Draft

Dynamics of Growth-Inequality Nexus in China:

Roles of Surplus Labor, Openness, Education & Technical Change

in Province-Panel Analysis

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Abstract

The paper examines the complex inter-relationship among economic growth, (urban-rural) income inequality, surplus labor, openness, and education and technological progress in China. It uses a panel dataset covering 29 provinces in China and spanning the period from 1988 to 2007, and compares the earlier period (1988-1997) and the later period (1998-2007) to analyze the changing determinants and relationship. The followings are important findings.

Economic growth in China is primarily fixed investment driven for the whole period, is more related to openness in the early period, and more related to education and innovation in the later period. The urban-rural income inequality is caused by economic growth during the earlier reform period, but the impact of growth on the inequality has become insignificant or even negatively related during the later period when openness, high education or technology variables are controlled, which indicates some evidence of the Kuznets hypothesis. On the other hand, there is some evidence that urban-rural income inequality is detrimental to economic growth in China during the later period, but the impact is not significant during the earlier period. Surplus agricultural labor was found to be positively and significantly related to the urban-rural income inequality in China, thus confirming Lewis's dual-economy theory.

Openness was the economic-growth-enhancing and income-inequality-increasing factor during the earlier reform period. However, in the later reform period, exports still had a positive and significant impact on economic growth, whereas FDI lost its significance. Furthermore, both exports and FDI had no significant impact on the inequality in the later reform period. While education and technological progress did not facilitate the economic growth in the early period, it did so in the later reform period. While education and technological progress decreased the urban-rural income inequality in the earlier period, it rather increased the inequality in the later reform period. Government expenditure was found to increase the urban-rural income inequality, implying that public spending in China has been directed towards the urban residents rather than towards the poor rural residents.

Keywords: China, economic growth, urban-rural income inequality, surplus agricultural labor, opening up, education and technological progress

1. Introduction

For the last three decades since the 1980s, China has marched forward with economic growth through a shift from an agricultural nation to an industrial nation. The reform and open door policy also followed an idea that some Chinese nationals in certain areas should first become rich before they can lead other people and regions to become gradually rich. Under this vision, China drove forward with the creation of special economic zones in coastal areas, utilized foreign capital and management, and modernized its trading system to boost exports.

Since then China has had 30 years of remarkable achievements, but it is now suffering from problems that include a wide gap in income among its people, regions, and between rural and urban areas. Starting from a relatively low Gini coefficient of household income of 0.257 in 1984, China reached a relatively high Gini coefficient of income of 0.378 in 1992, and more recently it reached 0.403 in 1998 and 0.469 in 2004, according to the UNU-WIDER World Income Inequality Database. The same source indicates that between 1984 and 2004, while the share of income of the top quintile in total income rose from 34.5% to 51.9%, the bottom quintile's share dropped from 10.1% to 4.3%; the middle class (middle three quintiles) also suffered with the lapse, as its claim dropped by 12% from 55.9% to 43.9%.

This seemingly positive relationship between economic growth and income inequality in China poses many intriguing questions. What is the role of economic development in changing income distribution? If government policies are designed to foster growth, what is their impact on inequality? What specific factors lie behind the noticeable increase in income inequality in post-reform China? In this paper, answers to these questions are postulated and inquiries are made on the role of public policy in enhancing growth and equality.

The literature on economic growth and income inequality can be divided into several strands. The one strand of literature tends to investigate a one-way relationship, either from growth to inequality or from inequality to growth. The other strand looks at the two-way relationship between economic growth and income inequality, which are determined together or *simultaneously* (Lundberg and Squire, 2003). These studies can be regarded as an extension of earlier studies that looked at the determinants of either growth or inequality with including the other factor but without considering its simultaneity.

The literature following the pioneering work of Kuznets (1955) has concentrated mainly on the causal effect of economic growth on income distribution. In this line of studies, the conventional wisdom or the so-called Kuznets curve is that income inequality and per-capita GDP have an inverted-U-shaped relation; income inequality increases over time while a country is developing; then when a certain level of income is attained, the income inequality begins to decrease. Following

Kuznets, a number of studies using the cross-section data of developed and developing countries have found evidence in support of Kuznets' theory (Adelman and Morris, 1973; Paukert, 1973; Ahluwalia, 1974, 1976a, 1976b; Robinson, 1976; Chenery and Syrquin, 1975; Lydall, 1977; Loehr, 1981; Summers et al., 1984; Lindert and Williamson, 1985). This inverted-U hypothesis has become ambiguous in the more recent literature, however, especially with regard to developing countries (Oshima, 1991; Anand and Kanbur, 1993; Ravallian, 1995; Deininger and Squire, 1998).

The other framework for the relationship between economic growth and income inequality, derived from studies going back to at least that of Kaldor (1956), emphasizes the opposite causal link from income distribution to economic growth. While a conventional wisdom argues that income inequality is *necessarily* good for incentives and therefore good for economic growth, it has been challenged by a number of theories claiming that income inequality has a negative effect on economic growth. The most common arguments for a negative causality from income inequality to economic growth are that a greater income inequality increases the demand for redistributive policies and hence distorts the incentives for working and investing (Alesina and Rodrik, 1994; Persson and Tabellini, 1994; Bertola, 1993); that in imperfect capital markets, a more unequal income distribution reduces the opportunities for accumulating human capital and physical assets because a greater number of people are credit-constrained (Chatterjee, 1991; Banerjee and Newman, 1993; Galor and Zeira, 1993; Tsiddon, 1992; Fishman and Simhon, 2002); and finally, that a worsening income inequality may lead to sociopolitical instability and may thus harm the investment environment (Alesina and Perotti, 1996).

