	**5**	**11**	**9**	**9**	**9**	**13**	**12**	**10**	**10**
Guangdong*	RULC	**-4**	**-14**	**-5**	**-13**	**-12**	**-16**	**-16**	**-9**	**-12**
	NLC	3	2	7	**-3**	2	3	7	9	3
	RLP	**7**	**16**	**12**	**10**	**14**	**19**	**22**	**18**	**15**
Guangxi	RULC	**-4**	**-8**	**-10**	**-9**	**-6**	**1**	**-11**	**-10**	**-9**
	NLC	3	5	4	3	4	14	2	**-2**	2
	RLP	**7**	**14**	**13**	**13**	**11**	**13**	**12**	**8**	**11**
Sichuan*	RULC	**-5**	**-13**	**-11**	**-9**	**-9**	**-20**	**-15**	**-13**	**-15**
	NLC	**-3**	**-2**	**-1**	**-3**	**-3**	**-1**	0	**-2**	**-3**
	RLP	**2**	**11**	**10**	**6**	**5**	**19**	**15**	**12**	**12**
Guizhou	RULC	**-5**	**-13**	**-10**	**-10**	**-3**	**-14**	**-14**	**-11**	**-11**
	NLC	1	1	**-3**	**-1**	5	0	**-1**	2	2
	RLP	**6**	**13**	**7**	**9**	**8**	**14**	**14**	**14**	**13**
Yunnan	RULC	**-6**	**-14**	**-10**	**-17**	**-7**	**-10**	**-15**	**-11**	**-12**
	NLC	**-1**	1	**-3**	**-5**	1	5	**-1**	0	0
	RLP	**5**	**15**	**8**	**12**	**8**	**15**	**14**	**11**	**12**
Shaanxi	RULC	**-5**	**-12**	**-13**	**-6**	**-9**	**-25**	**-12**	**-12**	**-11**
	NLC	**-2**	**-4**	**-5**	0	2	**-7**	0	**-1**	0
	RLP	**3**	**9**	**8**	**7**	**10**	**17**	**13**	**11**	**11**
Gansu	RULC	**-6**	**-14**	**-11**	**-10**	**-11**	**-21**	**-17**	**-12**	**-10**
	NLC	**-3**	**-7**	**-5**	**-3**	**-8**	**-9**	**-6**	**-4**	**-4**
	RLP	**3**	**7**	**6**	**7**	**3**	**12**	**11**	**8**	**7**
Qinghai	RULC	**-6**	**-13**	**-14**	**-8**	**-14**	**-12**	**-13**	**-12**	**-11**
	NLC	**-1**	**-3**	**-6**	**-3**	**-5**	2	**-8**	**-6**	**-12**
	RLP	**5**	**10**	**8**	**5**	**10**	**14**	**6**	**5**	**-1**
Ningxia	RULC	**-8**	**-11**	**-11**	**-9**	**-8**	**-14**	**-11**	**-12**	**-10**
	NLC	**0**	**-2**	**-3**	**-4**	**-3**	**-1**	**-2**	**-3**	**-3**
	RLP	**7**	**9**	**8**	**5**	**5**	**13**	**9**	**9**	**8**
Xinjiang	RULC	**-6**	**-13**	**-9**	**-8**	**-7**	**-16**	**-14**	**-11**	**-11**
	NLC	2	0	3	4	6	-2	2	3	1
	RLP	**8**	**12**	**12**	**12**	**13**	**14**	**16**	**13**	**12**

Notes:

1. The sectors are Primary sector (AtoB), Manufacturing (D), Construction (F), Trade (G), Transportation (I), Finance (J), Real estate (K), Education (M) and Health (N)
2. The bold values represent province's advantage (dulc<0, dnlc<0 or dlp>0)

Table 4.11 Decomposition of relative unit labour costs, other 28 provinces compared with national level, 1995-2009 (Values have been timed 100)

Province	95-09	AtoB	D	F	G	I	J	K	M	N
Beijing	RULC	7	5	5	1	4	**-1**	3	1	4
	NLC	4	2	5	**-3**	**-3**	**-1**	2	3	3
	RLP	-3	-4	-1	-4	-7	0	-1	**2**	-2
Tianjin	RULC	6	5	6	0	6	4	5	0	0
	NLC	6	3	7	4	4	3	5	5	5
	RLP	0	-2	**1**	**4**	-1	-1	0	**5**	**4**
Hebei	RULC	**-1**	0	2	2	**-2**	4	0	**-2**	**-3**
	NLC	**-1**	1	2	**-2**	**-1**	0	0	**-2**	**-2**
	RLP	0	0	0	-4	**2**	-4	0	0	**1**
Shanxi	RULC	**-1**	1	1	**-1**	0	1	1	**-2**	**-3**
	NLC	0	2	2	**-1**	0	0	2	1	1
	RLP	0	**1**	**2**	0	0	-1	**1**	**2**	**4**
Inner Mongolia	RULC	5	4	9	**-1**	2	4	2	1	0
	NLC	2	7	8	8	5	5	5	5	5
	RLP	-3	**3**	0	**10**	**3**	**1**	**3**	**4**	**5**
Liaoning	RULC	1	2	2	2	2	2	2	2	3
	NLC	**-1**	4	6	5	2	1	4	1	1
	RLP	-2	**1**	**4**	**3**	0	-1	**2**	-1	-2
Jilin	RULC	0	1	1	**-1**	3	3	3	1	1
	NLC	**-4**	4	5	5	1	1	2	1	1
	RLP	-4	**3**	**4**	**6**	-2	-3	-1	0	-1
Heilongjiang	RULC	0	2	1	0	0	5	2	**-1**	2
	NLC	**-3**	1	1	1	0	**-1**	**-1**	0	0
	RLP	-2	-1	0	0	0	-5	-3	0	-2
shanghai	RULC	3	6	5	2	8	2	6	4	4
	NLC	11	2	5	2	0	**-4**	4	5	3
	RLP	**8**	-4	0	0	-8	-6	-2	**1**	-1
Jiangsu	RULC	2	3	2	2	4	2	4	3	3
	NLC	2	0	2	2	2	0	3	2	1
	RLP	0	-3	0	**1**	-2	-3	-1	-1	-2
Zhejiang	RULC	3	3	3	5	6	**-4**	2	1	2
	NLC	7	**-5**	**-6**	**-1**	0	**-2**	**-1**	**-1**	**-2**
	RLP	**4**	-7	-9	-5	-6	**2**	-3	-2	-4
Anhui	RULC	0	3	**-1**	0	1	2	0	**-3**	**-5**
	NLC	**-1**	2	0	0	1	-1	0	**-2**	**-1**
	RLP	-1	-1	**1**	-1	0	-3	0	**1**	**4**
Fujian	RULC	1	2	4	1	4	0	3	3	2
	NLC	**-1**	**-9**	**-3**	**-2**	**-2**	**-2**	**-3**	**-1**	**-1**
	RLP	-2	-11	-7	-4	-6	-2	-6	-4	-4
Jiangxi	RULC	0	1	2	**-3**	0	5	2	3	2
	NLC	1	2	-2	2	**-1**	0	-2	**-1**	**-1**
	RLP	**1**	**1**	-3	**5**	-1	-5	-4	-4	-3

Shandong	RULC	2	3	4	2	4	6	4	2	1
	NLC	4	**-1**	**-4**	1	2	2	2	1	2
	RLP	**2**	-4	-8	-1	-2	-4	-3	0	0
Henan	RULC	**-1**	0	1	**-1**	1	2	3	1	2
	NLC	**-3**	0	**-3**	**-4**	**-2**	**0**	**-2**	**-3**	**-2**
	RLP	-2	0	-3	-2	-2	-2	-5	-4	-4
Hubei	RULC	**-1**	2	0	2	1	1	1	**-1**	1
	NLC	0	1	**-1**	1	0	1	0	0	0
	RLP	**1**	-1	-1	-2	-1	0	-2	**1**	-1
Hunan	RULC	**-2**	0	0	**-1**	0	0	0	**-3**	**-4**
	NLC	6	0	**-6**	1	**-1**	**-2**	**-3**	**-2**	**-3**
	RLP	**7**	0	-6	**3**	-1	-1	-2	0	**2**
Guangdong*	RULC	2	2	10	**-2**	4	-1	3	6	4
	NLC	3	**-4**	2	0	**-1**	1	**-2**	0	**-1**
	RLP	**1**	-7	-8	**2**	-4	**1**	-5	-6	-5
Guangxi	RULC	**-3**	**-1**	**-2**	0	**-1**	**-4**	**-1**	**-1**	**-2**
	NLC	**-4**	**-4**	**-4**	**-6**	**-5**	**-3**	**-5**	**-4**	**-5**
	RLP	-2	-3	-3	-5	-3	**1**	-4	-3	-4
Sichuan*	RULC	**-1**	2	4	0	**-1**	0	1	0	1
	NLC	**-2**	0	**-4**	1	0	**-1**	**-2**	**-1**	**-1**
	RLP	-1	-2	-8	0	**1**	-1	-3	-1	-1
Guizhou	RULC	0	0	**-2**	**-1**	**-8**	**-2**	**-2**	**-7**	**-9**
	NLC	0	**-1**	**-3**	**-5**	**-1**	**-1**	**-5**	**-2**	**-1**
	RLP	**1**	-1	-1	-4	**8**	**2**	-2	**5**	**8**
Yunnan	RULC	**-1**	2	**-2**	1	4	0	3	5	1
	NLC	**-2**	**-1**	**-1**	**-2**	**-1**	**-1**	**-2**	**-1**	**-2**
	RLP	-1	-3	**1**	-3	-4	0	-5	-6	-2
Shaanxi	RULC	1	0	0	**-4**	1	2	3	0	0
	NLC	**-2**	2	3	**-2**	**-1**	1	**-2**	1	1
	RLP	-2	**2**	**3**	**2**	-2	-1	-5	0	**1**
Gansu	RULC	**-2**	2	**-2**	4	**-1**	5	3	**-2**	**-2**
	NLC	**-2**	2	1	0	0	1	0	**-1**	1
	RLP	0	-1	**3**	-4	**1**	-5	-2	**1**	**3**
Qinghai	RULC	**-1**	0	2	1	0	3	3	2	1
	NLC	**-1**	4	5	0	**-1**	2	**-4**	0	**-1**
	RLP	0	**4**	**4**	-1	-1	-1	-7	-2	-1
Ningxia	RULC	1	1	**-1**	1	-5	1	**-1**	**-5**	**-6**
	NLC	1	2	0	1	1	2	1	2	1
	RLP	-1	**1**	**1**	0	**6**	0	**2**	**7**	**7**
Xinjiang	RULC	**-1**	**-3**	1	2	1	0	2	**-1**	**-2**
	NLC	**-2**	1	0	**-2**	**-1**	**-1**	**-3**	**-2**	**-3**
	RLP	-1	**4**	-1	-4	-3	-1	-5	-1	-1

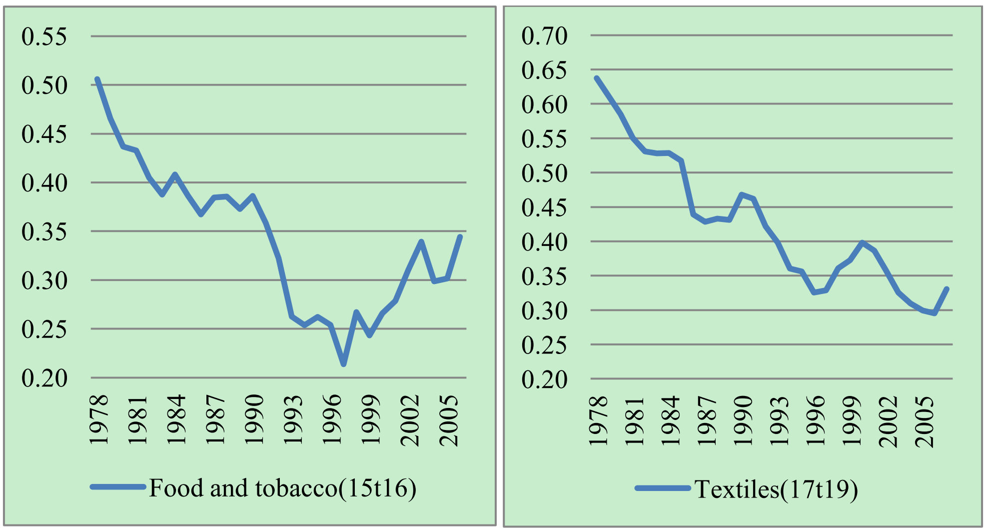
Notes:

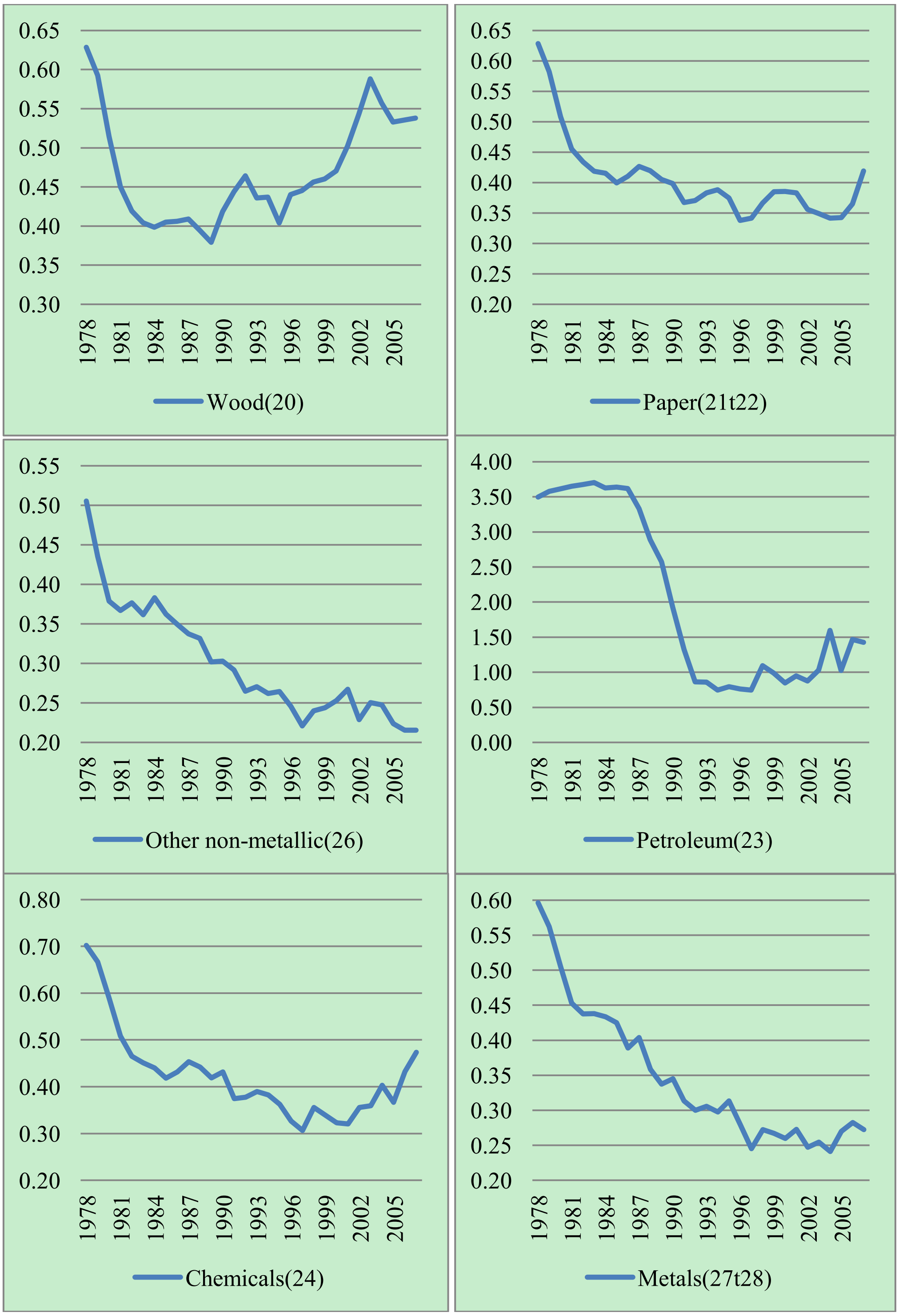
1. The sectors are Primary sector (AtoB), Manufacturing (D), Construction (F), Trade (G), Transportation (I), Finance (J), Real estate (K), Education (M) and Health (N)
2. The bold values represent province's advantage (dulc<0, dnlc<0 or dlp>0)

4.6 Convergence in RULC, RLP and RNLC

To have a better understanding of the degree of convergence that has taken place across countries and provinces, we further look at the dispersion of the relative levels of ULC, LP and NLC across countries and provinces. Figure 4.1 is the coefficients of variation of RULC for cross-country comparisons by 12 manufacturing subsectors. The Textiles (17t19), Paper and Publishing (21t22), other non-metallic (26), Chemicals (24), Metals (27t28), Machinery (29), Electrical equipment (30t33), Transport equipment (34t35) and Manufacturing nec (36t37) sectors have convergence trend over time. The RULC disparity of Petroleum (23) is stable from 1978 to 1987, then converges sharply during 1987-1993, and then keeps stable afterwards. The Food and Tobacco (15t16) sector has "U" style of RULC with convergence in 1978-1995 and then divergence in 1995-2007. The Woods (20) sector also has "U" style of RULC with vibration between 1988 and 1996.

Figure 4.1: Coefficients of variations of RULC for international comparisons




0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Wood(20)
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Paper(21t22)
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Other non-metallic(26)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Petroleum(23)
0.80
0.70
0.60
0.50
0.40
0.30
0.20
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Chemicals(24)
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Metals(27t28)

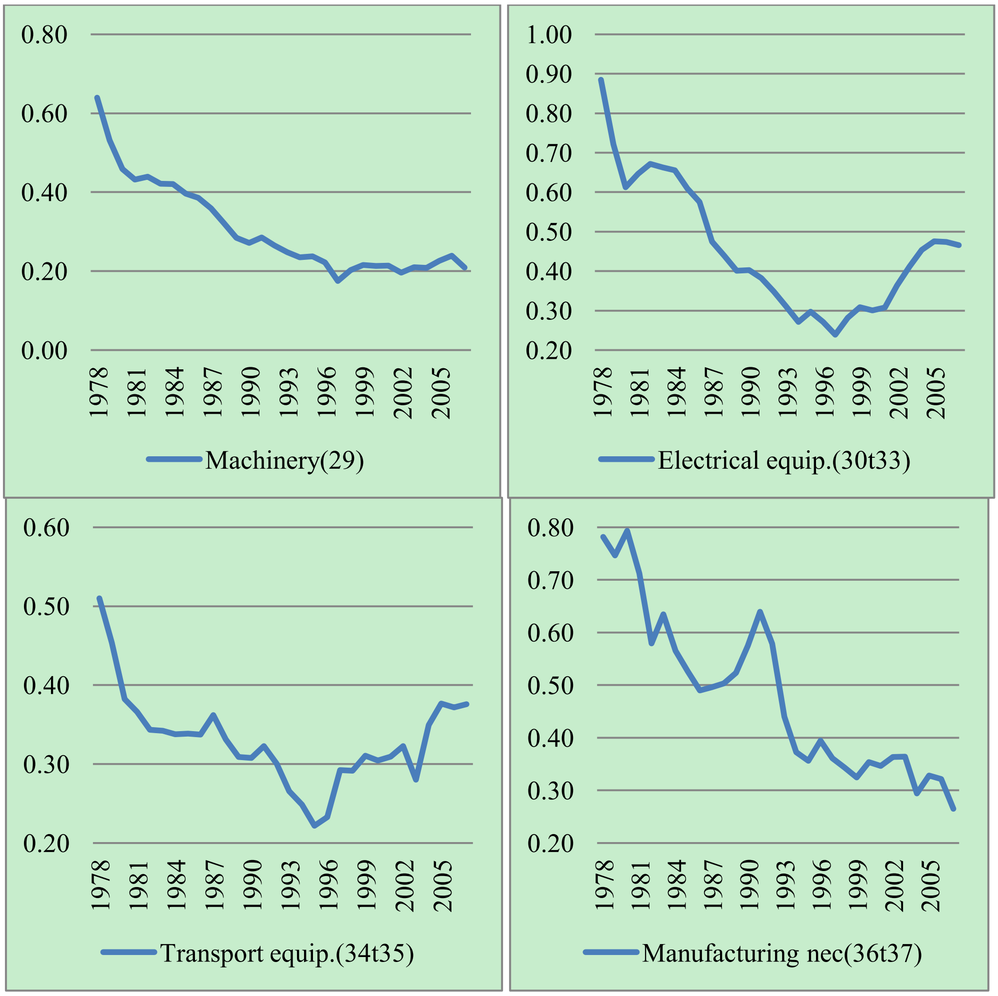


Table 4.12 illustrates the annual growth rates of coefficients of variation of RULC, RLP and RNLC for cross-country comparisons by 12 manufacturing subsectors. RLP converges much more quickly than RULC and RNLC, suggesting a fast technology spillover effect across countries. Labour market institutional factors such as collective bargaining of trade union, minimum wages, coordination of wage setting and employment protection legislation may withhold the convergence of nominal wages (and the unit labour costs) across country. The convergence of RULC, RLP and RNLC appear in all sectors during 1978-1995, but only in Textile (17t19), other non-metallic products (26), Machinery (29) and Manufacturing nec (36t37) during the period 1995-

2007.

