博士論文

The Effect of Inequality and Polarization on Growth, Innovation and Crime: Evidence from China

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2017 年 3 月

March 2017

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March 2017

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Acknowledgments

During the period this paper is accomplished, there are a lot of help and support from many people received.

Firstly, particular gratitude should be for my academic supervisor, professor Taro Akiyama. He gave me academic support and research guidance. Without his inspiration, I could not finish my PHD. Course. This paper is also based on his original ideas. In addition, I am indebted to him for his care in many ways. For example, he cares about my future career planning, and gives me a lot of valuable advices. From him, I learned rigorous research attitude and responsible personality. I appreciate Professor Masahito Kobayashi and Professor Tsunao Okumura for helpful comments and advices.

I am grateful to all professors and staff of Graduate School of International Social Sciences who helped me in my study. And there are thanks to my family and boyfriend Mr. Lai for their support and company in my days of studying abroad.

Finally, I am honored to have a PHD. Course in YNU, with the support and help from these people mentioned above, and I will continue to move forward with gratitude for them.

Contents

Chapter 1 Inequality and Polarization

Chapter 1：Inequality and Polarization

1.1 Introduction

In the last decades, income distribution problems have attracted more and more attention from worldwide. Theoretical and empirical literature on income distribution emerged in large number, which focused on indexes describing income distribution and relationship between them and economic growth or other social issue, for example, crime rate. Income distribution problems could be described by income inequality and polarization.

About inequality, GINI coefficient is universally used, which measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. It is also generally accepted that GINI coefficient is used to reflect poverty and society unrest of countries. (world bank database) in addition, there are other indexes is used in empirical research, such as Theil index (Takahiro Akita,2001; Jacek Kochanowicz, Joanna Rymaszewska and Joanna Tyrowicz, 2008; ect.), GE index (generalize entropy index), and Atkinson index and so on.

About polarization, discussion of “middle-class empty” from 1980s is accepted as a start that authors research income distribution problem not only from inequality but also polarization perspective. (Tuo Sheng, 2014) It is conceptually different between inequality and polarization. And several authors have argued that polarization is intimately connected with conflict. (Chakravarty 2009; Esteban and Ray, 1994 etc.) According to data of various countries and regions, empirical results of relationship between polarization and growth or conflict were different. (Sripad Motiram and Nayantara Sarma, 2011; Jose G. Montalvo and Marta Reynal-Querol, 2010. ect.)

In the case of China, although GINI coefficient was down to 0.474 which is the lowest value in decade before, it far exceeded the international alertness line level of 0.4. (World Bank Database) Some researchers focused on computational method of inequality and polarization adjusting to the situation of China. (Weimin Tian, 2012; Tuo Sheng, 2014. ect.) While others paid attention to relationship between rapidly widening wealth gap and miracle of economic growth, innovation, well-being and crime rate and so on. (Nong ZHU, Xubei LUO and Cuizhen ZHANG, 2007. ect.) Just last years, polarization began to attract scholars' attention in China, while foreign researchers have noted the importance of polarization which in rapidly developing multinational country, which may lead to social discontent and create or intensify social conflicts (manifested in strikes, demonstrations, riots, or social unrest) and political instability (Esteban and Ray, 1994, 1999, 2011; Alesina and Perotti, 1996).

In this paper, we discuss inequality and polarization in china and their effect on economic growth, innovation and crime in chapter 2, chapter3, chapter4. This chapter is structured as follows. Section 2 presents the literature review. Section 3 is about the evolution of inequality. Section 4 presents the evolution of polarization. Section 5 presents difference between polarization and inequality. Section 6 is the conclusions.

1.2 Literature Review

In the last decades, we have witnessed the emergence of an extensive body of theoretical and empirical literature. The study on inequality start from about 1890's. Pareto proposed that income is a variable with distribution. Based on that, Lorenz propose "Lorenz curve". The area between Lorenz curve and absolute equality line is known as "GINI coefficient". The GINI coefficient is widely used to represent

income inequality level of country or a region. World Bank calculate and announced annual data of GINI coefficient and delineate 0.4 for the warning line. An extensive body of study on impact of inequality on development, poverty and social stability emergence in last decades. Scholars use different indexes to describe inequality for different topics.

Measurement of income inequality can be divided in two kinds. Kolm-Pollak Index is an absolute index, basing on researches of Kolm (1976) and Pollak (1971). GINI coefficient and other indexes belong to relative index, like Atkinson Index, Theil Index and Coefficient of Variation. Atkinson (1970) used the symmetric utilitarian social welfare function and defined what he called the “equally distributed equivalent income “, and identifies a functional form for Atkinson index. Theil (1967) propose generalized entropy index from the concept of information entropy theory. The higher generalized entropy index means more average income distribution.

Over the last 15 years or so, the study of polarization has become quite important. Its role in analyzing the income distribution evolution, social conflict, and economic growth is the major reason of rising concern. Polarization is concerned with appearance of groups in a distribution. Polarization is realized as “bipolarization”, with the reason of thriving middle class. Bipolarization indexes have been investigated in details by Foster and Wolfson (1992), Wolfson (1994, 1997), Wang and Tsui (2000), chakravarty and Majumder (2001), Duclos and Echevin (2005), Chakravarty et al (2007), and others. Esteban and Ray (1994) developed a more general notion of polarization. They assumed that the society is divided into groups or poles, where the individuals belonging to the same group have a feeling of identification and there is a feeling of alienation against individuals in a different group. And they regard the concept of polarization. Others suggest result of Esteban and Ray’s researches, like Zhang and Kanbur (2001), Duclos et al

(2004), and Esteban et al. (2007).

Some researchers focused on computational method of inequality and polarization adjusting to the situation of China. (Weimin Tian, 2012; Tuo Sheng, 2014. ect.)

1.3 The Evolution of Inequality

The empirical study on inequality begin from about 1890's. Pareto (1895) focus on statistical method of inequality issue firstly. Income is disposed as a variable with statistical distribution function in Pareto's paper. Lorenz (1905) propose famous "Lorenz curve" base on correcting income logarithmic curves by Pareto, and GINI coefficient is defined by measures the area between the Lorenz curve and a hypothetical line of absolute equality. Then GINI coefficient is generally recognized and applied. Scholars (Cowell, 1980; Shorrocks, 2013; Theil, 1967, 1972; Atkinson, 1907. et. al.) explore lots indexes to describe income and measure inequality.

Measurement of income inequality can be divided in two kinds, the absolute index and the relative index. Absolute index is simple calculatedly but inaccurate, like variance, range and Kolm-Pollak index and so on. Relative index is applied more generally, being not affected by dimension. There are some indexes of inequality listed in Table 1.1.

In addition to those given in Table 1.1, there are others used in literatures, like relative mean deviation and third quintiles (Masako Oyama, 2014). GINI coefficient is adopted in this paper in the form of panel and cross section data.

Table 1.1 The measurement of inequality

Indexes	Calculation	Illustration	Type
GINI coefficient	$\mathrm{GINI} = \frac{1}{2\mathrm{n}^2\mathrm{Y}}\sum_{\mathrm{i}=1}^{\mathrm{n}}\sum_{\mathrm{j}=1}^{\mathrm{n}}\lvert\mathrm{Y_i} - \mathrm{Y_j}\rvert$ or $\mathrm{GINI} = 1 - 2\int_0^1 Q(p)dp$	p is proportion of population, Q is income.	Relative
Coefficient of Variation	$\mathrm{CV} = \frac{1}{Y}\sqrt{\frac{\sum_{i=1}^{n}(Y_i - Y)^2 F_i}{n}}$ or $\mathrm{CV} = \frac{\sqrt{\int_0^1 (Q(p)-\mu)^2 dp}}{\mu}$	F is population weight.	Relative
Atkinson Index	$\mathrm{At} = 1 - [\frac{1}{n}\sum_{i=1}^{n}\left(\frac{Y_i}{Y}\right)^{1-\varepsilon}]^{\frac{1}{1-\varepsilon}}$ or $\mathrm{At} = \begin{cases} 1 - \frac{(\int_0^1 Q(p)^{1-\varepsilon}dp)^{\frac{1}{1-\varepsilon}}}{\mu}, \varepsilon \neq 1 \\ 1 - \frac{\exp(\int_0^1 lnQ(p)dp)}{\mu}, \varepsilon = 1 \end{cases}$	ε is aversion parameter.	Relative
Theil Index (Generalized Entropy Index)	$\mathrm{GE}(\theta) = \frac{1}{\theta^2 - \theta}[\frac{1}{n}\sum_{i=1}^{n}(\frac{Y_I}{Y})^{\theta} - 1]$	θ is aversion parameter.	Relative
Kolm-Pollak Index	$\mathrm{KP} = \lambda(\mathrm{x}) + \frac{1}{\beta} log \frac{1}{n}\sum_{i=1}^{n}(\exp(-\beta x_i))$	λ is unit translatable.	Absolute

1.4 The Evolution of Polarization

The history of study on polarization is shorter than inequality, and over the last 15 years or so, the study on polarization has become quite important. One notion of income polarization, which we refer to as bipolarization, is concerned with the decline of the middle class.

According the literatures, there are two main approaches to conceptualize polarization. The first approach measures polarization by arbitrary number of groupings in a continuous or discrete distribution. (Esteban and Ray, 1991, 1994; Estaban et al, 2007; Duclos et al, 2004) The second approach measures polarization by bipolarization. (Foster and Wolfson, 1992; Wolfson, 1994).

According the paper of Estaban and Ray (1994), the definition of polarization: the population is grouped into significantly-sized “clusters”, such that each cluster is “very similar” in terms of the attributes of its members, but different clusters have members with very “dissimilar” attributes.

As Esteban and Ray (2012) assume, all measures of polarization share some basic characteristics:

a) The impact of single individuals on polarization measures is negligible, since polarization describes the features and relative positions of social groups.

b) With two or more groups, polarization increases when intragroup inequality is reduced.

c) Polarization rises when distances between groups are increased.

Several measurements of polarization have been proposed by scholars. The most frequently uses are showed in table 1.2.

Table 1.2 The measurements of polarization

Indexes	Calculation	Grouping	Reference
Wolfson Index	$\mathrm{W} = \frac{2\mu}{m}(\frac{\mu_H - \mu_L}{\mu} - G)$	Above and below median	Wolfson (1994)
Bipolarization Index	$\mathrm{B} = \frac{(\frac{1}{n}\sum_{i=1}^{n}\lvert m - x_i\rvert^{\varepsilon})^{\frac{1}{\varepsilon}}}{m}$, $0 < \varepsilon < 1$	Above and below median	Chakravarty (2007)
Relative Bipolarization Curve	RB(x,j/k)=$\begin{cases}\frac{1}{km}\sum_{j\le i\le k}(m - x_i) & if\, x_j \le m \\ \frac{1}{km}\sum_{k\le i\le j}(x_i - m) & if\, x_j \le m\end{cases}$	According to percentiles. (j/k)	Chakravarty and Majumder (2001)
ER Index	$\mathrm{ER}(\alpha) = \mathrm{K}\sum_{i=1}^{n}\sum_{j=1}^{n} p_i^{\alpha+1} p_j \lvert y_i - y_j\rvert$	Defined by authors	Esteban and Ray (1994)
DER Index	$\mathrm{DER}(\alpha) = \frac{1}{2\mu^{1-\alpha}}\iint f(x)^{1+\alpha} f(y)\lvert y - x\rvert dydx$	No	Duclos, Esteban and Ray (2004)

ER index is used in chapter 2 to describe the income gap between urban and rural, which have a natural grouping. DER index is used in chapter 3 and 4, which is calculated with GINI coefficient by setting parameter.

1.5 The difference between polarization and inequality

The conceptual difference between polarization and inequality is most evident when considering property b), referring to 1.4. Income polarization means the frequency of observations is concentrated on several extreme values, formatting fault between groups. For example, in the case of bipolarization, the relative frequency of observations associated with the extreme values is high compared to those in the central values.

Compared to inequality, polarization emphasizes the distance between income groups and densities in income groups, which is defined as “identification-alienation” framework. (Duclos et al. 2004)

An example from the paper of Esteban and Ray(1994) is quoted to explain the difference between polarization and inequality visually. There are two kinds of income distribution S1 and S2. For S1, there are 4 levels of income, and the gap between groups is 1. For S2, there are 2 levels of income, and the gap between 2 groups is 2. Assuming S1 and S2 have same size of population, it is showed in figure 1.3 that the Lorenz curve of S1 is farer from absolute equality line than S2. It means the inequality of S2 is lower than S1, although S2 presents a distribution which can reflect the characters of polarization.