Empirical evidences are also mixed. Cross-section regressions (Alesina and Rodrik, 1994; Persson and Tabellini, 1994; Birdsall et al., 1995; Perotti, 1996; Hausmann and Gavin, 1996; Deininger and Squire, 1998; Sylwester, 2000) all found a negative relationship across countries, while the contrary was found using panel data models (Forbes, 2000; Li and Zou, 1998). In addition, Barro (2000) indicates that evidence from a broad panel of countries shows little overall relation between income inequality and the economic-growth rates when rich and poor countries are pooled together.

There are also many studies that have sought to identify the causal factors influencing the evolution of economic growth and income inequality *independently*. This research has looked either at economic growth (Barro, 1991, 1997, 2000; Levine and Renelt, 1992; Mankiw et al., 1992; Barro and Lee, 1994; Barro and Sala-i-Martin, 1995; Sala-i-Martin, 1997; Clarke, 1997; Lee and Kim, 2009) or at income inequality (Ben-David, 1993; Tsai, 1995; Li et al., 1998; Xu and Zou, 2000; Wu, 2000; Ivaschenko, 2003; Lu and Chen, 2006; Jaumotte et al., 2008) but has not tried to identify the factors that may simultaneously influence both (Lundberg and Squire, 2003). As indicated by Lundberg and Squire (2003), the literature that looks *simultaneously* at economic growth and income inequality

relates them in a mechanistic manner that ignores or minimizes the role of other causal factors, including policy, while the literature that incorporates other causal factors, including policies, tend to look at economic growth and income inequality separately. Thus, neither approach is particularly useful for policymakers, who need to balance the impact of policies on both economic growth and income distribution. Following the method of Lundberg and Squire (2003), this study investigates whether and how economic growth and income inequality are simultaneously determined, and more importantly, whether they are subject to the same set of determining factors.

We take up the case of post-reform China, employing the method involving the use of simultaneous equations. Especially, the study focused on three factors: (1) surplus agricultural labor as an initial condition; (2) openness; and (3) education and technological progress. This focus differentiates our study from the literate in following ways.

Until now, there is a vast literature on China's income inequality either in the urban (Démurger et al., 2006; Okushima and Uchimura, 2005; Meng, 2004; Xu and Zou, 2000; Zhou, 2000; Khan et al., 1999; Knight and Song, 1991) and rural areas (Benjamin et al., 2006; Wan and Zhou, 2005; Zhang and Fan, 2004; Morduch and Sicular, 2002; Gustafsson and Li, 2002; Wan, 2001; Benjamin and Brandt, 1999; Tsui, 1998; Yao, 1997; Rozelle, 1996; Knight and Song, 1993; Griffin and Saith, 1982) or between them (Sicular et al., 2007; Wan et al., 2006; Shi, 2004; Wei and Wu, 2001; Knight and Song, 1999; Kanbur and Zhang, 1999; Yang and Zhou, 1999). However, no research has been undertaken to empirically understand the impact of surplus agricultural labor on income inequality, although many scholars agree that in China, which has a dual economy, the migration of the surplus agricultural laborers to the urban areas is one way of reducing the income inequality. Moreover, little has been done to identify the effect of inward foreign direct investment (FDI) on income inequality and to compare this with its effect on economic growth. Moreover, few research has been undertaken to identify the impact of technological progress on either the economic growth of China or the income inequality. Furthermore, although the existing related literature has considered the impact of education on China's economic growth or income inequality (Lee, 1996; Chen and Feng, 2000; Xu and Zou, 2000; Zhou, 2000; Wan et al., 2006), this paper identifies the effect of education at three levels: the primary, junior secondary, and higher education levels.

By including these variables in the simultaneous structure of economic growth and income inequality, this paper will go slightly farther in understanding the forces that might have contributed to the changes in economic growth and income distribution in China. The period studied in this paper is also much longer (20 years, from 1988 to 2007), and the period is further divided into two sub-periods: the earlier reform period (1988-1997) and the later reform period (1998-2007), thus allowing

for a more pronounced comparative analysis—that is, analyzing the changing determinants of economic growth and income inequality during the two sub-periods, which is found an important feature of the Chinese economy by Jin et al (2008).

In this paper, *income inequality* pertains to the urban-rural income inequality. There are two reasons for this. First, as indicated by Lu and Chen (2006), the existing related literature has attributed China's great income inequality to the growing interregional urban-rural income inequality (Kanbur and Zhang, 1999; Khan and Riskin, 1998; Li, 2003; World Bank, 1997; Yang, 1999; Yao and Zhu, 1998; Zhao, 1999). Moreover, the decomposition of income inequality shows that interregional income inequality is also related to the great urban-rural income inequality (Hussain et al., 1994; Kanbur and Zhang, 1999; Tsui, 1993). A Theil decomposition by Li and Yue (2004) showed that the urban-rural income gap represents over 40% of the overall income inequality in China, and, more importantly that while the level of within-rural or within-urban inequality is more or less flat, the urban-rural inequality is ever increasing and is thus accounting for the absolute majority of the net increase of the overall inequality. Second, income inequality measurement, such as Gini coefficient, at each province cannot be estimated due to data unavailablity.

The remainder of this paper is structured as follows. Section 2 provides a general background of how economic growth and urban-rural income inequality evolved in China. Section 3 discusses the estimation methodology and data that are used in the regressions. The regression results and findings are presented in section 4. Finally, in section 5, summary and concluding remarks follow.

2. Economic Growth and Urban-Rural Income Inequality in China

Inter-Provincial and Urban-Rural Difference in economic growth

The average growth rate of China's real per capita GDP from 1978 to 2007 was 8.7%. Due to its huge territory, each region of China has a different economic-growth pattern. Table 1 presents the provinces' average annual per-capita GDP growth rates. The best-performing provinces are located mainly in the coastal areas; these provinces have sustained exceptionally high economic-growth rates. For example, the per-capita GDP of Fujian grew by a factor of 12.32 from 1988 to 2007. Table 1 also presents the economic-growth figures for the subperiods 1988-1997 and 1998-2007. As can be seen in the table, the provinces located in the eastern region saw a slight decline in economic growth in the later reform period while the provinces located in the inland region, especially in the central region, witnessed great economic improvement.

