

# Understanding the Kuznets Process—An Empirical Investigation of Income Inequality in China: 1978–2011

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**Abstract** This paper investigates income inequality in post-reform China using both national time series and provincial panel data from 1978 to 2011. We identify a Kuznets inverted-U relationship between economic development and income inequality and show that this relationship was driven by the process of urbanization. We estimate that the Kuznets turning point occurred in the mid-1980s, and argue that increased urbanization after the mid-1980s had the effect of narrowing income inequality but its effect was more than offset by other factors. In particular, we found that low productivity in agriculture relative to that of the economy as a whole (i.e., dualism) and inflation were significant contributing factors to income inequality. We also present evidence to suggest that secondary education and higher education may have different effects on income inequality at the national level and at the provincial level.

**Keywords** Kuznets curve · Income inequality in China · Theil index · Urbanisation · Dualism

## 1 Introduction

The Chinese economy has experienced phenomenal growth since 1978 when its transition to a market economy began. Over the period of our analysis from 1978 to 2011, real GDP per capita (at constant 2005 prices) grew from 1,582 to 27,309 Chinese yuan (CNY), which amounts to an average annual growth rate of 9.15 %. Initially, the economic growth also

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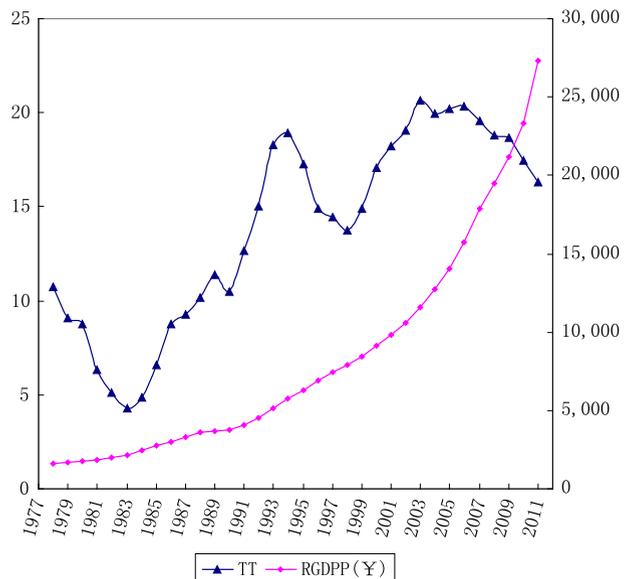
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reduced income inequality; however income inequality rose substantially from the mid-1980s to the mid-1990s. The second half of the 1990s saw some reduction in inequality, but it did not last. Inequality continued to rise, reaching a peak in the mid-2000s before showing some signs of improvement (see Fig. 1). The broad pattern of income inequality gives rise to three questions: (1) is rising income inequality an inevitable “side effect” of economic development in its early stages? (2) Can we expect inequality to fall as the economy develops further? Or in other words, is there a Kuznets inverted-U relationship between income inequality and economic development in China? (3) What are some of the contributing factors to income inequality that we might be able to influence through government policy?

This paper uses both national time series and provincial panel data to investigate whether there was a Kuznets relationship between economic development and income inequality in China during the post-reform period of 1978–2011. It also studies other factors that may contribute to the observed inequality pattern. The main findings of our analysis are: (1) there was a Kuznets relationship between economic development and income inequality; (2) a driving force behind the non-linearity of the Kuznets process was urbanization; (3) low productivity in agriculture relative to that of the economy as a whole (i.e., dualism) was a significant contributing factor to income inequality; (4) the effect of education on inequality was not robust, but it appears that the expansion of secondary education and that of higher education had different effects on inequality; and (5) inflation exacerbates inequality. Our paper contributes to the existing literature in that (1) it lends empirical support to Kuznets’ original insight that urbanization is a main driver of the inverted-U relationship between inequality and economic development; (2) it establishes a direct empirical link between inequality and dualism in China; (3) it points to the possibility that education expansion at different levels may have different effects on inequality; and (4) it provides some evidence suggesting that inflation hurts the poor more than it hurts the rich.

**Fig. 1** Real GDP per capita (at constant 2005 prices) and inequality 1978–2011. Data source China Compendium of Statistics 1949–2009, and 2010–2012 issues of China Statistical Yearbook



The rest of the paper is organized as follows. Section 2 reviews related literature and explains how this paper contributes to it. Section 3 presents the empirical model and describes the data used in this study. Section 4 analyzes the estimation results. Section 5 concludes with some policy implications.

## 2 Literature Review

There is a vast literature on income inequality in China. We only survey two areas of studies that are closely related to this paper: the Kuznets hypothesis, and the pattern and some identified determinants of income inequality in China.

### 2.1 The Kuznets Hypothesis

Based on the statistical regularities he observed from historical economic data of England, Germany and the United States, Kuznets (1955) suggests that there is an inverted-U relationship between inequality and development: with inequality “widening in the early phases of economic growth when the transition from the pre-industrial to the industrial civilization was most rapid; becoming stabilized for a while; and then narrowing in the later phases” (p. 18). This is the well-known Kuznets hypothesis.

In his original work, Kuznets (1955) emphasized two drivers behind his hypothesis: the concentration of savings, and urbanization. Since upper-income earners generally save more, over time they would hold an increasing proportion of society’s total assets and as a result take an increasingly larger share of the total income. However, several factors have counteracted this savings concentration, for example, income redistribution policies, the increasing importance of service income, and the dynamism of a growing economy that offers more opportunities to all individuals.

On the role of urbanization, Kuznets (1955) argues that income tends to be more unevenly distributed in urban areas, and that the income gap between urban and rural residents does not necessarily narrow with economic development.<sup>1</sup> Given these tendencies, urbanization raises the share of the more unequal of the two component distributions, which increases overall inequality. In later stages of development, the widening of overall income inequality associated urbanization is more than offset by the narrowing of inequality within the urban sector as new migrants better adapt to urban life and obtain greater political power to support their claims for a larger income share. Thus the income inequality path takes the shape of an inverted-U.

While the features of the urbanization process as described by Kuznets (1955) would explain an inverted-U relationship between inequality and development, other researchers have shown that the simple fact that urbanization enables some initially poorer rural individuals to earn a higher income in urban areas could explain the Kuznets hypothesis. Using a simple two-sector model, Robinson (1976) demonstrates that even if the mean income and the income distribution for the urban and the rural sector remain unchanged, the overall inequality (as measured by the log variance of income) is a quadratic function of the urban population share. In other words, in a two-sector economy, overall inequality first rises and then falls as the share of urban population increases. Knight (1976) and Fields (1979) have obtained similar results with different measures of inequality. Knight

<sup>1</sup> Greater income disparity in urban areas may be due to greater occupational diversity and the large income gap between established professionals and recently arrived migrants.