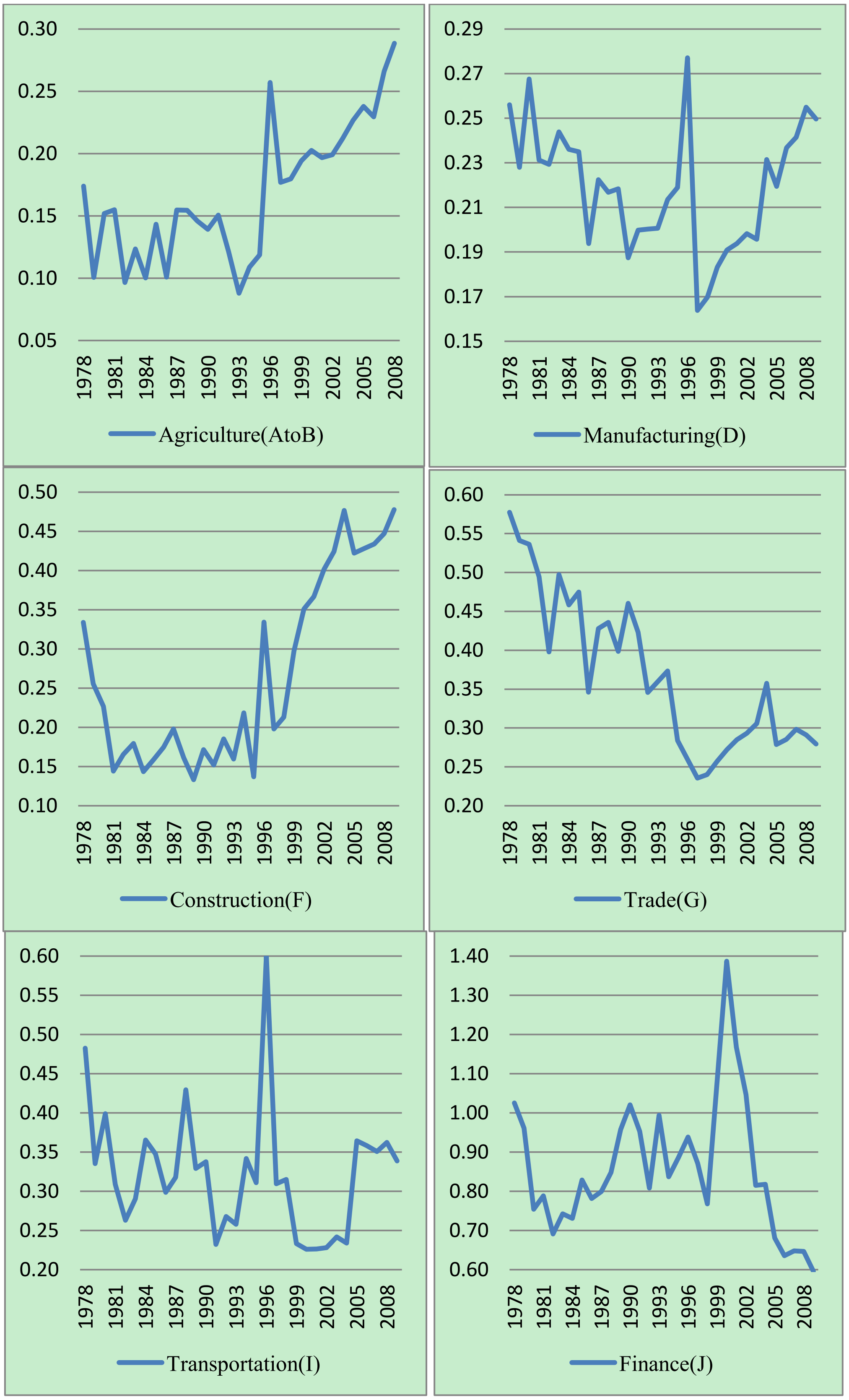
Table 4.12 Annual Growth rates of Coefficients of variations for cross-country comparisons

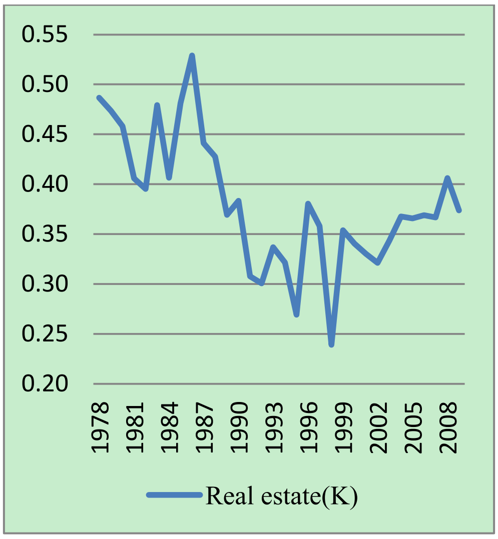
	15t16	17t19	20	21t22	26	23	24	27t28	29	30t33	34t35	36t37
	Relative unit labour costs											
78-95	-0.04	-0.03	-0.03	-0.03	-0.04	-0.09	-0.04	-0.04	-0.06	-0.06	-0.05	-0.05
95-07	0.02	-0.01	0.02	0.01	-0.02	0.05	0.02	-0.01	-0.01	0.04	0.04	-0.02
	Relative labour productivity											
78-95	-0.05	-0.04	-0.11	-0.05	-0.07	0.01	-0.05	-0.09	-0.08	-0.14	-0.12	-0.12
95-07	0.03	-0.05	0.04	0.07	0.00	0.02	0.01	0.01	0.00	0.13	0.04	0.00
	Relative nominal labour costs											
78-95	-0.02	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.01	0.00	-0.01
95-07	0.00	-0.03	-0.02	-0.01	-0.02	0.00	-0.02	-0.02	-0.03	-0.01	0.00	-0.02

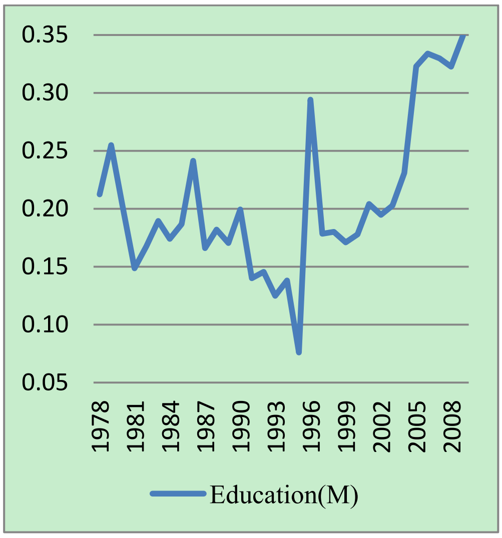
Note: The subsectors represent Food and Tobacco (15t16), Texiles (17t19), Wood (20), Paper and publishing (21t22), Petroleum (23), Chemicals (24), other non-metallic products (26), Metals (27t28), Machinery (29), Electrical equipment (30t33), Transport equipment (34t35) and Manufacturing nec (36t37).

Figure 4.2 presents the coefficients of variations of RULC for provincial comparisons from 1978 to 2009, which have more variation than international comparisons. The Trade (G) and Real Estate (K) sectors have convergence trend over time, especially from 1978 to 1995. The Manufacturing (D), Transportation (I) and Health (N) sectors have “W” trend with sharp divergence and convergence from 1990 to 1997. The disparity of Finance (J) sector is stable before 1998, then has sharp divergence until 2000, then convergence quickly afterwards. The disparities of Primary (AtoB), Construction (F) and Education (M) sectors are stable before 1993 but diverge afterwards.

Figure 4.2 Coefficients of variations of RULC for cross-provincial comparisons







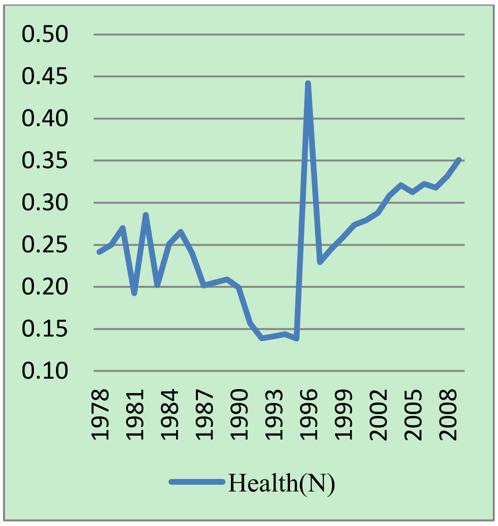


Table 4.13 shows the annual growth rates of coefficients of variations of RULC, RLP and RNLC for the cross-provincial comparisons by 9 sectors over 1978-1995 and 1995-2009. The RULC convergence appear in all sectors with the highest growth rate (-0.06) in Education (M) before 1995, but only in Finance (J) after 1995. The convergence of RLP and RULC occur in Primary (AtoB) sector, Manufacturing (D), Real estate (K), Education (M) and Health (N) sectors in one or both time periods. The RNLC diverges in Trade (G) and Transportation (I) in the whole time periods.

Table 4.13 Annual growth rates of coefficients of variation for provincial comparisons

	AtoB	D	F	G	I	J	K	M	N
	Relative unit labour costs								
78-95	-0.02	-0.01	-0.05	-0.04	-0.03	-0.01	-0.03	-0.06	-0.03
95-09	0.07	0.01	0.09	0.00	0.01	-0.03	0.02	0.11	0.07
	Relative labour productivity								
78-95	-0.01	-0.01	0.00	0.01	0.01	0.00	-0.01	-0.03	-0.06
95-09	0.01	-0.03	0.00	-0.01	-0.02	-0.01	-0.01	0.04	0.01
	Relative nominal labour costs								
78-95	-0.01	0.01	-0.02	0.01	0.02	0.02	-0.04	-0.04	-0.07
95-09	0.02	-0.02	0.02	0.01	0.00	-0.01	0.02	0.05	0.03

Note: The sectors are Primary sector (AtoB), Manufacturing (D), Construction (F), Trade (G), Transportation (I), Finance (J), Real estate (K), Education (M) and Health (N)

4.7 Conclusions

In this chapter, we examine Chinese international and internal provincial disparities and convergence from the labour cost perspective. Analysis on the drivers of unit labour costs and decomposition of cost competitiveness help us understand how Chinese economy gains comparative advantages over other countries and how provinces within China compete with each other.

First, regarding to the relative unit labour costs (RULC), China has the largest cost advantage with the USA and the three large EU countries, and can competes with Mediterranean countries in the high-tech subsectors and with neighbouring countries in the low-tech subsectors. Within China, provinces should develop the specific industries according to their comparative advantages. The provinces in the Northeast and Coastal have strong advantages in the manufacturing sector. However, gaining more comparative competitiveness in the Primary sector, Construction and Real estate sectors are best strategies for the provinces in the Interior and West. Developing transportation sector is also a good direction for the provinces in the Interior possibly due to their central geographic location.

Second, the two drivers of RULC are relative nominal labour costs (RNLC) and relative labour productivity (RLP). The RNLC gap between China and other 19 countries decreases about 80 percent from 1978-1995 to 1995-2007, which explains the sharp decrease of RULC in China. For cross-provincial comparisons, we find that the decrease of RULC is mainly because the growth rates of RLP are higher than the growth rate of RNLC in most cases.

Third, the decomposition analysis of cost competitiveness across the country and province shows many interesting points. During 1978-1995, China has cost competitiveness gains only relative to the Mediterranean countries, mainly relying on the negative change in labour productivity of these countries and depreciation in China currency relative to foreign currency. After 1995, China loses its cost competitiveness relative to other countries because the negative changes in labour productivity in these countries have been offset by the appreciation in China currency. Similarly, there are much more cost competitiveness gains, relative decrease of nominal labour costs and labour productivity improvement before 1995 than afterwards for Chinese provinces.

Finally, we find convergence of RULC is more prominent before 1995 than afterwards for both cross-country and provincial comparisons. The fast convergence of the RLP in cross-country comparisons could be from the continuous decline of relative labour productivity in many European countries. However, for cross-provincial comparisons within China, the fast convergence of RULC is consistent with the fast converging relative labour productivity among provinces with static wages. It suggests the importance of institutional factors such as rigid wage setting in Chinese labour markets.

CHAPTER FIVE: A SELECTION ANALYSIS ON EDUCATION RETURNS [34]

5.1 Introduction

There is a well-established literature on the economic returns to education, since Schultz (1961a) and Mincer (1974a). According to human capital theory, following Becker (1962), education is an investment that produces knowledge acquisition and increases productivity, which in turn leads to higher income. Human capital theory bears a strong resemblance to vintage capital theory. The individual's capital stock (his or her level of education) can be treated as a factor of production in its own right and may gradually depreciate with time (Byron and Manaloto, 1990). Thus, the distribution of labour incomes can be regarded as a function of education and experience, as in the benchmark Mincerian model which involves regression of the natural logarithm of earnings against educational attainment and working experience.

A large amount of empirical research, based on the Mincerian model, has been carried out for many countries and time periods and confirms that better-educated individuals earn higher wages, experience less unemployment, and work in more prestigious occupations than their less-educated counterparts (Card, 1999; O'Mahony and Stevens, 2009). Psacharopoulos and Patrinos (2004) finds that the education returns for one additional year are 9.7 percent for world average, 9.9 percent for Asian average as well as the 10.7-10.9 percent range for low and middle incomes. However, literature on economic returns to education in China is still sparse and shows much lower rates of returns compared with those from other countries, especially developing ones. An early

[34] The minor revised version of this chapter will be published in the *Post-Communist Economics* (Kang and Peng, forthcoming).

study on this topic for China was made by Byron and Manaloto (1990). Using a sample of eight hundred adult workers from the city of Nanjing in 1986, they estimate a low rate of returns between 1.2 percent and 3.7 percent for one additional year of schooling. Meng and Kidd (1997) also find a low rate of returns to education of 2.7 percent in 1987. Liu (1998) uses the China Household Income Project (CHIP) 1988 data and finds a slightly larger but still low rate of returns to education of 3.6 percent . Therefore, Fleisher *et al.* (2005) conclude that China is an outlier, in that its rapid economic growth is associated with returns to education remaining below the world average for comparable countries.

Low returns to education do not necessarily imply that education has no value in China. It may be because the value of education has not been properly reflected as private economic returns in labour markets. Fleisher and Wang (2004) find that the wages of educated workers are well below their marginal product in China, and the social returns to education will exceed the estimated private returns. Hence, the most widely accepted explanation of lower Chinese education returns may be the explanation of labour markets transition. Before 1978, wages of all workers were determined and controlled through a rigid system in China, designed to reduce labour costs during the rapid industrialization. Low wages were made possible by state-subsidized food prices and state provision of non-wage benefits to workers and their families. Throughout the economic reforms in China into the early 1990s, the wage differentials by levels of skill and schooling still remained narrow. After the "socialist market economy" was authorized in the early 1990s, the rigid wage system was gradually replaced by the flexible wage system.[35] Thus, the wage reform in China freed up the compressed wage

[35] The flexible wage system allows a variable component in the usual fixed wages. The fixed wage

differentials and thereafter had similar implications for the economic returns to education.

The explanation of labour markets transition is supported by the literature dealing with evidence of increasing returns to education over time, following the progress of economic reforms. Recent research suggests that reform and marketization are finally contributing to an increase in the relative wages of educated workers (Fleisher and Wang, 2005). Zhang *et al.* (2005) find a dramatic increase in education returns, from only 4.0 percent in 1988 to 10.2 percent in 2001 for one additional year of schooling. Most of the rise occurs after 1992 and supports the explanation of labour markets transition.

This chapter provides alternative points of view on returns to education in China, using recent available China Health and Nutrition Survey (CHNS) datasets from 1989 to 2009. We have three objectives. First, education has an important effect on wages but it is not clear whether this is because education raises productivity or because education is simply a signal of innate ability (Chevalier *et al.*, 2004). We need to test whether the returns to education in China reflect accumulation of human capital or are just signals of innate ability. Following Qiu and Hudson (2010), we put the interaction of education and experience into regressions for all employees and for four age groups. We calculate the marginal effects of schooling at different percentiles of experience (Dreher and Gassebner, 2007; Friedrich, 1982; Potrafke, 2009) and then graph their trends with ranges of standard errors. We find that Chinese data appear to strongly support the human capital explanation.

---

includes the basic wages, seniority wage, insurance (medical, unemployment and pensions) and a housing fund. The variable wage includes bonuses, based on both individual productivity and enterprise profitability. The system of allocated housing was largely abolished around 1998 and replaced with a housing fund.

Second, most studies on education returns in China only apply the traditional OLS Mincerian model, which ignores the probable selection biases of employment. If the job assignments in the labour markets are not random, OLS estimation of education returns might be biased. The direction of biases is dependent on how jobs are assigned and how people make self-selections in the labour markets (Heckman, 1974; Heckman and Honoré, 1990; Roy, 1951). Appleton *et al.* (2005) observe a continued influence of political forces of loyalty, power, and patronage on the rewards for labour in the Chinese labour markets. Considering the selection bias of employment, we compare the estimates of education returns in a Heckman selection model with results from traditional OLS.

Last, but not least, to consider the composition bias mentioned in the chapter 3, we separate our sample into four age groups: people born before 1950, during 1950-1961, during 1962-1980 and in 1981 or after (see the birth rate graph 3.2). The special age group born 1950-1961 mainly received their education during the "Cultural Revolution" period (1966-1976), when the leftist ideological goals of an egalitarian educational agenda reached a peak and the normal education process was interrupted and replaced by continuous political movements (Qian and Smyth, 2008). They find this group has considerably lower returns to education than younger people who received standardised education and entered the labour market during the urban economic reform era.

The rest of this chapter is organized as follows: In section 5.2 we outline the empirical specifications for our three objectives. In section 5.3 we describe our data and present descriptive statistics. Estimates of the returns to schooling are presented in section 5.4. Section 5.5 forms our conclusions.

5.2 Empirical specifications

Most previous literature relies on the theoretical foundations for returns to education, laid down by Schultz (1961a), Becker (1962) and Mincer (1974a). We also estimate a semi-logarithmic specification for the wages based on the Mincerian equation, given as:

$$\ln w_i = \beta_0 + \beta_1 S_i + \beta_2 Exp_i + \beta_3 Exp_i^{\,2} + \beta_4 Urban_i + \beta_5 Gender_i + \beta_6 \Pr_i + \theta_1 \qquad (5.1)$$

where the dependent variable $\ln w_i$ is the log form of real hourly wage rate of employee *i*. Wages consist of basic wages, subsidies and bonuses. We use the urban/rural consumer price indices, classified by year and province from the China Statistics Yearbooks, to deflate employees' labour incomes. In the independent variables S_i is years of schooling; Exp_i is an employee's potential labour markets experience, measured as age minus years of schooling minus six (Katz and Murph, 1992); $Urban_i$ is a dummy variable for the urban areas; $Gender_i$ is a dummy variable capturing the wage differential between men and women; and Pr_i is a set of province dummy variables.