Table 1 Difference in economic growth (unit: percent)

Region	Whole reform period	Earlier reform period	Later reform period
Beijing	8.47	8.23	8.71
Tianjin	10.57	8.94	12.21
Hebei	10.74	10.99	10.49
Shanxi	9.00	7.47	10.53
Inner Mongolia	11.27	7.79	14.75
Liaoning	9.10	7.66	10.55
Jilin	9.49	8.31	10.67
Heilongjiang	8.50	7.11	9.90
Shanghai	10.68	10.29	11.07
Jiangsu	12.20	12.51	11.90
Zhejiang	12.25	12.59	11.91
Anhui	9.57	9.69	9.45
Fujian	12.32	14.14	10.51
Jiangxi	10.15	10.11	10.19
Shandong	11.67	11.37	11.97
Henan	9.97	9.43	10.50
Hubei	9.82	9.34	10.30
Hunan	9.05	8.24	9.87
Guangdong	11.96	12.98	10.93
Guangxi	9.96	10.21	9.70
Hainan	9.88	11.20	8.57
Sichuan	9.46	8.93	9.99
Guizhou	7.63	6.15	9.10
Yuannan	8.31	8.51	8.11
Shaanxi	8.55	6.43	10.66
Gansu	8.80	7.88	9.72
Qinghai	7.58	5.25	9.91
Ningxia	8.04	6.89	9.18
Xinjiang	7.87	8.29	7.45
Eastern region	10.90	10.99	10.80
Central region	9.68	8.77	10.59
Western region	8.28	7.29	9.27

Source: Calculated by the author based on data from various issues of *China Statistical Yearbook.*

Table 2 Annual per-capita incomes of the urban and rural households (unit: yuan at the current prices)

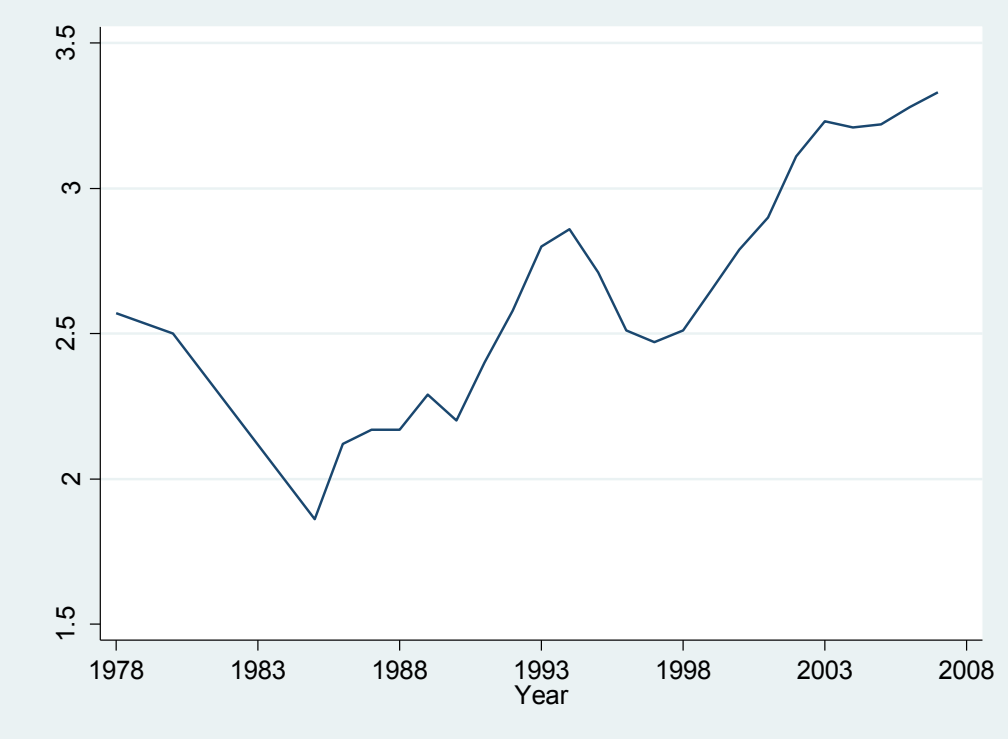
Year	Urban	Rural income	Income ratio	Urban CPI	Rural CPI
1978	343.4	133.6	2.57	100.0	
1980	477.6	191.3	2.50	109.5	
1985	739.1	397.6	1.86	134.2	100.0
1986	899.6	423.8	2.12	143.6	106.1
1987	1002.2	462.6	2.17	156.3	112.7
1988	1181.4	544.9	2.17	188.6	132.4

1989	1375.7	601.5	2.29	219.4	157.9
1990	1510.2	686.3	2.20	222.2	165.1
1991	1700.6	708.6	2.40	233.6	168.9
1992	2026.6	784.0	2.58	253.7	176.8
1993	2577.4	921.6	2.80	294.5	201.0
1994	3496.2	1221.0	2.86	368.1	248.0
1995	4283.0	1577.7	2.71	430.0	291.5
1996	4838.9	1926.1	2.51	467.8	314.5
1997	5160.3	2090.1	2.47	482.3	322.3
1998	5425.1	2162.0	2.51	479.4	319.1
1999	5854.0	2210.3	2.65	473.2	314.3
2000	6280.0	2253.4	2.79	477.0	314.0
2001	6859.6	2366.4	2.90	480.3	316.5
2002	7702.8	2475.6	3.11	475.5	315.3
2003	8472.2	2622.2	3.23	479.8	320.3
2004	9421.6	2936.4	3.21	495.6	335.7
2005	10493.0	3254.9	3.22	503.5	343.1
2006	11759.5	3587.0	3.28	511.1	348.2
2007	13785.8	4140.4	3.33	534.1	367.0

Source: Various issues of *China Statistical Yearbook*

Table 2 shows the ratio of the annual per-capita disposable and net incomes of China's urban and rural residents. The ratio of urban to rural per-capita incomes decreased from 2.57 in 1978 to 1.86 in 1985, showing the initial benefits of agricultural reform through the household responsibility system of assigning land to individual farm households. Afterwards, the urban-rural income gap kept rising until the government raised the prices of agricultural products in 1995. Since 1997, however, the gap once again increased, and steadily, as the prices of agricultural products fell. In 2007, the ratio of urban to rural incomes reached 3.33.