(1976) explains the logic behind the inverted-U curve in the context of urbanization as follows. If everyone is initially in the rural sector and has the same low income, the Gini coefficient ( $G$ ) is zero. If one person moves to the urban sector and receives a higher income without changing anyone else's income,  $G$  goes up slightly. As more people move to the higher income sector,  $G$  continues to rise. When the number of people remaining in the lower-income rural sector falls to a certain level,  $G$  starts to fall. Therefore the process of urbanization would be accompanied by an initial increase and a subsequent decline of overall measured inequality.

A number of early cross-country empirical studies have confirmed the Kuznets relationship between income inequality and development (see for instance, Ahluwalia 1976; Lecaillon et al. 1984). However these studies have been criticized on both methodological and data comparability grounds (Saith 1983; Adelman and Robinson 1989; Anand and Kanbur 1993). It is argued that inter-temporal national studies rather than cross-country analyses are required to test the Kuznets hypothesis (Saith 1983). As an empirical investigation of the relationship between development and inequality in China over the post-reform period of 1978–2011, our paper provides a useful test of the Kuznets hypothesis. To our knowledge, few studies have specifically tested the Kuznets hypothesis in the Chinese context. One exception we find is Zhang et al. (2012) who, in the process of examining the effects of financial development on urban–rural inequality in China over the period 1978–2006, also identified an inverted-U relationship between urban–rural income gap and per capita real GDP. Different from Zhang et al. (2012), we focus on urbanization as the driver behind the Kuznets relationship in line with Kuznets' original conjecture and subsequent theoretical work discussed above. Moreover, we consider a longer time period from 1978 to 2011 and use both national time series and provincial panel data.

## 2.2 Pattern and Determinants of Income Inequality in China

On the pattern of inequality in China, a number of distinctive features have been highlighted in the literature. First, the time path of inequality was non-linear. Kanbur and Zhang (2005) identify three peaks in inequality over the 50 years between 1950 and 2000: during the Great Famine (1961), at the end of the Cultural Revolution (1978) and in the current period of global integration (2000). Zhang and Zou (2012) also emphasize the rise and fall of inequality during different policy eras from central planning, cultural revolution to the reform era beginning in 1978. Second, rural–urban income disparity accounts for a large share of overall inequality in China (Hussain et al. 1994; Lin et al. 2004; Kanbur and Zhang 2005; Lu and Chen 2006; and Xie and Yang 2014). Third, poverty and inequality decreased substantially during the years of rural reform from 1978 to 1985 (Lu and Chen 2006; Ravallion and Chen 2007; and Knight 2014). However, the urban–rural income gap started to widen again in the mid-1980s (Zhang and Zou 2012). By 2002, per capita income of urban households were more than 3 times higher than that of rural households. The urban–rural income ratio started to fall in mid-2000s, but has remained above 3 (Li, et al. 2013).

There is an extensive literature on the determinants of income inequality in China. We only discuss some general findings and focus on a few determinants related to this paper. The first general conclusion to note is that inequality in China is not a result of the poor getting poorer, but rather of the rich getting richer much faster (Li et al. 2013). Based on the Rural Household Surveys and Urban Household Surveys, Ravallion and Chen (2007) demonstrate that over the period 1980–2001 when inequality rose, the incidence of extreme poverty fall drastically. Poverty rate has continued to fall in recent years. Using a PPP

\$1.25 a day definition of a poverty line, it is estimated that poverty rate fell from 19 % in 2002 to 8 % in 2007 (Li et al. 2013).

Secondly, it is well-recognized that understanding urban–rural income differences is crucial to understanding overall inequality in China. The urban–rural income gap can be attributed to a number of factors. Yang (2002) argues that the origin of China’s urban–rural divide can be traced back to the development strategy of the central planning era (1950s–1970s) which extracted agricultural surplus to support heavy-industries and urban development. To implement this strategy, the government artificially lowered the prices of agricultural commodities through unified procurement, set up people’s communes for collective agricultural production, and restricted rural to urban migration via the household registration (*hukou*) system. By the late 1970s, capital was mostly deployed in urban areas whereas rural labor was tied to collective agriculture. As a result, urban workers had much higher productivity and income than rural workers. Since 1978, a series of rural reforms were introduced, including the household responsibility system and greater labor mobility to non-agricultural activities. These reforms significantly increased farmers’ earnings and resulted in a reduction in urban–rural disparity between 1978 and 1985 (Yang 2002).

Unfortunately, the progress towards greater equality did not last. From mid-1980s, urban–rural inequality rose again. Many studies have looked into the reasons that possibly explain the reversal of the inequality trend. One main reason identified is the remaining barriers to labor mobility from rural to urban areas (Yang 1999, 2002; Lin and Chen 2011). Lin et al. (2004) observe that although the government gradually relaxed migration rules in the 1990s, most cities still denied permanent residency (“*hukou*”) to migrants. While mid-sized cities started granting permanent residency to migrants on selective bases in early 2000s, the *hukou* system remains a critical barrier to labor mobility (Zhang and Zou 2012). In particular, many rural migrants are unable to relocate to urban areas permanently as they face employment discrimination and high housing costs, and have difficulty accessing public services including education and healthcare (Li et al. 2013). As a result of the migration barrier, more labor remains in agriculture than is desirable and agricultural productivity suffers.

At the same time agricultural productivity growth was suppressed, labor productivity growth in urban industries has grown rapidly thanks to increasing capital intensity on account of massive investments over time. Some of the investments came directly from the government. Others were facilitated by government policies. For example, the government has kept the prices of fuel, electricity, water and land low and has not strictly enforced environment regulations (Kuijs and Wang 2006). These policies artificially inflated industrial profits and stimulated investment in urban industries. In addition, industrial firms, in particular large firms and state-owned-enterprises, were given preferential access to bank credit (Gordon and Li 2003; Allen et al. 2005).

As labor productivity growth in agriculture was hindered, and that in urban industries was promoted, the productivity gap between agriculture and the rest of the economy grew. This productivity gap is referred to in the literature as dualism. Nielsen (1994) and Bourguignon and Morrisson (1998) find dualism to be an important explanatory factor of income inequality in cross-country studies. However there seems to be a lack of empirical evidence on how dualism affects inequality in the Chinese context. A contribution of this paper is that it establishes a direct empirical link between dualism and inequality in China.