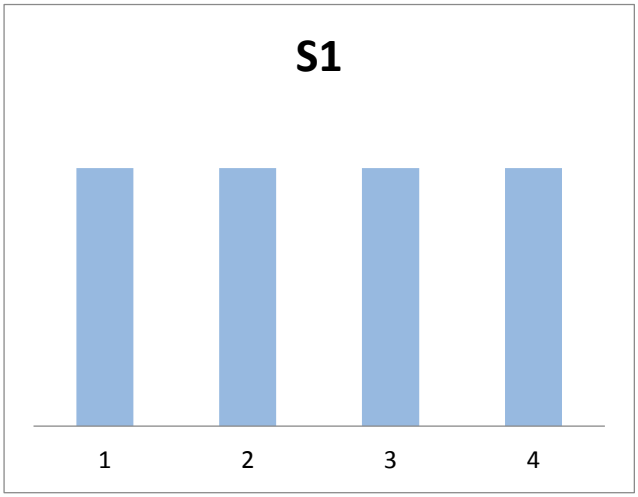

Figure 1.1 The distribution of inequality

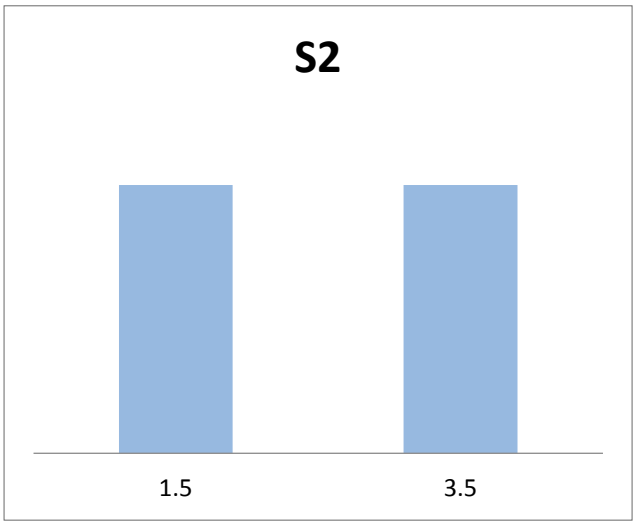

Figure 1.2 The distribution of polarization

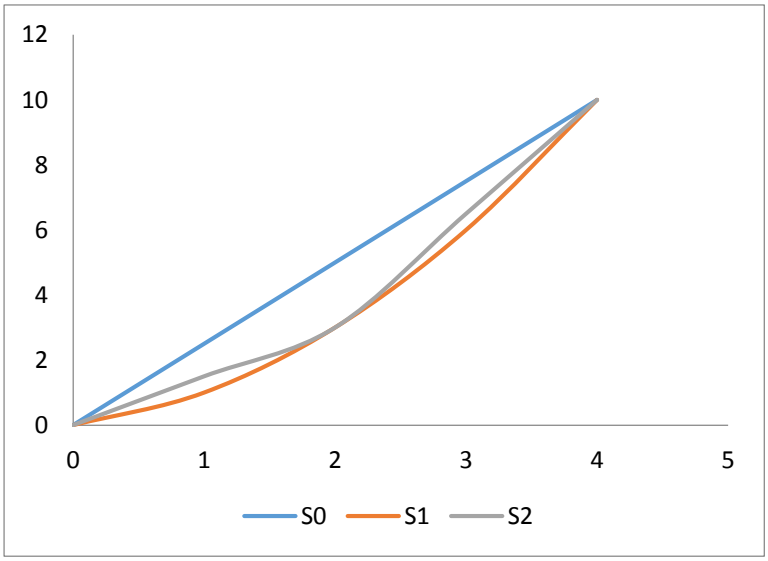

Figure 1.3 The Lorenz curve of S1 and S2

* Figure 1.1, Figure 1.2 and Figure 1.3 are quoted from Esteban and Ray. 1994. “On the Measurement of Polarization”

1.6 conclusion

Inequality and polarization have attracted a substantial amount of attention in academe. They are different conceptually, and significant economically. Scholars have different methods to measure them, and focused on the effect of inequality and polarization on growth and social stability. This chapter summarizes the commonly used calculation methods, and illustrates the difference between inequality and polarization. The rest is discussed in the remaining chapters.

References

Alesina, A. and Perotti, R. (1996), “Income Distribution, Political Instability, and Investment”. *European Economic Review*, 40, 1203- 1228.

Atkinson, T. (1970). “On the measurement of inequality”. *Journal of Economic Theory,* 2, 244-263.

Chakravarty, S. (2007). “A deprivation-based axiomatic characterization of the absolute Bonferroni index of inequality”. *Journal of Economic Inequality,* Volume 5, Issue 3, 339–351.

Chakravarty, S. and Majumder, A. (2001). “Inequality, polarization and welfare: theory and application”. *Australian Economic Papers*, Volume 40, Issue 1, 1-110.

Cowell. F.A. (1980). “On the structure of additive inequality measure”. *Review of Economic studies,* 47, 521-531.

Duclos, J. and Echevin, D. (2005). “Bipolarization comparisons”. *Economics Letters,* Volume 87, Issue 2, 249–258.

Duclos, J., Esteban, J., and Ray, D. (2004). “Polarization: concepts, measurement, estimation”. *Econometrica,* Volume 72, Issue 6, 1737–1772.

Esteban, J. and Ray, D. (1994). “On the Measurement of Polarization”. *Econometrica*, Volume 62, No. 4, 819-851.

Esteban, J., Gradin, C. and Ray, D. (2007). “Extensions of a measure of polarization, with an application to income distribution of five OECD countries”. *Journal of Economic Inequality,* 5(1), 1-19.

Foster, J.E. and Wolfson, M.C. (1992). “Polarization and the decline of the middle class: Canada and the US”. *Oxford Poverty & Human Development Initiative(OPHI) WORKING PAPER NO. 31.*

Kuzenets, S. (1955). “Economic Growth and Income Inequality”. *The American Economic Review,* Vol. 45, Issue 1, 1-28.

Kochanowicz, J., Rymaszewska, J. and Tyrowicz, J. (2008). “Intra-provincial inequalities and economic growth in China”. *Mpra Paper.* No. 15044.

Kolm, S. (1976). “Unequal inequalities Ⅰ “. *Journal of Economic Theory,* 12, 416-442.

Kolm, S. (1976). “Unequal inequalities Ⅱ “. *Journal of Economic Theory,* 13, 82-111.

Lorenz, M.O. (1905). “Methods of measuring the concentration of wealth”. *Publications of American Statistical Association,* Vol. 9, No. 70, 209-219.

Masako Oyama. (2014). “How does income distribution affect economic growth? Evidence from Japanese prefectural data”. *The Institute of Social and Economic Research Osaka University.* Discussion Paper No. 910.

Pareto, V. (1895). “La legge della domanda”. *Giornale degli Economisti,* 10, 59–68. *English translation in Rivista di Politica Economica,* 87 (1997), 691–700.

Pollak, R.A. (1971). “Additive utility functions and linear Engel curves”. *Review of Economic Studies,* Vol. 38, No. 4, 401-414.

Shorrocks, A. (2013). “Decomposition procedures for distributional analysis: a unified framework based on the shapley value”. *The Journal of Economic Inequality,* Vol. 11, issue 1, 99-126.

Takahiro Akita. 2001. “Regional income inequality in China a two-stage Nested inequality decomposition analysis”. *International development, graduate school of international relations, international university of Japan.* Working Paper No.9

Theil, H. (1967). “Economics and information theory”. *Amsterdam: North-Holland Publishing Company.*

Theil, H. (1972). “Statistical decomposition analysis”. *Amsterdam: North-Holland*

Publishing Company.

Tian, W. (2012). “Measurement and analysis of the Gini coefficient provinces in China” in Chinese. *Economic Science,* 2012(2),48-59.

Wang, Y. and Tsui, K. (2000). “Polarization orderings and new classes of polarization indices”. *Journal of Public Economic Theory,* Vol. 2, Issue 3, 349-363.

Wolfson, M.C. (1994). “When inequalities diverge”. *American Economic Review,* Vol. 84, No. 2, 353-358.

Wolfson, M.C. (1997). “Divergent inequalities: theory and empirical results”. *Review of Income and We*alth, Vol. 43, Issue 4, 401–421.

Zhang, X. and Kanbur, R. (2001). “What differences do polarization measures make? An application to China”. *Journal of Development Studies*, Vol. 37, Issue 3, 85-98.

Chapter 2 Inequality, Polarization and Growth: Empirical Issues of China

Chapter 2：Inequality, Polarization and Growth: Empirical Issues of China

2.1 Introduction

The relationship between income distribution and economic growth is one of important issues of economics research in recent decades. The theoretical literature has proposed numerous transmission channels through which income distribution may affect growth both positively and negatively. Particularly, discussion about inequality began earlier than polarization. The effect of income inequality has attracted a lot of attention of scholars since Kuznets (1955) made a groundbreaking contribution by proposing his famous inverted-U hypothesis, called Kuznets curve.

However, the substantive conclusions of empirical studies seem to be very sensitive to the quality or comparability of data, to the sample coverage, and to the econometric specification (de Dominicis et al. , 2008) Forbes (2000) argues that the existence of a positive correlation and negative correlation between income inequality and economic growth may not be mutually exclusive. Barro (2000) report the opposite effect in countries with different income levels.

Esteban and Ray (1994) believe that the income polarization is more suitable than inequality for exploring the link between income distribution and economic growth, because of its effect on social tension, which has a negative impact on economic growth. More and more scholars have begun to focus on polarization as another issue of income distribution. (Barro, 1991; Voitchovsky, 2009; and so on)

The results of empirical studies on polarization are also inconsistent. Scholars use different indicators basing on dataset from different countries and regions to report evidence that polarization may affect economic growth positively or negatively. (Moriram and Sarma, 2011; Brzezinski, 2013; Chen and Sun, 2014; and

so on)

Among the many indicators of polarization (as DER, Wolfson index and so on mentioned in chapter 1), ER index is used in issue of China (Chen and Sun, 2014), because “urban-rural” dual development form in China provide a natural condition of polarization. When grouping data is not available, “urban-rural” income gap province a research route of income polarization and economic growth.

This chapter is structured as follows. Section 2 presents the literature review about effect of income distribution on economic growth theoretically and empirically. Section 3 describes the indexes and data, and the measures of income inequality and polarization are introduced in Section 2.3.1, and independent variable is introduced in Section 2.3.2, while other variables are explained in Section 2.3.3. Section 4 presents the research method. Section 5 offers the analysis of result. Section 6 presents the conclusions.

2.2 Literature review

Income distribution issue has been one of central issues for long time. One of the biggest controversy is the relationship between income distribution and economic growth. It will be reviewed in this section that the theoretical foundations and empirical results about the effect of inequality and polarization on economic growth.

2.2.1 Theoretical foundation of inequality

As summary in the paper of Kochanowicz et al. (2008), inequality is not only a result but also a reason of economic growth. Scholars try to explain the channels of inequality-growth interaction by accumulation, skills differences and arguments of political economy, stability or credit constraints. According to Barro (2000), these

theories can be classified into four categories: credit-market imperfections, political economy, social instability and saving rates. Concerning incentives is added as a category by Benabou (1996), and others.

The effects of inequality on growth are ambiguous through the mechanisms above. A rise in inequality tends to raise aggregate rate of saving and enhance economic growth at least in a transitional sense. And skill differences in certain range could improve the productivity. The explanations of political economy are various. As one of them, fiscal channel is a important line of argument link inequality and growth, proposed by Alesina and Rodrik (1994) and others.

2.2.2 Theoretical foundation of polarization

Esteban and Ray (2011) propose a behavioral theory of conflict across social groups, which implies that the conflict is linearly related to polarization. This link between economic polarization and conflicts has direct and negative consequences for growth.

From another point of view, polarization has often been associated with the "disappearing of the middle class". (Wolfson, 1994) various economic theories suggest that a stable and sizable middle class is a source of new entrepreneur, by increasing saving and promoting human capital, and creating demand for quality consumer goods. (Banerjee and Duflo, 2008) Therefore, polarization may affect growth in a negative way.

2.2.3 About "urban-rural" dual development structure

Since 1958, the urban-rural barrier based on the household registration system has formatted. After the reform and opening-up, the rural labor force begun to flow into urban area. But because of the different resource allocation, the gap between rural and urban area is aggressive, representing in development of agriculture and other industries (industry and services), education and public

facilities, income level, and consumption capacity. It has become a consensus that "urban-rural" dual development structure is a serious obstacle of development in China.

2.2.4 Empirical evidence of relationship between income distribution and economic growth

The results of empirical researches are various, and sensitive to quality of data, the sample coverage, and the econometric specification. Michat Brzezinski (2013) prove that income polarization measured by DER and Wolfson index has a negative impact on growth in the short term, while the impact of income inequality on growth is statistically insignificant, using an unbalanced panel of more than 70 countries of EU during the 1960-2005 period. Using the panel data of EU similarly, Barro (2000) conclude that the negative effect of inequality on growth shows up for poor countries, but that the relationship for rich countries is positive, and the overall effects of inequality on growth are weak.

In the empirical research about India, Motiram and Sarma (2011) argue that there is a weakly negative relationship between increase of polarization and growth. Based on data in prefecture level of Japan, the effect of inequality measured by the third quintile on growth is significantly positive, while the effect of inequality measured by GINI is negative sometimes. (MASAKO OYAMA, 2014)

In the research about China, inequality is increasing in both rural and urban area, particularly, in urban area (Nong ZHU, Xubei LUO, Cuizhen ZHANG. 2007). There is a coincident process of inequality and growth (Kenneth S. Chan, Xianbo Zhou, Zhewen Pan. 2014). The urban-rural income polarization measured by ER index in certain level may improve economic growth in the region.

2.3 Indexes and Data

The dataset used in this chapter is panel data of 24 provinces from 1996~2010.

The data for main indexes in the model used in this chapter are from China National Statistical Yearbook. In order to make the results more valid, the indexes used in the chapter are calculated by using multiple original indexes from yearbooks.

2.3.1 Inequality and polarization

About inequality, urban-rural Theil coefficient (Jacek Kochanowicz, Joanna Rymaszewska and Joanna Tyrowicz, 2008), two-stage nested Theil coefficient (Takahiro Akita, 2001), third quintiles (Masako Oyama, 2014) and other indexes are adopted. However, GINI coefficient is most widely used in literatures (Robert J Barro, 2000; Michat Brzezinski, 2013. et. al.)

Because the original data is unavailable, we adopt GINI coefficient, the result of literature. GINI coefficient is from Weimin Tian (2012), calculated by

$$\mathrm{GINI} = 1 - \frac{1}{PW}\sum_{i=1}^{n}(W_{i-1} + W_i)P_i$$

Where P is population, W is income, W_i is accumulated income until group i. The equation group the population with incomelevel, avoiding the issue of equally and unequally grouping.

About polarization, various indexes are adopted by scholars, like relative bipolarization (Sripad Motiram and Nayantara Sarma, 2011), DER index (Michat Brzezinski, 2013) and ER coefficient (F. Chen and X. Sun, 2014). Urban-rural ER coefficient is used in this chapter, measured

$$\mathrm{ER}\ (\alpha) = \mathrm{K}\sum_{i=1}^{n}\sum_{j=1}^{n} p_i^{\alpha+1} p_j |y_i - y_j|$$

Where K is population standardization constant, K=1/2. α is sensibility parameter, and there is no obvious change in the value of the ER index with different α. so it is set as α=1.3 simply (F. Chen and X. Sun, 2014). p_i is population share of group I, y_i is per capita income of group I. In this chapter, group i is urban group, group j is rural group.

It should be noted that the index “per capita total income of urban household” is adopted to describe income level of urban. The Total Household Income refers to the sum of wage income, net business income, property income, transfer income given to all family members living together in the investigation of the resulting during the household surveys not including the sale of property and lending revenues. It can reflect the ability to improve the quality of life and afford a variety of social insurance.

While the index “per capita net income of rural household” is adopted to describe income level of rural. Net income of rural household refers to the total income of rural households from all sources minus all corresponding expenses. It can reflect the income level of rural and ability to expand reproduction and improve the quality of life in a given area.