5.2.1 Signal and human capital effects

There is debate whether the impact of education on earnings isolates the effects that are caused by education from the consequences of innate ability. Economists have relied on natural experiments, twins data, regression discontinuity, and field experiments to control for innate ability and estimate the causal impact of education (human capital) on earnings (see a review in Card (1999)). The CHNS cannot provide data for a direct control on innate ability as do these classic models. However, we can develop Qiu and Hudson's (2010) model to test whether education is the signal of innate ability, or the accumulation of human capital. It is assumed that schooling (S_i) that an individual acquires is a function of innate ability (A_i):

$$S_i = m(A_i) \qquad (5.2)$$

Hence, more able individuals can grasp knowledge more rapidly and transform schooling into human capital more efficiently, that is, $\partial S_i / \partial A_i > 0$. We can argue that the basic theory underlying the earnings' equation is that wages (w_i) are a function of human capital (H_i):

$$w_i = f(H_i) \qquad (5.3)$$

In efficient labour markets, jobs with higher wages will be assigned to individuals with higher productivity. Hence, individuals with higher human capital would have higher wages, that is, $\partial f / \partial H_i > 0$. Human capital of an individual itself is a function of innate ability (A_i), education-augmented human capital (S_i) and experience-augmented human capital (from on-the-job training or "learning by doing" processes, Exp_i) as follows:

$$H_i = A_i + h(S_i) + g(Exp_i) \qquad (5.4)$$

Human capital augmented by experience is also possibly influenced by innate ability. More able individuals can grasp knowledge from on-the-job training or "learning by doing" processes more rapidly and transform it into human capital more efficiently, that is $\frac{\partial g(Exp_i, A_i)}{\partial A_i} > 0$. However, an inverted U curve of experience in earnings equations with quadratic experience is widely observed in the literature (for China, see Appleton *et al*. (2005) and Qiu and Hudson (2010)). The individual's capital stock from experience can be treated as a factor of production in its own right and gradually depreciates with time. Hence, we can firstly assume (for simplicity) that the experience-augmented human capital is derived only from experience, and we also assume linearity and that it is possible to separate the three types of human capital, in equation (5.4). We cannot observe innate ability directly, hence we estimate wages as a function of education and experience as:

$$w_i = f(m^{-1}(S_i) + h(S_i) + g(Exp_i)) \tag{5.5}$$

The total derivative of the wage function with respect to experience is as follows:

$$dw_i = \frac{\partial f}{\partial Exp_i} dExp_i + \frac{\partial f}{\partial S_i} dS_i \tag{5.6}$$

We calculate the partial derivative of wage function with respect to schooling, and allow the correlation between schooling and experience-augmented human capital. The equation (5.6) has the form:

$$dw = \frac{\partial f}{\partial Exp} dExp + \frac{\partial f}{\partial H}\left(\frac{\partial m^{-1}(S)}{\partial S} + \frac{\partial h(S)}{\partial S}\right) dS + \frac{\partial f}{\partial H}\frac{\partial g(Exp)}{\partial h(S)}\frac{\partial h(S)}{\partial S} dS \tag{5.7}$$

For simplicity, we drop the individual subscript *i*. The first item is the quadratic experience items in equation (5.1) to proxy the isolated experience effect on the wage. The second item is the combination of signal and human capital effects of schooling on the wage. The final item is the interaction of schooling and experience. If the only impact of schooling is to proxy innate ability, schooling cannot enhance human capital, that is, $\frac{\partial h(S)}{\partial S} = 0$. Then, the above equation becomes:

$$dw = \frac{\partial f}{\partial Exp} dExp + \frac{\partial f}{\partial H}\frac{\partial m^{-1}(S)}{\partial S} dS = \frac{\partial f}{\partial Exp} dExp + \frac{\partial f}{\partial H} dA \tag{5.8}$$

The coefficients of schooling are only capturing the effects of variations of innate ability among individuals on wages. The impact of education on wages should be constant over time, as the coefficients of experience and education interaction are zero. Riley (1979) and Farber and Gibbons (1996) also argue that a basic condition for a signalling equilibrium is that employers' predictions based on education signals are correct on average. If not, then education and experience could enhance productivity, supporting the human capital theory.

Do the returns to schooling decline with rising experience since the individual left formal education? Normally, with rising experience, education will depreciate. Hence, the interaction between schooling and experience-augmented human capital should show a negative correlation (substitution relationship) $\frac{\partial g(Exp)}{\partial h(S)} < 0$ and make the coefficients of interaction items also negative because $\frac{\partial f}{\partial H} > 0$ and $\frac{\partial h(S)}{\partial S} > 0$. But, in a reforming society such as China, education chances may be very selective for innate ability (for example, very strict college entrance examinations) or political virtue (Broaded, 1990). Individual human capital, enhanced by education and experience, could be complementary if we consider the possibility that the innate ability or political virtue also enhances human capital from experience. Education-augmented human capital could be positively correlated with experience-augmented human capital. The marginal effects of schooling may increase with experience in this simultaneous system. We use pooled data to test the trend of education returns with rising experience over time. Therefore, an interaction item is very important in our wage equation. After we add the interaction variable of schooling and experience, and allow year dummies *Y* for macro time dynamics, the empirical specification for our pooled data is as follows:

$$\ln w = \delta_0 + \delta_1 S + \delta_2 Exp + \delta_3 Exp^2 + \delta_4 (S * Exp) + \delta_5 Urban + \delta_6 Gender + \delta_7 \Pr + \delta_8 Y + \mu_1 \tag{5.9}$$

5.2.2 Heckman selection bias

One important issue to consider is the fact that wages are only observed for individuals actually working. Some individuals become inactive because they do not find a job, or their reservation wages are higher than offer wages. There would be a potential selection bias when estimating earnings equations. The Heckman selection model provides a solution through an additional selection equation (Heckman, 1976). People with more education might have higher participation rates, because they are more attractive to employers and their opportunity cost of unemployment are higher. Education increases expected wages over time, through higher wages when working (the effect captured through the Mincerian equation above) and through a higher probability of being employed (this effect will be captured through the Heckman selection model below).

As derived from equation (5.9), the hourly wage rate is a function of schooling, experience, urban, gender, province and year dummies, whereas the likelihood of employment is a function of marital status and (implicitly) the wage (via the inclusion of all above variables which determine the wage). The identifying variable for employment selection is the marital status of a respondent, that is, a dummy variable (0= single; 1=once married) which is widely used in literature (see an example for Italy, in Brown and Sessions (1999)). Therefore, we assume that wage is observed if

$$\begin{aligned}&\gamma_0 + \gamma_1 Married + \gamma_2 S + \gamma_3 Exp + \gamma_4 Exp^2 + \gamma_5 (S * Exp) + \gamma_6 Urban \\ &+ \gamma_7 Gender + \gamma_8 \Pr + \gamma_9 Y + \mu_2 > 0\end{aligned} \tag{5.10}$$

The inverse Mills ratio (lambda) defined as in (Heckman, 1979) is designed to correct for selectivity bias in the samples. A significant coefficient on the lambda term indicates non-random selection into employment in the relevant sample.

5.3 Data description

The data used in this chapter are eight waves (1989, 1991, 1993, 1997, 2000, 2004, 2006 and 2009) of the CHNS dataset, which has been collected by the Carolina Population Centre and the National Institute of Nutrition and Food Safety. The CHNS data cover two decades of Chinese economic reform since 1989, and contain accurate information on wages, education, and other demographic information which provides a basis for an estimate of the returns to education. Eight provinces are covered by data in the period of 1989-1997 and nine provinces thereafter.[36] We exclude individuals working as farmers, fishermen and hunters in the primary sector (mainly agriculture). Employees with a salary (wage earners) between 16 and 65 years old are our basic sample.[37] The full sample composed of employees, unemployed persons and self-employees is also analyzed for the Heckman correction.

Table 5.1 represents the data description for the employee and full samples. For the employee sample, the real hourly wage rate (based on 1995 RMB) is below 2 Yuan and grows comparatively slowly before 1993. However, the hourly wage rate dramatically doubles in the 4 years from 1993 to 1997, and then doubles again in the 9 years from 1997 to 2006. In the last 3 years of our sample period, 2006-2009, the hourly wage rate still grows by about 30 percent. The rapidly rising wage rate, especially after 1993, is also observed by other authors, such as Yang *et al.* (2010).

The average schooling increases with rising wages by about 40 percent over the last two decades (from 7.49 years in 1989 to 10.54 years in 2009). The working experience decreases in the 1990s and increases in the 2000s, but still seems quite stable,

---

[36] There are 8 provinces (Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi and Guizhou) for years 1989-1993, and 8 provinces in 1997 (replacing Liaoning with Heilongjiang), and 9 provinces for years 2000-2009 (with both Liaoning and Heilongjiang, and other provinces as well).

[37] The current retirement age in China is usually 60 for men and 50-55 for women. But civil servants or professionals can postpone their retirement. Hence, we put the upper limit as 65 for our sample.

ranging between 20.15 years in 2000 to 24.33 years in 2009. About 60 percent of employees are males and less than half the employees are in an urban area. About 80 percent of the employees are married once, in our employee sample. The largest baby boom group, born in 1962-1980, occupies 37 percent of total employment in 1989, increasing to around 55 percent after 1993. Hence, this group can benefit much more than others from the dramatic rising wages after 1993. Actually, we find the special wage premium (or "rent") in returns to schooling of this group in the later analysis. The oldest group (born before 1950) keeps on decreasing due to retirement. The youngest group (born in 1981 or after) has no observation before 1997, and is still small in 1997, so we involve this group only after 1997. The share of the group born just after the foundation of China is stable at around 30 percent in the past two decades. Compared with the employee sample, the main difference in the full sample is that the average years of schooling is lower (8.48 years in 1989 to 9.06 years in 2009). That is consistent with the findings that higher educated individuals have higher probability to be employed (O'Mahony and Stevens, 2009).

Table 5.2 shows descriptive statistics for the four groups in the pooled dataset of all eight waves. For employees, the younger groups have higher real hourly wage rates and years of schooling, but shorter potential labour markets experience. For example, the youngest group (born in 1981 or after) has the highest hourly wage rate at 6.35 Yuan (double the oldest), and years of schooling (at 10.89 years, this is 4.35 years longer than the oldest), and lowest experience at 5.11 years (35.6 years less than the oldest). In addition, the younger group has a higher female participation rate, higher participation rates in rural regions and lower marriage rates.

Compared with employees, the full sample in the bottom panel has fewer years of schooling than employees for all four groups, as we find in Table 5.1. Each group still has distinguishable features as employees. These distinctive characteristics among groups reflect volatile changes of Chinese society in recent decades, which imply heterogeneous human capital accumulation of different groups from their education and experience. If we only consider aggregated results, our estimate may be biased by the composition shifts of groups.

Table 5.1: Data description for cross-sectional data

Employee sample (Ordinary Least Square model)									
Variable	**All**	**1989**	**1991**	**1993**	**1997**	**2000**	**2004**	**2006**	**2009**
Real hourly wage rate (Yuan)	3.93	1.22	1.46	1.73	3.49	5.13	6.07	6.93	9.05
Years of schooling (Years)	9.17	7.49	8.29	8.59	9.36	9.85	10.46	10.64	10.54
Experience (Years)	22.63	23.21	23.40	22.99	20.50	20.15	22.53	23.54	24.33
Male (%)	0.57	0.52	0.56	0.57	0.58	0.59	0.59	0.59	0.59
Urban (%)	0.48	0.49	0.51	0.48	0.48	0.44	0.50	0.47	0.47
Married (%)	0.79	0.75	0.80	0.77	0.74	0.74	0.87	0.88	0.88
Born before 1950 (%)	0.20	0.35	0.34	0.30	0.15	0.11	0.07	0.05	0.03
Born 1950-1961 (%)	0.29	0.28	0.31	0.30	0.29	0.29	0.30	0.30	0.25
Born 1962-1980 (%)	0.47	0.37	0.35	0.41	0.55	0.55	0.54	0.55	0.57
Born in 1981 or after (%)	0.04				0.00	0.06	0.09	0.10	0.16
Full sample (Heckman selection model)									
Variable	**All**	**1989**	**1991**	**1993**	**1997**	**2000**	**2004**	**2006**	**2009**
Years of schooling (Years)	8.48	7.16	7.90	8.12	8.37	8.95	8.79	9.04	9.06
Experience (Years)	24.77	23.45	22.28	22.42	22.36	22.14	26.82	27.87	28.80
Male (%)	0.51	0.51	0.53	0.54	0.52	0.52	0.49	0.49	0.48
Urban (%)	0.43	0.45	0.46	0.43	0.43	0.41	0.42	0.42	0.43
Married (%)	0.78	0.74	0.73	0.71	0.71	0.71	0.88	0.89	0.90
Born before 1950 (%)	0.23	0.35	0.32	0.29	0.24	0.19	0.18	0.16	0.11
Born 1950-1961 (%)	0.27	0.27	0.27	0.26	0.24	0.24	0.29	0.30	0.31
Born 1962-1980 (%)	0.43	0.38	0.41	0.45	0.50	0.45	0.41	0.41	0.43
Born in 1981 or after (%)	0.07				0.03	0.12	0.12	0.13	0.16

Data source: CHNS 1989-2009

Table 5.2: Data description for pooled data (four age groups)

Employee sample (Ordinary Least Square model)				
	Born	Born	Born	Born
Variable	before 1950	1950-1961	1962-1980	in 1981 or after
Real hourly wage rate (Yuan)	2.99	3.88	4.11	6.35
Years of schooling (Years)	6.53	9.41	10.06	10.89
Experience (Years)	40.71	26.31	13.57	5.11
Male (%)	0.63	0.6	0.53	0.5
Urban (%)	0.53	0.53	0.44	0.4
Married (%)	0.99	0.98	0.63	0.23
Full sample (Heckman selection model)				
	Born	Born	Born	Born
Variable	before 1950	1950-1961	1962-1980	in 1981 or after
Years of schooling (Years)	5.88	8.43	9.6	10.36
Experience (Years)	44.09	30.21	14.39	3.83
Male (%)	0.5	0.51	0.51	0.52
Urban (%)	0.48	0.47	0.39	0.39
Married (%)	0.98	0.98	0.64	0.19

Data source: CHNS 1989-2009

5.4 Empirical results

Table 5.3 presents results of repeated cross-section OLS, as in equation (5.1). We find, in common with others that education returns for one additional year generally increase from 2.6 percent in 1989 to 7.9 percent in 2009. Results by groups are very similar to the aggregated results in 1989, and this is consistent with the highly regulated wage setting in the 1980s. With the ownership reform in the 1980s, the role of state-owned enterprises has been weakened in the Chinese economy and has triggered the transformation from a planned labour allocation system into a well-functioning labour markets (Appleton *et al.*, 2005). China authorized the "socialist market economy" to accelerate reforms, including to the labour markets, the effect of which led to a major reduction in rates of returns for the aggregated sample or groups in the early 1990s. Camposa and Jolliffe's (2003) study of Hungary, as well as that of Flabbi *et al.* (2008) in examining eight transition economies (Bulgaria, Czech Republic, Hungary, Latvia, Poland, Russia, Slovak Republic and Slovenia) argue that the skills acquired cannot be easily transferred to a changed economic situation. Thus one would expect to see a temporary decline to returns during any period of transition.

Between the trough of 1.4 percent in 1993 and peak of 9.4 percent in 2004, there is a continuous rising trend of education returns for one additional year, which is also noted in the most recent literature (for example, Liu *et al.* (2010)). After 1997, the four groups experience different, but still increasing paths of education returns. Groups born before 1950 (8 percent for one additional year) and 1962-1980 (10 percent for one additional year) have a peak in 2004 as for the employee sample, while the other two groups experience peaks in 2006 (both around 10 percent for one additional year). The decline of education returns after 2004 is caused mainly by the structural break of education returns of the group born before 1950. Their dramatic fall of education returns (from the peak value to insignificance) may reflect the human capital loss of compulsory retirement (especially for women), and the rapidly depreciated human capital from education by the new skill-biased technology (Liu *et al.*, 2010). This loss can only be partly offset by the rising employment proportions of the younger groups with still significant and high education returns.

Table 5.4 shows the estimates from OLS regressions using the pooled dataset for all eight waves. In order to test whether schooling only reflects the signal effects of innate ability the interaction of schooling and experience has been regarded as an explanatory variable, as in equation (5.9). For all employees, the coefficient of schooling is 6 percent for one additional year. The highest coefficients are for groups born before 1950 and in 1981 or after (around 10 percent), but they are below 5 percent for the other two middle-aged groups, suggesting lower rates of returns to schooling acquired during the Mao era. The difference between Table 5.4 and Table 5.3 is derived from the interaction item of schooling and experience. The coefficients of schooling in Table 5.4 are actually the education returns when the labour market experience is equal to zero (Friedrich, 1982). Thus, the above results only show that the new entrants of the oldest and youngest groups have higher education returns than new entrants in the other two groups. We need to investigate the interaction item for the marginal effects of schooling with experience.

The interaction variable of schooling and experience (divided by 100) is only significantly negative for the full employee sample and the group born before 1950, which casts doubt on the human capital explanation of education. In order to show the dynamics of changing schooling returns by groups, we follow Dreher and Gassebner (2007) and Potrafke (2009) to evaluate the marginal effects of schooling at various points of the distribution of experience; namely at the 5th, 25th, median, 75th and 95th percentiles of the interacted variable.[38] Using this method we can distinguish between the impact of schooling on wage rates when the levels of experience are low and high. All marginal effects are presented in the bottom panel of Table 5.4.

[38] We use the 5th percentile and 95th percentile to replace the minimum and maximum experience years, which are extreme values and hence not representative.

Table 5.3: Ordinary Least Square regressions, by year

Employee sample	**All years**	**1989**	**1991**	**1993**	**1997**	**2000**	**2004**	**2006**	**2009**
Years of schooling	0.043***	0.026***	0.015***	0.014**	0.028***	0.051***	0.094***	0.090***	0.079***
	0.003	*0.004*	*0.004*	*0.006*	*0.007*	*0.008*	*0.009*	*0.007*	*0.007*
R-squared	0.597	0.138	0.12	0.102	0.1	0.09	0.222	0.238	0.197
N	17,212	2,712	2,759	2,307	2,080	1,879	1,695	1,787	1,993
Born before 1950	**All years**	**1989**	**1991**	**1993**	**1997**	**2000**	**2004**	**2006**	**2009**
Years of schooling	0.026***	0.028***	0.009	0.014	0.02	0.070***	0.080**	0.026	-0.106
	0.004	*0.006*	*0.006*	*0.009*	*0.019*	*0.016*	*0.033*	*0.043*	*0.068*
R-squared	0.482	0.211	0.097	0.117	0.055	0.236	0.25	0.441	0.304
N	2,962	877	736	551	339	210	116	80	53
Born 1950-1961	**All years**	**1989**	**1991**	**1993**	**1997**	**2000**	**2004**	**2006**	**2009**
Years of schooling	0.048***	0.026***	0.020*	0.017	0.047***	0.065***	0.086***	0.107***	0.095***
	0.005	*0.009*	*0.011*	*0.012*	*0.013*	*0.016*	*0.017*	*0.015*	*0.018*
R-squared	0.614	0.084	0.087	0.077	0.134	0.101	0.19	0.253	0.192
N	5,706	978	1,006	849	704	590	531	544	504
Born 1962-1980	**All years**	**1989**	**1991**	**1993**	**1997**	**2000**	**2004**	**2006**	**2009**
Years of schooling	0.051***	0.026***	0.014	0.014	0.022**	0.034***	0.100***	0.093***	0.087***
	0.004	*0.009*	*0.009*	*0.012*	*0.009*	*0.01*	*0.012*	*0.01*	*0.008*
R-squared	0.605	0.063	0.05	0.063	0.09	0.047	0.222	0.209	0.226
N	7,891	857	1,017	907	1,034	1,000	936	997	1,143
Born in 1981 or after	**Years in 2000s**	**1989**	**1991**	**1993**	**1997**	**2000**	**2004**	**2006**	**2009**
Years of schooling	0.080***					0.022	0.025	0.102***	0.087***
	0.013					*0.154*	*0.038*	*0.023*	*0.016*
R-squared	0.306					0.04	0.354	0.243	0.204
N	650					79	112	166	293

Note: The standard errors are in italics and adjusted by clusters. *** Significant at 1%, **significant at 5%, *significant at 10%. Province dummies are included for all regressions. Year dummies are included in the 'all years' regression. Constants and controlled variables are not reported.