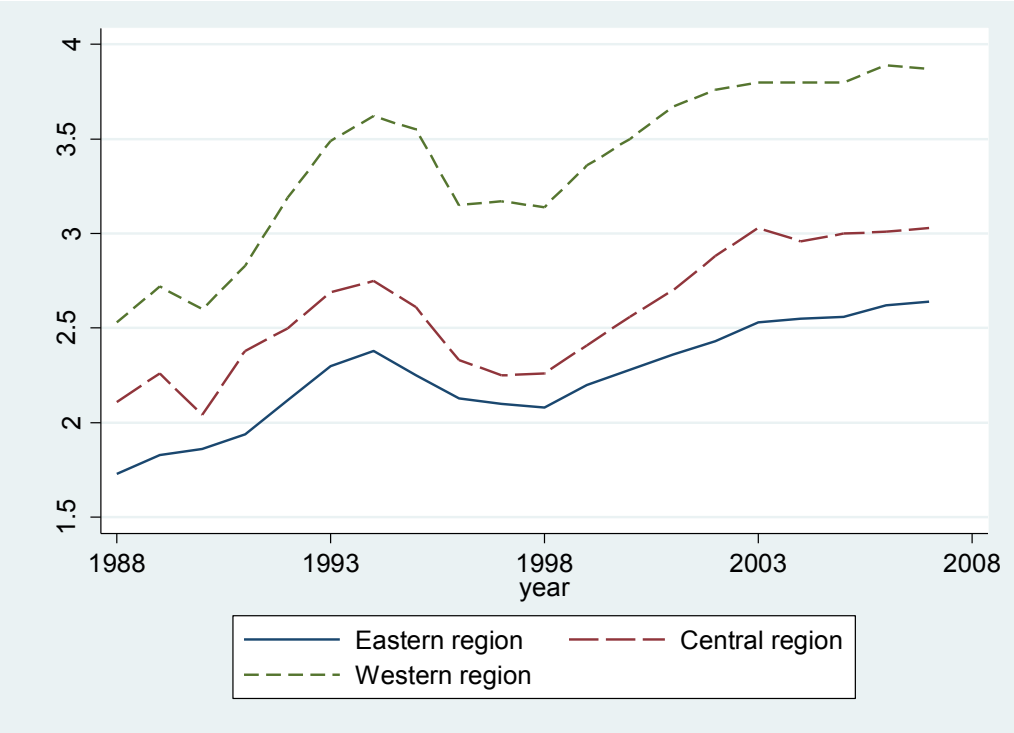
Figure 1 Trend of the urban-rural income gap in China



Data source: Compiled by the author based on data from various issues of *China Statistical Yearbook.*

Figure 1 shows the trend of the urban-rural income gap. It is clear that the urban-rural income gap has kept on growing, except during the period from 1978 to 1985 when agricultural reform was initiated, and from 1995 to 1997 when the prices of agricultural products were raised, respectively. Based on this finding, we divide the whole period into a sub-period up 1997 and a sub-period since 1998.

Figure 2 Disparity in the urban-rural income gap by region



Data source: Compiled by the author based on data from various issues of *China Statistical Yearbook.*

Geographically, the urban-rural income gap in China is most severe in the inland areas, especially in the western region, as can be seen in Figure 2. The urban-rural income gap between the western region and the two other regions is very large. Another conclusion that can be drawn from this figure is that the urban-rural income gap became wider in the later reform period.

To consider change in per capita real incomes of China's urban and rural residents, the consumer price index for the urban and rural residents (1978=100 and 1985=100, respectively) is presented in the last two columns of Table 2. Using these, the calculation in Table 3 shows that the per capita net incomes of the rural households increased by 5.3% per year between 1988 and 2007, and that the rate of increase of the per-capita disposable incomes of the urban households was 7.5% per year, which is higher than the rural figure by more than two percentage points. These data show that while the urban-rural income ratio increased during China's reform period, the rural residents also enjoyed a fairly substantial rate of increase in net income, as much as 5.3% per year, even though it is two percentage points below the corresponding figure for the urban residents. The table also shows that the income disparity between the two areas became wider in the later reform period.

Table 3 Income growth of the urban and rural households in China (unit: percent)

	Whole reform period (1988-2007)	Earlier reform period (1988-1997)	Later reform period (1998-2007)
Urban	7.3	5.3	9.2
rural	5.3	4.8	5.7

Source: Calculated by the author based on data from various issues of *China Statistical Yearbook.*

Sources for Urban-Rural Income Inequality

China's economic reform was initially launched in the rural areas, and in the mid-1980s with the completion of the household responsibility system reform, it had been extended to the urban areas, now targeting the state sector. Diverse dimensions of the reform have inevitably affected the country's urban-rural income inequality. Especially, we can consider opening of the economy, enhancement of education and technology, privatization (or the reduction of state involvement in business), and the policy of getting rich first. Besides, we should also consider one important initial condition, which is the existence of huge amount of surplus labor in rural area. Let us discuss how these reform policies and the initial condition affect the urban-rural income inequality.