Apart from dualism, a considerable number of other determinants of inequality in China have been identified in the literature, including education (Zhang et al. 2012), financial development (Jalil and Feridun 2011), fiscal decentralization (Huang and Chen 2012), government transfers (Li et al. 2013), inflation (Ravallion and Chen 2007), openness (Jalil

2012) and taxation (Tao et al. 2004). We focus on education and inflation here. There are mixed views about the effect of education expansion on inequality in China. On the one hand, some researchers attribute urban–rural income differences to differences in education opportunities and outcomes, and argue that education expansion would improve human capital in rural areas and reduce income inequality (Sicular et al. 2007; Gustafsson et al. 2008). On the other hand, Zhang et al. (2012) find education expansion to be correlated to a worsening of rural–urban inequality in Eastern China probably due to brain drain in rural areas. In the existing literature, education expansion is typically measured by secondary school enrollment. In this paper, we measure education separately by higher education enrollment and secondary school enrollment, and examine whether they had different effects on inequality.

As for the effect of inflation on inequality, the results are mixed in different country studies (see for instance, Easterly and Fischer 2001; Bulir 2001; Clarke et al. 2006). In the Chinese context, the effect of inflation on inequality does not seem to have received much research attention although Ravallion and Chen (2007) have found that inflation hurts the poor. In this paper, we discuss the possible mechanisms through which inflation may improve or exacerbate inequality, and provide new evidence which suggests that on balance, inflation has the effect of worsening inequality in China.

### 3 Empirical Models

#### 3.1 Model Specifications

We consider four factors that determine income inequality ( $IT$ ) in China: urbanization ( $URBAN$ ), dualism ( $DUAL$ ), inflation ( $INF$ ), and education ( $EDU$ )

$$IT = f(URBAN, DUAL, INF, EDU) \quad (1)$$

where  $EDU$  may be either higher education ( $HEDU$ ) or secondary education ( $SEDU$ ).

Based on Eq. (1), we can specify two empirical models, one with higher education and another with secondary education:

$$\ln(IT) = \alpha_0 + \alpha_1 \ln(URBAN) + \alpha_2 (\ln(URBAN))^2 + \alpha_3 \ln(DUAL) + \alpha_4 \ln(INF) + \alpha_5 \ln(HEDU)_{-5} + u \quad (2a)$$

$$\ln(IT) = \beta_0 + \beta_1 \ln(URBAN) + \beta_2 (\ln(URBAN))^2 + \beta_3 \ln(DUAL) + \beta_4 \ln(INF) + \beta_5 \ln(SEDU)_{-5} + \varepsilon \quad (2b)$$

Equations (2a) and (2b) specify a non-linear relationship between urbanization and inequality in line with the Kuznets hypothesis. As noted in the last section, a driving force behind the non-linear relationship between income inequality and development is the urbanization process. That is, as an economy develops, a larger share of the population moves to urban areas and earn a higher income. This movement leads to an initial increase and a subsequent fall in inequality (Kuznets 1955; Knight 1976). If the Kuznets relationship applies to the Chinese experience, we would find the coefficients of  $\ln(URBAN)$  (i.e.,  $\alpha_1$  and  $\beta_1$ ) to be positive and the those of  $(\ln(URBAN))^2$  (i.e.,  $\alpha_2$  and  $\beta_2$ ) to be negative.

The second determinant of income inequality in our model is dualism (*DUAL*). As noted earlier, dualism is a measure of productivity difference between agriculture and the rest of the economy. Standard neoclassical economic theory postulates that if marginal productivity of a factor is higher in one sector than another, factors of production would be attracted to the sector with higher marginal productivity. Factor movement would continue until marginal productivities in all sectors are equalized, which means factor income should also tend to equalize. In real economies, however, such factor movements may be significantly constrained so that dualism results which in turn produces income disparity across sectors. In China, labor movements are restricted by the system of household registration (“*hukou*”), and capital allocation is also biased in favor of the urban sector, both leading to dualism. Dualism affects inequality because productivity differences correspond to different income-generating abilities. The higher the degree of dualism, that is, the more productivity in agriculture lags behind that in other sectors, the lower income rural residents are likely to earn relative to urban residents. Thus we expect the coefficients of  $\ln(DUAL)$  (i.e.,  $\alpha_1$  and  $\beta_1$ ) to be positive.

The third determinant of inequality in our model is inflation (*INF*). The study of redistributive effect of inflation can be traced back to Cantillon (1755), who links inflation to an increase in money supply. He contends that where there is an increase in money supply, the new money enters the economy *at a specific point*, which means some people receive the new money first. The first receivers of new money spend it, so the money reaches their suppliers who in turn pass it on through their own purchases. In this way, the new money permeates the economy via multiple *sequential* transactions. The early recipients of the new money benefit at the expense of the late receivers because their income increase before prices increase for all the goods they buy; whereas the late recipients experience higher prices before their income levels rise. Since higher income earners tend to be politically more powerful and have better access to finance, they are more likely to receive the new money first and benefit from inflation (Bai and Cheng 2014). That is, inflation driven by a monetary expansion would redistribute wealth from the poor to the rich, thereby exacerbating inequality.

On the other hand, Lewis (1954) argues that in a dual economy with “unlimited supplies of labor”, credit creation can facilitate the employment of more labor to speed up capital formation. The expansion of credit will lead to inflation in the short run, but prices will fall after output expands with the increased capital investment. Before more output is produced however, the existing quantity of output is redistributed to the newly employed workers at the expense of the rest of the community and the income share of capital owners rises as more capital is accumulated. The increased employment tends to reduce income inequality but the higher share of capital income tends to raise it, so the net effect depends on the relative magnitudes of the two forces.

While the theories do not give a clear prediction about inflation’s net effects on inequality, we suspect that inflation driven by credit expansion in China had more of the effect of enriching the privileged class than creating job opportunities benefiting the poor. Thus we hypothesize that inflation had a net effect of widening inequality in China, that is, we expect  $\alpha_4$  and  $\beta_4$  to be positive.

The fourth determinant of inequality in our model is education. It is generally believed that in the long run, education is an important income equalizer for at least two reasons. First, low income families can more easily acquire human capital through education than accumulate physical or financial capital through savings or inheritance. Secondly, unlike physical capital accumulation that is prone to concentration, the expansion of human capital involves dispersion of knowledge and skills across the wider population (Ahluwalia

1976). However, in the short run, education expansion may be associated with higher inequality. For instance, if people from high income families have better education opportunities, overall inequality may increase during the course of education expansion (Nielsen 1994). Also, the income gap between the educated and the uneducated may increase as skill-biased technological change in recent decades has raised the return to education (Acemoglu 2002). Moreover, in the Chinese context, as migrants to urban areas tend to be more highly-educated, the brain drain in rural areas hinders rural sector productivity growth, thereby aggravating urban–rural income inequality.