Table 5.4: Ordinary Least Square regressions, by age group

	Employee sample	Born before 1950	Born 1950-1961	Born 1962-1980	Born in 1981 or after
Years of schooling	0.060***	0.091***	0.047***	0.041***	0.093***
	0.005	*0.019*	*0.013*	*0.008*	*0.026*
School*experience/100	-0.067***	-0.178***	0.004	0.063	-0.265
	0.015	*0.053*	*0.048*	*0.043*	*0.413*
Experience	0.030***	0.136***	0.054***	0.020**	0.032
	0.003	*0.023*	*0.014*	*0.008*	*0.076*
Experience square	-0.000***	-0.002***	-0.001***	-0.001***	0.001
	0	*0*	*0*	*0*	*0.003*
R-squared	0.598	0.484	0.614	0.605	0.308
N	17212	2962	5706	7891	653

Marginal effects of schooling (OLS)

	Percentile	5%	25%	50%	75%	95%
	Experience	3.41	11.57	21.39	31.83	47.98
Employee sample	Marginal effects	0.058***	0.052***	0.046***	0.038***	0.028***
	standard error	*0.004*	*0.003*	*0.003*	*0.003*	*0.004*
Born before 1950	Marginal effects	0.085***	0.071***	0.053***	0.035***	0.006
	standard error	*0.018*	*0.014*	*0.009*	*0.004*	*0.007*
Born 1950-1961	Marginal effects	0.047***	0.048***	0.048***	0.049***	0.049***
	standard error	*0.012*	*0.008*	*0.005*	*0.006*	*0.012*
Born 1962-1980	Marginal effects	0.043***	0.048***	0.054***	0.061***	0.071***
	standard error	*0.006*	*0.004*	*0.005*	*0.008*	*0.015*
Born in 1981 or after	Marginal effects	0.084***	0.062***	0.036		
	standard error	*0.015*	*0.028*	*0.067*		

Note: The standard errors are in italics and adjusted by clusters. *** Significant at 1%, ** significant at 5%, * significant at 10%. Constants and controlled variables are not reported.

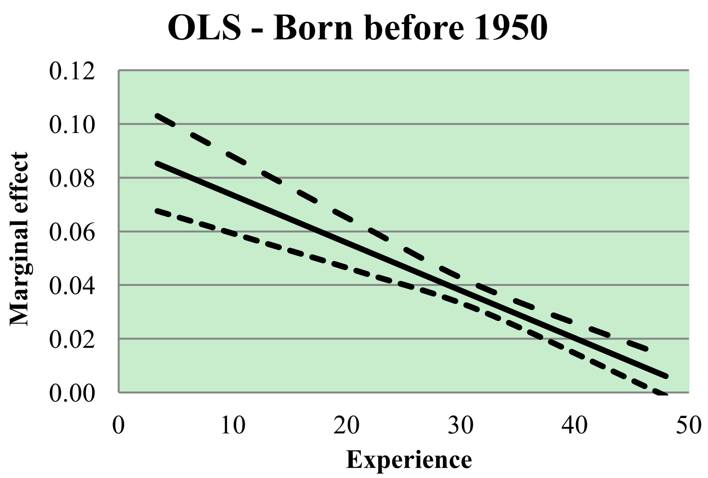
At the fifth percentile of potential labour markets experience (3.41 years), the groups born before 1950 and in 1981 or after have the marginal effects of about 8.5 percent , higher than the other two middle-aged groups (each around 4.5 percent), and similar to the coefficients of schooling as experience equals 0. With increase in experience, the groups born before 1950 and in 1981 or after have declining marginal effects of schooling. However, the group born 1962-1980 has significant and increasing marginal effects, which are also significant and stable over experience for the group born 1950-1961.

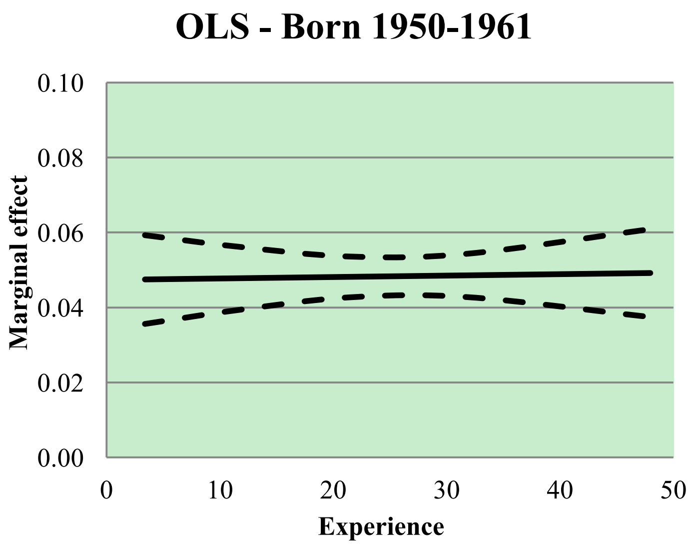
Figure 5.1 illustrates the trends of marginal effects of schooling with increasing experience, with the lower and upper limits of one standard deviation for all the employees and the four groups. Equation (5.7) shows that the coefficients of schooling only reflect the signal of innate ability, because the coefficients of interaction are insignificantly different from zero. Hence, the signal model fits the group born 1950-1961 in Table 5.4 and Figure 5.2 very well. If the interactions have negative coefficients, the longer an individual has been out of school, the lower are his/her education returns for one additional year of schooling, which fits the groups born before 1950 and in 1981 or after in Table 5.4 and Figure 5.2. Possible explanations for this difference include a vintage effect, the rising quality of education, and greater mobility among younger workers because they have made fewer employer-specific investments. People with longer experience also are likely to be more constrained by wage compression and other restrictions of past employment arrangements. Coefficients of schooling in this case may include both signal and human capital effects of schooling, which would be a traditional endogeneity problem. [39]

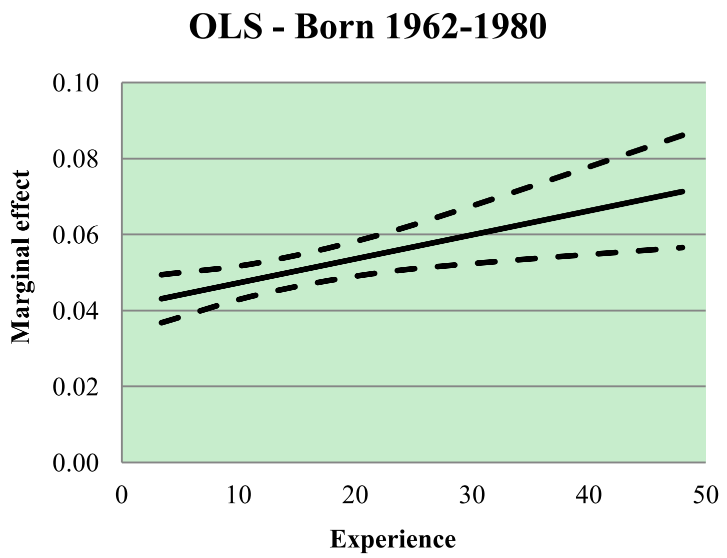
Moreover, if the innate ability or education enhanced human capital can also enhance human capital from on-the-job training and "learning by doing" processes, education enhanced human capital is positively correlated (hence complementary) with experience enhanced human capital in equation (5.7). The longer an individual has been out of school, the higher are his/her returns to education. Therefore, the group born 1962-1980 (if they are employed) can benefit from the "rent" from interaction between education and experience. In this case, coefficients of schooling also include both signal and human capital effects of schooling and show a rising trend in Figure 5.1.

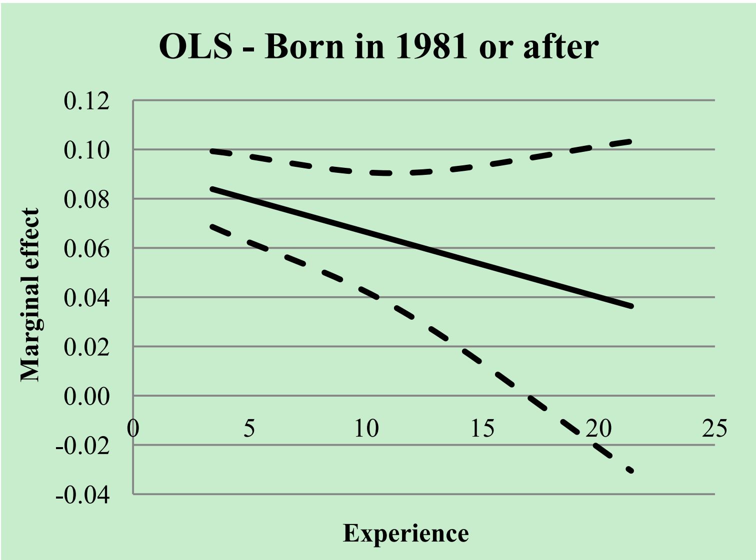
[39] We acknowledge the possible endogeneity of schooling in the sense of unobserved innate ability in the OLS regressions and the bias it can cause. We have corrected the endogeneity biases in the section 3.6 of the chapter 3.

Figure 5.1: Ordinary Least Square Model (OLS) - marginal effects and low/upper limits









Next, we will use the Heckman selection model to correct selection biases. We apply the Heckman selection model to provide consistent, asymptotically efficient estimates for schooling. Table 5.5 presents the results of the Heckman selection model using equation (5.9) and (5.10). The selectivity effect (lambda) is significant for the full sample and the four groups. LR/Wald tests of independent equations (rho = 0) are easily rejected for all ML specifications. These tests clearly justify the Heckman selection model with data. By correcting the selection bias, the education returns for the full sample decrease from 6 percent to 5.2 percent for one addition year, and decrease from 9.1 percent to 7.4 percent for the group born before 1950. Returns do not change very much for the group born 1950-1961, while the two younger groups have higher rates (from 4.1 percent to 11.8 percent for the group 1962-1980; and from 9.3 percent to 22.1 percent for the group born in 1981 or after) than in the OLS specification. Although these results are only point estimates, as experience is equal to 0, we still find that they are closer to the results in other transition countries (Psacharopoulos and Patrinos, 2004; Flabbi *et al.*, 2008).

The Heckman correction also has a significant effect on coefficients of interaction of schooling and experience. Figure 5.2 illustrates all negative correlations (substitution relationship) between marginal effects of schooling and experience. Compared with the OLS estimates, the interactive variable of schooling and experience becomes significantly negative for the largest baby-boom group (1962-1980) and the one-child-policy group (in 1981 or after). Selection biases seem very serious for the group 1962-1980. The positive coefficients of interaction variable in OLS regressions just fit the "rents", as above-equilibrium wages in this group and could give rise to a "hitting the jackpot" effect when a job is won (Peng and Siebert, 2008). After we correct the selection biases, the significantly positive trend of the group 1962-1980 in Figure 5.1 is replaced by a significantly negative trend in Figure 5.2.

The only insignificant coefficient remains that to be found in the group born 1950-1961, the schooling years of which may only reflect the innate ability as we find in the OLS regressions. This is not very surprising, because the group born 1950-1961 mainly received their education during the "Cultural Revolution" period (1966-1976), when education chances were only allocated for selected students based on political virtue.

Those from families of workers, peasants or soldiers were deemed the most “virtuous” and were among the first admitted. This has generated the label of worker-peasant-soldier student (*gong-nong-bing xueyuan*) for those students entering college during the early 1970s. Identification as a Cultural Revolution-era university student continues to carry a negative loading and, in general, depressed opportunities for advancement (Broaded, 1990; Fleisher and Wang, 2005).

For the only-child-policy group, even though the starting education for one additional year are as high as about 20 percent , the most rapidly depreciation of education offsets the high coefficients of schooling as a new entrant. However, since we have only a few hundred observations in the youngest group, any formal interpretation should be concerned with caveats and needs further research. Therefore, the human capital explanation of education is supported by our study, except for the group educated during the “Cultural Revolution”.

Table 5.5: Heckman Selection Model

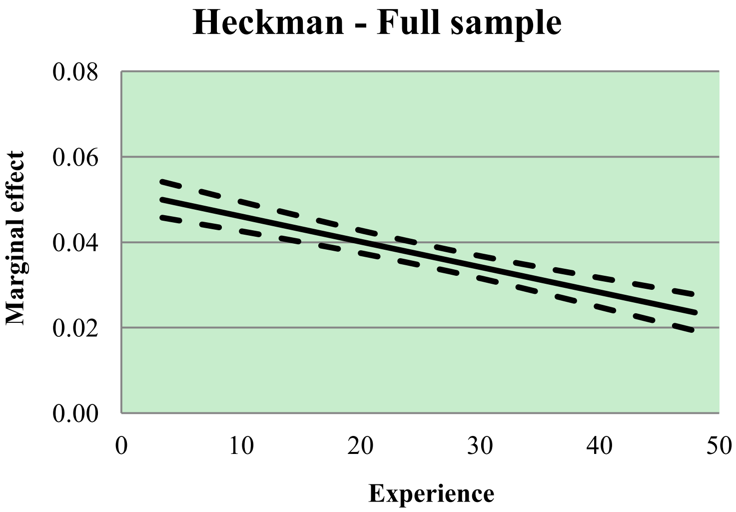
	Full sample	Born before 1950	Born 1950-1961	Born 1962-1980	Born in 1981 or after
Ln (real hourly wage rate)					
Years of schooling	0.052***	0.074***	0.049***	0.118***	0.221***
	0.005	*0.019*	*0.013*	*0.01*	*0.037*
School*experience/100	-0.059***	-0.135***	-0.028	-0.105**	-1.009**
	0.015	*0.052*	*0.046*	*0.052*	*0.499*
Experience	0.027***	0.117***	0.062***	0.116***	0.369***
	0.003	*0.023*	*0.014*	*0.01*	*0.103*
Experience square	-0.000***	-0.001***	-0.001***	-0.003***	-0.014***
	0	*0*	*0*	*0*	*0.004*
Select model					
Married	0.080**	0.248*	0.234**	-0.054	-0.220***
	0.034	*0.145*	*0.113*	*0.033*	*0.064*
Years of schooling	0.210***	0.246***	0.282***	0.182***	0.217***
	0.008	*0.038*	*0.028*	*0.012*	*0.029*
School*experience/100	-0.470***	-0.651***	-0.574***	-0.355***	-1.040***
	0.022	*0.09*	*0.083*	*0.06*	*0.398*
Experience	0.172***	0.062	0.193***	0.213***	0.535***
	0.005	*0.041*	*0.025*	*0.011*	*0.075*
Experience square	-0.003***	-0.001***	-0.003***	-0.005***	-0.022***
	0	*0*	*0*	*0*	*0.003*
Mills (lambda)	-0.04***	-0.06***	-0.04***	0.67***	0.80***
standard error	0.01	0.01	0.01	0.03	0.09
t value	-5.04	-3.81	-3.27	20.68	8.87
Wald test of indep. Eqns. (rho=0)	25.62***	13.51***	10.79***	342.22***	70.59***
	0	0.0002	0.001	0	0
N	40,933	9,494	11,668	17,218	2,553

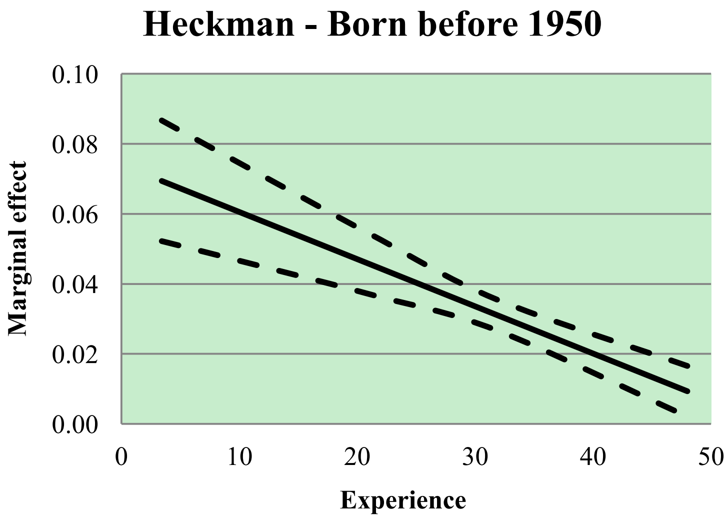
Marginal effects of schooling (Heckman selection model)

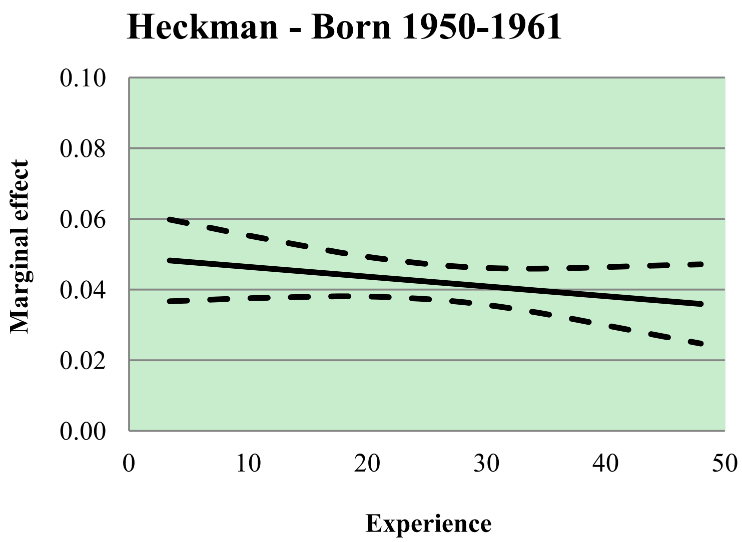
	Percentile	5%	25%	50%	75%	95%
	Experience	3.41	11.57	21.39	31.83	47.98
Full sample	Marginal effects	0.050***	0.045***	0.039***	0.033***	0.024***
	standard error	0.004	0.003	0.003	0.003	0.004
Born before 1950	Marginal effects	0.069***	0.058***	0.045***	0.031***	0.009
	standard error	0.017	0.013	0.008	0.004	0.007
Born 1950-1961	Marginal effects	0.048***	0.046***	0.043***	0.040***	0.036***
	standard error	0.012	0.008	0.005	0.006	0.011
Born 1962-1980	Marginal effects	0.114***	0.106***	0.096***	0.085***	0.068***
	standard error	0.009	0.006	0.006	0.009	0.017
Born in 1981 or after	Marginal effects	0.187***	0.104***	0.005		
	standard error	0.023	0.030	0.075		

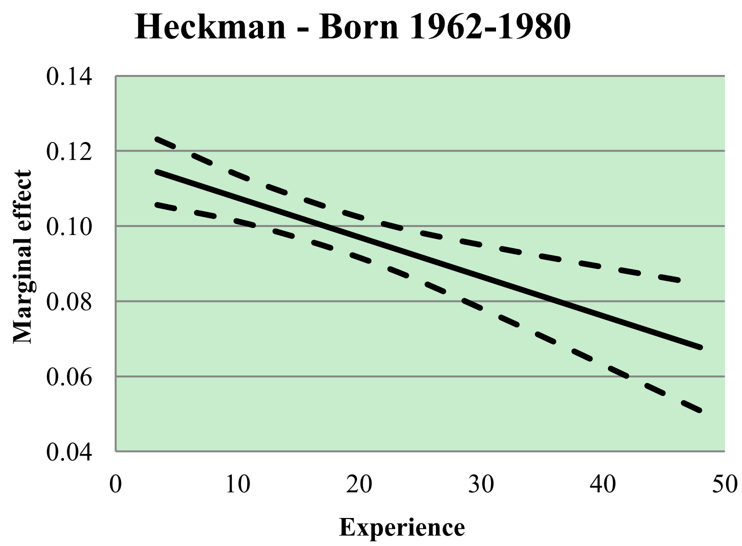
Note: The standard errors are in italics and adjusted by clusters. *** Significant at 1%, ** significant at 5%, * significant at 10%. Year dummies and province dummies are included for all regressions. Constants and controlled variables are not reported.

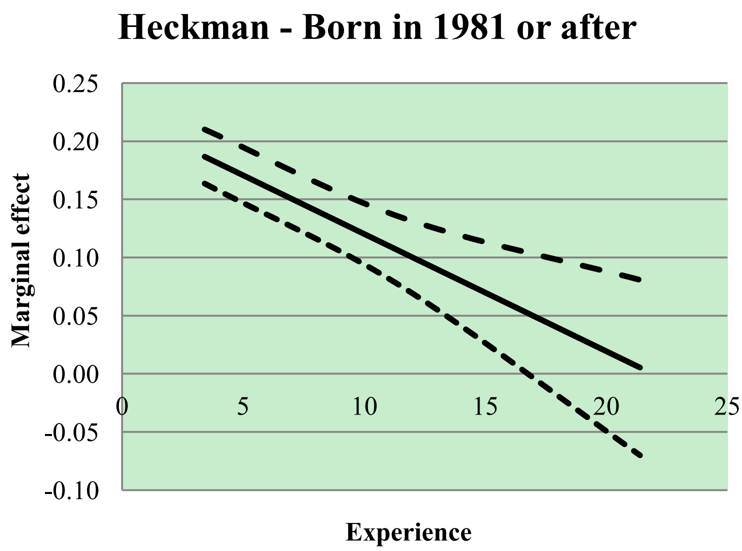
Figure 5.2: Heckman Selection Model - marginal effects and low/upper limits






Heckman - Born 1950-1961
Marginal effect
0.10
0.08
0.06
0.04
0.02
0.00
0
10
20
30
40
50
Experience


Heckman - Born 1962-1980
Marginal effect
0.14
0.12
0.10
0.08
0.06
0.04
0
10
20
30
40
50
Experience


Heckman - Born in 1981 or after
Marginal effect
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
0
5
10
15
20
25
Experience

5.5 Conclusions

Schooling itself can be identified as an augmenting factor of human capital, or merely as signals reflecting innate ability. Moreover, traditional aggregated Ordinary Least Squares (OLS) estimates are biased by selection problem and mix-ups of group heterogeneity. Hence, in this chapter, we use the eight waves of the CHNS dataset to estimate the rates of private returns to schooling in China over the last two decades. We categorize data into four age groups according to the structural breaks of the birth rates and estimate the marginal effects of schooling with increasing experience, using OLS and the Heckman selection model.