In “urban-rural” dual economic structure, the income level of two sectors should be calculated by different indicators. Data and explanation of both of two indicators are from China National Statistical Yearbook 2003-2011.

In table 2.1, it shows provinces in descending order of GINI and ER in 2010. In chart 2.1 and chart 2.2, they show the geographical and sequential position of provinces. It is shown in table 2.1, chart 2.1 and chart 2.2 that distributions of GINI and DER are not totally same regionally.

Table 2.1 Provinces in descending order of GINI and ER in 2010

GINI	ER
GUIZHOU	ZHEJIANG
QINGHAI	GUANGDONG
GANSU	FUJIAN
GUANGXI	JIANGSU
NINGXIA	GUANGXI
SHANXI	CHONGQING
XINJIANG	NEIMENGGU
NEIMENGGU	SHAANXI
GUANGDONG	NINGXIA
SHAANXI	LIAONING
CHONGQING	ANHUI
HENAN	SHANXI
SICHUAN	HUBEI
FUJIAN	SICHUAN
ANHUI	QINGHAI
HUBEI	HEBEI
JIANGSU	HENAN
ZHEJIANG	BEIJING
HEBEI	GUIZHOU
JIANGXI	JIANGXI
LIAONING	XINJIANG
HEILONGJIANG	GANSU
SHANGHAI	SHANGHAI
BEIJING	HEILONGJIANG

Chart 2.1 Distributions of GINI regionally in 2010

Chart 2.2 Distributions of ER regionally in 2010

2.3.2 Dependent variables

For the dependent variable economic growth, per capita GDP or GDP is most commonly used to represent economic growth when analysis the relationship between income distribution and economic growth. Real GDP (1996 constant prices) is calculated to be the dependent variable. In order to make the results more valid, the logarithm to GDP data is adopted in this chapter.

Because of regional method used in this chapter (see section 2.4), it don not need to calculate growth rate of real GDP. In order to observe the trend of income distribution and growth rate directly, it is shown in Chart 2.3 that there is the positive relationship between real GDP growth rate and GINI of the provinces in 2010, while the relationship between real GDP growth rate and ER of the provinces in 2010 is negative. It is shown that the trend line of relationship between GINI and growth rate is sharply upward while the trend line of relationship between ER and Growth rate is mild. It should be noted that the charts just show institution only in the year of 2010.

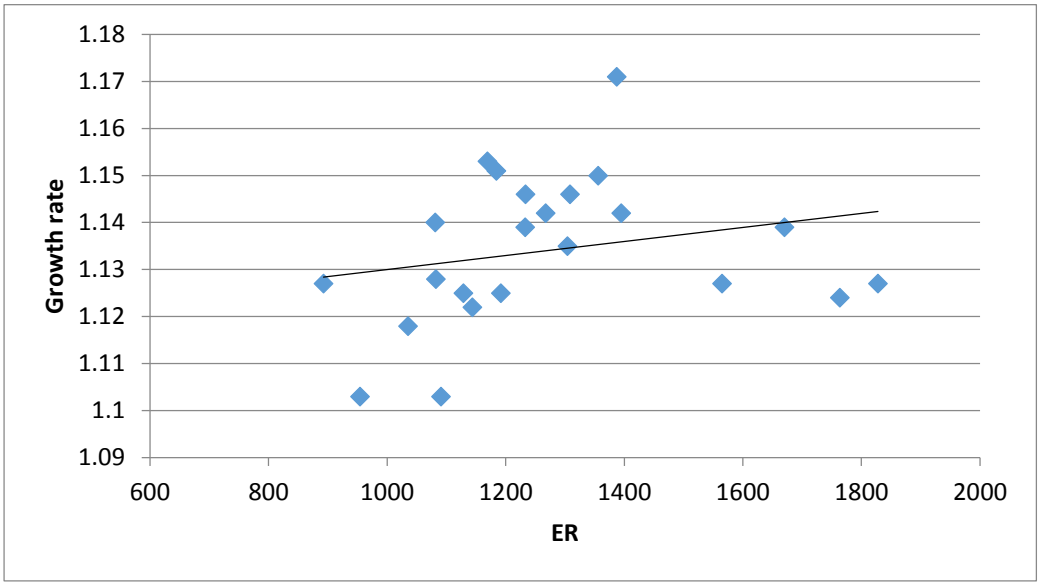

Chart 2.3 (1) the scatter of ER and growth rate of provinces in 2010

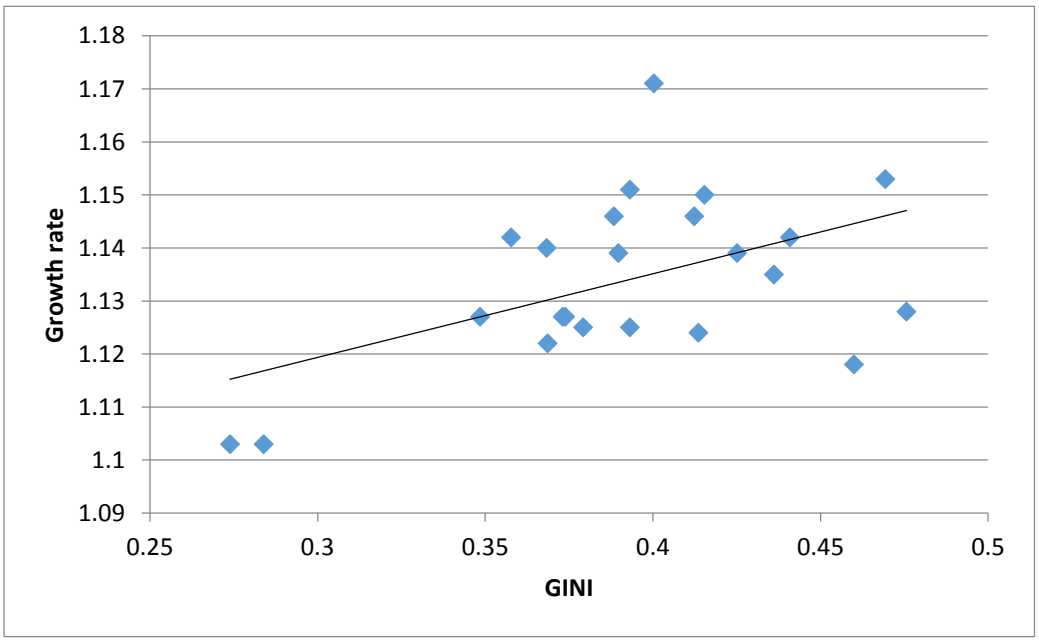

Chart 2.3 (2) the scatter of GINI and growth rate of provinces in 2010

2.3.3 Independent variables

For the control variables, investment is chosen as one of engines of economic growth. The variable of investment is measured by the logarithm of real total fixed asset investment (1996 constant prices) and the input-output ratio of the province, and the former represents the absolute amount, while the latter represents the efficiency of production. The two indicators are used in different regression to ensure the robustness.

The other important control variable is urbanization rate. Urbanization is a population shift from rural to urban areas, meaning occupational shift of population, shift of the way land capital used on, and shift of industrial structure. It has been one of the main reasons for economic and income growth in China, since reform and opening-up.

The variable of urban residents' disposable income growth rate is adopted to describe growth of urban development and income level. The impact of the degree of urban-rural income polarization on economic growth is closely related to the actual urban-rural income level. (Chen and Sun, 2014)

Education is an important factor affecting regional development. The average years of schooling in the population aged 25 and over is adopted in research of Brzezinski (2013), but because of the unavailability of data at the provincial level, the index of literacy rate is adopted in this chapter. The gap of literacy rate of provinces is not very clear, except the backward class.

The natural population growth rate was also added to the control variables. Population growth rate means not only the growth of labors but also the burden of economic.

Table 2.2 shows the variables used in the chapter, and table 2.3 presents the descriptive statistics of all of variables in 1-year interval panel and 3-year interval

panel data. All of the raw data is from publications of the National Bureau of statistics of China.

The correlation matrix is shown in table 2.4. ER and GINI are not correlative closely in two panels. The independent variables of the panels are in a low level collinearity, assuring the validity of the regression.

Table 2.2 Other variables used estimation

Index	Description	Data source
GDP	Log (real GDP) * 1996 constant prices	China National Statistical Yearbook 1996-2011
Investment	Log(Real total fixed asset Investment) * 1996 constant prices	China National Statistical Yearbook 1996-2011 The Gross Domestic Product of China 1952-1995
Input-output ratio	Real Investment/Real GDP	China National Statistical Yearbook 1996-2011
Urbanization rate	The percentage of urban population	China National Statistical Yearbook 1996-2011
Education	The ratio of people who can read and write in the legal labors over the age of 15	China National Statistical Yearbook 1996-2011
UDGR	Urban residents' disposable income growth rate	China National Statistical Yearbook 1996-2011
P	Natural population growth rate	China National Statistical Yearbook 1996-2011

Table 2.3 (1) Descriptive statistics of variables (annual)

Variables	Mean	Std. Dev	Min.	Max.
GDP	8.149014	1.028857	5.215859	10.46528
GINI	0.380665	0.058160	0.227500	0.490700
ER	618.6543	369.8888	135.6068	1827.946
Investment	7.288522	1.085636	4.278054	9.733855
Input-output ratio	0.451246	0.169465	0.205235	1.139656
Education	88.44654	6.769325	56.38000	98.30000
Urbanization rate	0.417122	0.162316	0.138600	0.893000
UDYR	1.094903	0.044259	1.000000	1.246041

Table 2.3 (2) Descriptive statistics of variables (3-year)

Variables	Mean	Std. Dev	Min.	Max.
GDP	8.256891	1.035836	5.390000	10.47000
GINI	0.382141	0.056804	0.229300	0.490700
ER	690.2842	401.3899	152.1559	1827.946
Investment	7.470088	1.091222	4.627946	9.733855
Input-output ratio	0.486736	0.185133	0.228221	1.139656
Urbanization rate	0.430641	0.161544	0.140400	0.893000
P	1.005937	0.003346	0.998200	1.014480

Table 2.4 (1) Correlation matrix of independent variables (annual)

	GINI	ER	Investment	Input-output ratio	Education	Urbanization rate	UDYR
GINI	1	0.346619	-0.095924	0.380601	-0.145045	-0.287195	0315586
ER		1	0.723413	0.611739	0.502769	0.478009	0.478452
Investment	-	-	1	0.299470	0.685315	0.442675	0.377110
Input-output ratio	-	-	-	1	0.177591	0.215757	0.360824
Education	-	-	-	-	1	0.532616	0.309138
Urbanization rate	-	-	-	-	-	1	0.283000
UDYR	-	-	-	-	-	-	1

Table 2.4 (2) Correlation matrix of independent variables (3-year)

	GINI	ER	Investment	Input-output ratio	Urbanization rate	P
GINI	1	0.295157	-0.136757	0.380722	-0.329569	0.404073
ER	-	1	0.734729	0.622644	0.475703	-0.209873
Investment	-	-	1	0.296451	0.449186	-0.560261
Input-output ratio	-	-	-	1	0.171793	0.042786
Urbanization rate	-	-	-	-	1	-0.554540
P	-	-	-	-	-	1

2.4 Model

Panel data models are used in this chapter, similar to models used in the inequality-growth literature (Robert J. Barro, 2000; Michat Brzezinski, 2013).

In the model of inequality-growth, the estimated equation takes the following form:

$$y_{it} - y_{i,t-1} = (\alpha - 1)y_{i,t-1} + \beta x_{it} + \mu_{it}$$

Where i=1, … , N denotes a province and t=1, …, T is time with t and t-1 one-year or three-year interval. The variable y is the log of real GDP per capita. The approximate growth rate of a province between t and t-1 is given by the left-hand side of estimated equation. The $y_{i,t-1}$ on the right-hand side controls for convergence, while the vector x_{it} includes current or lagged values of a number of control variables. It includes GINI coefficient at t-1, investment index at t, and the Natural population growth rate at t-1. μ_{it} is an error term.

In the model of polarization-growth, the estimated equation takes the following form:

$$y_{it} = \alpha y_{i,t-1} + \beta x_{it} + \mu_{it}$$

Where i=1, … , N denotes a province and t=1, …, T is time with t and t-1 one-year apart. The variable y is real GDP per capita growth rate. The vector x_{it} includes current or lagged values of a number of control variables. It includes ER coefficient, GINI coefficient and the Natural population growth rate at t-1, investment growth rate, consumption growth rate and UDGR at t. μ_{it} is an error term.

The standard estimation methods (like OLS, fixed-effects or random-effects model for panel data) do not account for the dynamic structure of the estimated equation. The presence of a lagged dependent variable means that the OLS

estimator is biased and inconsistent. The main approach in estimating equation is to use the generalized method of moment (GMM) estimator. (Michat Brzezinski, 2013) Moreover, in GMM model, the requirement on random error term is relatively loose than other method, allowing the heteroscedasticity and dependence. In this chapter, EVIEWS 6.0 is adopted to estimate the equation.

2.5 Result and discussions

Results of estimation are shown in table 2.5. The first part of the table contains the usual information, including estimation method, time period and the number of cross-section. The results are apart to two tables according to time interval. It is shown in Colum Coefficient (prob.) in both of table 2.5(1) and (2) that the coefficients of ER index and GINI index is inverse. The impact of inequality on economic growth is positive and the impact of polarization on economic growth is negative. The results of ER and GINI are significant in both annual and 3-year time interval. However, the invest indicators are almost significant in annual time interval while the urbanization rate is significant in 3-year time interval. The education and population growth indicators are insignificant in the models using them.

The coefficients of GINI are significant and positive in both annual and 3-year time interval at significance level of 10%, while the coefficients of ER are significant and negative in both annual and 3-year time interval at the same significant level. And the coefficients are aggressive over the subsequent 3-year period in long-term model.

The results about negative impact of income polarization are similar with the results of Brzezinski's research (2013) using DER index and Wolfson index. The middle class, who can fill the gap urban and rural in this chapter, plays an important

role in linking distribution and growth through modelling the level of redistribution and stressing the size of domestic demand for manufactured goods (Zweimüller, 2000 and so on). And polarization can bring negative consequences for growth by leading to crime, social discontent and creating social conflicts (Esteban and Ray, 1994, 1999, 2011). The relationship of polarization and crime will be tested empirically in Chapter 4 of this paper.