Rural Surplus Labor as an initial condition: In a highly influential article (Lewis, 1954)., namely, "Economic Development with Unlimited Supplies of Labor," Lewis first analyzed the way poor countries with surplus labor transform their economic structures. Lewis explained that many poor countries are characterized by a dual (or two-sector) economy that consists of a large and traditional (subsistence agriculture) sector and a small and modern (industrial) sector. Lewis rejected the neo-classical economics view that the quantity of labor is fixed and instead argued that there is an unlimited supply of labor (because of population pressures) in many poor countries. This keeps wages low. The traditional sector provides a large pool of cheap labor for the modern sector, and this leads to high profits and growth in the modern sector.

Lewis explained the transition to a modern economy in the following way. Technological advances and capital formation in the modern sector result in increased profits, and the increased profits are used to increase investments, which fuel further growth and employment in the sector. Eventually, a turning point is reached when no surplus labor is left and the dualistic nature of the economy ends, with wages rising to reflect productivity (Lewis, 1954).

A conjecture can be drawn from the Lewis Model: that the income gap between the urban and rural sectors would continue until the modern urban sector absorbs surplus labor in the traditional sector, and that after the turning point. it would decrease. This conjecture has been found to be right in the case of Korea (Lee 2010 Bae 1982). China, as a large transitional country, also faces the dualistic

problem, with the most labor allocated in primary industries (44.8% in 2007). The presence of surplus labor in the agricultural sector is related to the increased urban-rural income gap in China. Thus, the following hypothesis is made: A major reason for China's urban-rural income gap is the existence of a large amount of agricultural surplus labor, and slow urbanization and the resulting slow reduction in rural surplus labor have widened the urban-rural income gap, and thus, the overall income inequality.

Economic Opening: When China's open-door policy for foreign investment and trade was put in place in the late 1970s, it was expected to give China access to modern technology and management techniques that would improve its industrial efficiency and infrastructure, would create employment, and would expand its export industries to increase foreign-exchange availability. The earliest open-door policies were characterized by the formulation and establishment of new regulations and by the setting up of special economic zones and "open cities" in several coastal provinces, including Guangdong and Fujian. Such zones' and cities' superior infrastructure, taxation, and foreign-exchange regulations were intended to attract foreign investment and foreign export-oriented firms.

Since it became a member of the World Trade Organization (WTO), China has taken several steps to promote globalization. It abolished its trade quota and license arrangement for grains, wool, cotton, chemical fertilizers, etc., and modified or abolished its laws and regulations that were inconsistent with the WTO rules. Moreover, at around its entry into the WTO, China issued new laws and regulations concerning service trade, legal services, telecommunications, financial institutions, insurance, audio and video products, tourism, etc. Laws regarding the entry of foreign sales companies and joint stock exchange ventures were drawn up. Further, measures were taken to ensure compliance with the WTO rules on intellectual property, foreign investment, and information transmission (Wan et al., 2007).

In the three decades since China began to integrate with the global economy in 1978, the growth in its exports has been astonishing. Between 1978 and 2007, China rose from the 27th largest trading nation in the world to the third. China's total exports increased from USD9.8 billion in 1978 to USD 1,218 billion in 2007, and the ratio of its exports to its GDP reached 37.5% in 2007.

China's FDI has also grown dramatically. From an economy virtually without any foreign investment in the late 1970s (0.08 million in 1979), China has become the largest FDI recipient among the developing countries and the second globally, next only to the U.S., since 1993. The FDI flows into China from 1979 to 2007 constituted over 20% of the total FDI in the developing economies. By 2007, the total FDI received by China reached USD755 billion (UNCTAD database, http://stats.unctad.org/FDI/TableViewer/tableView.aspx?ReportId=3084). The share of FDI flows in

China's GDP was almost zero in 1978, rose to 2.25% in 1992, and then reached its peak in 1994, at 6.04%. It then began to fall continuously to 2.28% in 2007. This reveals that while the absolute amount of FDI received by China is still increasing, the relative FDI has shown a decreasing trend of late.

How, then, does China's integration into the world economy affect the urban-rural income inequality therein? The role of globalization in income distribution has long been debated much. The debate on the distributional impact of globalization often polarizes into two opposite strands of thought, one of which argues that globalization leads to more uneven income distribution because the benefits obtained from globalization are not evenly shared by the citizens of a country. There are clear losers in relative and possibly even absolute terms, although globalization, in general, may improve the overall incomes (IMF, 2007). Trade increases the differentials in the returns to education, and globalization marginalizes certain groups of people or geographic regions (Hurrell and Woods, 2000).

The other strand argues that globalization helps reduce income inequality. The modernization theorists argue that the integration of the world economy may raise income inequality in the earlier stages of development, but that such income inequality will eventually decline in the long run (Srinivasan and Bhagwati, 1999; Ben-David, 1993).

Jaumotte et al. (2008), on the other hand, argue that the effects of trade and financial globalization are different in developing countries. While trade globalization reduces income inequality, financial globalization increases it. They argue that trade can reduce income inequality through agricultural exports in developing countries. Given that a large proportion of the workforce can still be found in agriculture, the opening up of trade therein will increase the income of those who are dependent on agriculture for their livelihood. Concerning the inward FDI, they argue that FDI is associated with rising income inequality because it tends to take place in the higher-skill and higher-technology sectors. As such, while FDI increases employment and income, this tends to favor those who already have relatively higher skills and education.

Combining these theories can lead to the conclusion that both exports and FDI increased the urban-rural income gap in China, for the following reasons. Since its economic reform, the structure of China's export pattern has changed considerably. The proportion of its manufacturing goods in terms of the value of its exports has kept rising and reached 94.9% in 2007. That is to say, China's integration into the global market has mainly promoted the development of manufacturing, related finance, and trade and services therein. As these sectors agglomerated in the urban areas, however, the development of exports mainly benefited the urban residents. Similarly, the FDI was mainly allocated to the manufacturing sectors, increasing the employment opportunities and income for the urban

residents rather than for the agricultural workers. Therefore, it can be said that China's economic opening increased its urban-rural income inequality.