The OLS estimates of education returns for all employees are 2.6 percent for one addition year in 1989, then declining to around 1.5 percent in 1991 and 1993, possibly due to the political campaigns and delayed reaction for labour market reforms. And then, education returns increase to 9.4 percent for one addition year in 2004 before finally dropping to 7.9 percent for one addition year in 2009 with the dramatic loss of human capital of the retired group (born before 1950). Groups have similar education returns in the early years of the 1990s, but they experience heterogeneous dynamics later. This suggests a substantial influence of institutional reforms in the labour markets. Our age group analyses support the labour market transition explanation of the evolution of returns to schooling over time.

The interactive variable of schooling and experience is used in the Heckman model to test whether years of schooling only reflect the signal effects of innate ability. We find that the education returns for one additional year decline with labour markets experience, which supports the human capital hypothesis for all groups except the group born 1950-1961, the schooling years of which may only reflect the innate ability or political virtue as we find in the OLS regressions. This conclusion is not very surprising because the group born 1950-1961 mainly received their education during the “Cultural Revolution” period (1966-1976) when education chances were only allocated for selected students based on political virtue. This group also has the lowest education returns after we correct selection biases, just as found by Fleisher and Wang (2005).

Selection biases are very serious for the group born in the period 1962-1980. The positive coefficients of interaction variable in OLS regressions just fit the “rents” argument in this group with a “hitting the jackpot” effect when a job is won. After we correct the selection biases, the significantly positive marginal effects of the group 1962-1980 in OLS are replaced by significantly negative marginal effects, as expected by the human capital hypothesis. For the only-child-policy group, even though the starting returns to schooling are as high as about 20 percent, the most rapid depreciation of education offsets the high coefficients of schooling as a new entrant. However, since the youngest group has many fewer observations than other groups in our sample, any formal interpretation should be concerned with caveats and demands further research.

CHAPTER SIX: CONCLUSIONS

The reform and open-door policy launched in 1978 is the starting point of China's success story. The reforms in the past three decades include many dramatic changes in political and economic institutions, but the most important issue may be the economic transition from a highly central-planned economy to a market-oriented one. The market-oriented economic reform began in the agricultural sectors at the end of the 1970s, spreading to manufacturing sectors by the speeding-up of marketization in the goods market and an increase of profitability within the state sector. As more and more foreign and private enterprises are set up, market competition causes the financial collapse of many State-owned Enterprises (SOEs) which initiates dramatic changes in the labour market in the mid-1990s.

Under the planned economic regime, Chinese workers have lifetime employment whereby their jobs are assigned by the state. SOEs are not allowed to fire workers, and wage levels are centrally determined and rigid (Kang and Peng, 2012). The growth of joint venture firms and demand for openness increase demand for workers in cities, met by the large scale inflow of rural migrants to urban centre. Ownership reforms shift workers from SOEs to private sector employment. Workers can have the right to move and search for a job around the country. This labour mobility enhances the growth 'miracle', and is also associated with a widening of income inequality. This is partly due to reform-induced economic gains that are distributed more to workers on a high income than to those on a low income, and also comes from economic restrictions, such as enlarged disparities of low and high skills with labour market liberalization (Meng, 2004).

The open-door policy is the other side of the coin. Openness to the outside world is not only reflected in increasing exports and income for the whole country, but also in an adaptation process of new technology and entrepreneurship from other countries. Joining the global value chain, especially after becoming a formal member of the World Trade Organisation (WTO) in 2000 brings big success for China and causes its economic convergence towards western developed countries. However, openness also exacerbates the economic disparities among regions and provinces within China. Enterprises and workers in the Coastal region can benefit more from the export-orientation policies. This region has advantages in the import and export of goods to other countries and can attract more Foreign Domestic Investment (FDI). Through these channels, technical spill-over and increasing productivity disparities also help this region to push their institutional reforms further (Acemoglu *et al.*, 2001; Acemoglu, 2003). Capital and skill-intensive technologies from developed countries dramatically change the institutions of ownership, education and labour market in the Coastal region. The other three regions, the Northeast, Interior and West have been left behind, not only in an economic but also in an institutional sense, which exacerbates the regional disparities within China.

This thesis uses the "Human Capital Theory" to discuss four issues in China: production processes and productivity change, regional productivity disparities and convergence, cost competitiveness comparisons and private returns to education. Chapter 2 reviews the growth accounting model and measurement methods of physical capital services, labour inputs, and labour composition index (LCI) and Total Factor Productivity (TFP) from 1978 to 2009. We verify that China's growth miracle in the past 30 years, that has mostly taken place in the advanced Coastal region, has mainly been driven by the accumulation of physical capital. The growth rate of physical capital in the Coastal region was at about double the speed of the other three regions before 2000. During the period of 2000-2009, the growth rates of physical capital in the regions previously left-behind have caught up with that of the Coastal. However, the contribution of physical capital has been declining, from 83 percent in the 1980s to 66.80 percent in the 2000s. In contrast, the contribution of TFP increased from 18 percent to 32 percent, and the contribution of LCI rose from 0.2 percent to 1.4 percent over the same period.

The annual growth rate of labour productivity in the Coastal region is the highest among all regions in China, while labour input and TFP growth contribute more in the Interior and West regions. This can reasonably explain the regional disparities. Since physical capital can make a similar contribution to economic growth in all regions, with more investment of physical capital in the less developed three regions, further research would find more evidence of convergence of economic growth. The labour composition index suggests that education also contributes to economic growth. The Interior has the highest LCI, perhaps because it is centrally located between Beijign and Shanghai (two educational and economic centers in China). Although its contribution is not as dominant as physical capital in the current stage of development, LCI is becoming more and more important in the growth accounting model. Education will be the next potential engine of economic growth among regions, leaving much space for less developed regions to catch up.

China's spectacular economic growth coincides with unequal economic performance of provinces and regions. Chapter 3 examines the effects of the physical and human capital formation on labour productivity, TFP and wages, incorporating the market reform factors such as ownership types, One-Child Policy, openness and fiscal expenditures on human capital. We find that, in a simple production function, the adjusted labour inputs are slightly more important than capital services. And the returns to adjusted labour in the West, which has the poorest education resources, are the highest among the four regions. This suggests a strategy to attract more skilled workers, while the returns to capital input are still the highest in the traditional industrial Northeast region.

In more accurate specifications for labour productivity, TFP and wages, the Chinese economic miracle is mainly propelled by the deepening of capital rather than labour composition. Perhaps because of this, the effect of human capital factor has been reflected in market reform variables such as ownership, population growth, openness, and fiscal expenditures on human capital. Privatization and openness are more important than labour composition for TFP growth. Competing with foreign companies advances provincial labour productivity and TFP growth, but harms the local average wages. The average wage is harmed by the fiscal expenditures on human capital, verifying Zhang and Zou (1998)'s argument that central government spending (such as in highways, railways, power stations, telecommunications and energy) benefits economic growth, while a high degree of provincial government spending is associated with lower provincial economic growth.

The structural break between the pre-1994 and post-1994 periods illustrates significant differences in economic growth patterns, especially for the TFP and wage growth, indicating that the market economy affects determinants of productivity. After 1994, the capital inputs contribute more with the open-door policy but, since the late

1990s, the returns to labour composition decrease with the expansion of education. The four regions also show different patterns in their economic growth path. The capital services and labour composition mostly help the labour productivity and wage growth in the West. The greater share of persons employed in the public sector and the private firms, the higher the labour productivity and TFP growth in the Northeast and Coastal regions. The collective-owned enterprises are the most important ownership type in the West region for all the three productivity proxies. For the Interior region, the public sector and private firms only have a significant effect for wages. Openness facilitates the technology spill-over for all four regions, but harms labour productivity in the Northeast and wages in the Coastal region.

Moreover, provinces within each region present strong evidence of beta-convergence for all three productivity proxies. The highest convergence speed is found in the provinces in the Northeast and Coastal regions for labour productivity and TFP growth, suggesting fast technology spill-over. The provinces in the Coastal region, as the most advanced region in China, have the highest convergence speed for average wages, while the provinces within the Northeast region has no convergence trends for average wages by both OLS and Generalized Least Square (GLS) models.

Finally, we overcome the endogeneity problem of education by the Generalized Instrumental Variables (GIV) method using the CHNS dataset (1989, 1991, 1993, 1997, 2000, 2004, 2006 and 2009), considering the composition bias of gender and age groups. We argue the validity of instruments applied in the past literatures, and try three instruments (number of brothers, number of sisters and tap water). These IVs pass the required tests (F tests and Chi-square tests). Results of the first step of GIV regressions show that, children born before 1961 appear mainly to compete with their same sex siblings, while children born in the largest baby boom period 1962-1980 compete with both brothers and sisters, and girls suffer from siblings than boys. For the youngest group born in 1981 and after, girls appear to compete strongly with their sisters. Having tap water always favours the years of schooling for the three age groups and both genders (more for girls, as expected). By eliminating the endogeneity problem, males' returns to schooling are higher than females' for the two older age groups, in contrast with the higher returns for females in the OLS estimation. The returns from the GIV estimators are higher than the OLS estimators, supporting the domination of downwards bias due to the endogeneity problem.

Chapter 4 examines Chinese international and provincial disparities and convergence of sectors from the perspective of labour cost, the drivers of unit labour cost, decomposition of cost competitiveness and the convergence trends among countries/provinces by industry. This chapter helps us to understand how the Chinese economy gains comparative advantages against other countries and how provinces within China compete against each other.

First, with regard to the relative unit labour cost (RULC), China has the largest cost advantage against the USA and the three large (the UK, France and Germany) among the 19 countries. The comparative advantage of China's industry appears in high-tech manufacturing subsectors against Mediterranean countries, and low-tech manufacturing subsectors against neighbouring countries (such as Korea). Within China, provinces are able to develop a development strategy according to their cost competitiveness. Provinces in the Northeast and Coastal regions have strong advantages in the manufacturing subsector, coming from the huge physical capital accumulation which we discussed in chapter 2 and 3. The undeveloped West and Interior provinces could encourage Agriculture, Construction and Real estate sectors, as they have relatively low price of land. The Interior provinces also can make full use of their geographic location for the transportation sector.

Comparing the time periods before 1995 and afterwards, the relative unit labour costs (RULC) from both international and provincial comparisons decline, but due to different reasons. For the international comparison, that is because the relative nominal labour cost (RNLC) decreases about 80 percent, while for the provincial comparison, that is because the growth rate of relative labour productivity (RLP) is higher than the growth rate of RNLC.

Third, the decomposition of cost competitiveness across the country and provinces demonstrates many interesting points. During 1978-1995, China has cost competitiveness gains relative only to some Mediterranean countries (Spain, Greece, Italy and Portugal), relying on the negative change in labour productivity of these countries (verified by their situations in the current financial crisis) and depreciation in China's currency relative to foreign currencies. After 1995, these countries still have negative changes in labour productivity, but China loses its cost competitiveness by the appreciation in China's currency. Similarly, for comparison between provinces, there are many more cost competitiveness gains across sectors before 1995 than afterwards.

Finally, we find convergence of RULCs appears more before 1995 than afterwards for both country and provincial comparisons. And, when we compare the convergence trends of RULC, RLP and RNLC, we find that the quickest speed of convergence occurs in RLP for the international comparison, but in RULC for the cross-provincial comparison. RLP converge much more quickly than RULC and RNLC, suggesting a fast technology spill-over effect across the world. Labour market institutional factors such as collective bargaining of trade unions, minimum wages, coordination of wage setting and employment protection legislation may all withhold the convergence of wages and the unit labour costs across the country.

In chapter 5, we investigate the private returns to schooling in China over the last two decades. The OLS estimates of returns to schooling for all employees are 2.6 percent in 1989, declining to around 1.5 percent in 1991 and 1993 possibly due to political campaigns and delayed reactions to labour market reforms. From then, returns to schooling increase to 9.4 percent in 2004 and finally drop to 7.9 percent in 2009 with the dramatic loss of human capital of the retired age group (people born before 1950). This general rising of returns education over time with the increase of demand and supply for human capital are consistent with Katz and Murphy (1992) and Murphy and Welch (1992; 1993). They find changes in the supply and demand for human capital, leading to the coexistence of higher estimated rates of returns to education and significant increases in wage inequality.

Our age group analyses support the labour market transition explanation, of the evolution of returns to schooling over time. Cohorts have similar returns to schooling in the early years of the 1990s, but experience heterogeneous dynamics later, suggesting a large influence of institutional reforms in the labour market. For example, the wage reforms may free up the compressed wage differentials.

The interactive variable of schooling*experience is used in the Heckman model to test whether years of schooling only reflect the signal effects of innate ability. We find that the returns to schooling decline with labour markets experience, which supports the human capital hypothesis for all cohorts except the cohort born 1950-1961. The schooling years of these people may only reflect the innate ability or political virtue, as we find in the OLS regressions. This is not very surprising, because the cohort born 1950-1961 mainly received their education during the "Cultural Revolution" period (1966-1976) when education opportunities were only allocated for selected students, based on their political virtue. This cohort also has the lowest returns to schooling after we correct selection biases, just as found by Fleisher and Wang (2005).

Selection biases are very serious for the age group (people born during 1962-1980). The positive coefficients of the interaction variable in the OLS regressions just fit the "rents" argument in this group, with a "hitting the jackpot" effect when a job is won. After we correct the selection biases, the significantly positive marginal effects of the age group 1962-1980 in OLS are replaced by significantly negative marginal effects, as expected by the human capital hypothesis. For the One-Child policy age group (people born in 1981 or after), even though the starting returns to schooling are as high as about 20 percent, here the most rapid depreciation of education offsets the high coefficients of schooling as a new entrant. However, since the youngest group has far fewer observations than other groups in our sample, any formal interpretation should be concerned with caveats and demands further research.

For further research, we would extend Chinese provincial comparison of cost competitiveness to the manufacturing subsectors, over long-run time period. It would need better data for detailed manufacturing sectors for gross value added, price deflators of gross value added, number of staff and workers and labour compensation. In addition we would acquire detailed annual working hours for macro data, to evaluate labour productivity and nominal labour cost more precisely.

In summary, this thesis emphasizes the effect of human capital on productivity and wages. After thirty years' development, relying heavily on physical capital accumulation, Chinese regions appear to show disparities and convergence on labour productivity, TFP and wages. Reforms and open-door policies bring prosperity as well as inequality in China. Contribution of physical capital to economic growth has been declining. Finding the new growth engine and keeping the economic growth more sustainable are great challenges for China. We find that human capital formation should be the next growth engine for Chinese sustainable growth because of its potential and great space to improve (Ding and Knight, 2011).

However, institutional impediments to human capital formation are still very serious in China. Inefficient and monopoly SOEs occupy more than half the economic resources and make the emerging market and private enterprises very weak. Lacking an efficient financial market of education has made higher education in China an unfair inverse-selection process (Wang *et al.*, 2010). Moreover, the command and market coordination in the labour market leaves the lagging private sector behind (Kang and Peng, 2012). Therefore, this thesis concludes that Chinese sustainable growth in the next stage is dependent on human capital formation. And institutional reforms on ownership, education and labour market, as well as continuous openness to the globalization, would be the vital factors for human capital formation in China, as Hayek said: *Our generation has forgotten that the system of private property is the most important guaranty of freedom. It is only because the control of the means of production is divided among many people acting independently that we as individuals can decide what to do with ourselves (Hayek, 1944).*

REFERENCES:

Acemoglu, D. (2003). "Patterns of skill premia". *Review of Economic Studies,* 70**,** 199-230.

Acemoglu, D., Aghion, P. and Violante, G. (2001). "Deunionization, technical change, and inequality". *Carnegie-Rochester Conference Series on Public Policy*.

Agarwala, R. (1992). "China: Reforming intergovernmental fiscal relations". *World Bank Discussion Papers, China and Mongolia Department, Washington D.C.*

Angrist, J. D. and Pischke, J.-S. (2009). "Mostly harmless econometrics: An empiricist's companion". *Princeton: Princeton University Press*.

Appleton, S., Knight, J., Song, L. and Xia, Q. (2002). "Labor retrenchment in China determinants and consequences". *China Economic Review,* 13**,** 252-275.

Appleton, S., Song, L. and Xia, Q. (2005). "Has China crossed the river? The evolution of wage structure in urban China during reform and retrenchment". *Journal of Comparative Economics,* 33**,** 644-663.

Bai, C.-E., Hsieh, C.-T. and Qian, Y. (2006). "The return to capital in China". *Brookings Papers on Economic Activity,* 2.

Banister, J. (2005). "Manufacturing earnings and compensation in China". *Monthly Labor Review,* Aug.

Barro, R. J. and Lee, J.-W. (1993). "International comparisons of education attainment". *Journal of Monetary Economics,* 32**,** 363-394.

Barro, R. J. and Lee, J.-W. (2001). "International data on educational attainment: Updates and implications". *Oxford Economic Papers,* 3**,** 541-563.

Barro, R. J. and Lee, J. W. (1996). "International measures of schooling years and schooling quality". *American Economic Review,* 86**,** 218-23.

Barro, R. J. and Sala-I-Martin, X. (1992). "Convergence". *Journal of Political Economy,* 100**,** 223-251.

Becker, G., Glaeser, E. and Murphy, K. (1999). "Population and economic growth". *The American Economic Review,* 89**,** 145-149.

Becker, G. S. (1960). "An economic analysis of fertility". *NBER working paper*.

Becker, G. S. (1962). "Investment in human capital: A theoretical analysis". *The Journal of Political Economy,* 70**,** 9-49.

Becker, G. S. (1993). "Human capital: A theoretical and empirical analysis, with special reference to education". *3rd edition, University of Chicago Press, Chicago*.

Becker, G. S. and Lewis, H. G. (1973). "On the interaction between the quantity and quality of children". *Journal of Political Economy,* LXXXI**,** S279–S288.

Becker, G. S. and Tomes, N. (1976). "Child endowments and the quantity and quality of children". *Journal of Political Economy,* LXXXIV.

Behrman, J. R. (1988). "Intrahousehold allocation of nutrients in rural india: Are boys favored?". *Oxford Economic Papers,* XL**,** 32-54.

Belley, P. and Lochner, L. (2007). "The changing role of family income and ability in determining educational achievement". *Journal of Human Capital,* 1**,** 37-89.

Black, S. E., Devereux, P. J. and Salvanes, K. G. (2005). "The more the marrier? The effect of family size and birth order on children's education". *The Quarterly Journal of Economics*.

Bls (1993). "Labor composition and us productivity growth, 1948–1990". *Bureau of Labor Statistics Bulletin 2426, Washington DC*.

Blundell, R., Dearden, L. and Sianesi, B. (2005). "Evaluating the effect of education on earnings: Models, methods and results from the national child development survey". *Journal of the Royal Statistical Society. Series A (Statistics in Society),* 168**,** 473-512.

Borensztein, E. and Ostry, J. D. (1996). "Accounting for China's growth performance". *The American Economic Review,* 86**,** 224-228.

Boserup, E. (1981). "Population and technical change: A study of long-term trends". *Chicago: University of Chicago Press*.

Broaded, M. (1990). "The lost and found generation: Cohort succession in Chinese higher education". *The Australian Journal of Chinese Affairs,* 23**,** 77-95.

Brown, S. and Sessions, J. G. (1999). "Education and employment status: A test of the strong screening hypothesis in italy". *Economics of Education Review,* 18**,** 397-404.

Butcher, K. F. and Case, A. (1994). "The effect of sibling sex composition on women's education and earnings". *The Quarterly Journal of Economics,* 109.

Byrne, J. and Vecchi, M. (2010). "Does labour productivity flow across industries? Estimation robust to panel heterogeneity and cross sectional correlation". *Applied Economics Letters, Taylor and Francis Journals,* 17**,** 111-115.

Byron, R. P. and Manaloto, E. Q. (1990). "Returns to education in China". *Economic Development and Cultural Change,* 38**,** 783-796.