The results about positive impact of income polarization are similar with the results of the research of Kochanowicz et al. (2013) using Theil index of China's data. They believe that inequality is inevitable and in some way also positive as motivating for work and innovation, then positively related to growth. The relationship of inequality and innovation will be discussed empirically in Chapter 3 of this paper.

In the regression with annual time interval, the significant coefficients of investment and input-output ratio are positive. Investment and productivity in one-period lag is important factor of economic growth, however, investment index of absolute value lost its statistical significance over the subsequent 3-year period while the effect of input-output ratio is still positive and significant. In a long-term model, production efficiency has sustainable driving force for the regional development.

The variables of urbanization and UDYR do not have significant coefficients in short-term model, while the coefficient of urbanization rate become significant and positive in long-term model. Rural surplus labor could be transferred to urban, leading to the increase of rural income level and regional demand size. The effect of urbanization on economic growth is valid in long-term model.

The education variable in one-period lag is used in the short-term model, but insignificant. As the explanation in Section 2.3.3, the quality of data may lead to

unsatisfactory result, although it is proved in literatures that education is a important factor to improve economic growth.

The natural population growth rate in one-period lag is used in the long-term model, and also insignificant.

Table 2.5 Estimation Results of Inequality (GINI index) and Polarization (ER index)

Dependent variable: GDP

Periods: 1996~2010

Cross-section: 24

Method: panel generalized method of moments

Effects specification: cross-section fixed

(1) Time interval: Annual

Variable	Coefficient (Prob.)		
GDP (-1)	1.054303 (0.0000)	0.993479 (0.0000)	0.957616 (0.0000)
GINI (-1)	1.414619 (0.0850)	0.501891 (0.0000)	0.344758 (0.0000)
ER (-1)	-0.000393 (0.0337)	-2.68E-05 (0.0136)	-3.93E-05 (0.0428)
Input-output ratio (-1)	-0.239147 (0.5229)	0.104038 (0.0012)	-
Investment (-1)	-	-	0.057138 (0.0000)
Education (-1)	0.001853 (0.2813)	-	-
UDYR	-0.024431 (0.7904)	-	0.032906 (0.1073)
Urbanization rate (-1)	-	0.021589 (0.1128)	-

(2) Time interval: 3-year

Variable	Coefficient (Prob.)		
GDP (-1)	1.138270 (0.0000)	1.139973 (0.0000)	1.093330 (0.0000)
GINI (-1)	0.962901 (0.0305)	1.004129 (0.0003)	0.957857 (0.0002)
ER (-1)	-0.000249 (0.0003)	-0.000252 (0.0312)	-0.000238 (0.0364)
Input-output ratio (-1)	0.132513 (0.0720)	0.134807 (0.0684)	-
Investment (-1)	-	-	0.046255 (0.1625)
Urbanization rate (-1)	0.300651 (0.0000)	0.295451 (0.0000)	0.291523 (0.0000)
P	-	2.551796 (0.4323)	0.764713 (0.8060)

2.6 Conclusions

The effects of inequality on growth are ambiguous through the mechanisms of accumulation, skills differences and arguments of political economy, stability or credit constraints. Polarization may affect growth in a negative way by leading to conflict and reducing of middle class which is related to increasing saving and promoting human capital, and creating demand for quality consumer goods.

GINI index and urban-rural ER index is adopted in this chapter. And the distributions of GINI and DER are not totally same regionally, which presents the different of inequality and polarization in definition.

The result of GMM regression on panel data of 24 provinces during 1996-2010 period shows that the impact of inequality on economic growth is positive and significant while the impact of polarization on economic growth is negative and significant in both short-term model and long-term model. Intra-provincial inequality is a factor to promote economic growth, but the gap of “urban-rural” is harmful. The “urban-rural” development structure should be changed in the future, and the lives of labors who are from rural region should be improved.

References

Alesina, A. and Rodrik, D. (1994). “Distributive Politics and Economic Growth”. *Quarterly journal of economics,* 109(2), 465-90.

Banerjee, A. and Duflo, E. (2008). “What is Middle Class about Middle Classes around the World?” *Journal of Economic Perspectives*, 22(2), 3-28.

Barro, R.J. (1991). “Economic Growth in a Cross Section of Countries”. *Quarterly Journal of Economics,* 106, 407-444.

Barro, R.J. (2000). “Inequality and Growth in a Panel of Countries”. *Journal of Economic Growth,* Vol. 5, Issue 1, 5-32.

Benabou, R. (1996). “Inequality and Growth”. *NBER Working Paper, No.5658.*

Bhattarai, K. and Chen, N. (2014). “Rural Urban Income and Consumption Gaps across Provinces of China, 1978-2008”. *Advances in Economics and Business 2(2):* 70-77.

Brzezinski, M. (2013). “Income Polarization and Economic Growth”. *National Bank of Poland Working Paper No. 147.*

Chan, K.S., Zhou, X. and Pan, Z. (2014). “The Growth and Inequality Nexus: The Case of China”. *International Review of Economics and Finance,* Vol. 34, Issue C, 230-236.

Chen, F. and Sun, X. (2014). “Urban-rural Income Polarization and Economic Growth in China: Evidence from the Analysis of a Dynamic Panel Data Model”. *Applied Economics,* Vol. 46, Issue 32, 4008-4023.

de Dominicis, L., Florax, R. J. and De Groot, H. L. (2008). “A Meta-Analysis on the Relationship between Income Inequality and Economic Growth”. *Scottish Journal of Political Economy,* 55(5), 654-682.

Esteban, J. and Ray, D. (1994). “On the Measurement of Polarization”. *Econometrica,*

64(4), 819-851.

Esteban, J. and Ray, D. (1999). “Conflict and Distribution”. *Journal of Economic Theory,* 87(2), 379-415.

Esteban, J. and Ray, D. (2011). “Linking Conflict to Inequality and Polarization”. *American Economic Review,* 101, 1345-1374.

Forbes, K. (2000). “A Reassessment of the Relationship between Inequality and Growth”. *American Economic Review,* 90(4), 869-887.

kochanoweicz, J., Rymaszewska, J. and Tyrowicz, J. (2008). “Intra-Provincial Inequality and Economic Growth in China”. *Faculty of Economic Sciences, University of Warsaw Working Papers No. 10.*

Kuznets, S. (1955). “Economic Growth and Income Inequality”. *American Economic Review,* Vol. 45, No. 1, 1-28.

Masako Oyama. (2014). “How does Income Distribution Affect Economic Growth? Evidence from Japanese Prefectural Data”. *The Institute of Social and Economic Research, Osaka University. Discussion Paper No. 910.*

Motiram, S. and Sarma, N. (2011). “Polarization, Inequality and Growth: The Indian Experience”. *Indira Gandhi Institute of Development Research, Mumbai. 2011.*

Persson, T. and Tabellini, G. (1994). “Is Inequality Harmful for Growth? Theory and Evidence”. *American Economic Review, 84(3), 600-621.*

Tian, W. (2012). “Measurement and analysis of the Gini coefficient of the provinces” in Chinese. *Economic Science,* 2012(2), 48-59.

Voitchovsky, S. (2009). “Inequality and Economic Growth, in: Wiemer Salverda, Brian Nolan, and Tim Smeeding (eds)”. The Oxford Handbook of Economic Inequality. *Oxford: Oxford University Press.*

Wolfson, M.C. (1994). “When Inequality Diverge”. *American Economic Review,* 84(2), 353-358.

Zhu, N., Luo, X. and Zhang, C. (2007) “Growth, Inequality and Poverty Reduction: A Case Study of Eight Provinces in China”. *CERDI-IDREC, University of Auvergne, France.*

Zweimüller, J. (2000). “Schumpeterian Enterpreneurs Meet Engel’s Law: The Impact of Inequality on Innovation-Driven Growth”. *Journal of Economic Growth,* 5(2), 185-206.

Chapter 3 Inequality, Polarization and Innovation: Empirical Issues of China

Chapter 3: Inequality, Polarization and Innovation: Empirical Issues of China

3.1 Introduction

That the past decades have witnessed a sharp increase in technological innovation which is a major driving force for economic development, particularly for developing countries. “Scientific and technological innovation is the strategic support to improve social productive forces and the comprehensive national strength.” proposed in the report of the Communist Party of China.

Innovation not only plays a role in the economic development, but can also impact income inequality. While there are more and more scholars starting to concern the impact of the innovation level on income inequality (Qingchun Liu and C.-Y. Cynthia Lin Lawell, Ping Li and Tinghua Liu, et al.), there is less concern about the effect of income distribution problem including inequality and polarization on innovation. The distribution of skill may make innovation processes to be a reason of increase in income inequality. (Qingchun Liu and C.-Y. Cynthia Lin Lawell, 2015)

There are four mechanisms to explain the relation between inequality and innovation through impact of innovation on skill premia. The first focuses on that higher skilled worker ted to earn higher returns in higher innovation. (Van Reenen, 1996. Faggio, Salvanes and Van Reenen, 2007.) The second focuses on knowledge spillovers, which allow those workers with fewer skillers to learn from the highly skilled and increase their productivity, therefor income inequality will decrease. (Glaeser, 1999) The third focuses on the spatial agglomeration effect of innovation, which result labor migration. (Van Reenen, 1996.) The fourth focuses on that technological advances may change the employment shares and wages for the different skill groups. (Levy and Murnane, 2003.)

According cities and the creative theory, social assets, human capital and

regional inclusiveness are main conditions of innovation in an area. Income distribution of labors have a close relationship with concentration and immigration of skilled-labors. (Richard Florida, 2009, 2010)

While lots of literatures focus on the impact of innovation on income and economic growth, this paper try to search the impact of inequality and polarization on innovation empirically. This paper examines the impact of income inequality and polarization on innovation respectively. The innovation index is described by binary variable whether local enterprises launch new products, which measures innovation in a micro level. Meanwhile, inequality and polarization is computed from a micro-level dataset.

This chapter is structured as follow. Section 2 presents the literature review. Section 3 describes the indexes and data. Section 4 presents the research method. Section 5 offers the analysis of result. Section 6 presents the conclusions.

3.2 Literature Review

According to endogenous growth theory, a major driving force for economic growth is technological progress. Innovation is thought as an endogenous factor of income inequality and policy to protect the exclusivity of technology can exacerbate inequality in paper of Shenbiao Pan (2011). In paper of Qingchun Liu and C.-Y.Cynthia Lin Lawell (2015), the effect of innovation on income distribution relevant for skill premia is summarized as four mechanisms.

The first mechanism by which innovation can impact skill premia then leading income inequality is that higher skill workers tend to earn higher returns in higher innovation regions. The second mechanism by which innovation can impact skill premia then leading income inequality is through knowledge spillovers. Workers with fewer skills to learn from the highly skilled and increase their productivity. But

the conclusions about whether innovative environments can raise productivity for low-skilled groups are various. The third mechanism by which innovation can impact skill premia then leading income inequality is through the spatial agglomeration effects of innovation. Innovation can produce great gains which results in labor migration, however the impact of migration on overall inequality is ambiguous. The fourth mechanism is that technological advances may change the employment shares and wages for the different skill groups.

In the creative cities theory, income in high level attract labors with high skill and high level of education, which is the kay driving force of innovation and development in cities. Then, immigration of high-skilled labors could bring soaring real estate and commodity price, squeezing native and low-skilled labors, for example works of service sector, out of cities. Polarization between high-skilled labors and low-skilled labors destroy inclusiveness and diversity which are also important conditions of innovation and development as provider of comfortable working and social environment. Concentration of skilled labors could cause a vicious circle between regional closeness and polarization. (Richard Florida, 2009, 2010) Based on this theory, this paper tries to verify the effect of inequality and polarization on regional innovation.

In empirical aspect about effect of innovation on relationship, Qingchun Liu and C.-Y.Cynthia Lin Lawell (2015) show that there is a U-shaped relationship between the innovation level and the income gap between urban and rural regions by panel data of China. They also show that there is an inverse U-shaped relationship between innovation and the proportion of the population that is high-skilled.

As the result of empirical research basing on data of China in 1985-2006, it is shown that there is long-term stable relationship between innovation and inequality, and domestic innovation in 1 lag period is reason of income inequality,

so is spillover of foreign technology. But there is not significant effect of inequality on innovation. (Ping Li and Tinghua Liu, 2009)

Greenwood and Mukoyama (2001) prove that the scale of income distribution can stimulate innovation motivation by using partial equilibrium model, although there is opposite conclusion in other papers (Young, 1993. Ping Li and Tinghua Liu, 2009). Reto and Joset (2006) also support that income inequality could affect innovation through price effect and market size effect. The higher the degree of inequality, the more demand of top group for new products.

Some scholars try to explain the relationship between income distribution and innovation. Fan Hongzhong (2007) finds that income gap could stunt improvement of R&D, even more serious than other factors under certain conditions. Hongguang Sui and Tinghua Liu (2015) argue that large income gap is disincentive to innovation through causing the fault of consumption structure, the lack of social demand and the inefficient allocation of economic resource. While Ling Shen and Guoqiang Tian (2009) argue that a certain income gap could increase demand of high-tech products, and a higher relative income of the urban residents is good for innovation, but a larger population share of the rural residents is bad for innovation.

Literatures have proved that there is a close relationship between income distribution and innovation, however, most of researchers focus on the relationship between inequality and innovation, while impact of polarization is not paid enough attention. The polarization index in this study is DER index, of which the original data is from micro survey. The data of innovation is also from micro dataset to pursue valid result.

3.3 Indexes and Data

The data for main variables used in this chapter are from Urban Household and Expenditure Survey (UHIES) by the National Bureau of Statistics (NBS) of China and Enterprise Survey 2012 by the World Bank. Some macro-level indexes from China National Statistical Yearbook 2011 are used as independent variables.

3.3.1 Polarization and Inequality

The data used to calculate polarization and inequality in this chapter is based on Urban Household Income and Expenditure survey (UHIES) by the National Bureau of Statistics (NBS) of China. This yearly data contains household data from eight representative provinces of China (Beijing, Liaoning, Zhejiang, Anhui, Hubei, Guangdong, Sichuan, and Shanxi) in year 2002-2009. Polarization and inequality indexes are estimated for 7 provinces (Beijing, Liaoning, Zhejiang, Anhui, Hubei, Guangdong and Sichuan) in year 2009, using wage level. Because of the deficiency of enterprises data in Shanxi province.