Education and Technology: When China initiated its economic reform in the late 1970s, the Chinese government recognized that to meet the goals of modernization and economic development, it was necessary to develop science and technology as well as the country's intellectual resources, and to raise the people's education level. New demands on education (for new technology, information science, and advanced management expertise) arose as a result of the reform of the economic structure and the emergence of new economic forms.

In 1980, China's education policy promoted expanded enrollments, with the long-term objective of achieving universal primary and secondary education. In 1985, the commitment to modernization was reinforced by the plans for the implementation of nine-year compulsory education and for the provision of good-quality higher education. In 1986, the Law on Nine-Year Compulsory Education took effect. Deng Xiaoping's far-ranging educational-reform policy, which involved all levels of the education system, aimed to narrow the gap between China and other developing countries. The modernization of education was critical to the modernization of China.

The implementation of the nine-year-compulsory-education policy in China yielded remarkable results: rising educational attainments in the country. Table 4 presents the changes in the educational structure in China between 1989 and 2007.

Table 4 Evolution of the educational structure for the Chinese population aged 6 and above (unit: percent)

Year	No schooling	Primary school	Junior secondary	Senior secondary	College and higher level
1989	20.6	42.1	26.5	9.1	1.6
1990	20.6	42.3	26.5	9.0	1.6
1993	19.5	40.2	28.9	9.1	2.3
1996	16.0	42.4	30.2	9.1	2.2
1997	14.2	40.7	32.1	10.4	2.7
1998	13.7	39.8	33.0	10.7	2.8
1999	13.4	38.5	34.3	10.7	3.1
2000	9.4	38.3	36.4	12.0	3.9
2001	10.1	36.3	36.8	12.4	4.4
2002	10.2	35.0	37.6	12.5	4.7
2003	9.7	33.4	38.0	13.4	5.5
2004	9.2	32.4	39.3	13.4	5.8
2005	10.4	33.3	38.3	12.4	5.6
2006	8.8	33.1	39.0	12.9	6.2
2007	8.0	31.8	40.2	13.4	6.6

Source: Author's calculation based on data from various issues of *China Population Statistical Yearbook.*

Technological progress was also mentioned in the early reform program but it was in the mid-1990s that it received a bigger emphasis, as indicated in the May 1995 Decision on Accelerating Scientific and Technological Progress (IDRC and the State Science and Technology Commission, 1997). The achievements since the mid-1990s due to these science and technology initiatives can be measured using various innovation indicators, such as research and development (R&D) intensity and patents. China's spending on R&D as a percentage of its GDP, termed "R&D intensity," has more than doubled, from 0.6% in 1988 to over 1.4% in 2007 (Jin et al 2009). The average annual growth rate of China's R&D spending in the earlier reform period was 10.7%, while the figure was 20% for the later reform period. China registered the world's fourth largest R&D spending in 2007 at USD48.8 billion, just behind the U.S., Japan, and Germany.

This growing R&D in China has resulted in a rapid increase in the number of patent applications. The average annual growth rate of total patents in the earlier reform period was approximately 17%, whereas for the later reform period, it was 20%. With regard to the invention patents, the share of the foreign patents was larger than that of the domestic patents up to 2002, but the situation has been reversed since then (Lee 2010). The number of domestic-invention patents has increased dramatically since 2002. The surge in domestic-invention patent applications reflects the growing technological capabilities of the Chinese inventors. Of course, such an increase since 2002 was also partially a result of the revision of the Chinese patent law in 2000 and of China's accession to the WTO in 2002.

What then is the relation between education, technological progress, and income inequality? According to the traditional view of the economic-development process in Kuznets' hypothesis, economic growth is bound to bring about a steady reduction in income inequality in the long run. Some empirical studies, however, such as those of Juhn et al. (1993) and Machin (1995), pointed to a substantial increase in wage and income inequality in several OECD countries in the 1980s and 1990s. The ratio of the 90^{th} to the 10^{th} percentile of the male wage distribution in the U.K. rose from 2.53 to 3.21 between 1980 and 1990. In the U.S., it rose from 4.76 to 5.63 from 1980 to 1989 (OECD, 1993). Atkinson (1997) and Aghion and Williamson (1999) explain that the increase in income inequality is largely due to the changes in the wage component, and that a major cause of these changes has been the shift in the relative demands for skilled and unskilled labor. Further, Atkinson (1996) provides a straightforward explanation for the rising earnings dispersion. He writes, "There appears to be a widespread agreement on the fact that there has been a shift in demand away from unskilled labor in favor of skilled workers" (Atkinson, 1997).

Three competing explanations have been proposed for this structural change in the relative demand for skilled labor, and one of them concerns the skill-biased technological changes (Aghion and Williamson, 1999). A competing hypothesis of skill-biased technical progress is that the shift in the relative labor demands has been caused by technological change. Now, if technological change is to generate an increase in wage inequality, it must be because technological change is biased towards certain skills or specializations in the sense that it reveals and enhances new differences in abilities among workers across or within educational cohorts (Juhn et al., 1993; Piketty, 1996). The empirical evidence from the U.K. and the U.S. indicates that the more technologically advanced industries are more likely to have increased their relative use of skilled workers in the 1980s, thus providing evidence in favor of the aforementioned hypothesis.

In the study conducted by Berman et al. (1994), it was shown that both the computer (as a share of the total investment in 1974) and R&D expenditures have a positive and significant impact on the proportion of nonproduction workers in employment: These two factors accounted for 70% of the move away from production labor from 1979 to 1987. A similar analysis for the U.K. shows that the R&D expenditures had a positive and significant impact on the proportion of nonmanuals in employment (Machin, 1995). The same results were obtained when technical progress was ushered in by the introduction of microcomputers by firms. This is consistent with Krueger's (1993) findings regarding the return to computer usage. When he included a computer use variable into a human-capital wage equation, he found that the wage premium of the workers who were using a computer was highly significant in the U.S., and that it increased from 15 to 17.6% between 1984 and 1989.