Camposa, N. F. and Jolliffe, D. (2003). "After, before and during: Returns to education in hungary". *Economic Systems,* 27**,** 377-390.

Card, D. (1999). "The causal effect of education on earnings". *Handbook of Labor Economics,* Vol. 3A, Elsevier Science North-Holland, Amsterdam, New York and Oxford**,** 1801-1863.

Carmichael, F., Ercolani, M., Kang, L., Maimaiti, Y., O'mahoney, M., Peng, F. and Robinson, C. (2009). "Education, training and productivity". *In European Competitiveness Report 2009, Chapter 4, p97-131, European Committee, Brussels, ISSN 1682-0800.*

Ceglowski, J. and Golub, S. (2007). "Just how low are China's labour costs?". *The World Economy,* 30**,** 597-617.

Chen and Feng, Y. (1996). "Some political determinants of economic growth: Theory and empirical implications". *European Journal of Political Economy,* 12**,** 609-627.

Chen and Feng, Y. (2000). "Determinants of economic growth in China: Private enterprise, education, and openness". *China Economic Review,* 11**,** 1-15.

Chen, G. and Hamori, S. (2009). "Economic returns to schooling in urban China: Ols and the instrumental variables approach". *China Economic Review,* 20**,** 143-152.

Chen, J. and Fleisher, B. M. (1996). "Regional income inequality and economic growth in China". *Journal of Comparative Economics,* 22**,** 141-164.

Chen, V. W., Wu, H. X. and Van Ark, B. (2009). "More costly or more productive? Measuring changes in competitiveness in manufacturing across regions in China". *Review of Income and Wealth,* 55.

Cheng, L. K. and Kwan, Y. K. (2000). "What are the determinants of the location of foreign direct investment: The chinese experience". *Journal of International Economics,* 51.

Chevalier, A., Harmon, C., Walker, I. and Zhu, Y. (2004). "Does education raise productivity, or just reflect it?". *The Economic Journal,* 114**,** F499-F517.

Chinloy, P. (1980). "Sources of quality change in labor input". *The American Economic Review,* 70**,** 108-119.

Chow, G. C. (1993). "Capital formation and economic growth in China". *The Quarterly Journal of Economics,* 108**,** 809-842.

Clark, J. M. (1923). "Overhead costs in the modern industry". *Journal of Political Economy,* 31 (October)**,** 606–36.

Cox, W. M. and Koo, J. (2003). "China: Awakening giant". *Southwest Economy, Federal Reserve Bank of Dallas,* 5.

Cragg, J. G. and Donald, S. G. (1993). "Testing identifiability and specification in instrumental variable models". *Econometric Theory,* 9**,** 222-240.

Dearden, L. (1999). "The effects of families and ability on men's education and earnings in britain". *Labour Economics,* 6**,** 551-567.

Dearden, L., Reed, H. and Van Reenen, J. (2006). "The impact of training on productivity and wages: Evidence from british panel data". *Oxford Bulletin of Economics and Statistics,* 68.

Deaton, A. (1989). "Looking for boy-girl discrimination in household expenditure data". *The World Bank Economic Review,* III**,** 1-15.

Denison, E. F. (1962). "Sources of economic growth in the u.S. And the alternatives before us". *New York, Committee for Economic Development*.

Dension, E. F. (1962). "The sources of economic growth in the united states and the alternatives before us". *Committee for Economic Development, New York*.

Ding, S. and Knight, J. (2011). "Why has China grown so fast? The role of physical and human capital formation". *Oxford Bulletin of Economics and Statistics,* 73**,** 141-174.

Dollar, D. and Wolff, E. (1994). "Capital intensity and tfp convergence in manufacturing, 1963–1985, in william j. Baumol, richard r. Nelson, and edward n. Wolff, eds., convergence of productivity: Cross national studies and historical evidence. ". *New York, Oxford University Press.*

Dowrick, S. and Nguyen, D. (1989). "Oecd comparative economic growth 1950–85: Catch-up and convergence". *American Economic Review,* 79**,** 1010–30.

Dreher, A. and Gassebner, M. (2007). "Greasing the wheels of entrepreneurship? The impact of regulations and corruption on firm entry". *CESifo Working Paper No 2013*.

Ehrlich, S. and Murphy, K. M. (2007). "Why does human capital need a journal?". *Journal of Human Capital,* 1**,** 1-7.

Farber, H. and Gibbons, R. (1996). "Learning and wage dynamics". *The Quarterly Journal of Economics,* 111**,** 1007-47.

Flabbi, L., Paternostro, S. and Tiongson, E. (2008). "Returns to education in the economic transition: A systematic assessment using comparable data". *Economics of Education Review,* 27**,** 724-740.

Fleisher, Li, H. and Zhao, M. Q. (2010). "Human capital, economic growth, and regional inequality in China". *Journal of Development Economics,* 92**,** 215-231.

Fleisher, B., Sabirianova, K. and Wang, X. (2005). "Returns to skills and the speed of reforms: Evidence from central and eastern europe, China, and russia". *Journal of Comparative Economics,* 33**,** 351-370.

Fleisher, B. and Wang, X. (2005). "Returns to schooling in China under planning and reform". *Journal of Comparative Economics,* 33**,** 265-277.

Fleisher, B. M. and Wang, X. (2004). "Skill differentials, return to schooling, and market segmentation in a transition economy: The case of mainland China". *Journal of Development Economics,* 73**,** 315-328.

Friedrich, R. J. (1982). "In defense of multiplicative terms in multiple regression equations". *American Journal of Political Science,* 26**,** 797-833.

Fu, L. (2008). "How has China's market-oriented reform affected regional productivity performance in industry?". *Paper prepared for the 30th General Conference of the International Association for Research in Income and Wealth, Portoroz, Slovenia*.

Goldsmith, R. W. (1951). "A perpetual inventory of national wealth". *in M.R. Gainsburgh (ed.) Studies in Income and Wealth, Princeton*.

Goodman, D. S. G. (2004). "China's campaign to "Open up the west": National, provincial and local perspectives". *The China Quarterly Special Issues New Series, No. 5*.

Gronau, R. (1974). "Wage comparisons: A selectivity bias". *Journal of Political Economy,* 82**,** 1119-1143.

Harmon, C. and Walker, I. (2000). "Returns to the quantity and quality of education: Evidence for men in england and wales". *Economica,* 67**,** 19-35.

Hayek, F. (1944). "The road to serfdom". *Routledge Press (UK), University of Chicago Press (US)*.

Heckman, J. J. (1974). "Shadow prices, market wages, and labor supply". *Econometrica,* 42**,** 679-694.

Heckman, J. J. (1976). "The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models". *Annals of Economic and Social Measurement,* 5**,** 475-492.

Heckman, J. J. (1979). "Sample selection bias as a specification error". *Econometrica,* 47**,** 153-161.

Heckman, J. J. (2005). "China's human capital investment". *China Economic Review,* 16**,** 50-70.

Heckman, J. J. and Honoré, B. E. (1990). "The empirical content of the roy model". *Econometrica,* 58**,** 1121-1149.

Heckman, J. J. and Li, X. (2004). "Selection bias, comparative advantage and heterogeneous returns to education: Evidence from China in 2000". *Pacific Economic Review,* 9**,** 155-171.

Ho, M. and Jorgenson, D. (1999). "The quality of the us workforce, 1984 -1995". *Unpublished Manuscript, Harvard University*.

Holz, C. A. (2006). "Measuring chinese productivity growth, 1952-2005". *Working paper*.

Hsueh, T. and Li, Q. (1999). "China's national income, 1952-1995". *Boulder: Westview Press*.

Hulten, C. R. and Wykoff, F. C. (1981). "The estimation of economic depreciation using vintage asset prices". *Journal of Econometrics***,** 367-396.

Islam, N. (2003). "What have we learnt from the convergence debate?". *Journal of economic surveys,* 17**,** 309-362.

Islam, N., Dai, E. and Sakamoto, H. (2006). "Role of tfp in China's growth". *Asian Economic Journal,* 20**,** 127-159.

Jefferson, G. (2000). "Ownership, productivity change, and financial performance in chinese industry". *Journal of Comparative Economics,* 28**,** 786-813.

Jian, T. L., Sachs, J. D. and Warner, A. M. (1996). "Trends in regional inequality in China". *China Economic Review,* 7**,** 1-21.

Jorgenson (2005). "Accounting for growth in the information age". *in Philippe Aghion and Steven Durlauf (eds), Handbook of Economic Growth, Amsterdam, North-Holland*.

Jorgenson, D., Gollop, F. and Fraumeni, B. (1987). "Productivity and u.S. Economic growth". *Harvard University Press, Cambridge, MA*.

Jorgenson, D. W. (1963). "Capital theory and investment behavior". *American Economic Review,* 53**,** 247-259.

Jorgenson, D. W. (1990). "Productivity and economic growth". *in Ernst Berndt and Jack E. Triplet, eds., Fifty Years of Economic Measurement, Chicago, University of Chicago Press***,** 19-118.

Jorgenson, D. W. and Griliches, Z. (1967). "The explanation of productivity change". *Review of Economic Studies,* 34**,** 249-283.

Jorgenson, D. W. and Nishimizu, M. (1978). "Us and japanese economic growth, 1952-1974". *The Economic Journal,* 88**,** 707-726.

Kanbur, R. and Zhang, X. (2005). "Fifty years of regional inequality in China: A journey through central planning, reform, and openness". *Review of Development Economics,* 9**,** 87-106.

Kang, L. and Peng, F. (2012). "Real wage cyclicality in urban China". *Economics Letters,* 115**,** 141-143.

Kang, L. and Peng, F. (forthcoming). "A selection analysis on education returns in China". *Post-Communist Economies*.

Katz, L. F. and Murph, K. M. (1992). "Changes in relative wages, 1963-1987: Supply and demand factors". *The Quarterly Journal of Economics,* 107**,** 35-78.

Kendrick, J. W. (1961). "Productivity trends in the united states". *The George Washington University*.

Knight, J. and Song, L. (2001). "Economic growth, economic reform, and rising inequality in China". *In Riskin, C., Zhao, R., W., and Li, S. (eds) China's retreat from equality: income distribution and economic transition. M.E. Sharpe*

Levine, R. and Renelt, D. (1992). "A sensitivity analysis of cross-country growth regressions". *American Economic Review,* 82**,** 942-963.

Lewis, H. G. (1974). "Comments on selectivity biases in wage comparisons". *Journal of Political Economy* 82**,** 1145-1155.

Li (2007). "Family background, financial constraints and higher education attendance in China". *Economics of Education Review,* 26**,** 725-735.

Li, H. (2003). "Economic transition and returns to education in China". *Economics of Education Review,* 22**,** 317-328.

Li, H. and Luo, Y. (2004). "Reporting errors, ability heterogeneity, and returns to schooling in China". *Pacific Economic Review,* 9**,** 191-207.

Li, H. and Zhang, J. (2007). "Do high birth rates hamper economic growth?". *The Review of Economics and Statistics,* 89**,** 110-117.

Lin, J. Y. (1990). "Collectivization and China's agricultural crisis in 1959-1961". *The Journal of Political Economy,* 98**,** 1228-1252.

Lindley, J. and Stephen, M. (2011). "Rising wage inequality and postgraduate education". *IZA Discussion Papers 5981, Institute for the Study of Labor (IZA)*.

Liu (2008). "Foreign direct investment and technology spillovers: Theory and evidence". *Journal of Development Economics,* 85**,** 176-193.

Liu, X., Park, A. and Zhao, Y. (2010). "Explaining rising returns to education in urban China in the 1990s". *IZA DP No. 4872*.

Liu, Z. (1998). "Earnings, education, and economic reforms in urban China". *Economic Development and Cultural Change,* 46**,** 697-725.

Ma, J. (1995). "Modelling central-local fiscal relations in China". *China Economic Review,* 6**,** 105-136.

Ma, J. and Norregaard, J. (1998). "China's fiscal decentralization". *International Monetary Fund paper*

Maddison, A. (1998). "Chinese economic performance in the long run". *OECD Development Centre, Paris*.

Maimaiti, Y. and Siebert, W. S. (2009). "The gender education gap in China: The power of water". *IZA DP No. 4108*.

Malthusian, T. (1798 [1986]). "An essay on the principle of population". *London: W. Pickering*.

Mankiw, N. G., Romer, D. and Wei, D. N. (1992). "A contribution to the empirics of economic growth". *The Quarterly Journal of Economics,* 107**,** 407-437.

Maurer-Fazio, M. (1999). "Earnings and education in China's transition to a market economy survey evidence from 1989 and 1992". *China Economic Review,* 10**,** 17-40.

Meng, X. (2004). "Economic restructuring and income inequality in urban China". *Review of Income and Wealth,* 50**,** 356-379.

Meng, X. and Kidd, M. P. (1997). "Labor market reform and the changing structure of wage determination in China's state sector during the 1980s". *Journal of Comparative Economics,* 25**,** 403-421.

Mincer, J. (1958). "Investment in human capital and personal income distribution". *Journal of Political Economy,* 66 (August)**,** 281-302.

Mincer, J. (1974a). "Schooling, experience and earnings". *National Bureau of Economic Research, New York.*

Mincer, J. (1974b). "Schooling, experience, and earnings". *New York: Columbia University Press*.

Murphy, K. M. and Welch, F. (1992). "The structure of wages". *The Quarterly Journal of Economics,* 107 (February)**,** 285–326.

Murphy, K. M. and Welch, F. (1993). "Inequality and relative wages". *American Economic Review,* 83 (May)**,** 104-9.

National Bureau of Statistics, D. O. C. S. (1999). "Comprehensive statistical data and materials on 50 years of new China". *Beijing: China Statistics Press*.

Nbs (1999). "Xin zhongguo wushi nian tongji ziliao huibian (comprehensive statistical materials on 50 years of new China)". *Beijing: Zhongguo tongji chubanshe*.

O'Mahony and Timmer, M. P. (2009). "Output, input and productivity measures at the industry level: The euklems database". *The Economic Journal,* 119**,** F374-F403.

O'Mahony, M. and Peng, F. (2008). "Skill bias, age and organisational change". *EU KLEMS working paper, No. 36, http://www.euklems.net*.

O'Mahony, M., Robinson, C. and Vecchi, M. (2008). "The impact of ict on the demand for skilled labour: A cross-country comparison". *Labour Economics,* 15**,** 1435-1450.

O'Mahony, M. and Stevens, P. (2009). "Output and productivity growth in the education sector: Comparisons for the us and uk". *Journal of Productivity Analysis,* 31**,** 177-194.

O'Mahony, M. and Vecchi, M. (2009). "R&d, knowledge spillovers and company productivity performance". *Research Policy,* 38**,** 35-44.

Oates, W. E. (1972). "Fiscal federalism". *Harcourt Brace Jovanovich, New York*.

O'Mahony, M., Robinson, C. and Vecchi, M. (2008). "The impact of ict on the demand for skilled labour: A cross-country comparison☆". *Labour Economics,* 15**,** 1435-1450.

Oster, E. and Thornton, R. (2011). "Menstruation, sanitary products, and school attendance: Evidence from a randomized evaluation ". *American Economic Journal: Applied Economics,* 3**,** 91-100.

Pal, S. (2010). "Public infrastructure, location of private schools and primary school attainment in an emerging economy". *Economics of Education Review,* 29**,** 783-794.

Parish, W. L. and Willis, R. J. (1992). "Daughters, education and family budgets: Taiwan experiences". *mimeo, University of Chicago, April*.

Peneder, M. (2009). "Sectoral growth drivers and competitiveness in the european union". *European Commission book*.

Peng, F. and Siebert, W. S. (2007). "Real wage cyclicality in germany and the uk: New results using panel data". *IZA DP No. 2688*.

Peng, F. and Siebert, W. S. (2008). "Real wage cyclicality in italy". *LABOUR,* 22.

Potrafke, N. (2009). "Did globalization restrict partisan politics? An empirical evaluation of social expenditures in a panel of) oecd countries". *Public Choice,* 140**,** 105-124.

Psacharopoulos, G. and Patrinos, H. A. (2004). "Returns to investment in education: A further update". *Education Economics,* 12.

Pwt (2011). "Description of pwt 7.0 (june 3, 2011)". http://pwt.econ.upenn.edu/php_site/pwt_index.php.

Qian (1997). "Progression to second birth in China: A study of four rural counties". *Population Studies,* 51**,** 221-228.

Qian and Weingast, B. R. (1997). "Federalism as a commitment to perserving market incentives". *The Journal of Economic Perspectives,* 11**,** 83-92.

Qian, X. and Smyth, R. (2008). "Private returns to investment in education: An empirical study of urban China". *Post-Communist Economies,* 20**,** 483-501.

Qiu, T. and Hudson, J. (2010). "Private returns to education in urban China". *Economic Change and Restructuring,* 43**,** 131-150.

Raiser, M. (1998). "Subsidizing inequality: Economic reforms, fiscal transfers and convergence across chinese provinces". *Journal of Development Studies,* 34**,** 1-26.

Rawski, T. (1993). "How fast has the chinese industry grown?". *Policy Research Working Paper, WPS 1194, Policy Research Department, World Bank, Washington D.C.*

Riley, J. (1979). "Testing the educational screening hypothesis". *Journal of Political Economy,* 87**,** s227-52.

Romer, P. M. (1986). "Increasing returns and long-run growth". *The Journal of Political Economy,* 94**,** 1002-1037.

Romer, P. M. (1990). "Endogenous technological change". *The Journal of Political Economy,* 98**,** S71-S102.

Roy, A. D. (1951). "Some thoughts on the distribution of earnings". *Oxford Economic Papers, New Series,* 3**,** 135-146.

Sala-I-Martin, X. X. (1996). "Regional cohesion: Evidence and theories of regional growth and convergence". *European Economic Review* 40**,** 1325-1352.

Schultz, T. W. (1959). "Investment in man: An economist's view". *The Social Service Review,* 33 (June).

Schultz, T. W. (1961a). "Investment in human capital". *American Economic Review,* 51**,** 1-17.

Schultz, T. W. (1961b). "Investment in human capital". *American Economic Review,* 51 (March)**,** 1-17.

Schwerdt, G. and Turunen, J. (2007). "Growth in euro area labor quality". *Review of Income and Wealth,* 53**,** 716-734.

Silles, M. A. (2010). "The implications of family size and birth order for test scores and behavioral development". *Economics of Education Review,* 29**,** 795-803.

Solon, G., Barsky, R. and Parker, J. A. (1994). "Measuring the cyclicality of real wages: How important is composition bias?". *NBER working paper*.

Solow, R. M. (1956). "A contribution to the theory of economic growth". *The Quarterly Journal of Economics,* 70**,** 65-94.

Solow, R. M. (1957). "Technical change and the aggregate production function". *The Review of Economics and Statistics,* 39**,** 312-320.

Statistics, B. O. L. (1993). "Labor composition and us productivity growth, 1984 - 1990". *Bureau of Labor Statistics Bulletin 2426, Washington DC*.

Stock, J. H. and Yogo, M. (2002). "Testing for weak instruments in linear iv regression". *NBER Technical working paper 284*.

Su, M. and Zhao, Q. (2004). "China's fiscal decentralization reform". http://www.econ.hit-u.ac.jp/~kokyo/APPPsympo04/PDF-papers-nov/Zhao-China.pdf.

Szirmai, A., Ren, R. and Bai, M. (2005). "Chinese manufacturing performance in comparative perspective, 1980-2002". *Working paper*.

Timmer, M., Inklaar, R., O'Mahony, M. and Van Ark, B. (2010). "Economic growth in europe: A comparative industry perspective, volume 1". *Cambridge University Press*

Timmer, M., Moergastel, T. V., Stuivenwold, E., Ypma, G., O'Mahony, M. and Kangasniemi, M. (2007). "Eu klems growth and productivity accounts version 1.0 part i methodology". http://www.euklems.net/data/EUKLEMS_Growth_and_Productivity_Accounts_Part_I_Methodology.pdf.

Unctad (2002). "China’s accession to wto: Managing integration and industrialization". *Trade and Development Report*, 141-174.

Uusilato, R. (1999). "Returns to education in finland". *Labour Economics,* 6, 569-580.

Van Ark, B., O’Mahony, M. and Timmer, M. P. (2008). "The productivity gap between europe and the united states: Trends and causes". *The Journal of Economic Perspectives,* 22, 25-44.

Van Ark, B., Stuivenwold, E. and Ypma, G. (2005). "Unit labour costs, productivity and international competitiveness". *GGDC Research Memorandum GD-80*.

Villaverde, J., Maza, A. and Ramasamy, B. (2010). "Provincial disparities in post-reform China". *China & World Economy,* 18, 73-95.