DER index and GINI index calculated by wage level could reflect the polarization and inequality between high-skilled labors and low-skilled labors.

DER index is used to express polarization, while Gini coefficient is used to express inequality, which are estimated by SPSS statistics software. These are micro-level datasets which will make the results more valid.

By imposing a set of axioms, Duclos et al (2004) derive the following family of polarization measures:

$$\mathrm{DER}(\alpha) = \frac{1}{2\mu^{1-\alpha}} \iint f(x)^{1+\alpha} f(y)|y-x|dydx, \ \alpha \in [0.25,1]$$

Where f is the density function of the relevant distribution, μ is the mean income and α is an ethical parameter expressing the weight given to the identification part of the frame work.

When $\alpha = 0$, DER index is equal to Gini coefficient of inequality.

$$\text{Gini} = \text{DER}(\alpha = 0) = \frac{1}{2\mu}\iint f(x)f(y)|y - x|dydx$$

Let $$\text{DER}(\alpha) = \frac{1}{2\mu^{1-\alpha}}P_\alpha(F) = \frac{1}{2\mu^{1-\alpha}}\int f(y)^{1+\alpha}a(y)dF(y)$$

Where observations of income drawn from the distribution F(y) and ordered such that: $y_1 \le y_2 \le \cdots \le y_n$

Then the natural estimator of P (F) is $P_\alpha(\hat{F}) = \frac{1}{n}\sum_{i=1}^{n}\hat{f}(y_i)^\alpha\,\hat{a}(y_i)$,

Where $\hat{a}(y_i) = \hat{\mu} + y_i\left[\frac{1}{n}(2i-1) - 1\right] - \frac{1}{n}(2\sum_{j=1}^{i-1}y_j + y_i)$

$$\hat{f}(y_i) \equiv \frac{1}{n}\sum_{i=1}^{n}K_h\,(y - y_i) \text{ with } K_h(z) \equiv \frac{1}{h}K(\frac{z}{h})$$

According to Duclos et al., a estimation of h is $h^* \approx 4.7n^{-0.5}\sigma\alpha^{0.1}$

A simple decomposition suggested by Duclos et al.(2004) is :

$$\text{DER} = \bar{\alpha} * \bar{t_\alpha}(1 + \rho)$$

Where $\bar{\alpha}$ is the alienation (suggested by Gini), $\bar{t_\alpha}$ is identification (according to α), and ρ is the corelation factor between the former two.

In table 3.1, it shows provinces in descending order of DER and GINI. In chart 3.1 and chart 3.2, they show the geographical and sequential position of provinces. It is shown in table 3.1, chart 3.1 and chart 3.2 that distributions of GINI and DER are not totally same regionally.

Table 3.1 Provinces in descending order of DER and GINI

DER	GINI
Zhejiang	Zhejiang
Liaoning	Liaoning
Anhui	Anhui
Hubei	Guangdong
Sichuan	Hubei
Guangdong	Sichuan
Beijing	Beijing

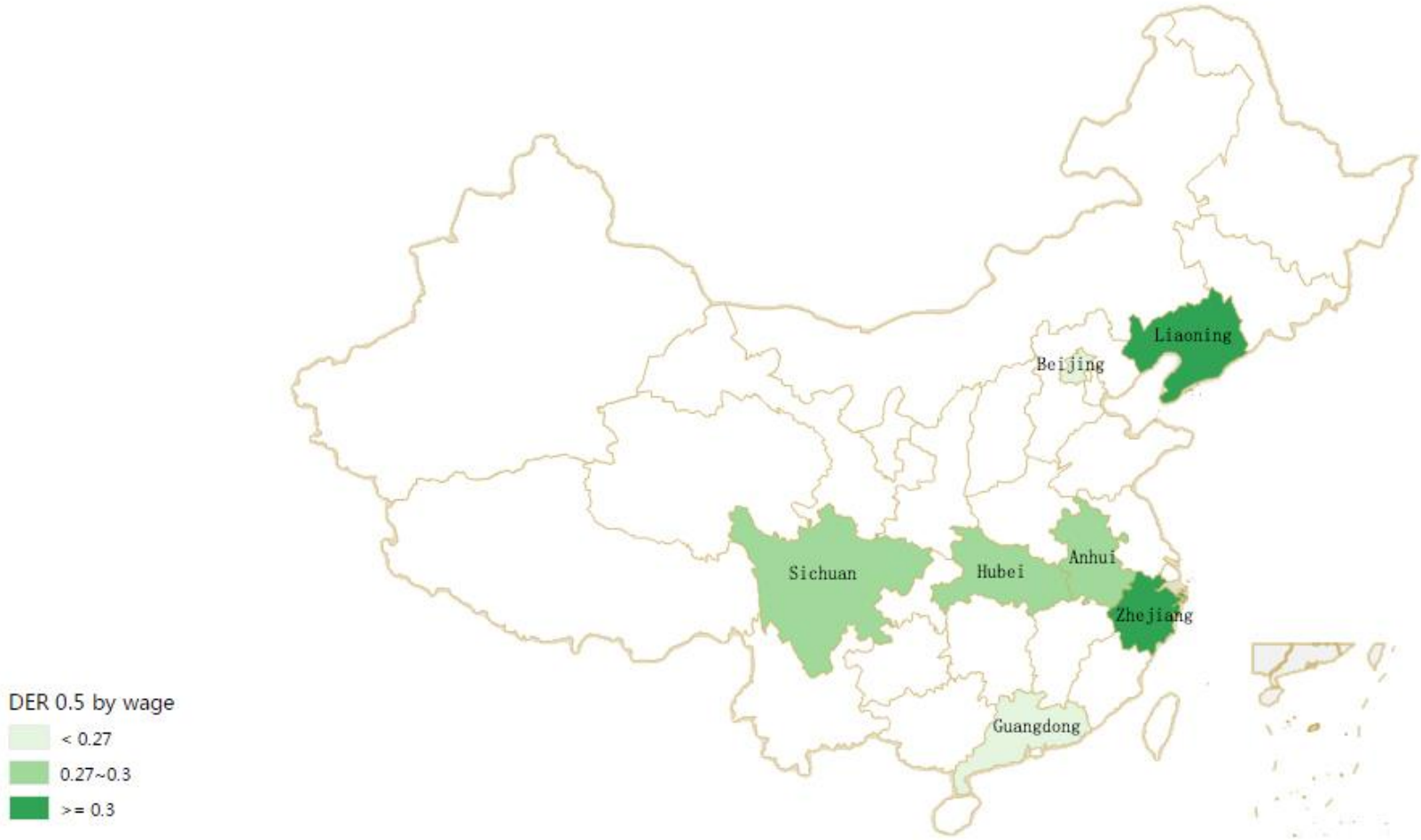

Chart 3.1 Distributions of DER(0.5) regionally

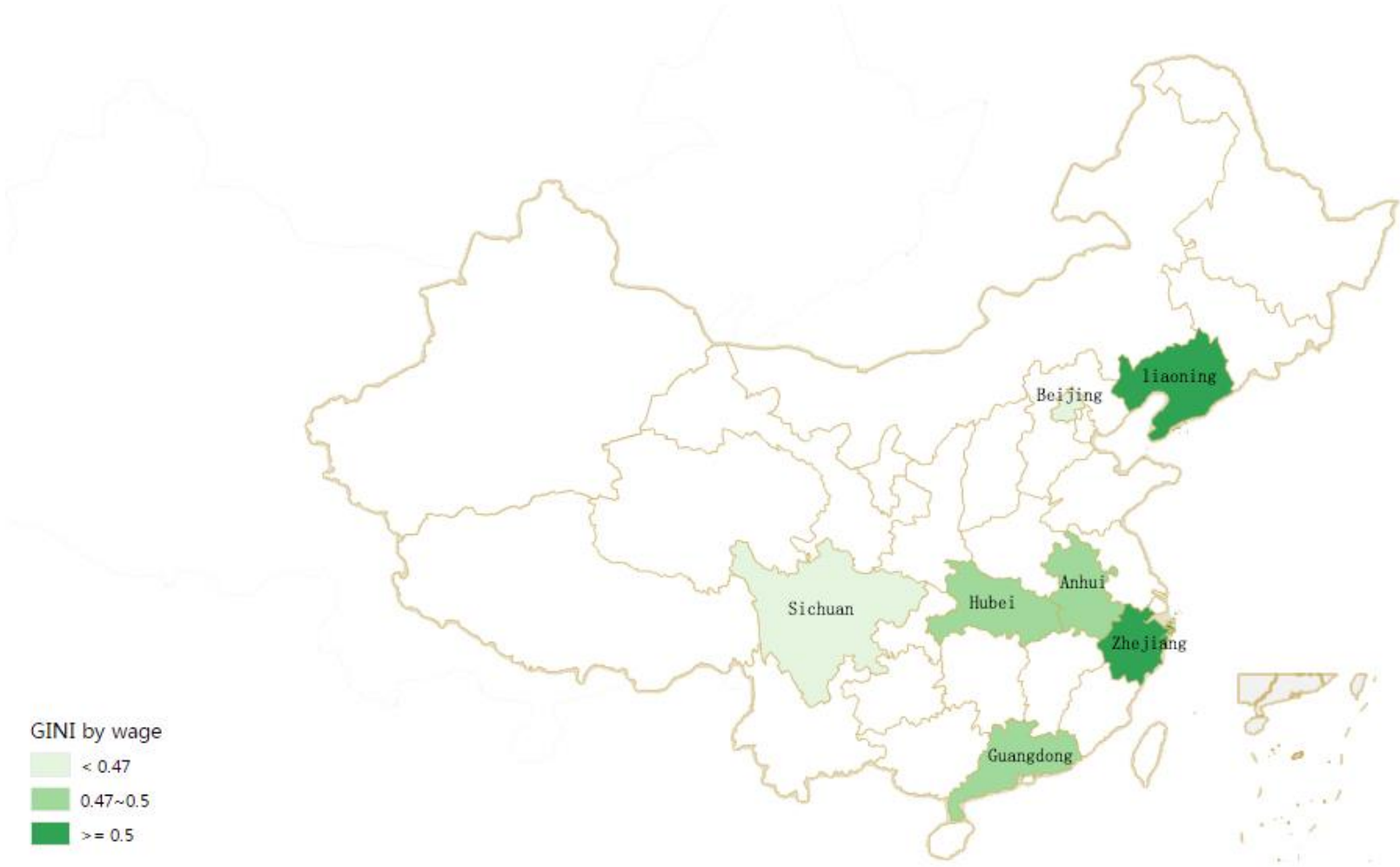

Chart 3.2 Distributions of GINI regionally

3.3.2 Innovation

There are lots of indexes used to describe innovation. The number of patent applications and the number of patents approved in different regional level are used, which reflect the output of the regional research and development. (Qingchun Liu and C.-Y. Cynthia Lin Lawell, 2015. Hongguang Sui and Tinghua Liu, 2015.) Some indexes relative to innovation also are adopted, such as R&D capital spillover caused by foreign patent application, R&D spillover caused by import trade (Ping Li and Tinghua Liu, 2009.) and high-skilled population proportion (Qingchun Liu and C.-Y. Cynthia Lin Lawell, 2015.).

In this study, an index which is directly relative to productor behavior is adopted. Data is from Enterprise Survey 2012 by the World Bank, by the question “In the last three years, has this establishment introduced any new products or services?” It is compiled in the form of “Yes or No”, which the”0, 1” binary dependent variable base on. The number of samples is 1405. Table 3.2 shows dependent variable frequencies.

Table 3.2 dependent variable frequencies

Dep. Value			Cumulative	
	Count	Percent	Count	Percent
0	675	48.00	675	48.04
1	730	51.00	1405	100.00

3.3.3 Other independent variables

Other independent variables are used to make model more complete. The indexes describing enterprises is from The World Bank Enterprise Survey-China

(2012), like crime indexes. While the macroeconomic indexes describing characters of cities or provinces where enterprises are located is from China National Statistical Yearbook and China Labor Statistical Yearbook.

Macroeconomic variables include economic growth and income level. For the robustness of the result, GDP by different computing methods and income in different regional levels are adopted.

The growth ratio of per capita GDP measures the state of the economy and reflects the economic development of the region. GDP per capita also is used in research of Qingchun Liu and C.-Y. Cynthia Lin Lawell (2015).

Per capita disposable income in city level and urban per capita disposable income in province level are adopted in this chapter, to describe the revenue environment of the location of the enterprises. Two kinds income level data is used to ensure the robustness.

Table 3.3 shows the variables used in the chapter, and table 3.4 presents the descriptive statistics of all independent variables. It should be noted that the Gini coefficient and DER coefficient are computed from data of wage level. It is a reason why the mean of intra-provincial Gini coefficient is a little higher than it in country level published by the World Bank. It also is related to the survey object and sampling method.

The correlation matrix of all of the independent variables is shown in table 3.5. There is high correlation level between DER (0.5) and GINI, because they are calculated from same method and same income data. GINI is DER (0).

Table 3.3 Variables used in estimation

Index	Description	Level	Year	Data source
Total sale	Total annual sales for all products and services.	Enterprise	2011	The World Bank Enterprise Survey-China (2012)
Number of labors	Number of full-time individuals worked in this establishment	Enterprise	2011	The World Bank Enterprise Survey-China (2012)
Per capita GDP growth rate	Per capita GDP of 2010/ Per capita GDP of 2009	Province	2010	China National Statistical Yearbook 2011
Income(city)	Per capita disposable income	City	2010	China National Statistical Yearbook 2011
Income(province)	Urban per capita disposable income	province	2010	China National Statistical Yearbook 2011

Table 3.4 Descriptive statistics of independent variables

	Mean	Std. Dev	Min	Max
GINI	0.496155	0.036185	0.426538	0.550812
DER(0.5)	0.289735	0.024331	0.258039	0.325046
Income(province)	25266.28	5255.337	17899.00	32903.00
Income(city)	29918.84	5491.493	22459.00	39513.00
Total sale	2.00E+08	1.67E+09	30000.00	4.00E+10
Number of labors	239.6448	1207.812	5.0000	30000.00
Per capita GDP growth rate	1.081528	0.061362	0.986628	1.179474

Table 3.5 Correlation matrix of independent variables

	GINI	DER (0.5)	Income (province)	Income (city)	Total sale	Number of labors	Per capita GDP growth rate
GINI	1	0.933691	0.162596	-0.005522	-0.011784	-0.014404	-0.024953
DER (0.5)	-	1	0.062441	-0.238606	-0.000413	-0.007567	-0.078617
Income(province)	-	-	1	0.804744	-0.032062	-0.0196692	-0.300261
Income(city)	-	-	-	1	-0.050016	-0.024265	-0.090370
Total sale	-	-	-	-	1	0.679402	-0.015341
Number of labors	-	-	-	-	-	1	-0.011339
Per capita GDP growth rate	-	-	-	-	-	-	1

3.4 Method

Refer to the dependent variable taking on only two values as a choice between two alternatives, binary regressions with probit and logit specifications are adopted in this chapter. For a binary dependent variable y taking on values of 0 and 1, a simple linear regression of y on x is not appropriate. Instead, a specification is adopted to handle the specific requirements of binary dependent variables. Suppose the probability of observing a value of 1 as:

$$\Pr(y_i = 1|x_i, \beta) = 1 - F(-x_i'\beta)$$

Where F is a continuous, strictly increasing function that takes a real value and returns a value ranging from 0 to 1, with simplifying convention of assuming that the index specification is linear in the parameters so that it takes the form $x_i'\beta$.