We measure education separately by higher education enrollment (lagged by 5 years) and secondary school enrollment (lagged by 5 years), and examine whether they had different effects on inequality. To the extent that higher education is one path for talented young people in rural areas to find highly-paid employment in cities, the expansion of higher education may result in brain drain in rural areas, thereby widening rural–urban inequality. Secondary education expansion on the other hand may have a different effect. As an important way of accumulating human capital, secondary education improves the labor productivity and income earning abilities of all those receiving the education. The expansion of secondary education is likely to benefit the rural region more because the rural region started from a lower secondary school enrollment rate, and would receive a relatively greater improvement in education opportunities. Thus, we hypothesize that higher education expansion would have an inequality-widening effect, whereas secondary education expansion would have an inequality-narrowing effect. That is, we expect  $\alpha_5$  to be positive and  $\beta_5$  to be negative.

We performed the Chow Test for structural change and identified year 1992 as a breakpoint in the national time series. However year 1992 is not identified as breakpoint in the provincial panel data. Therefore we have included a time dummy  $T1992$  (with  $T1992 = 0$  for years 1978–1992; and  $= 1$  for years 1993–2011) in our national time series estimation. Two events in 1992 help explain why there might be a structural break. First, following Deng Xiaoping’s southern tour in 1992, the Chinese central government endorsed the notion of “socialist market economy” and sped up the pace of economic reforms. Second, China’s adoption of the United Nations System of National Accounts 1993 marked a major step towards an international standard of national accounting.

### 3.2 Data and Variable Definitions

We use both national time series and provincial panel data for the period 1978–2011 to estimate Eqs. (2a) and (2b). The provincial panel data contain information for 31 province-level divisions of administrative areas (which includes 22 provinces, 5 autonomous regions and 4 directly-administered municipalities). The time series and panel data for 1978–2008 are from *China Compendium of Statistics 1949–2009*. The time series data for 2009–2011 are from 2010 to 2012 issues of *China Statistical Yearbook*. The panel data for 2009–2011 are from 2010 to 2012 issues of *China Statistical Yearbook for Regional Economy*.

The definitions of all variables in our model together with their corresponding data sources are presented in Table 1. The national time series data are in “Appendix 2”. The summary statistics of the panel data is provided in Table 2. We provide further details below.

The Theil index ( $TT$ ) is our measure of income inequality. We have computed  $TT$  from provincial data on rural and urban incomes and populations (see the “Appendix 1” for calculation details). It is important to note that in the national time series,  $TT$  can be understood as capturing three components: inequality between rural and urban residents,

**Table 1** Definitions of variables

Variables	Definitions
TT	Theil's index $\times 100$ Calculated by the authors (see "Appendix 1" for details of the calculation)
URBAN	Urbanization $= \frac{\text{Urban population}}{\text{Total population}} \times 100$
DUAL	Dualism $= \frac{\text{Average productivity}}{\text{Agricultural productivity}}$ $= \frac{\text{GDP/Total employment}}{\text{Primary industry GDP/Primary industry employment}}$
INF	Consumer price index series (preceding year = 100)
HEDU	Higher education $= \frac{\text{Enrollment in higher education institutions}}{\text{Total population}} \times 10,000$
SEDU	Secondary education $= \frac{\text{Enrollment in secondary schools}}{\text{Total population}} \times 100$
T1992	Dummy variable = 0 for years 1978–1992; 1 for years 1993–2011

inequality within rural residents across different provinces and inequality within urban residents across different provinces. In contrast, *TT* in the provincial panel data capture only inequality between rural and urban residents.

*URBAN* is the degree of urbanization measured by the share of urban population in total population. The degree of urbanization has increased substantially over our data period. In 1978, about 17.9 % of the population resided in urban areas. By 2011, the figure had risen to 51.3 %.

*DUAL* is measured by the inverse of agricultural labor productivity relative to labor productivity for the economy as a whole, so that a larger value of *DUAL* indicates a lower relative productivity in agriculture. Since the primary sector in China contains mainly agriculture, it is often treated as being "equivalent to" agriculture in the literature (Fan et al. 2011). We thus use primary sector productivity as a proxy for agricultural productivity. *DUAL* fell from 2.5 in 1978 to 1.99 in 1984, then started to rise, reaching a peak of 3.8 in 2003. In 2011, *DUAL* remained at a high level of 3.5.

*INF* is measured by the consumer price index series with preceding year equal to 100. *HEDU* is higher education enrollment per 10,000 population (lagged by 5 years). Higher education enrollment increased substantially from 3.52 in 1973 to 132.28 in 2006. *SEDU* is secondary education enrollment per 100 population (lagged by 5 years). Secondary enrollment increased from 3.86 in 1973 to 7.82 in 2006.

## 4 Estimation Results

We conduct our time series estimation of Eqs. (2a) and (2b) using the Autoregressive Distributed Lag model (ARDL) advocated by Pesaran (1997) and Pesaran and Smith (1998). This approach has been widely used in time series analyses, including studies of inequality (see, for instance, Jalil 2012). The ARDL procedure consists of three steps. The first step involves selecting the appropriate lag orders of the ARDL model using either the