Wang, X., Fleisher, B. M., Li, H. and Li, S. (2010). "Access to higher education and inequality: The chinese experiment". *IZA Discussion Papers 2823, Institute for the Study of Labor (IZA)*.

Wang, Y. and Yao, Y. (2003). "Sources of China's economic growth 1952–1999: Incorporating human capital accumulation". *China Economic Review,* 14, 32-52.

Woo, W. T. (1998). "Chinese economic growth: Sources and prospects". *in M. Fouquin and F. Lemoine (eds.) The Chinese Economy, Economica, London*.

Wu and Xu, X. (2002). "Measuring the capital stock in chinese industry - conceptual issues and preliminary results". *Paper prepared for the 27th General Conference of International Association for Research in Income and Wealth Stockholm, Sweden*.

Wu, H. X. (2000a). "China's gdp level and growth performance: Alternative estimates and the implications". *Review of Income and Wealth,* 46, 475-499.

Wu, Y. (2000b). "Is China's economic growth sustainable? A productivity analysis". *China Economic Review,* 11, 278-296.

Yang, D. T. (2002). "What has caused regional inequality in China?". *China Economic Review,* 13, 331-334.

Yang, D. T., Chen, V. W. and Monarch, R. (2010). "Rising wages: Has China lost its global labor advantage?". *IZA DP No. 5008*.

Young, A. (1992). "A tale of two cities: Factor accumulation and technical change in hong kong and singapore". *NBER working paper*.

Young, A. (2003). "Gold into base metals: Productivity growth in the people's republic of China during the reform period". *The Journal of Political Economy,* 111, 1220-1261.

Zhang, J., Zhao, Y., Park, A. and Song, X. (2005). "Economic returns to schooling in urban China, 1988 to 2001". *Journal of Comparative Economics,* 33**,** 730-752.

Zhang, T. and Zou, H.-F. (1998). "Fiscal decentralization, public spending, and economic growth in China". *Journal of Public Economics,* 67**,** 221-240.

APPENDICES

Figure A2.1: Geographic graph of four regions in this thesis

(1) Northeast region: Heilongjiang, Jilin, Liaoning;

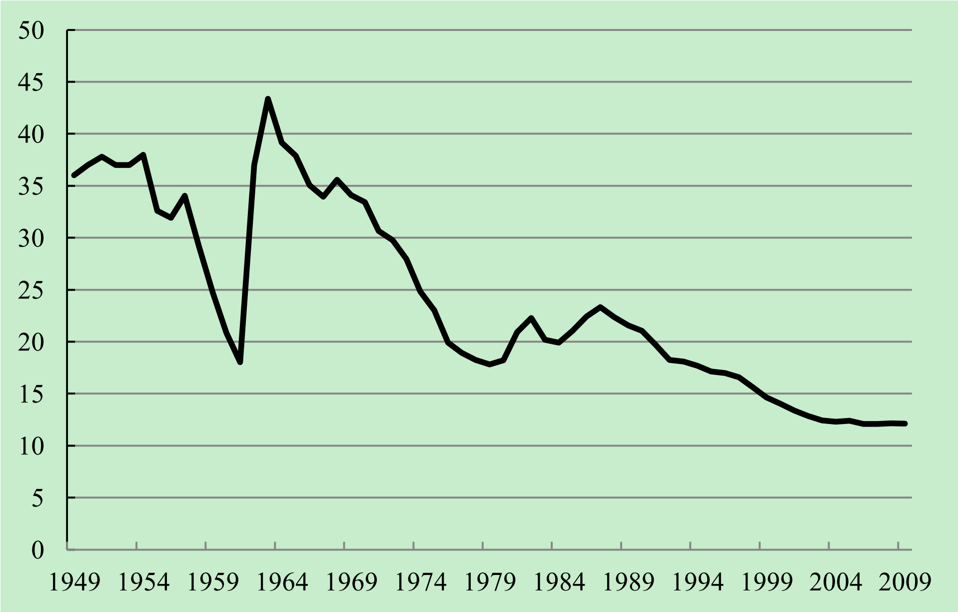
(2) Coastal region: Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong-Hainan;

(3) Interior region: Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan;

(4) West region: Guangxi, Sichuan-Chongqing, Guizhou, Yunnan, Inner Mongolia, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang.

Note: We do not study Tibet due to data limitation.

Figure A3.1: Birth rate (per thousand, 1949-2009)



Data source: National Bureau of Statistics (1999) ; China Statistics Yearbook 2010

Table A2.1: Measured wage rate – average approach (by province)

	Urban Area								Rural Area							
	1989	1991	1993	1997	2000	2004	2006	2009	1989	1991	1993	1997	2000	2004	2006	2009
	Primary school and below															
LN	0.66	0.85	0.93		4.09	5.01	4.14	4.63	0.79	1.14	1.43		5.85	4.76	6.31	17.4
HLJ				2.81	2.89	3.47	12.5	7.05				2.63	6.78	5.19	5.31	13.01
JS	0.68	1.16	1.55	3.01	5.24	6.02	6.12	8.08	0.54	1.04	1.29	4.21	4.61	3.52	3.94	7.61
SD	0.55	0.65	1.12	2.5	5.57	4.2	3.18	9	0.68	0.82	1.26	3.11	4.1	6.46	3.88	9.59
HEN	0.57	1.19	0.81	2.48	2.84	3.28	3.57	7.45	0.65	0.97	0.73	2.55	2.62	2.52	3.59	7.63
HB	0.61	0.74	1.15	3.01	3.13	3.22	6.18	13.12	0.42	0.79	0.82	2.76	6.57	6.88	7.88	21.52
HUN	0.79	1.05	2.71	3.06	5.24	8.88	6.99	9.24	0.87	0.93	2.58	5.51	4.44	5.85	6.23	6.41
GX	0.6	0.79	1.22	2.53	5.39	2	3.69	5.25	0.77	0.87	1.14	2.58	4.2	3.6	3.77	5.61
GZ	0.52	0.61	2.23	3.75	3.12	3.85	4.86	7.57	0.65	0.91	1.09	3.27	4.03	4.57	6.33	5.37
	Lower middle school															
LN	0.5	0.65	1.07		3.63	4.51	6.21	7.34	0.56	0.93	1.39		4.3	10.34	8.5	9.67
HLJ				3.37	5.92	6.34	6.51	9.62				3.35	3.71	4.47	4.78	7.13
JS	0.63	1	1.6	3.87	4.48	7.23	7.67	11.23	0.61	0.73	1.18	3.31	4.31	5.63	4.98	8.44
SD	0.67	0.7	1.36	2.61	7.39	4.68	5.34	10.6	0.79	0.79	1.16	2.8	4.23	5.6	6.74	11.13
HEN	0.68	0.76	1.06	2.46	4.67	4.14	4.85	8.52	1.66	0.6	1.09	2.73	4.59	3.41	6.21	11.69
HB	0.6	0.78	1.26	3.08	3.73	7.97	13.42	11.12	0.49	0.62	1.13	2.63	4.16	4.22	3.9	7.99
HUN	0.83	0.94	1.55	3.88	3.94	6.87	13.33	7.71	0.95	1.09	3.44	3.08	3.81	5.97	10.07	27.86
GX	0.62	0.59	1.59	2.84	3.72	4.77	3.76	7.89	0.51	0.88	1.35	3.08	5	4.95	5.24	7.31
GZ	0.49	0.58	1.01	2.54	7.63	4.08	5.5	7.74	0.61	0.52	1.57	3.43	4.08	10.03	8.42	11.78

Continue...

	Urban Area								Rural Area							
	1989	1991	1993	1997	2000	2004	2006	2009	1989	1991	1993	1997	2000	2004	2006	2009
Upper school																
LN	0.6	0.67	0.86		4.56	5.77	9.21	7.53	0.47	1.87	1.17		3.33	5.45	7.95	10.22
HLJ				2.99	5.78	9.58	9.19	14.09				1.86	4.33	7.17	8.21	10.5
JS	0.6	0.93	1.7	3.9	5.45	9.55	10.83	15.83	0.55	0.69	1.04	3.54	5.97	7.46	9.98	14.28
SD	0.6	0.71	1.48	3.18	7.1	5.65	5.57	11.98	0.72	0.81	1.44	3.62	4.5	7.11	6.47	7.14
HEN	0.58	0.69	0.84	2.89	4.56	7.03	8.34	9.71	0.4	0.66	0.78	2.69	6.16	4.3	5.51	7.8
HB	1.05	0.8	1.24	3.47	5.2	5.19	7.87	14.12	0.52	0.59	0.89	3.44	5.1	5.76	8.07	15.03
HUN	0.77	0.89	1.31	5.17	8.87	8.88	11.32	13.91	0.91	0.96	0.93	4.27	4.84	8.46	7.89	13.25
GX	0.54	0.57	1.18	2.75	3.97	6.24	7.43	12.94	0.49	0.69	1.08	2.95	4.62	5.87	6.28	7.97
GZ	0.52	0.68	1.26	2.58	4.13	8.93	10.83	13.68	0.48	0.64	0.77	2.92	5.35	8.34	7.02	23.6
College and above																
LN	0.63	0.75	1.09		5.84	10.31	11.79	16.17	0.59	0.82	1.02		3.85	6.16	9.51	12.29
HLJ				3.04	7.33	9.97	14.83	18.79				1.88	4.79	6.41	13.64	13.92
JS	0.6	1.05	1.49	4.64	9.68	12.16	18.26	22.02	0.48	0.67	1.12	3.32	6.15	21.2	12.81	14.57
SD	0.74	0.6	1.25	3.25	3.91	5.28	5.92	11.68		0.56	0.71	1.83	3.86	6.07	9.32	11.3
HEN	0.61	0.83	3.13	4.96	7.23	9.27	16.07	14.27	0.77	1.17		2.98	5.96	4.26	9.11	8.84
HB	0.82	0.94	2.1	5.47	8.53	7.63	8	17.38	0.51	0.65	1.43	4.32	6.02	7.27	8.51	11.48
HUN	0.8	0.84	1.32	5.69	10.09	14.63	18.85	19.99	0.7	0.87	0.98	2.33	47.32	8.7	7.95	23.75
GX	0.51	0.69	1.68	4.12	6.87	6.44	11.67	14.18	0.48	0.79	0.6	3.7	4.82	5.3	9.04	11.29
GZ	0.64	0.7	1.2	2.6	4.56	16.6	10.16	17.31	0.58	0.59	0.61	3.19	4.38	6.77	11.1	25.99

Note: Province abbreviations (LN: Liaoning; HLJ: Heilongjiang; JS: Jiangsu; SD: Shandong; HEN: Henan; HB: Hubei; HUN: Hunan; GX: Guangxi; GZ: Guizhou)

Table A2.2: Ordinary Least Square model (by province)

Primary school and below	1989	1991	1993	1997	2000	2004	2006	2009
					Urban Area			
Liaoning	0.184	0.051	-0.056		0.081	0.025	-0.83	-0.267
Heilongjiang				-0.233	-0.324	-0.344	-0.004	0.083
Jiangsu	0.259	0.165	0.396**	-0.095	0.152	-0.042	-0.112	0.275*
Shandong	0.008	-0.131	0.13	-0.275*	0.232	-0.19	-0.543***	0.238
Henan	0.036	0.226	-0.188	-0.280*	-0.289	-0.447	-0.557***	0.121
Hubei	0.181	0.023	0.035	-0.084	-0.32	-0.598*	-0.195	0.627**
Hunan	0.365**	0.238*	0.653***	-0.101	0.26	0.591***	0.149	0.443**
Guangxi	0.053	-0.033	0.147	-0.213	-0.113	-0.834***	-0.402	-0.11
Guizhou	-0.055	-0.167*	0.293	-0.185	-0.219	-0.285	-0.277	0.171
					Rural Area			
Liaoning	0.261	0.246	0.063		0.216	-0.258	-0.181	0.532***
Heilongjiang				-0.217	-0.082	0.014	-0.274	0.420**
Jiangsu	0.03	0.027	0.143	0.088	0.118	-0.426**	-0.467***	0.145
Shandong	0.095	-0.004	0.118	-0.219	-0.027	-0.209	-0.471***	0.118
Henan	0.147	-0.087	-0.266*	-0.404**	-0.593**	-0.843***	-0.648***	0.098
Hubei	-0.205	-0.148	-0.226	-0.224	0.116	-0.176	0.034	0.738**
Hunan	0.225*	0.078	0.141	0.271	0.023	-0.021	-0.409	0.05
Guangxi	0.185	0.059	0.118	-0.251**	0.047	-0.308*	-0.539***	-0.064

Continue...

Lower middle school	1989	1991	1993	1997	2000	2004	2006	2009
	Urban Area							
Liaoning	0.06	-0.072	0.004		-0.059	-0.178	-0.213	0.101
Heilongjiang				-0.07	0.329*	0.111	-0.084	0.447***
Jiangsu	0.268*	0.287	0.480***	0.031	0.133	0.308*	0.069	0.467***
Shandong	0.292**	-0.055	0.138	-0.324**	0.146	-0.203	-0.317*	0.370**
Henan	0.260*	0.092	0.006	-0.249	0.028	-0.381	-0.269*	0.287*
Hubei	0.213	0.148	0.226	-0.044	-0.07	0.061	0.069	0.426***
Hunan	0.329*	0.194	0.374**	0.095	0.044	0.319**	0.557***	0.176
Guangxi	0.142	-0.155*	0.208	-0.183	-0.104	-0.004	-0.637***	0.113
Guizhou	-0.038	-0.15	0.02	-0.285	0.205	-0.229	-0.206	0.21
	Rural Area							
Liaoning	0.022	0.108	0.097		-0.092	-0.022	-0.158	0.243
Heilongjiang				-0.345**	-0.089	-0.095	-0.380*	0.106
Jiangsu	0.149	-0.059	0.165	-0.079	0.095	-0.012	-0.264*	0.308**
Shandong	0.184	0.101	0.178	-0.358**	-0.004	-0.089	-0.114	0.227*
Henan	0.283	-0.169	0.069	-0.390**	-0.069	-0.249*	-0.104	0.312**
Hubei	-0.036	-0.095	-0.017	-0.312**	0.058	-0.221	-0.433***	0.174
Hunan	0.343**	0.076	-0.06	-0.028	0.07	0.241*	0.157	0.747**
Guangxi	0.072	0.143	0.209	-0.116	0.13	-0.014	-0.319*	0.125
Guizhou	0.106	-0.291**	0.287*	0.008	0.068	0.354*	-0.026	0.537***

Continue...

Upper school	1989	1991	1993	1997	2000	2004	2006	2009
	Urban Area							
Liaoning	0.207	0.004	-0.073		0.17	0.143	0.048	0.242*
Heilongjiang				-0.103	0.409**	0.594***	0.364**	0.815***
Jiangsu	0.226*	0.280***	0.593***	0.175	0.358*	0.681***	0.435**	0.891***
Shandong	0.183	0.015	0.298**	-0.06	0.282	0.036	-0.175	0.471**
Henan	0.181	0.004	-0.152	-0.099	0.187	0.24	0.21	0.452***
Hubei	0.348*	0.197**	0.256	0.001	0.243	0.01	0.058	0.692***
Hunan	0.365**	0.242**	0.268*	0.199	0.536***	0.619***	0.507***	0.825***
Guangxi	0.029	-0.166*	0.223	-0.116	0.045	0.293	0.115	0.412*
Guizhou	0.07	-0.011	0.249*	-0.224	0.151	0.483***	0.282	0.797***
	Rural Area							
Liaoning	0.03	0.077	-0.121		-0.11	0.032	0.085	0.420**
Heilongjiang				-0.510***	0.197	0.364**	0.127	0.626***
Jiangsu	0.109	-0.07	0.07	0.011	0.321	0.306	0.25	0.558***
Shandong	0.329*	0.054	0.239	-0.053	0.178	0.127	-0.053	0.138
Henan	-0.186	-0.158	-0.189	-0.228*	-0.012	-0.105	-0.176	0.199
Hubei	-0.006	-0.137	-0.063	-0.112	0.135	0.163	0.138	0.796***
Hunan	0.152	0.11	-0.058	0.099	0.218	0.346**	0.11	0.709***
Guangxi	-0.006	-0.08	0.064	-0.117	0.175	0.133	-0.069	0.275**
Guizhou	-0.016	-0.034	-0.149	-0.063	0.281	0.384*	0.12	1.012***

Continue...

College and above	1989	1991	1993	1997	2000	2004	2006	2009
	Urban Area							
Liaoning	0.239**	0.04	0.095		0.369*	0.785***	0.636***	1.005***
Heilongjiang				-0.233	0.608***	0.699***	0.650***	1.195***
Jiangsu	0.197	0.311***	0.294	0.374**	0.775***	0.934***	1.005***	1.367***
Shandong	0.516***	-0.149	0.251*	0.066	0.084	0.164	0.018	0.701***
Henan	0.220*	0.123	0.353**	0.362**	0.690***	0.637**	0.666***	0.818***
Hubei	0.482**	0.216**	0.574***	0.042	0.494**	0.471***	0.266*	1.121***
Hunan	0.488***	0.153	0.265	0.539***	0.784**	1.005***	0.907***	1.242***
Guangxi	0.131	0.065	0.432***	0.326***	0.611	0.441***	0.847***	0.966***
Guizhou	0.292**	-0.014	0.234*	-0.135	0.189	0.657*	0.538***	0.965***
	Rural Area							
Liaoning	0.246	0.119	0.037		0.04	0.195	0.420**	0.751***
Heilongjiang				-0.474***	0.272	0.339**	0.508***	0.873***
Jiangsu	0.089	-0.038	0.201	0.093	0.438*	1.316***	0.693***	0.970***
Shandong	0	0.073	-0.359***	-0.493***	0.1	0.274	0.171	0.669***
Henan	0.467***	0.845***		0.005	0.574	0.1	0.487*	0.479**
Hubei	-0.053	-0.078	0.27	0.290**	0.499*	0.424***	0.298**	0.647***
Hunan	0.287**	0.135	-0.039	-0.265	1.783	0.598***	0.242	1.058***
Guangxi	0.014	0.21	-0.523**	0.195*	0.332	0.194	0.390**	0.763***
Guizhou	-0.06	-0.081	-0.430***	-0.015	-0.038	0.389**	0.466**	0.927***

Note: The coefficients are incremental effects on the baseline group “primary school and below * Guizhou province * rural area”.