The choice of the function F determines the type of binary model. It follows that:

$$\Pr(y_i = 0|x_i, \beta) = F(-x_i'\beta)$$

And the parameters could be estimated using maximum likelihood method as:

$$\iota(\beta) = \sum_{i=0}^{n} y_i \log(1 - F(-x_i'\beta)) + (1 - y_i)\log(F(-x_i'\beta))$$

The binary model is often motivated as a latent variables specification. Suppose that there is an unobserved latent variable y_i^* that is linearly related to x:

$$y_i^* = x_i'\beta + \mu_i$$

Where μ_i is a random disturbance. Then the observed dependent variable is determined by whether y_i^* exceeds a threshold value:

$$y_i = \begin{cases} 1 & if \quad y_i^* > 0 \\ 0 & if \quad y_i^* \leq 0 \end{cases}$$

In this case, the threshold is set to 0. Then:

$$\Pr(y_i = 1|x_i, \beta) = \Pr(y_i^* > 0) = \Pr(x_i'\beta + \mu_i > 0) = 1 - F_\mu(-x_i'\beta)$$

Where F_μ is the cumulative distribution function of μ, adopting logistic and probit specification which is based on the cumulative distribution function for the logistic distribution and the standard normal distribution.

Expected value of y is simply the probability that y=1:

$$\mathrm{E}(y_i|x_i, \beta) = 1 \cdot \Pr(y_i = 1|x_i, \beta) + 0 \cdot \Pr(y_i = 0|x_i, \beta) = \Pr(y_i = 1|x_i, \beta)$$

From which, the binary specification can be interpreted as a conditional mean specification, and can be written as a regression model:

$$y_i = (1 - F(-x_i'\beta)) + \varepsilon_i$$

Where ε_i is a residual representing the deviation of the binary y_i from its conditional mean. Then:

$$\mathrm{E}(\varepsilon_i|x_i, \beta) = 0$$

$$\mathrm{Var}(\varepsilon_i|x_i, \beta) = F(-x_i'\beta)(1 - F(-x_i'\beta)$$

Interpretation of the coefficient values is complicated by the fact that estimated coefficients from a binary model cannot be interpreted as the marginal effect on the dependent variable. The marginal effect on the probability is given by:

$$\frac{\partial \mathrm{E}(y_i|x_i, \beta)}{\partial x_{ij}} = f(--x_i'\beta)\beta_j$$

Where $\mathrm{f(x)} = \mathrm{dF(x)/dx}$ is the density function corresponding to F. β_j is weighted by a factor f that depends on the values of all the regressors in x. The direction of the effect of a change in x_j depends only on the sign of the β_j coefficient.

3.5 Results and Discussions

Result of estimate is regressed by STATA 12. Coefficients are shown in table 3.6. and marginal effect of variables is shown in table 3.7. The first part of the table contains the usual information, including estimation method and sample size. The coefficients and statistical significance of independent variables are shown in Colum Coefficient (prob.), of which the sign represent direction of the effect of independent variables on innovation variable. It is shown in table 3.7 that average marginal effect of variables in varlist. The consistent results are got in the four regressions. The results of enterprise characters are insignificant.

The effects of DER (0.5) is significant and negative, while the coefficient of GINI are significant and positive. As the theory by Richard Florida (2009, 2010), income inequality between high-skilled labors and low-skilled labors could encourage innovation, while polarization act as an obstacle to innovation. By the consumption theory, a certain income gap could increase demand of high-tech products, and enterprises can benefit more by separating pricing policy. While it has ben proved that the diversity of culture, industry and occupation plays a role in attracting high-skilled labors and promoting high-tech industry by Richard Florida. The distensible gap between high-skilled labors and low-skilled labors will squeeze the low-skilled class from cities, damaging the diversity in a region.

The effects of income in province and city level are significant and negative. Under the separating pricing policy, enterprises prefer to gain profit by introducing new products when high-level income class expand, rather than income of low-level class increasing to fill the gap of income. (Ling Shen and Guoqiang Tian, 2009) Higher income level in a region may mean equality which is bad for innovation. It is obvious that Beijing which have highest income level is in bottom place in both of inequality and polarization rankings.

The effects of Per capita GDP growth rate are significant and positive. The faster the economic growth in the regional, the more active the innovation of enterprises. Rapid growth could bring expansive demand of new products, and enterprises could gain more profits through introducing new products than region with economic stagnation.

The results of enterprise characters are insignificant. Regional indicators play stronger role on innovation behavior of enterprises, but the scale of enterprises has no significant impact on it.

Table 3.6 Results of estimation
Dependent variable: new product
Method: Binary logit and probit
SAMPLE: 1405

Variables	coefficient(prob.)			
	(1)		(2)	
	Probit	Logit	Probit	Logit
GINI	21.83432 (0.000)	34.98339 (0.000)	11.45367 (0.000)	18.32551 (0.000)
DER0.5	-43.0.1297 (0.000)	-68.9619 (0.000)	-25.32147 (0.000)	-40.54904 (0.000)
Income(city)	-0.0000515 (0.000)	-0.0000833 (0.000)	-	-
Income(province)	-	-	-0.0000266 (0.000)	-0.0000429 (0.000)
Rate of per capital GDP(province)	1.857674 (0.001)	3.029384 (0.001)	1.972211 (0.001)	3.17668 (0.001)
Total sales	1.22e-11 (0.705)	2.38e-11 (0.671)	1.65e-11 (0.604)	3.10e-11 (0.574)
L	0.0000259 (0.545)	0.0000493 (0.503)	0.0000235 (0.580)	0.0000449 (0.537)

Data: Statistical yearbook of China. DER (0.5) and GINI is from National Bureau of Statistics of China.
GINI: DER (0) computed from wage level of 2009.
DER (0.5): computed from wage level of 2009.

Table 3.7 Average marginal effect of variables

Dependent variable: new product

Method: Binary logit and probit

SAMPLE: 1405

Variables	dy/dx			
	(1)		(2)	
	Probit	Logit	Probit	Logit
GINI	8.074743 (0.000)	7.94837 (0.000)	4.194798 (0.000)	4.233811 (0.000)
DER0.5	-15.90701 (0.000)	-15.66843 (0.000)	-9.49483 (0.000)	-9.368196 (0.000)
Income(city)	-0.000019 (0.000)	-0.0000189 (0.000)	-	-
Income(province)	-	-	-9.96e-06	-9.91e-06 (0.000)
Rate of per capital GDP (province)	0.6870028 (0.001)	0.6882886 (0.001)	0.7395229 (0.001)	0.7339202 (0.001)
Total sales	4.51e-12 (0.705)	5.40e-12 (0.671)	6.19e-12 (0.604)	7.16e-12 (0.574)
L	9.59e-06 (0.545)	0.0000112 (0.503)	8.81e-06 (0.580)	0.0000104 (0.537)

3.6 Conclusions

According to endogenous growth theory, a major driving force for economic growth is technological progress Innovation not only plays a role in the economic development, but can also impact income inequality. There are four mechanisms to explain the relation between inequality and innovation through impact of innovation on skill premia. Income inequality and polarization also impact innovation by affecting composition of labors, industrial structure and social environment.

By binary logit regression method, this chapter discusses impact of regional income inequality and polarization on innovation local enterprises. The conclusion is that income inequality between high-skilled labors and low-skilled labors could encourage innovation, while polarization act as an obstacle to innovation.

The result is accord with the theory of cities and creative class by Richard Florida and consumption theory. The consumption theory also can be used to explain positive effect of growth and negative effect of income level.

For a region, not only the proportion of high-skilled labors but also diversity should be kept to promote innovation. Decreasing population of low-leve income is a more efficient way than increasing income of low-level class to stimulate innovation.

References

Autor, D., Levy, F. and Murnane, R.J. (2003). “The Skill Content of Recent Technological Change: An Empirical Exploration”. *Quarterly Journal of Economics,* 118:1279–1333.

Fan, H. (2007). “A Hypothesis on Effective Demand Size, R&D Expenditure and National Innovation Capacity, [J]”. *Economic Research Journal,* 33-44.

Faggio, G., Salvanes, K.G. and Van Reenen, J. (2007). “The Evolution of Inequality in Productivity and Wages: Panel Data Evidence”. *CEP Discussion Paper 821.*

Florida, R. (2009). “Who’s Your City? How the Creative Economy is Making Where to Live the Most Important Decision of Your Life”, Japanese Version translated by Norio Iguchi. *Diamond.*

Florida, R. (2010). “Cities and the Creative Class”, Japanese Version translated by Kazuyuki Kongagaya. *Nihonhyouronsya*.

Foellmi, R. and Zweimüller, J. (2006). “Income Distribution and Demand-Induced Innovations, [J]”. *The Review of Economic Studies,* 73, 941-960.

Glaeser, E.L. (1999). “Learning in Cities”. *Journal of Urban Economics,* 46: 254–277.

Greenwood, J. and Mukoyama, T. (2001). “The Effect of Income Distribution on the Timing of New Product Introductions”. *Mimeo, University of Rochester.*

Li, P. and Liu, T. (2009). “Innovation and Income Inequality—Base on Data of China, [J]” in Chinese. *Journal of Industrial Technological Economics,* 28 (1), 41-45.

Liu, Q. and C.-Y. Cynthia Lin Lawell. (2015). ” The effects of innovation on income inequality in China”. *Shandong Province Educational Department.*

Pan, S. (2011). “Technological Innovation, Science& Technology Policy and Income Inequality” in Chinese. *Journal of Zhejiang University of Technology (Social Science),*

1, 87-90.

Shen, L. and Tian, G. (2009). “Income Inequality, urbanization and Economic Growth: A Demand-side Analysis, [J]” in Chinese. *Economic Research Journal,* 2, 17-29.

Sui, H. and Liu, T. (2015). “How Income Inequality Affects Technological Innovation, [J]” in Chinese. *Inquiry into Economic Issues,* 1-6.

Van Reenen, J. (1996). “The Creation and Capture of Rents: Wages and Innovation in A Panel of U.K. Companies”. *Quarterly Journal of Economics,* 111: 195–226.

Young, A. (1993). “Substitution and Complementarities in Endogenous Innovation, [J]”. *Quarterly Journal of Economics,* (108):775~807.

Chapter 4 Inequality, Polarization and Crime: Empirical Issues of China

Chapter 4：Inequality, Polarization and Crime: Empirical Issues of China

4.1 Introduction

In the circumstance with rapidly rising economic growth, various social problems are propagated. Some of these problems are accompanied by not appropriate income distribution，for instance, social unrest, rising crime, moral degradation, corruption, and regional conflict. (YAO, S. ZHANG, Z. &FENG, G. 2005) In case of China, rapid economic growth coincides with swift social changes. Negative changes are prominent and are evolving into a major great threat to the country's further development, social stability, and harmony. (AI GUO HAN, 2008) Increasing crime rate is considered as one of the unfortunate consequences of income distribution problems described as inequality and polarization.

Income inequality and polarization are different concepts. A large pool of literature focused on the relationship of them and crime rate or social conflict. On the base of data of individual countries and regions, increasing polarization intra competing groups is the driving force to increase the risk of conflict; (Joan Esteban, Gerald Schneider) in the country with heterogeneous ethnics, polarization is a reason of conflict and civil war; (Jose G. Montalvo, Marta Reynal-Querol. 2010) in different regions, there is a higher crime rate in the region with higher level of income inequality. (Tsun Se Chenong, Yanrui Wu)

Higher criminality brings about substantial cost and expenditures. The direct cost include the loss of social accumulation, amounts spent on the legal system, policing, prisons and courts, health-care costs and potential years of life lost through murder and private security expenditures. The indirect costs include the discounted value of property damaged and reductions in investment, productivity, employment et al. (Fajnzylber, P., Lederman, D., Loayza, N. 2002) A high crime rate

impedes economic growth. (Gordon, M. B., Iglesias, J. R., Semeshenko, V., Nadal, J. P. 2009) All of those indexes can be used to describe the severity of crime.

This paper examines the impact of income inequality or polarization on crime respectively. The impact of crime is described by level of damage local enterprises bearing from crime abstractly, which probably include the direct and in direct cost of enterprises and subjective feeling of managers.

This chapter is structured as follows. Section 2 presents the literature review. Section 3 describes the indexes and data. Section 4 presents the research method. Section 5 offers the analysis of result. Section 6 presents the conclusions.

4.2 Literature review

Since 1970s, there are lots of empirical researches about effect of inappropriate income distribution on social unrest springing in worldwide, researchers also attempt to explain the effect theoretically. Then researches base on Chinese case appeared a little later.

About this issue, most popular theories include that economic theory of crime (Becker, G. S.1968), strain theory (Merton, 1938) and social disorganization theory (Shaw and Mckay, 1942). Economic model of crime was developed by Becker (1968), and expanded by Ehrlich (1973), Block and Heineke (1975) and ect. The model suggests that crime can be affected by socio-cultural factors, crime deterrence policy factors and economic inequality. According to this approach, the decision to commit a crime is determined by the expected returns and opportunity cost of crime. Therefore, in region with serious income inequality, expected returns that would be gained from committing the crime can encourage the poor to engage in crime rather than marketing dealing.