**Table 2** Summary statistics

Variables	YEAR	TT	URBAN	DUAL	INF	HEDU <sub>-5</sub>	SEDU <sub>-5</sub>	
Mean	1978	7.559820	22.43739	2.572859	100.4290	5.420203	4.123087	
	1980	5.816278	24.05860	2.439619	100.4419	8.069975	5.228406	
	1985	4.165883	30.02923	2.061602	110.1452	15.91685	5.842710	
	1990	6.770242	33.35956	2.041593	102.8710	21.87893	5.007065	
	1995	11.95172	34.44436	2.364600	117.4258	23.85964	4.578835	
	2000	12.02891	36.70692	3.137320	100.1645	30.38434	5.126232	
	2005	14.20020	45.32338	3.601396	101.6387	51.16897	6.485271	
	2010	13.13105	50.38282	3.899997	103.4258	129.2951	7.440271	
	2011	12.04830	52.16357	3.999441	105.4806	141.7232	7.447448	
	Maximum	1978	20.18925	88.56293	8.525756	102.900	40.55690	11.7120
		1980	11.82986	87.45146	8.960611	113.600	52.70014	12.8648
1985		10.15148	84.26106	3.906917	117.600	91.78370	8.5629	
1990		16.71733	83.54676	2.637653	107.100	125.1784	7.7457	
1995		25.85851	96.98472	4.056039	121.400	128.5451	6.6389	
2000		29.52921	98.87941	6.393462	103.900	145.6318	7.4060	
2005		27.59742	89.08886	6.813653	102.900	207.2455	8.5660	
2010		23.61544	85.95749	9.234429	105.400	348.9597	9.5153	
2011		22.73780	89.30550	6.788529	106.300	350.8539	9.9459	
Minimum		1978	0.535523	7.922341	1.416654	98.800	1.110188	0.2823
		1980	0.878128	8.651395	1.421801	102.800	2.582126	0.7096
	1985	0.294663	10.29176	1.460208	104.600	4.886612	1.2036	
	1990	0.751928	13.43541	1.539045	97.500	6.694449	1.1380	
	1995	0.290362	16.31868	1.593023	113.500	8.263122	1.1514	
	2000	0.191525	18.61433	1.643170	96.700	9.891451	1.6260	
	2005	2.040571	26.81159	1.660932	100.700	21.24759	2.4599	
	2010	2.500521	22.92359	1.905741	102.200	52.25124	5.5816	
	2011	2.039072	22.77228	1.874757	104.900	58.95661	5.0538	
	SD	1978	4.295967	18.06831	1.383367	0.695794	7.604597	2.313582
		1980	2.697527	18.16823	1.455839	2.237525	10.37825	2.472329
1985		2.772816	17.83200	0.493636	2.901360	18.40871	1.605070	
1990		3.843586	18.17611	0.331021	2.118206	24.97305	1.300422	
1995		6.326752	17.3716	0.532697	2.056529	25.71963	1.031184	
2000		6.515996	17.37406	0.901109	1.521085	29.10436	1.114823	
2005		6.530801	15.30937	1.141905	0.539553	42.16538	1.243386	
2010		5.460428	13.82328	1.429827	0.665816	68.74776	1.172256	
2011		5.341256	14.46213	1.230162	0.372754	68.86248	1.266559	

Akaike Information Criterion (AIC) or the Schwartz Bayesian Criterion (SC). A variable Addition Test (ARDL case) is conducted to see whether there exists a long-run relationship among the variables. If the null hypothesis of no co-integration is rejected, one proceeds to the second step of estimating the long-run relationship using the selected ARDL model. In the third step, an error correction model is estimated, providing information on the speed of adjustment back to the long-run equilibrium following a shock.

We use the (province) fixed effects model for our panel data estimation. The model is estimated with first-differenced variables.

Before the models are estimated, we first test whether the variables under consideration are stationary. The test results for the time series and panel data are reported in Tables 3 and 4, respectively. The results suggest that all variables in first differences are stationary, which means that our estimation methods can be applied. For the time series, we also test the existence of a long term relationship among the variables (which is the second step of the ARDL method as described earlier). The test (reported in Table 5) indicates that a long run relationship exists for each model.

The results from the estimating our empirical model [Eq. (2a) and (2b)] are presented in Table 6. There are four estimation results, two (estimations 1 and 2) based on national time series data and two (estimations 3 and 4) based on provincial panel data.

#### 4.1 National Time Series Analysis

The model specifications for the two national time series estimations are the same except that in estimations 1, education is measured by higher education enrollment [ $\ln(HEDU)$ ] whereas in estimation 2, it is measured by secondary education enrollment [ $\ln(SEDU)$ ]. Since the estimated coefficient of  $\ln(SEDU)$  is insignificant but that of  $\ln(HEDU)$  is, we consider higher education to be a more suitable measure of education, and therefore we focus on the results of estimation 1 for the national time series data analysis.

In estimation 1, the coefficient of  $\ln(URBAN)$  is positive and significant; and that of  $LNURBAN^2$  is negative and significant. This is consistent with the theoretical prediction that urbanization is an important driver behind the Kuznets process. It indicates that the Chinese development experience confirms the Kuznets hypothesis that there is an inverted-U relationship between income inequality and development. Specifically, the coefficients of  $\ln(URBAN)$  and  $[\ln(URBAN)]^2$  combined imply that the Kuznets turning point is at where the rate of urbanization is about 25 ( $=e^{25.8252/(2 \times 4.0138)}$ ) percent. This occurred between year 1986 and 1987 (see “Appendix 2”). It is clear from Fig. 1 that inequality continued to rise in 1987, and did not peak until 2003. This suggests while increasing urbanization above 25 % had the effect of reducing inequality, this effect was more than offset by other factors which continued to push up inequality. These other factors included dualism [ $\ln(DUAL)$ ], inflation [ $\ln(INF)$ ] and higher education [ $\ln(HEDU)$ ].

The estimated coefficient of  $\ln(DUAL)$  is positive and significant. Noting that a high value of  $\ln(DUAL)$  means low agricultural productivity relative to productivity of the economy as a whole, the positive coefficient of  $\ln(DUAL)$  confirms our conjecture that low productivity in agriculture is likely to be associated with high overall income inequality. The importance of dualism in explaining inequality in China is consistent with the fact that a substantial proportion of overall inequality in China is attributable to urban–rural inequality (Lin and Chen 2011). This result is also in line with the findings of Nielsen (1994) and Bourguignon and Morrisson (1998). Estimation 1 indicates that a 1 % increase in dualism leads to a 2.8 % increase in inequality.

The estimated coefficient of  $\ln(INF)$  is also positive and significant. This lends some support to our conjecture that the inflation in China benefited the rich and privileged (in the form of easier access to credit) more than it benefited the poor (in the form of short term employment opportunities). Therefore the net effect of inflation on inequality was positive. It is estimated that a 1 % increase in inflation was associated with a 1.2 % increase in inequality.

In addition, the coefficient of  $\ln(HEDU)$  is positive and significant, suggesting that higher education expansion was associated with an increase in inequality. This is probably