A stronger evidence of the role of technological progress in income distribution comes from an IMF study conducted by Jaumotte et al. (2008), which find that the main factor that drove the recent increase in inequality across countries is technological progress. This factor alone explains much of the increase in the Gini coefficient from the early 1980s, supporting the view that new technology, in both advanced and developing countries, increases the premium on skills and substitutes for relatively low-skill inputs. Interestingly, among developing countries, the effect of technological progress is stronger in Asia than in Latin America, possibly reflecting the greater proportion of technology-intensive manufacturing in Asia.

Actually, the relative wage of the skilled workers in China increased when the country opened its market to the world. The average wage of workers in China's foreign-funded enterprises relative to the average wage of all workers (that is, the wage premium for workers in foreign-funded enterprises) increased from 1.07 in 1993 to 1.31 in 2000 (Xu and Li, 2008). This change in wage inequality in China is related to the technical change therein, as discussed above. Yu (2008) provides some

evidence of this. Based on China's 27 manufacturing sector data from 2000 to 2005, Yu found that technical change has an evident influence on the relative wage gap in the technology-intensive sectors, although the effect will be insignificant if the sector characteristic (that is, whether the sector is technology-, labor-, or capital-intensive) will not be taken into account. Thus, if the skill-biased technological hypothesis is right, technological progress will affect the urban-rural income inequality because such progress occurs mainly in urban cities.

The impact of education on income inequality is commonly known as "the spread of education," implying the positive impact of education on improving distribution. Ahituv and Moav (2003), Viaene and Zilcha (2003), and Rehme (2003) have all found that education reduces income inequality and consider education as a means of redistribution and policy prescription. The impact of education on income inequality differ, however, according to the education levels. While the attainment of general (primary and secondary) education reduces income inequality, the attainment of higher education might increase it. In the study conducted by Barro (2000), he found that the attainment of primary schooling is negatively and significantly related to income inequality, that the attainment of secondary schooling is negatively but insignificantly related to it, and that the attainment of higher education is positively and significantly related to it.

In China, while primary education was propagated even in the rural areas, secondary and higher education were not propagated in the rural areas until China started implementing nine-year compulsory education in 1986. Considering that the educational-attainment indicator that was used in this paper is the average years of schooling from age 6 and not school enrollment, and that the average education level reached in the urban areas is higher than that reached in the rural areas, it is expected that the attainment of secondary and higher education will increase the urban-rural income inequality in China.

Thus, we can hypothesize that the technological progress in China, especially in the later reform period, increased the demand for skilled workers and thereby increased their wage premium over the unskilled workers. The rising education level attained and the disparity therein between the urban and rural sectors together with the technological progress increased the urban-rural income inequality in China.

Urban-bias in Government Expenditure: Another reason for the existing urban-rural income gap in China is the central government's unfavorable treatment of the rural residents compared with the urban residents. The inadequacy of the government provisions for the rural residents can be seen in the following:

(1) The government has spent less on infrastructure investment in the rural areas than in the urban areas. In 2005, about 44% of the country's rural households did not have access to running water, 4% of the villages were still beyond the reach of highways, and 5% of the villages did not have access to telephones.

(2) The government provided less welfare benefits, including health care and education, to the rural residents, with 70% of the government's total expenditure on medical care concentrated in the urban areas and only 30% directed to the rural people despite the fact that the rural people in China represent more than half of the country's total population. According to the former vice minister of health, Zhu Qingsheng, 40-60% of the rural people in China cannot afford to see a doctor. Moreover, the per-capita education expenditure of the government for the rural residents was lower than that for the urban residents. Although much labor mobility was allowed so that the farmers could move to the urban areas to find work there, the rural residents working in the urban areas are subject to discrimination under the government's *hukou* system of separating the people according to their residence status, which thus also discriminates between the benefits that the urban and rural people are entitled to. The migrating workers do not have residence permits in the cities and thus cannot enjoy the services provided to the residents therein, such as health care and schooling for their children, unless the migrants have enough money to buy a *hukou*. Even then, however, these immigrants from the rural areas have to pay expensive fees so that their children can enter a school in the city. The *hukou* system disturbs the migration from the rural to the urban areas and thus makes the reduction of surplus agricultural labor slow.

(3) Although the commune system has been abolished, the procurement of farm products by government agencies has continued, and the procurement prices are often set below market prices. In the meantime, the farmers are not allowed to sell their products to private traders as the private trading and transport of grains are prohibited. Thus, the market economy does not work to the farmers' favor in terms of the distribution and pricing of grains (Chow, 2006).

Having realized these problems, the central government has given the agriculture sector much attention in recent years. Since 1993, the central government has held the Central Government's Country Work Conference once a year and has issued a document on agriculture and rural work every year. In 2003 conference, the secretary-general, Hu Jintao, delivered an important speech. He emphasized that "the most difficult task in building a well-off society in all respects concerns the rural areas." Since then, the society has paid much attention to the so-called *sannong* (three-farm) problem, namely problems in agriculture, rural areas, and farmers. In February 2004, the State Council announced the first "No. 1 Document" regarding the improvement of the revenues and living

conditions of the farmers. The document consists of several policy initiatives, such as: (Chow, 2006): to develop agricultural production in the grain-producing areas to increase the incomes of the farmers (this includes providing incentives to the farmers, improving their production methods and the quality of their lands, and increasing the government investment in agriculture); to change the structure of agricultural production by improving the output mix, management, and technology; to assist farmers in moving to the urban areas by reducing the levies collected from them by the city governments and by giving the latter the responsibility to train the incoming farmers and to educate their children; to establish a market mechanism for the distribution and marketing of grains by allowing more distribution channels, including collectives, and by promoting farm products;

A final important step was taken in 2005: The central government decided to abolish all the taxes imposed on the farmers. Although some local officials may still be imposing such levies, the existence of a policy that no tax should be imposed on the farmers makes it more difficult for them to do so (Chow, 2006). In addition, the government has abolished the *hukou* system in several regions. To date, 13 provinces have abolished the dualistic *hukou* system and have begun to use a unified *hukou* system, and Guangdong is likewise set to abolish the dualistic *houkou* system in the near future. Beijing and Shanghai also plan to ease the restrictions in obtaining an urban *hukou*.