Table A2.3: Labour composition index (by province)

Average	LN	HLJ	JS	SD	HEN	HB	HUN	GX	GZ
1989	95.21	103.70	100.88	101.86	109.76	103.16	100.76	97.15	100.00
1990	94.74	104.01	100.79	101.85	111.11	103.34	100.88	96.63	99.70
1991	94.36	104.31	100.28	101.87	110.87	103.17	101.01	96.41	99.14
1992	94.13	104.59	99.79	101.84	110.40	103.11	101.09	96.48	98.67
1993	94.10	104.87	99.55	101.82	110.92	103.42	101.11	96.79	98.52
1994	94.14	105.13	99.42	101.80	111.78	103.82	101.01	97.18	98.47
1995	94.14	105.37	99.28	101.76	112.41	104.13	100.74	97.55	98.39
1996	94.11	105.60	99.13	101.72	112.84	104.36	100.34	97.89	98.28
1997	94.33	105.12	99.05	101.55	113.26	105.55	98.91	97.81	98.27
1998	94.24	105.30	99.33	101.53	113.56	105.10	98.77	98.27	98.31
1999	94.19	105.74	99.41	101.57	113.17	104.84	100.44	98.27	98.48
2000	94.06	105.85	99.50	101.71	116.40	104.66	103.36	98.90	98.68
2001	93.94	106.13	99.88	101.91	119.94	104.15	106.95	99.63	99.06
2002	94.01	105.97	98.35	101.94	121.52	106.52	108.10	99.31	100.42
2003	94.98	105.82	100.99	101.71	119.38	104.92	110.21	100.20	100.82
2004	95.69	106.02	100.37	101.50	121.91	104.75	110.02	102.34	102.33
2005	94.64	108.28	104.69	100.71	119.36	104.99	109.29	99.46	96.96
2006	94.52	107.02	104.67	101.08	119.27	105.51	108.76	100.66	97.48
2007	94.59	105.65	103.09	102.54	119.73	104.80	110.64	100.35	98.88
2008	95.54	104.68	103.39	102.74	120.81	104.37	111.15	100.21	101.50
2009	95.40	104.60	104.29	103.27	121.20	102.89	114.15	100.80	99.94
OLS	LN	HLJ	JS	SD	HEN	HB	HUN	GX	GZ
1989	101.30	104.79	103.09	103.68	102.72	103.58	101.68	99.89	100.00
1990	101.04	104.88	103.15	103.76	102.97	103.87	101.78	99.77	100.02
1991	100.82	104.95	103.16	103.96	103.04	104.08	101.80	99.80	99.84
1992	100.69	105.02	103.14	104.11	103.21	104.32	101.70	99.94	99.68
1993	100.71	105.08	103.19	104.21	103.77	104.70	101.41	100.11	99.73
1994	100.77	105.14	103.24	104.27	104.42	105.08	101.06	100.31	99.85
1995	100.79	105.20	103.26	104.28	104.91	105.35	100.75	100.52	99.91
1996	100.77	105.24	103.26	104.24	105.23	105.52	100.47	100.73	99.92
1997	101.37	105.00	103.07	104.11	105.73	106.39	99.66	100.70	99.94
1998	100.99	105.08	103.60	103.90	106.19	106.05	99.60	101.08	99.96
1999	101.06	105.25	103.85	103.77	105.72	105.84	100.81	100.98	100.17
2000	100.90	105.84	104.08	104.32	109.28	106.84	102.62	102.13	100.27
2001	100.72	106.63	104.59	105.06	113.17	107.99	104.85	103.35	100.47
2002	100.46	106.66	102.99	105.46	114.94	105.33	105.42	103.00	101.20
2003	103.19	106.76	105.81	104.96	112.03	107.07	106.91	104.26	101.90
2004	101.57	106.93	105.13	104.97	115.42	108.40	107.50	106.53	102.15
2005	101.76	108.92	109.81	103.20	112.52	107.54	106.56	103.49	99.33
2006	101.73	107.28	109.91	103.58	112.30	108.88	105.86	104.45	98.68
2007	101.78	107.34	108.03	104.42	112.69	107.92	107.66	103.40	99.51
2008	103.70	106.49	108.28	104.86	113.73	107.70	108.44	103.00	100.94
2009	104.10	106.77	109.34	105.23	114.18	107.16	109.83	103.79	100.03

Note: Province abbreviations (LN: Liaoning; HLJ: Heilongjiang; JS: Jiangsu; SD: Shandong; HEN: Henan; HB: Hubei; HUN: Hunan; GX: Guangxi; GZ: Guizhou)

Table A2.4: Labour composition index (by region)

	Average approach				OLS regression			
Year	Northeast	Coastal	Interior	West	Northeast	Coastal	Interior	West
1989	96.31	99.31	101.61	100.00	98.83	100.79	102.33	100.00
1990	95.81	99.28	101.96	99.62	98.57	100.88	102.52	99.96
1991	95.44	99.01	101.90	99.27	98.34	100.95	102.60	99.89
1992	95.22	98.73	101.81	99.09	98.20	100.98	102.67	99.87
1993	95.18	98.60	101.95	99.16	98.20	101.02	102.80	99.98
1994	95.24	98.52	102.12	99.31	98.27	101.06	102.93	100.14
1995	95.36	98.44	102.16	99.47	98.33	101.06	103.02	100.30
1996	95.52	98.36	102.11	99.62	98.38	101.04	103.04	100.47
1997	94.85	98.32	101.86	99.68	98.10	100.98	103.12	100.54
1998	95.16	98.33	101.76	99.82	98.20	101.07	103.11	100.64
1999	95.32	98.31	101.79	99.95	98.26	101.09	103.21	100.79
2000	95.26	98.83	102.98	100.41	98.38	101.76	104.68	101.41
2001	95.24	99.68	104.39	101.02	98.54	102.81	106.48	102.15
2002	95.31	99.72	104.00	101.22	98.64	102.90	105.56	102.22
2003	96.40	100.14	103.82	102.40	100.51	103.31	105.86	103.48
2004	96.52	99.82	104.49	103.87	99.41	103.16	107.64	104.58
2005	96.11	99.18	103.67	100.08	100.20	102.38	105.98	101.38
2006	95.67	99.46	103.71	100.74	99.54	102.66	106.04	101.47
2007	95.67	99.47	103.97	101.37	99.80	102.45	106.28	101.65
2008	96.06	100.15	104.31	102.20	100.51	103.05	106.82	102.14
2009	95.90	100.56	104.77	102.08	100.84	103.53	107.24	102.06

Table A3.1: The location of the 211 famous universities

Coastal region											
Province	Whole	Beijing	Tianjin	Hebei	Shanghai	Jiangsu	Zhejiang	Fujian	Shandong	Guangdong*	
Number	63	26	4	1	10	11	1	2	3	5	
Percentage	56%	23%	3%	1%	9%	10%	1%	2%	3%	4%	
Northeast region											
Province	Whole	Liaoning	Jilin	Heilongjiang							
Number	12	4	3	5							
Percentage	10%	3%	3%	4%							
Middle region											
Province	Whole	Shanxi	Anhui	Jiangxi	Henan	Hubei	Hunan				
Number	16	1	3	1	1	7	3				
Percentage	15%	1%	3%	1%	1%	6%	3%				
West region											
Province	Whole	Inner Mongolia	Guangxi	Sichuan*	Guizhou	Yunnan	Shaanxi	Gansu	Qinghai	Ningxia	Xinjiang
Number	24	1	1	7	1	1	8	1	1	1	2
Percentage	22%	1%	1%	6%	1%	1%	7%	1%	1%	1%	2%

Table A3.2: Data description

	Born before 1961	Born 1962-1980	Born in 1981 or after
	Male		
Real hourly wage rate (Yuan)	3.77	4.62	6.8
Years of schooling (Years)	8.96	10.12	10.59
Number of brothers	2.07	1.58	0.43
Number of sisters	1.89	1.65	0.81
Having tap water (%)	0.83	0.81	0.82
Experience (Years)	30.86	13.73	5.45
Urban (%)	0.49	0.41	0.38
	Female		
Real hourly wage rate (Yuan)	3.17	3.53	5.92
Years of schooling (Years)	8.35	9.98	11.18
Number of brothers	2.01	1.58	0.82
Number of sisters	2.06	1.67	0.64
Having tap water (%)	0.89	0.84	0.79
Experience (Years)	27.32	13.36	4.77
Urban (%)	0.58	0.47	0.43

Data source: CHNS 1989-2009

Table A3.3: OLS regressions

Dependent: ln (hourly wage)	All	Born before 1961	Born 1962-1980	Born in 1981 or after
		Male		
Schooling	0.015***	0.021***		
	0.004	0.004		
Schooling*year1991	-0.010*	-0.010*	0.001	
	0.006	0.006	0.012	
Schooling*year1993	-0.004	-0.005	0.008	
	0.007	0.008	0.013	
Schooling*year1997	0.01	0.011	0.018	
	0.009	0.01	0.011	
Schooling*year2000	0.032***	0.041***	0.032***	
	0.009	0.012	0.012	
Schooling*year2004	0.067***	0.068***	0.085***	0.082**
	0.009	0.012	0.01	0.033
Schooling*year2006	0.074***	0.077***	0.087***	0.080***
	0.008	0.011	0.011	0.028
Schooling*year2009	0.061***	0.073***	0.071***	0.069***
	0.008	0.016	0.01	0.025
R-squared	0.607	0.594	0.615	0.301
N	9961	5383	4255	323
		Female		
Schooling	0.025***	0.036***		
	0.006	0.007		
Schooling*year1991	0	-0.006	0.022**	
	0.008	0.009	0.011	
Schooling*year1993	-0.009	-0.013	0.004	
	0.009	0.011	0.016	
Schooling*year1997	0.006	-0.004	0.031**	
	0.011	0.015	0.013	
Schooling*year2000	0.035***	0.049***	0.035***	
	0.011	0.014	0.012	
Schooling*year2004	0.086***	0.071***	0.107***	0.103**
	0.011	0.02	0.012	0.04
Schooling*year2006	0.073***	0.046***	0.099***	0.095***
	0.01	0.014	0.012	0.023
Schooling*year2009	0.082***	0.031	0.114***	0.088***
	0.01	0.021	0.011	0.019
R-squared	0.608	0.57	0.609	0.346
N	6708	2742	3636	330

Note: The standard error adjusted by clusters. The significant levels are * for 10%; ** for 5% and *** for 1%. Experience, experience square, urban dummy, provincial dummies and year dummies are not reported.

Coefficients table for years of schooling:

	All	Born before 1961	Born 1962-1980	Born in 1981 or after
		Male		
1989	0.015	0.021		
1991	0.005	0.011	0	
1993	0.015	0.021	0	
1997	0.015	0.021	0	
2000	0.047	0.062	0.032	
2004	0.082	0.089	0.085	0.082
2006	0.089	0.098	0.087	0.162
2009	0.076	0.094	0.071	0.151
		Female		
1989	0.025	0.036		
1991	0.025	0.036	0.022	
1993	0.025	0.036	0.022	
1997	0.025	0.036	0.053	
2000	0.06	0.085	0.057	
2004	0.111	0.107	0.129	0.103
2006	0.098	0.082	0.121	0.198
2009	0.107	0.036	0.136	0.191

Table A3.4: First step of GIV regressions

Dependent: Years of schooling	All	Born before 1961	Born 1962-1980	Born in 1981or after
		Male		
Number of brothers	-0.163***	-0.199***	-0.131***	-0.325
	0.026	0.036	0.032	0.278
Number of sisters	-0.060**	0.025	-0.175***	0.054
	0.026	0.034	0.041	0.203
Having tap water	1.492***	1.512***	1.417***	1.056***
	0.108	0.147	0.113	0.292
R-squared	0.321	0.389	0.157	0.443
N	11415	5955	5020	440
F-test	78.46	44.81	62.67	5.19
		Female		
Number of brothers	-0.167***	-0.066	-0.214***	-0.011
	0.043	0.062	0.058	0.262
Number of sisters	-0.174***	-0.123***	-0.202***	-0.379*
	0.031	0.047	0.041	0.214
Having tap water	1.742***	1.867***	1.641***	1.534***
	0.135	0.23	0.137	0.288
R-squared	0.396	0.501	0.201	0.475
N	7926	3176	4309	441
F-test	68.32	23.32	60.18	13.44

Notes:

1. The standard error adjusted by clusters. The significant levels are * for 10%; ** for 5% and *** for 1%. Experience, experience square, urban dummy, provincial dummies and year dummies are not reported.
2. The chi-2 statistics are 308.14 between males and females, 274.4 among the male groups and 240.39 among the female groups.

Table A3.5: Second step of GIV regressions

Dependent: ln (hourly wage)	All	Born before 1961	Born 1962-1980	Born in 1981 or after
		Male		
Schooling	0.031***	0.061***		
	0.011	0.016		
Schooling*year1991	-0.013	-0.014	-0.012	
	0.011	0.011	0.04	
Schooling*year1993	0.014	0.009	0.035	
	0.014	0.015	0.052	
Schooling*year1997	0.003	-0.006	-0.017	
	0.015	0.016	0.034	
Schooling*year2000	0.039***	0.041**	0.025	
	0.014	0.017	0.035	
Schooling*year2004	0.072***	0.073***	0.161***	0.118*
	0.015	0.021	0.029	0.064
Schooling*year2006	0.098***	0.088***	0.188***	0.125***
	0.013	0.018	0.031	0.048
Schooling*year2009	0.079***	0.074***	0.103***	0.146***
	0.015	0.022	0.031	0.055
R-squared	0.596	0.582	0.607	0.282
N	9607	5212	4082	313
		Female		
Schooling	0.048***	0.068***		
	0.015	0.021		
Schooling*year1991	-0.014	-0.015	0.05	
	0.015	0.017	0.036	
Schooling*year1993	-0.023	-0.021	-0.01	
	0.016	0.017	0.036	
Schooling*year1997	-0.022	-0.025	0.002	
	0.018	0.02	0.033	
Schooling*year2000	0.024	0.034	0.041	
	0.017	0.021	0.028	
Schooling*year2004	0.052***	0.034	0.135***	0.175***
	0.018	0.026	0.025	0.05
Schooling*year2006	0.031*	0.003	0.116***	0.158***
	0.018	0.024	0.03	0.044
Schooling*year2009	0.075***	0.053*	0.137***	0.167***
	0.019	0.028	0.029	0.043
R-squared	0.586	0.567	0.584	0.337
N	6569	2704	3545	320

Note: The standard error adjusted by clusters. The significant levels are * for 10%; ** for 5% and *** for 1%. Experience, experience square, urban dummy, provincial dummies and year dummies are not reported.

Coefficients table for years of schooling:

	All	Born before 1961	Born 1962-1980	Born in 1981 or after
		Male		
1989	0.031	0.061		
1991	0.031	0.061	0	
1993	0.031	0.061	0	
1997	0.031	0.061	0	
2000	0.07	0.102	0	
2004	0.103	0.134	0.161	0.118
2006	0.129	0.149	0.188	0.243
2009	0.11	0.135	0.103	0.264
		Female		
1989	0.048	0.068		
1991	0.048	0.068	0	
1993	0.048	0.068	0	
1997	0.048	0.068	0	
2000	0.048	0.068	0	
2004	0.1	0.068	0.135	0.175
2006	0.079	0.068	0.116	0.333
2009	0.123	0.121	0.137	0.342

Table A4.1: Recode China's Input-Output tables to EU KLEMS code

China, Input-Output table in 1987, 1990, 1992 and 1995 - 33 industries	
Description	EU KLEMS code
Agriculture	AtB
Coal mining and dressing	C
Petroleum and natural gas extraction	C
Metals mining and dressing	C
Non-metal minerals mining and dressing	C
Food manufacturing	15
Textile industry	17
Sewing and leather industry	18t19
Timber processing and furniture	20
Papermaking and cultural, educational goods	21t22
Production and supply of electric power, steam and hot water	E
Petroleum processing	23
Coking, gas and products	E
Chemical industry	24
Construction material and other non-metal mineral products	26
Smelting and pressing of metals	28
Metal products	27
Machinery	29
Transport equipment	34
Electric equipment and machinery	31
Electric and telecommunications equipment	32
Instruments, meters and office equipment	33
Machinery repairing	31
Other industries	36
Construction	F
Transport and Post services	I
Commerce	G
Catering services	H
Passenger transport	I
Public and resident services	N
Education, culture and research	M
Finance and insurance	J
Government agencies	L

Continue...

China, Input-Output table in 1997 - 40 industries	
Description	EU KLEMS code
Agriculture	AtB
Coal mining and dressing	C
Petroleum and natural gas extraction	C
Metals mining and dressing	C
Non-metal minerals mining and dressing	C
Food and tobacco manufacturing	15t16
Textile industry	17
Garments, leather, down and related products	18t19
Timber processing and furniture	20
Papermaking and cultural, educational goods	21t22
Petroleum processing and coking	23
Chemical industry	24
Non-metal mineral products	26
Smelting and pressing of metals	28
Metal products	27
Machinery	29
Transport equipment	34
Electric equipment and machinery	31
Electric and telecommunications equipment	32
Instruments, meters and office equipment	33
Machinery repairing	31
Other industries	36
Recycling and disposal	37
Utilities	E
Production and supply of gas	E
Production and supply of tap water	E
Construction	F
Transport and Storage	I
Post and telecommunication services	I
Commerce	G
Catering services	H
Passengers transport	I
Finance and insurance	J
Real estate	K
Social services	K
Health care, sports and social welfare	N
Education, culture and arts, radio, film, and television	M
Scientific research	K
Polytechnic services	K
Government agencies and others	L

Continue...

China, Input-Output table in 2002 and 2007 - 42 industries	
Description	EU KLEMS code
Agriculture	AtB
Coal mining and dressing	C
Petroleum and natural gas extraction	C
Metals mining and dressing	C
Non-metal minerals mining and dressing	C
Food and tobacco manufacturing	15t16
Textile industry	17
Garments, leather, down and related products	18t19
Timber processing and furniture	20
Papermaking and cultural, educational goods	21t22
Petroleum processing and coking	23
Chemical industry	24
Non-metal mineral products	26
Smelting and pressing of metals	28
Metal products	27
Manufacturing of general and specific purpose machinery	29
Transport equipment	34
Electric equipment and machinery	31
Manufacturing of communication equipment, computers and other electronic equipment	32
Manufacturing of measuring instruments and machinery for cultural activity and office work	33
Other manufacturing	36
Recycling and disposal	37
Utilities	E
Production and supply of gas	E
Production and supply of tap water	E
Construction	F
Transport and Storage	I
Post and telecommunication services	I
Information transfer, computer services and software	K
Wholesale and retail trade	G
Accommodation and catering	H
Finance and insurance	J
Real estate	K
Leasing and commercial services	K
Tourism	I
Scientific research	K
Technical services	K
Other social welfare	K
Education	M
Health care, social insurance and welfare	N
Culture, sports and entertainment	N
Public administration and social organization	L

Appendix A4.2 Manufacturing subsector ratios derived from the seven Chinese Input-Output tables

Industry	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
15t16	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.6%	13.0%	13.3%	12.3%	11.7%
17	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%	10.7%	10.6%	10.6%	9.5%	8.8%
18t19	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.4%	3.5%	3.6%	3.7%	3.6%	3.6%
20	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.5%	1.4%
21t22	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.8%	5.5%	5.3%
23	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	3.9%	3.8%	3.6%	3.0%	2.6%
24	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%	15.2%	15.5%	15.7%	15.4%	15.1%
26	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.6%	8.9%	9.2%	9.6%	9.8%
27	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.1%	4.2%	4.2%	4.0%	3.8%
28	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.6%	8.4%	8.1%	9.3%	10.1%
29	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	11.7%	11.0%	10.4%	11.3%	12.0%
31	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.9%	5.3%	4.7%	4.3%	4.3%	4.4%
32	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.9%	2.9%	2.9%	2.9%
33	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%
34	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	4.0%	4.6%
36t37	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.1%	1.3%	1.6%	1.9%	2.1%

Continue….

Industry	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
15t16	13.1%	14.8%	16.6%	14.6%	13.1%	12.8%	12.6%	12.3%	12.0%	11.8%	11.5%	11.3%	11.0%	10.8%	10.5%
17	8.1%	7.5%	6.9%	8.1%	9.0%	8.2%	7.6%	6.9%	6.4%	5.8%	5.7%	5.5%	5.4%	5.2%	5.1%
18t19	4.1%	4.8%	5.5%	6.1%	6.5%	6.0%	5.5%	5.1%	4.6%	4.3%	4.2%	4.2%	4.2%	4.2%	4.2%
20	1.5%	1.7%	2.0%	2.1%	2.1%	2.3%	2.4%	2.5%	2.7%	2.8%	2.8%	2.8%	2.8%	2.7%	2.7%
21t22	5.2%	5.0%	4.8%	4.8%	4.8%	5.0%	5.3%	5.6%	5.9%	6.2%	5.6%	5.0%	4.5%	4.1%	3.7%
23	2.7%	2.8%	2.8%	2.6%	2.3%	2.4%	2.5%	2.6%	2.7%	2.7%	2.9%	3.1%	3.4%	3.6%	3.9%
24	14.8%	14.4%	14.0%	14.0%	14.0%	14.3%	14.5%	14.7%	15.0%	15.2%	14.7%	14.3%	13.9%	13.4%	13.0%
26	9.6%	9.5%	9.3%	9.4%	9.6%	8.4%	7.4%	6.5%	5.7%	5.0%	5.3%	5.5%	5.8%	6.2%	6.5%
27	3.8%	3.8%	3.7%	3.9%	4.0%	3.9%	3.9%	3.8%	3.8%	3.7%	3.7%	3.8%	3.8%	3.8%	3.8%
28	10.0%	9.8%	9.7%	7.3%	5.4%	6.1%	6.9%	7.7%	8.7%	9.8%	10.3%	10.8%	11.3%	11.8%	12.3%
29	11.1%	10.2%	9.4%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.5%	9.4%
31	4.4%	4.4%	4.4%	4.9%	5.3%	5.1%	5.0%	4.8%	4.6%	4.5%	4.6%	4.6%	4.7%	4.7%	4.8%
32	3.4%	4.0%	4.7%	4.4%	4.3%	4.7%	5.2%	5.8%	6.4%	7.1%	7.1%	7.1%	7.1%	7.1%	7.0%
33	0.7%	0.6%	0.5%	0.7%	0.9%	0.9%	1.0%	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
34	4.5%	4.5%	4.4%	4.6%	4.8%	5.1%	5.4%	5.8%	6.2%	6.6%	6.6%	6.6%	6.6%	6.6%	6.6%
36t37	1.2%	0.7%	0.4%	2.7%	4.4%	4.2%	4.1%	4.0%	3.8%	3.7%	4.0%	4.3%	4.6%	4.9%	5.3%