**Table 3** Unit root tests: national time series 1978–2011

Test method <sup>a</sup>	Level variable	Test statistic (Prob.)	(C,T,L/B) <sup>b</sup>	First difference variable	Test statistic (Prob. <sup>a</sup> )	(C,T,L/B) <sup>b</sup>
ADF	ln(TT)	0.1783 (0.7317) <sup>c</sup>	(0,0,1)	$\Delta$ ln(TT)	-3.0492** (0.0034)	(0,0,0)
PP		0.1688 (0.7287) <sup>c</sup>	(0,0,2)		-2.8259*** (0.0062)	(0,0,5)
KPSS		0.1092** (-) <sup>d</sup>	(C,0,2)		0.1121 (-)	(C,0,2)
ADF	ln(URBAN)	-3.9926 (0.9999)	(0,0,1)	$\Delta$ ln(URBAN)	-1.7748* (0.0723)	(0,0,0)
PP		9.2350 (0.9999)	(0,0,4)		-1.6513* (0.0924)	(0,0,3)
KPSS		0.6833** (-)	(C,0,5)		0.0884 (-)	(C,0,4)
ADF	ln(DUAL)	-3.1443 (0.1132)	(C,T,0)	$\Delta$ ln(DUAL)	-5.0475*** (0.0000)	(0,0,0)
PP		-3.0898 (0.1252)	(C,T,0)		-4.9329*** (0.0000)	(0,0,0)
KPSS		0.6030** (-)	(C,T,5)		0.1914 (-)	(C,0,1)
ADF	ln(INF)	-3.3179** (0.0223)	(C,0,1)	$\Delta$ ln(INF)	-5.6106*** (0.0000)	(0,0,1)
PP		-2.4793 (0.1294)	(C,0,5)		-6.9375*** (0.0000)	(0,0,22)
KPSS		0.1934 (-)	(C,0,5)		0.2843 (-)	(C,0,22)
ADF	ln(HEDU)	2.1882 (0.9916)	(0,0,1)	$\Delta$ ln(HEDU)	-2.3549** (0.0201)	(0, 0,0)
PP		4.2554 (0.9999)	(0,0,3)		-2.3541** (0.0201)	(0, 0,3)
KPSS		0.7598*** (-)	(C,0,4)		0.1827 (-)	(C,0,3)
ADF	ln(SEDU)	-2.7497* (0.0770)	(C,0,1)	$\Delta$ ln(SEDU)	-2.5619** (0.0121)	(0,0,0)
PP		-1.5173 (0.5126)	(C,0,3)		-2.3893** (0.0185)	(0,0,5)
KPSS		0.1518** (-)	(C,T,4)		0.1244 (-)	(C,0,2)

<sup>a</sup> The unit root test methods used are the Augmented Dickey–Fuller test (ADF), the Phillips–Perron test (PP), and Kwiatkowski–Phillips–Schmidt–Shin test (KPSS) respectively. The null hypothesis of ADF test and PP test is that the tested series has a unit root, the null hypothesis of KPSS test is that the tested series is stationary

<sup>b</sup> (C,T,L/B) refer to intercept, trend, lag length (ADF)/Bandwidth (Bartlett kernel of PP) specified in the tests. Intercept and trend are obtained by experimentation in EViews 8.0. Lag length (ADF)/bandwidth (Bartlett kernel of PP) are selected automatically by EViews 8.0

<sup>c</sup> MacKinnon (1996) one-sided p-values is used for test critical values at 10, 5, and 1 % levels respectively

<sup>d</sup> Kwiatkowski–Phillips–Schmidt–Shin (1992, Table 1) is used for Asymptotic critical values at 10, 5, and 1 % levels, respectively. The asymptotic critical values here are 0.347, 0.463, 0.739 for (C,0,B), and 0.119, 0.146, 0.216 for (C,T,B) respectively

\*, \*\*, \*\*\* Statistical significance at 10, 5, and 1 % levels respectively

**Table 4** Unit root tests: provincial panel data 1978–2011

Variable	Test method <sup>a</sup>	Level test		First difference test	
		Statistic	Prob.	Statistic	Prob.
ln(TT)	LLC	-0.0311	0.4876	-16.8175***	0.0000
	ADF-F	80.2041	0.0598	404.841***	0.0000
	PP-F	87.7890	0.0173	506.097***	0.0000
ln(URBAN)	LLC	-0.4840	0.3142	-12.5758***	0.0000
	ADF-F	56.0894	0.6873	514.133***	0.0000
	PP-F	51.1018	0.8369	552.259***	0.0000
ln(DUAL)	LLC	2.5609	0.9948	-26.7957***	0.0000
	ADF-F	17.3154	1.0000	731.494***	0.0000
	PP-F	14.4106	1.0000	798.326***	0.0000
ln(INF)	LLC	-9.59588***	0.0000	-29.2149***	0.0000
	ADF-F	174.278***	0.0000	794.358***	0.0000
	PP-F	794.358***	0.0000	1264.27***	0.0000
ln(HEDU)	LLC	4.3626	1.0000	-15.3012***	0.0000
	ADF-F	19.2056	1.0000	346.461***	0.0000
	PP-F	24.8381	1.0000	371.812***	0.0000
ln(SEDU)	LLC	-1.1128	0.1329	-16.5288***	0.0000
	ADF-F	148.877	0.0000***	352.485***	0.0000
	PP-F	84.8473	0.0286**	294.883***	0.0000

<sup>a</sup> LLC, ADF-F, PP-F refer to Levin, Lin and Chu, ADF-Fisher Chi-square, PP-Fisher Chi-square unit root test methods for panel data respectively

\*, \*\*, \*\*\* Statistical significance at 10, 5, and 1 % levels respectively

due to unequal education opportunities and brain drain from poor regions of the country. A 1 % increase in higher education enrolled was associated with a 0.6 % increase in inequality. Finally, the time dummy variable  $Y1992$  is significantly negative (at 10 % level) suggesting a lower level of inequality after 1992.

## 4.2 Provincial Panel Data Analysis

Similar to the national time series estimations, we use two different measures of education: higher education enrollment (estimation 3) and secondary education enrollment (estimation 4). As shown in Table 5, the estimated coefficient of secondary education [ $\ln(SEDU)$ ] is negative and significant at 1 % level, in particular, an increase in secondary enrollment by 1 % was associated with a fall in inequality by 0.7 %. This is consistent with our conjecture that the expansion of secondary education benefits poorer rural areas more because in richer urban areas secondary education was already widespread during our data period. However, contrary to the result in the national time series analysis above, an expansion of higher education also had statistically significant (at 10 % level) negative effect on inequality. This suggests that possibly the brain drain effect encouraged by higher education participation operated more at the inter-provincial level—the brightest students from poor provinces went to better universities in richer provinces and worked in richer provinces after graduation. Since provincial data do not capture inter-provincial income differences, the expansion of higher education mainly had the effect of enhancing human

**Table 5** Variable addition tests for the existence of a long relationship

Corresponding empirical model	Lagrange multiplier statistic (Prob.)	Likelihood ratio statistic (Prob.)	F statistic (Prob.)
Equation (2a)	15.3522** (0.018)	21.1933*** (0.002)	2.4528* (0.074)
Equation (2b)	14.0056** (0.030)	18.8688*** (0.004)	1.6054 (0.235)

This is step 2 of the ARDL estimation procedure in our time series analysis as described Sect. 3. It is a joint test of zero restrictions on the coefficients of additional lagged level variables. The Lagrange multiplier statistic, the likelihood ratio statistic and the F statistic reported indicate that the null hypothesis of no co-integration can be rejected. See Pesaran (1997) and Pesaran and Smith (1998)

\*, \*\*, \*\*\* Statistical significance at 10, 5, and 1 % levels respectively

capital, which in turn narrowed income inequality although the quantitative impact was small: a 1 % increase in higher education expansion was associated with a 0.15 % decrease in inequality at the provincial level.