In empirical category, crime is considered as one of aspects reflecting social unrest. Some researchers focus on the effect of inequality and polarization on conflict. Joan Esteban and Gerald Schneider (2015) claim that increasing polarization increases the risk of conflict. The conclusion of Jose G. Montalvo and Marta Reynal-Querol (2010) is that there is no statistical relationship between the likelihood of conflict and inequality, and polarization can produce the likelihood of conflict.

In empirical researches using crime as the index of social unrest, crime against property, crime of violence and criminal offence etc. are adopted as dependent variable. The conclusion is not entirely consistent, but the majority of studies tend to argue that there is positive relationship between income inequality and crime. For example, Morgan Kelly (2000) proved income inequality could lead to crime of violence while have no statistical relation to crime against property by log linear model. Matin Daly found that there is more significant effect of inequality on crime than poverty, using dataset of Canada and USA.

In China's case, Tsun Se Cheong and Yanrui Wu (2014) examined the impact of intra-provincial regional inequality in crime rates in China, and found that intra-provincial regional inequality is positively correlated. In study of Bai and Wang (2007), both inequality measured by Gini coefficient and polarization measured by the ratio of the income of urban and rural impact social stability negatively. Wu and Rui (2010) found that the crime rate would rise by at least 0.185 percentage points with Gini coefficient increasing by 1 percentage point, using provincial panel data of China, and in the meantime, income inequality forced the government to increase its spending on welfare to fight crime.Hu et al. (2005) examined the effect of inequalities on crime rate in China over the period 1978-2003, with three different proxies of inequality, namely, national Gini coefficient, income disparity between rural and urban residents, and Theil index. The strong relation between

crime rate and all the different measures of inequality was found.

About other controlling variables, scholars use various indicators for different purposes, and conclusions are diversifying. Inter-provincial migration, welfare expenditure, unemployment rate and other factors are adopted by Wu and Rui (2007), and proved that inter-provincial migration could affect crime positively, and welfare expenditure would decrease crime. While Tsun Se Cheong and Yanrui Wu (2014) focused on education, inflation, unemployment rate and urbanization. The conclusion is that education is negatively correlated with the crime rate, and crime rates are positively linked with the level of inflation, unemployment rate, while the effect of urbanization is insignificant.

In the existing literatures about China, inequality and polarization and crime rate are computed by macro data mostly. Most of researchers focus on the relationship between inequality and crime, while impact of polarization is not paid enough attention. Literatures concerning polarization are almost used indicates of income gap between urban and rural areas. The polarization index in this study is DER index, of which the original data is from micro survey. The data of crime is also from micro dataset to pursue valid result.

4.3 Indexes and Data

The data for main indexes in the model used in this chapter are from Urban Household and Expenditure Survey (UHIES) by the National Bureau of Statistics (NBS) of China and Enterprise Survey 2012 by the World Bank. These are micro-level datasets which will make the results more valid. There are also some macro-level indexes from China National Statistical Yearbook 2011.

4.3.1 Polarization and Inequality

The data used to calculate polarization and inequality in this chapter is based on Urban Household Income and Expenditure survey (UHIES) by the National Bureau of Statistics (NBS) of China. This yearly data contains household data from eight representative provinces of China (Beijing, Liaoning, Zhejiang, Anhui, Hubei, Guangdong, Sichuan, and Shanxi) in year 2002-2009. Polarization and inequality indexes are estimated for 7 provinces (Beijing, Liaoning, Zhejiang, Anhui, Hubei, Guangdong and Sichuan) in year 2009, using disposable income. Because of the deficiency of enterprises data in Shanxi province.

DER index is used to express polarization, while Gini coefficient is used to express inequality, which are estimated by SPSS statistics software. The theory of calculation is same as chapter 3. The original data used in this chapter is disposable income of household, while wage level is used in chapter 3.

In table 4.1, it shows provinces in descending order of DER and GINI. In chart 4.1 and chart 4.2, they show the geographical and sequential position of provinces. It is shown in table 4.1, chart 4.1 and chart 4.2 that distributions of GINI and DER are not totally same regionally.

Table 4.1 Provinces in descending order of DER and GINI

DER	GINI
Guangdong	Guangdong
Zhejiang	Zhejiang
Liaoning	Liaoning
Beijing	Sichuan
Hubei	Beijing
Sichuan	Hubei
Anhui	Anhui

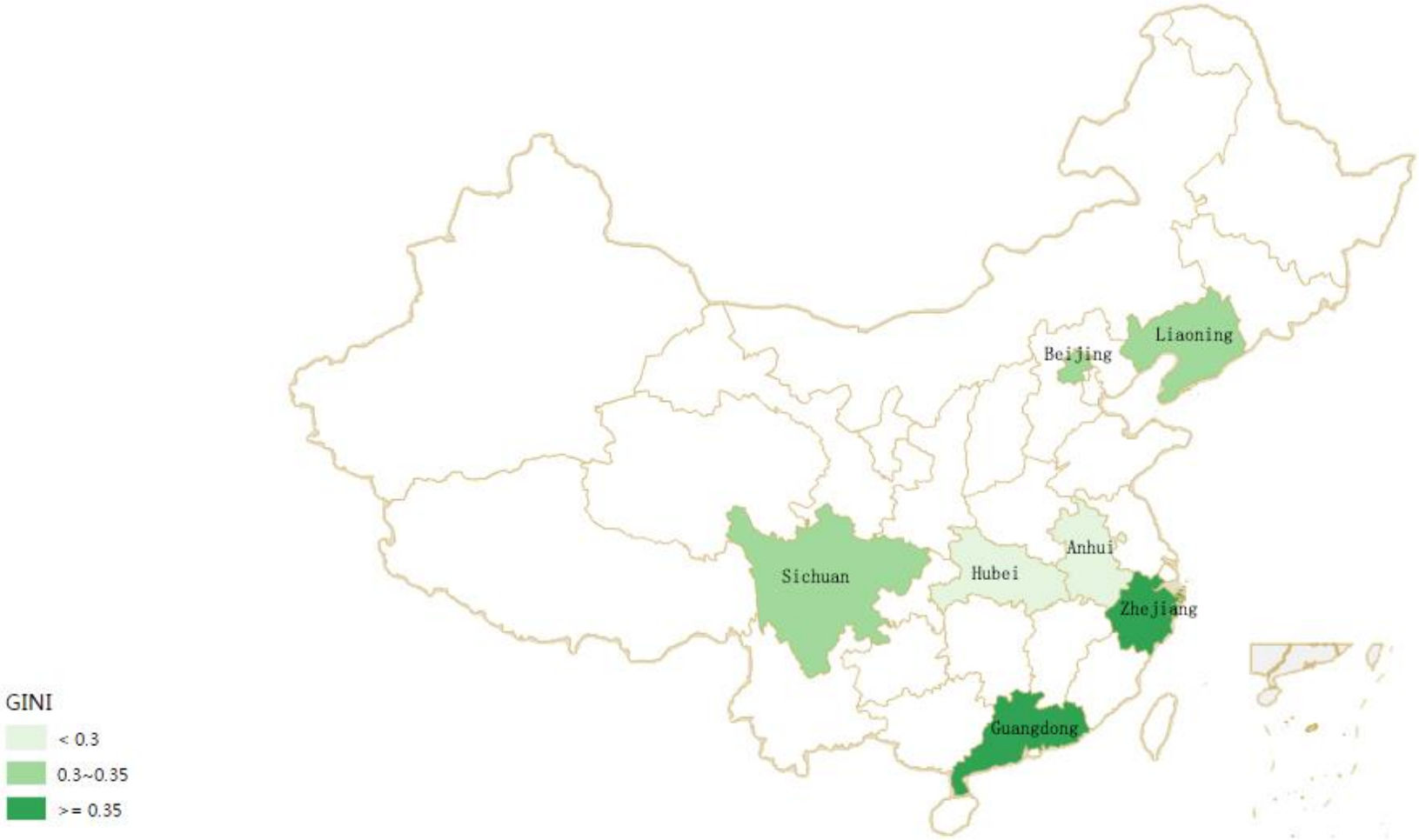

Chart 4.1 Distributions of GINI regionally

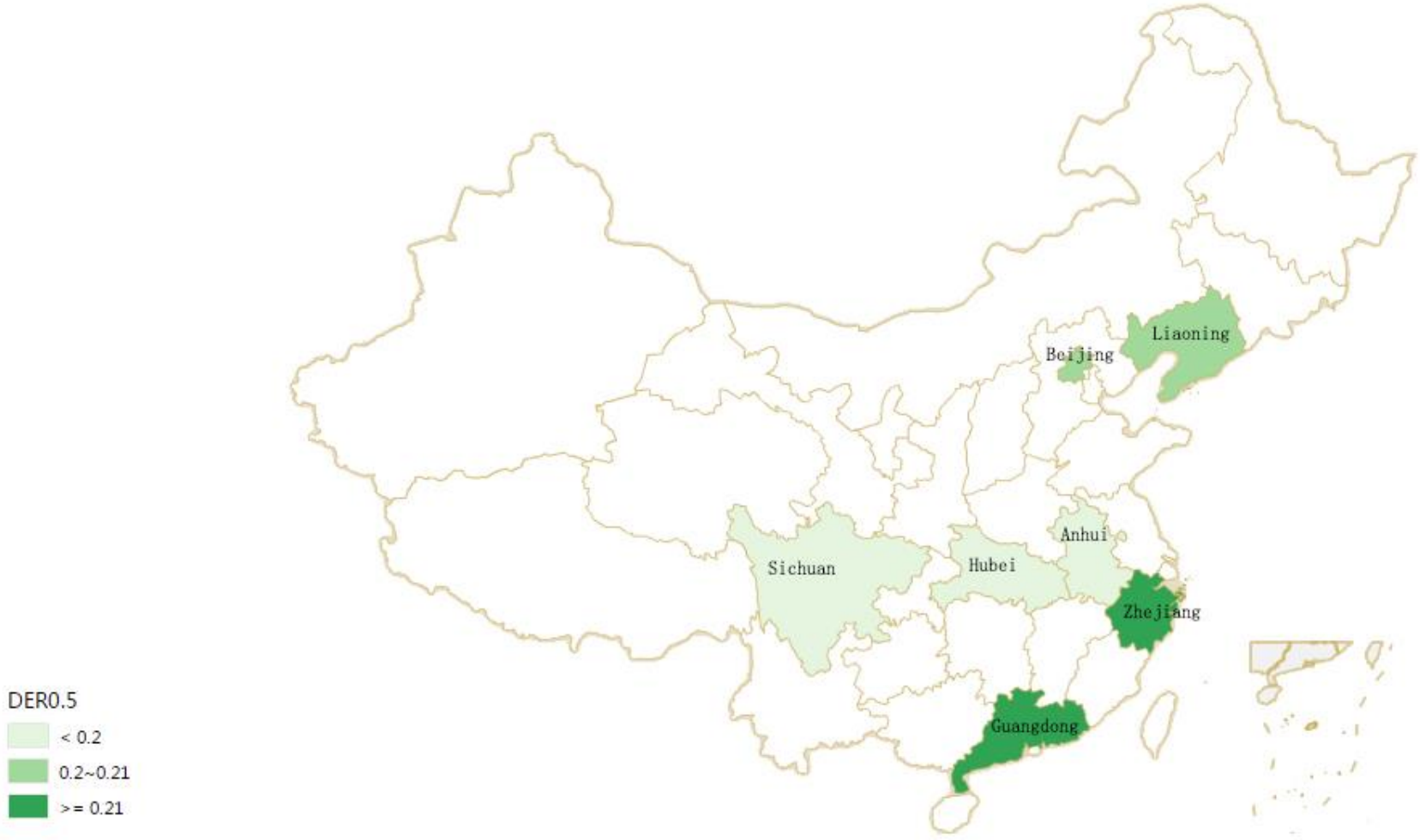

Chart 4.1 Distributions of DER0.5 regionally

4.3.2 Crime

Some researches before adopted crime rate data compiled from the Law Yearbook of China and the Procuratorial Yearbook of China. Approved arrests per 10000 persons (Tsun Se Cheong and Yanrui Wu, 2014.), arrests per million persons (Yiping Wu and Meng Rui, 2010), property-seizing crime per 100000 persons and violent cases per 100000 persons (Xuemei Bai and Shaojin Wang, 2007) are used as dependent variables.

In this study, crime is described in an economical perspective. Data from Enterprise Survey 2012 by the World Bank is adopted, by the question that “To what degree is Crime, Theft and Disorder an obstacle to the current operations of this establishment?” It is compiled in the form of 1 to 5 (means “no obstacle, minor obstacle, moderate obstacle, major obstacle, very severe obstacle”) ordered discrete data with sample size of 1409, which probably include the direct and in direct cost of enterprises and subjective feeling of managers. In the paper on the compact of income inequality and crime on subjective well-being, variable of well-being is also in the same form (Yuanping Lu and Tao Wang, 2011). Table 4.2 shows dependent variable frequencies.

Table 4.2 Obstacle of crime for local enterprises (dependent variable) frequencies

Value	Count	Percent (%)	Cumulative percent (%)
1	986	69.98	69.98
2	362	25.69	95.67
3	44	3.12	98.79
4	6	0.43	99.22
5	11	0.78	100

4.3.3 Other independent variables

Other independent variables are used to make model more complete. The indexes describing enterprises is from The World Bank Enterprise Survey-China (2012), like crime indexes. While the macroeconomic indexes describing characters of cities or provinces where enterprises are located is from China National Statistical Yearbook and China Labor Statistical Yearbook.

Macroeconomic variables include economics, income level, and population mobility. China's high growth rate is often quoted in the literature of interest to assess the impact of growth on crime rate. The ratio of provincial GRP (gross regional product) to national GDP was used to measure economic significance in the paper of Tsun Se Cheong and Yanrui Wu (2014).

The impact of income on crime rates is ambiguous because both the gains and opportunity cost of crime tend to increase with the rise in income, moreover, high

income means more cost on crime prevention will be available. Empirical researches on the impact of income on crime rate show contradictory results. For instance, negative correlation between average family income and crime rate is proved in research by Fleishier (1966), while researches shows opposite results (Ehrlich, 1973. Chen and Yi, 2009. Et al.). However, some find that there is no significant relationship between income and crime (Edlund et al., 2008. Tsun Se Cheong and Yanrui Wu, 2014).