Now turn to our main question of whether there was a Kuznets inverted-U relationship. In both estimations 3 and 4, the estimated coefficient of  $\ln(URBAN)$  is positive and significant at 1 % level, and that of  $[\ln(URBAN)]^2$  is negative and significant at 1 % level, confirming the Kuznets hypothesis. Estimation 3 suggests a Kuznets turning point at urbanization level of 31 ( $=e^{5.4365/(2 \times 0.7923)}$ ) percent whereas estimation 4 suggests a Kuznets turning point at urbanization level of 30 ( $=e^{5.0744/(2 \times 0.7459)}$ ) percent. On average this level of urbanization was achieved in 1985 (see Table 2). In general, richer provinces and provinces with a heavy industrial bias reached the turning point earlier than poorer ones (see Table 7). For example, Beijing and Helongjian reached the turning point before the beginning of our data period of 1978, whereas Guizhou did not reach it until 2010.

Consistent with the national time series analysis, both dualism  $[\ln(DUAL)]$  and inflation  $[\ln(INF)]$  are found to have had the effect of exacerbating inequality. A 1 % increase in dualism was associated with an increase in inequality by about 1.0 % (estimation 3) to 1.1 % (estimation 4). A 1 % increase in inflation was associated with an increase in inequality by 0.9 % (estimation 4) to 0.95 % (estimation 3).

## 5 Conclusion

In this paper, we have studied the pattern and determinants of overall income inequality in the post-reform Chinese economy of 1978–2011 using both national time series and provincial panel data.

We have identified in both datasets a Kuznets inverted-U relationship between income inequality and economic development and have shown that urbanization was an important driver of the Kuznets process. Further we estimate that the Kuznets turning point for the national time series is at the urbanization rate of about 25 %, and that for the panel data is at the urbanization rate of about 30 %. For both datasets, the turning point occurred in the mid-1980s. Since inequality continued to rise after the mid-1980s, we argue that while increased urbanization after the mid-1980s had the effect of narrowing inequality, this effect was more than offset by other factors. In particular, we found that dualism and inflation were significant contributing factors to income inequality.

**Table 6** Estimation results

DATA TYPE	National time series data		Provincial panel data	
	Estimation 1	Estimation 2	Estimation 3	Estimation 4
Estimate method	ARDL-ECM	ARDL-ECM	1st difference	1st difference
Dependent variable	LNTT	LNTT	LNTT	LNTT
Intercept	-48.6562*** (7.2664) [0.000]	-69.9779* (33.5823) [0.051]	0.0105 (0.0157) [0.5032]	0.0086 (0.0128) [0.4993]
T1992	-0.2107* (0.1131) [0.077]	0.0710 (0.1602) [0.663]	-	-
ln(URBAN)	25.8252*** (3.5423) [0.000]	34.1197* (16.9210) [0.058]	5.4365*** (1.0461) [0.000]	5.0744*** (1.0430) [0.000]
[ln(URBAN)] <sup>2</sup>	-4.0138*** (0.5404) [0.000]	-4.7460* (2.3997) [0.063]	-0.7923*** (0.1536) [0.000]	-0.7459*** (0.1531) [0.000]
ln(DUAL)	2.8331*** (0.4304) [0.000]	0.0821 (0.7605) [0.915]	1.0401*** (0.1258) [0.000]	1.0781*** (0.1247) [0.000]
ln(INF)	1.1581** (0.5061) [0.033]	2.0836* (0.8952) [0.031]	0.9607*** (0.2304) [0.000]	0.8950*** (0.2302) [0.0001]
ln(HEDU) <sub>-5</sub>	0.6103*** (0.1295) [0.000]		-0.1492* (0.0888) [0.0934]	
ln(SEDU) <sub>-5</sub>		1.1676 (0.9722) [0.245]		-0.6797*** (0.1298) [0.000]
ECM <sub>t-1</sub>	-0.4671*** (0.0512) [0.000]	-0.2779*** (0.0488) [0.000]	-	-
LM test for correlation	0.2041 [0.651]	0.9670 [0.325]	-	-
Ramsey's RESET test	8.8975*** [0.003]	12.5780*** [0.000]	-	-
Heteroskedasticity test	1.0811 [0.298]	1.0399 [0.276]	-	-
F-stat.	358.38***	298.08***	3.7848***	4.5103***
$\bar{R}^2$	0.9916	0.9909	0.0846	0.1073
ARDL order selected based on Schwarz Bayesian criterion	ARDL (3,1,0,0,0)	ARDL (2,2,0,1,0,0)	-	-
Adjusted sample range	1981–2011	1981–2011	1979–2011	1979–2011
Adjusted sample size	31	31	1013	1023

A couple of implications following from the results of our paper are worth noting. First, since measured inequality rises with the increasing relative size of the higher-income urban population in the initial stages of development even if the relative average income between

**Table 7** Kuznets turning points

Year in which Kuznets turning point was reached	Province-level administrative areas
Before 1978	Beijing, Tianjin, Heilongjiang, Shanghai
1978	Liaoning, Jilin
1983	Xinjiang
1984	Inner Mongolia, Guangxi, Shaanxi, Qinghai
1986	Jiangsu
1987	Zhejiang
1993	Hubei
1996	Guangdong
1997	Shanxi, Chongqing
2000	Tibet, Ningxia
2001	Jiangxi, Hunan
2002	Anhui, Fujian
2003	Shandong
2004	Hebei, Hainan
2005	Henan, Sichuan
2006	Gansu
2007	Yunan
2010	Guizhou

rural and urban residents remain constant (Knight 1976; and Fields 1979), measured inequality by itself does not give us sufficient information about the well-being of different social groups. To have a clear understanding of the welfare implications of inequality, it is important to also look at more detailed information instead of focusing on a single aggregate statistic. For instance, it will be informative to look at how population sizes change for groups of different income levels over time.

Secondly, the importance of dualism in explaining inequality (after controlling for urbanization) suggests that improving agricultural productivity not only enhances efficiency but also is likely to be an effective way of reducing inequality. From the beginning of the reforms in 1978 to the mid-1980s, agricultural productivity increased significantly with the implementation of the household responsibility system and with the rapid growth of township and village enterprises (TVEs) absorbing underemployed agricultural labor. During the same time, inequality fell substantially (see Fig. 1). The increased inequality in subsequent years may be partly attributable to urban-biased policies such as tightened state control of the financial sector severely hindering rural sector development (Huang 2012). To address growing public concern over inequality, policies should be directed to facilitate improvement in the rural sector. For instance, the rural sector's access to banking finance should be improved; the *hukou* system of household registration should be further relaxed to allow freer movement of labor between urban and rural areas; and the urban-bias in public investment spending should be corrected.

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### Appendix 1: Calculation of the Theil Index

The Theil index has its origin in Shannon’s (1948) information theory. Theil (1967) adapted Shannon’s formula of expected information content to measure inequality, leading to the now well-known Theil’s TT (Conceicao and Galbraith 2000):

$$TT = \sum \frac{y_i}{Y} \ln \frac{y_i/Y}{1/n} = \frac{1}{n} \sum \frac{y_i}{\mu} \ln \frac{y_i}{\mu} \tag{3}$$

where  $n$  is the number of individuals in the population,  $Y$  is the total income of the population,  $y_i$  is the income of individual  $i$ ,  $\mu$  is the average income of the population.

The Theil index can be understood as a summary statistic that measures the extent to which the distribution of income across groups differs from the distribution of population across the same groups (Conceição and Ferreira 2000). Groups that have higher income shares than their population shares contribute positively to the Theil index; those that have lower income shares than their population shares contribute negatively. If each group has their “fair” share of income (i.e., each group has the same share of income as its share of population), the Theil index is at its minimum value of zero.

If we consider a population that is divided into  $i$  groups each with  $j$  subgroups, the Theil index can be written as:

$$TT = \sum_i \sum_j \frac{Y_{ij}}{Y} \ln \left( \frac{Y_{ij}}{Y} / \frac{N_{ij}}{N} \right) \tag{4}$$

where  $Y_{ij}$  is the income of subgroup  $j$  in group  $i$ ;  $N_{ij}$  is the population size of subgroup  $j$  in group  $i$ .

To calculate the national time series Theil index given provincial data of China, we rewrite Eq. (4) as:

$$TT = \sum_i \sum_j \frac{Y_{ij}}{Y} \ln \left[ \frac{\frac{Y_{ij}}{Y}}{\frac{N_{ij}}{N}} \right] = \sum_i \sum_j \frac{N_{ij}}{N} \frac{\bar{Y}_{ij}}{\bar{Y}} \ln \left[ \frac{\frac{Y_{ij}}{Y}}{\frac{N_{ij}}{N}} \right] = \sum_i \sum_j \frac{N_{ij}}{N} \frac{\bar{Y}_{ij}}{\bar{Y}} \ln \left( \frac{\bar{Y}_{ij}}{\bar{Y}} \right) \tag{5}$$

where  $i = 1, 2$  representing the urban area and rural area, respectively;  $j = 1, 2, \dots, 31$ , representing 31 provinces (including autonomous regions and directly-administered municipalities);  $N_{ij}$  is the urban ( $i = 1$ ) or rural ( $i = 2$ ) population in province  $j$ ;  $N$  is the total population of China;  $\bar{Y}_{ij}$  is the average urban or rural income in province  $j$ ;  $\bar{Y}$  is the average income in China.

To calculate the provincial panel Theil index, we rewrite Eq. (4) to

$$TT = \sum_{i=1}^2 \frac{Y_i}{Y} \ln \frac{Y_i/Y}{N_i/N}$$

where  $Y_1$  = total annual disposable income of urban households,  $Y_2$  = total annual net income of urban households,  $Y = Y_1 + Y_2$ ,  $N_1$  = urban population,  $N_2$  = rural population

$$N = N_1 + N_2$$

## Appendix 2

See Table 8.

**Table 8** National time series data

Year	TT	RGDPP	URBAN	DUAL	INF	HEDU	SEDU	T1992
1978	10.7674	1582	17.9152	2.5020	100.70	3.52	3.86	0
1979	9.0501	1679	18.9611	2.2324	101.90	4.73	4.02	0
1980	8.7523	1789	19.3911	2.2783	107.50	5.42	4.83	0
1981	6.3032	1859	20.1565	2.1361	102.50	6.03	6.23	0
1982	5.1147	1999	21.1305	2.0405	102.00	6.58	7.14	0
1983	4.2832	2185	21.6236	2.0218	102.00	8.89	6.84	0
1984	4.8644	2481	23.0143	1.9932	102.70	10.46	6.10	0
1985	6.5710	2779	23.7069	2.1945	109.30	11.59	5.63	0
1986	8.7494	2979	24.5249	2.2456	106.50	12.78	4.90	0
1987	9.2491	3270	25.3193	2.2374	107.30	11.35	4.52	0
1988	10.1497	3584	25.8147	2.3098	118.80	11.72	4.39	0
1989	11.3821	3671	26.2102	2.3920	118.00	13.38	4.53	0
1990	10.5001	3755	26.4097	2.2164	103.10	16.09	4.66	0
1991	12.6606	4046	26.9402	2.4341	103.40	17.49	4.79	0
1992	15.0195	4565	27.4599	2.6847	106.40	17.92	4.77	0
1993	18.2827	5143	27.9901	2.8617	114.70	18.61	4.54	1
1994	18.9025	5751	28.5098	2.7340	124.10	18.47	4.29	1
1995	17.2399	6311	29.0404	2.6149	117.10	18.04	4.27	1
1996	14.8686	6870	30.4799	2.5646	108.30	17.65	4.32	1
1997	14.4210	7432	31.9100	2.7287	102.80	18.64	4.36	1
1998	13.7502	7937	33.3502	2.8366	99.20	21.4	4.30	1
1999	14.8848	8469	34.7797	3.0418	98.60	23.35	4.50	1
2000	17.0732	9111	36.2198	3.3194	100.40	23.99	4.80	1
2001	18.2303	9796	37.6597	3.4743	100.70	24.68	5.08	1
2002	19.0716	10614	39.0898	3.6383	99.20	25.67	5.28	1
2003	20.6257	11605	40.5302	3.8367	101.20	27.32	5.48	1
2004	19.9720	12700	41.7600	3.5018	103.90	32.87	5.81	1
2005	20.2312	14053	42.9900	3.6611	101.80	43.88	5.88	1
2006	20.3502	15747	43.9002	3.7554	101.50	56.34	6.21	1
2007	19.5674	17883	44.9402	3.6672	104.80	70.33	6.52	1
2008	18.8002	19506	45.6823	3.5019	105.90	85.79	6.70	1
2009	18.6684	21198	48.3417	3.6871	99.30	102.59	6.73	1
2010	17.4398	23299	49.9497	3.6354	103.30	119.44	7.82	1
2011	16.3288	27309	51.2703	3.4655	105.40	132.28	7.82	1

*Data Source:* China Compendium of Statistics 1949–2009, and 2010–2012 issues of China Statistical Yearbook

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