In study of Tsun Se Cheong and Yanrui Wu (2014), employment and urbanization indices are used as dependent variables, and both of them are found to be insignificant. In this study, population mobility index relative to employment and urbanization is chosen, measured by proportion of rural population in newly added urban employment. Table 4.3 shows the variables used in this study, while Table 4.4 presents the descriptive statistics of all of independent variables. It should be pointed out that the numbers of intra-provincial Gini coefficient are not as large as it in country level published by the World Bank. This is related to the survey object and the sampling method used in the survey.

The correlation matrix of all of the independent variables is shown in table 4.5. There is high correlation level between DER (0.5) and GINI, because they are calculated from same method and same income data. GINI is DER (0). And the variables with same economical meaning also have high correlative relationship, like FLOW and FLOW1, which are adopted in order to test the robustness of different regression. The variables of enterprise characters are not relative to ones of regional characters highly.

Table 4.4 Variables used in estimation

Index	Description	Level	Year	Data source
Total sale	Total annual sales for all products and services.	Enterprise	2011	The World Bank Enterprise Survey-China 2012
Number of labors	Number of full-time individuals worked in this establishment	Enterprise	2011	The World Bank Enterprise Survey-China 2012
Per capita GDP growth rate	Per capita GDP of 2010/ Per capita GDP of 2009	Province	2010	China National Statistical Yearbook 2011
GDP growth rate	GDP of 2010/ GDP of 2009	Province	2010	China National Statistical Yearbook 2011
Flow	The proportion of rural population in newly added urban employment	province	2010	China Labor Statistical Yearbook 2011
Income(city)	Per capita disposable income	City	2010	China National Statistical Yearbook 2011
Flow 1	The proportion of rural population in urban employment	province	2010	China Labor Statistical Yearbook 2011
Fowner	Whether there is female owner in this establishment	Enterprise	2011	The World Bank Enterprise Survey-China 2012

Table 4.5 Descriptive statistics of independent variables

	Mean	Std. Dev	Min	Max
GINI	0.331360	0.025576	0.285718	0.354866
DER (0.5)	0.211525	0.009921	0.193508	0.220718
Income(city)	29916.43	5491.041	22459.00	39513.00
Total sale	2.03E+08	1.68E+09	30000	4.00E+10
Number of labors	233.4045	1172.423	5	30000
Per capital GDP growth rate	1.081602	0.061296	0.986628	1.179474
GDP growth rate	1.129760	0.012429	1.103000	1.151000
Flow	0.444021	0.134223	0.224222	0.571161
Flow1	0.50101	0.030396	0.010311	0.080866
Fowner	0.653655	0.475974	0	1

Table 4.4 Correlation matrix of independent variables

	GINI	DER (0.5)	Income (city)	Total sale	Number of labors	Per capital GDP growth rate	GDP growth rate	Flow	Flow1	Fowner
GINI	1	0.998402	0.737053	-0.027312	-0.015325	-0.133273	-0.285567	0.947025	0.800790	-0.064442
DER(0.5)	-	1	0.748212	-0.028112	-0.014816	-0.157576	-0.325871	0.947940	0.808199	-0.063083
Income(city)	-	-	1	-0.048076	-0.027351	-0.091119	-0.693573	0.862285	0.909353	-0.102079
Total sale	-	-	-	1	0.688480	-0.012940	0.028704	-0.035468	-0.037952	-0.012395
Number of labors	-	-	-	-	1	-0.001351	0.017068	-0.022251	-0.027264	-0.018865
Per capital GDP growth rate	-	-	-	-	-	1	0.356241	0.008243	-0.029675	-0.144706
GDP growth rate	-	-	-	-	-	-	1	-0.468310	-0.667764	0.055219
Flow	-	-	-	-	-	-	-	1	0.936811	-0.108284
Flow1	-	-	-	-	-	-	-	-	1	-0.123334
Fowner	-	-	-	-	-	-	-	-	-	1

4.4 Model

Refer to the dependent variable representing ordered or ranked categories, ordered logit regression is adopted in this paper. The observed response y_i is modeled by a latent variable y_i^* that depends linearly on the explanatory variables x_i:

$$y_i^* = x_i'\beta_i + \varepsilon_i$$

Where，y_i is the obstacle level of crime for local enterprise i, valued as 1, 2, 3, 4, 5. β is the coefficients on x_i. ε_i is the idiosyncratic disturbance, with logistic distribution. y_i is determined from y_i^* using the rule:

$$y_i = \begin{cases} 1 & if \ \ y_i^* \le \gamma_1 \\ 2 & if \ \ \gamma_1 < y_i^* \le \gamma_2 \\ 3 & if \ \ \gamma_2 < y_i^* \le \gamma_3 \\ 4 & if \ \ \gamma_3 < y_i^* \le \gamma_4 \\ 5 & if \ \ \gamma_4 < y_i^* \end{cases}$$

It is worth noting that the actual values chosen to represent the categories in y are completely arbitrary. All the ordered specification requires is for ordering to be preserved so that $y_i^* < y_j^*$ implies that y_i<y_j.

The probabilities of observing each value of y are given by

$$\text{Pr}\ (y_i=1) = \text{F}\ (\gamma_1 - x_i'\beta_i)$$

$$\text{Pr}\ (y_i=2) = \text{F}\ (\gamma_2 - x_i'\beta_i) - \text{F}\ (\gamma_1 - x_i'\beta_i)$$

$$\text{Pr}\ (y_i=3) = \text{F}\ (\gamma_3 - x_i'\beta_i) - \text{F}\ (\gamma_2 - x_i'\beta_i)$$

$$\text{Pr}\ (y_i=4) = \text{F}\ (\gamma_4 - x_i'\beta_i) - \text{F}\ (\gamma_3 - x_i'\beta_i)$$

$$\text{Pr}\ (y_i=5) = \text{F}\ (\gamma_5 - x_i'\beta_i) - \text{F}\ (\gamma_4 - x_i'\beta_i)$$

Where F is the cumulative distribution function of ε_i.

The threshold values γ are estimated along with the β coefficients by maximizing

the log likelihood function:

$$\iota(\beta,\gamma) = \sum_{i=1}^{N}\sum_{j=1}^{M} \log(\Pr(y_i = j|x_i,\beta,\gamma)) \cdot 1(y_i = j)$$

Where $1(\cdot)$ is an indicator function which takes the value 1 if the argument is ture, and 0 if the argument is false.

4.5 Result and discussions

Results of estimation are shown in table 4.6. The first part of the table contains the usual information, including estimation method, the assumed error distribution, and sample size. It is shown in Column Coefficient (prob.) that the coefficient of DER (0.5) is significant and positive, while the coefficient of Gini is significant and negative. The coefficients of income, per capita GDP growth rate, and flow are significant, while the coefficients describing characters of enterprises are insignificant.

It should be noted that the coefficient of the DER (0.5) is found to be significant and positive in all the specifications in Table 4.4, while the coefficient of the Gini is found to be significant and negative. The result is robust to different specifications and it can be concluded that what can lead to loss of crime is regional polarization rather than inequality. Continuing increasing income inequality forced the government to increase its spending on welfare to fight crime (Wu and Rui, 2010).

The coefficient of income level is significant and negative, while is similar to Fleisher's conclusion (1966). It could be explained by that in region with high disposable income level, enterprises' protection for property is more effective, at the same time, people prefer to benefit by other way rather than by crime.

The coefficient of Per capita GDP growth rate and GDP growth rate are significant and positive. Some researchers believe that there is an inevitable relationship between the economic development and income increasing. Bai and Wang (2007) argue that

accompanying with economic development, income level, living condition and social welfare will become better, then the degree of social stability will be increased. Tsun Se Cheong and Yanrui Wu (2014) used per capita regional GDP as the income level. However, in this study, it is shown that the effect of income increasing and economic development is opposite. Regional economic situation does not directly mean improvement of social welfare, moreover, accumulating property may encourage people to crime.

The coefficient of population mobility (Flow) is significant and positive. Bai and Wang (2007) argue that the reason why urbanization lead to social unrest is population mobility. The similar conclusion is also proved in this study. Urbanization does not mean citizenization, the gap of education and living conditions make migrant workers to be risk of social unrest.

In enterprise data, total sale and number of labors have little effect on the results, while the effect of female owner index is positive and significant. The reason might is that there are more female owners in regions with higher income level where enterprises are troubled by crime.

Table 4.6 Results of estimation

Dependent variable: obstacle of crime

Method: Ordered Logit

Number of sample: 1409

variable	Coefficient(prob.)			
DER(0.5)	1676.025 (0.0000)	1483.893 (0.0000)	1690.029 (0.0000)	1948.855 (0.0000)
GINI	-616.9131 (0.0000)	-626.5098 (0.0000)	-631.1190 (0.0000)	-722.8404 (0.0000)
Income(city)	-7.88E-05 (0.0001)	-0.000226 (0.0000)	-0.000128 (0.0000)	3.08E-05 (0.2882)
Total sale	6.89E-06 (0.1108)	5.53E-11 (0.2076)	6.17E-11 (0.1743)	6.94E-11 (0.1223)
Number of labors	-6.29E-06 (0.9221)	2.38E-05 (0.7118)	1.45E-05 (0.8271)	2.02E-05 (0.7673)
Per capita GDP growth rate	10.86186 (0.0000)	-	-	-
GDP growth rate	-	-	-	48.45026 (0.0209)
Flow	-	20.80572 (0.0000)	-	-
Flow1	-	-	17.97890 (0.0007)	27.20354 (0.0019)
Fowner	-	-	-	0.679440 (0.0000)

Limit Points	Limit-2:C(7)	Limit-2:C(7)	Limit-2:C(7)	Limit-2:C(9)
	160.5317	109.8418	146.5158	214.6336
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Limit-3:C(8)	Limit-3:C(8)	Limit-3:C(8)	Limit-3:C(10)
	162.9648	112.3223	148.9159	216.8828
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Limit-4:C(9)	Limit-4:C(9)	Limit-4:C(9)	Limit-4:C(11)
	164.2777	113.6438	150.2349	218.1926
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Limit-5:C(10)	Limit-5:C(10)	Limit-5:C(10)	Limit-5:C(12)
	164.7166	114.0838	150.6752	218.6322
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log likelihood	-973.3012	-968.2314	-1001.416	-1062.641
LR statistic	218.5843	228.7239	162.3556	39.90388
Prob(LR statistic)	0.000000	0.000000	0.000000	0.000003

Data: Statistical yearbook of China. DER(0.5) is from household survey made by National Bureau of Statistics of China.

GINI: DER (0) 2009

DER (0.5):2009

*Significance at the 5% level

4.6 Conclusions

China is in the circumstance with rapidly rising economic growth and radical changes have taken place in the economic system since the initiation of its economic reform. Increasing crime rate is considered as one of the unfortunate consequences of income inequality and polarization brought by free market system.

This study focuses on the topic by empirically analyzing inequality and polarization with micro-level dataset. Furthermore, this study analysis the impact of inequality measured by Gini coefficient and polarization measured by DER coefficient on obstacle of crime for local enterprises.

The results show that what can lead to loss of crime is regional polarization rather than inequality. Moreover, income level relates to loss of crime significantly and negatively, while Per capita GDP growth rate and population mobility (Flow) relate to loss of crime significantly and positively.

Several policy implications can be drawn from this study. Firstly, government should not only make effort to increase overall income, but more importantly, to reduce the grouping and stratification of income. Secondly, economic growth should be transformed to social welfare effectively. At last, migrant from rural to urban should be managed and applied well living condition and education condition.

References

Bai, X. and Wang, S. (2007). “A Survey on the Relationship between Income Inequality and Social Stability in China”. *Research on Financial and Economic Issues,* (7), 16-23.

Becker, G. S. (1968). “Crime and Punishment: an Economic Approach”. *Journal of Political Economy.* 76(2), 169-217.

Chen C. &Yi J. 2009. “Effect of Income Inequality on Criminal Behavior: Evidence from China”. *The Journal of World Economy*, 32, 13-25.

Daly, M. (2001). “Income Inequality and Homicide Rates in Canada and United States”. *Canadian Journal of Crimimology,* Vol (4), 219 -236.

Duclos, J., Esteban, J. and Ray, D. (2004). “Polarization: Concepts, Measurement, Estimation”. *Economietrica,* 72(6), 1737-1772.

Ehrlich, I. (1973). “Participation in Illegitimate Activities: A Theoretical and Empirical Investigation”. *Journal of Political Economy*, 81, 521-565.

Esteban, J. and Ray, D. (2011). “Linking Conflict to Inequality and Polarization”. *American Economic Review,* Vol. 101, No. 4, 2011.07, 1345-1374.

Esteban, J. and Schneider, G. (2008). “Polarization and Conflict: Theoretical and Empirical Issues.” *Journal of Peace Research,* 45(2):131-141.

Fleishier, B. (1966). “The Effect of Income on Delinquency”. *American Economic Review,* 56, 118-137.

Han, A. (2008). “Building a Harmonious Society and Achieving Individual Harmony”. *Journal of Chinese political science,* 13(2), 143-164.

Hu L., Hu A. and Xu, S. (2005). “A Case Study of the Impact of the Disparity between the Rich and the Poor upon Criminal Offences”. *Management World,* 34-44.

Kelly, M. (2000). “Inequality and Crime [J]” .*The Review of Economics and Statistics,* 82(4), 530 -539.

Lu, Y and Wang, T. (2011). “Income Inequality, Crime and Subjective Well-Being: An Empirical Study from China”. *China Economic Quarterly,* Vol. 10, No. 4, 286-307.

Merton, R. K. (1938). “Social Structure and Anomie”. *American sociological review*, Vol. 3, Issue 5, 672-682.

Shaw, C.R. and McKay, H.D. (1942). “Juvenile Delinquency in Urban Areas”. *Chicago: University of Chicago Press.*

Tsun Se Cheong and Wu, Y. (2014). “Inequality and Crime Rates in China”. *Business School, University of Western Australia.*

Wu, Y. and Rui, M. (2010). “The Impact of Income Inequality on Crime” in Chinese. *China Economic Quarterly,* Vol. 10, No. 1, 291-310.

YAO, S. ZHANG, Z. and FENG, G. (2005). “Rural-Urban and Regional Inequality in Output, Income and Consumption in China under Economic Reforms”. *Journal of Economic Studies,* Vol. 32, Issue 1, 4-24.