The evolution of the government policies aimed at dealing with the *sannong* problem and at narrowing the gap between the urban and rural areas illustrates the use of experimentation and observation in revising and improving policies. We will investigate the effectiveness of these policies.

3. Research Methodology

3.1. Regression Models

This study is to investigate whether economic growth and income inequality are simultaneously determined, and whether they are subject to the same set of determining factors. For this purpose, a simultaneous system of equations was used in this study.

As in Lundberg and Squire (2003), the simultaneous system of equations of economic growth and urban-rural income inequality takes the following form:

Growth equation $gdpgr=\boldsymbol{X}'\boldsymbol{\alpha}+\boldsymbol{Z}'\boldsymbol{\beta}+u_{it}$,

Urban-rural inequality equation $urine=\boldsymbol{Y}'\boldsymbol{\varphi}+\boldsymbol{Z}'\boldsymbol{\gamma}+\varepsilon_{it}$,

where X is a vector of the "economic growth" variables, Y of the "urban-rural income inequality" variables, and Z of the variables common to both sets of variables.

The error terms in the system are made up of two components: the time-invariant heterogeneity across the provinces that is specific to the province but is not included in the explanatory variables, and the time-varying parameters that are likely to be associated with the regressors. Thus,

$u_{it} = \mu_i + \nu_{it}$ and $\varepsilon_{it} = \sigma_i + \omega_{it}$.

In this study, the problem of time-invariant province-specific heterogeneity is less severe because data from within China were used. This notwithstanding, some dummy variables were incorporated into the empirical model to further address the heterogeneity issue, as in Wan et al. (2006). The endogeneity problem of two-way causality between economic-growth and urban-rural income inequality variables is treated by specifying and estimating the simultaneous system of equations.

In this system of equations, we add a same set of determining factors, such as: surplus agricultural labor, openness, and education/technological progress. In the regressions, the value surplus agricultural labor in the initial year is used to control endogeneity problem. As openness and education/technology are the two key interest variables of ours, regression analyses are performed one by one, using these variables, while the basic model with surplus labor only serves as a bench mark.

The Bench Mark Model: Growth and Inequality with Surplus Labor

First, the basic model verifies the key relationship between growth and on urban-rural income inequality in the system of equations specified as follows:

$$\begin{aligned} gdpgr &= f_1(urine, inigdp, popgr, invt, infl, soe, gov, urbangr, center) \\ urine &= f_2(gdpgr, surlab, infl, soe, gov, agr, center, west) \end{aligned}.$$

The first equation in the system is the economic-growth equation, whose dependent variable is the real per-capita GDP growth rate. As the explanatory variables, the initial GDP level (*inigdp*), population growth rate (*popgr*) as a proxy of the change in the labor force participation rate (Blomström et al., 1996), and investment rate (*invt*) as a physical capital (Barro, 1991, 1997; Barro and Lee, 1994; Caselli et al., 1996; Levine and Renelt, 1992; Mankiw et al., 1992) were included. These are standard economic-growth determinants directly predicted by the Solow economic-growth model. To capture the government involvement in the economy, inflation (*infl*) (Barro, 1997, 2000; Clarke, 1997; Levine and Renelt, 1992; Kormendi and Meguire, 1985), the size of the state sector

(*soe*), and government consumption (*gov*) (Barro, 1991, 1997, 2000; Clarke, 1997; Barro and Lee, 1994) were added to the equation. The inflation rate may capture the macroeconomic conditions or business cycle effects, and the size of the state sector and the government consumption represents the government interference in the economic activities (Wan et al., 2006). The geographic variable (*center*) was also included in the economic-growth equation, following Levine and Renelt (1992) and Sala-i-Martin (1997).[1] Also controlled is urbanization (*urbangr*). Of course, urban-rural income inequality also enters the economic-growth equation. Detailed definitions of these variables are provided in the following sub-section on data.

The urban-rural income inequality equation in the system explains income inequality measured as the urban-rural income gap determined by economic growth (*gdpgr*), surplus labor (*surlab*), inflation rate (*infl*), the size of the state sector (*soe*), geographic location (*center* and *west*), government consumption (*gov*), and fiscal expenditure on agriculture (*agr*). Leaving the economic-growth, surplus-agricultural-labor, and location dummy variables aside, four other variables were included in the urban-rural income inequality equation. It is argued that inflation may have a strong redistributive impact through its effect on individuals whose nominal incomes are not adjusted proportionally to price increases (Ivaschenko, 2003). The size of the state sector was included as privatization is commonly perceived to be a cause of income inequality in China. The importance of income policy in the distribution of personal income has been emphasized by Atkinson (1997). If taxation and public spending intend to remedy income inequality, the government should subsidize the poor rather than the rich. Finally, given that the inequality variable is defined as the urban–rural income ratio, government support for agriculture is expected to help narrow the urban-rural income gap.

As you notice, one of the key features of our model, distinct from the literature, is that we have included as regressors the variable of the size of rural surplus labor. In these models and in those that follow, the sizes of surplus agricultural labor are taken from Jin (2010) where she estimated the sizes using the four different methods. In the basic model, the results are compared using the estimates from these four methods. Then, in the extended model to analyze the impact of openness or education/technology, estimations use the size of surplus labor estimated by the classical method only, which can be regarded as most reliable (Jin 2010).

Openness, Growth and Inequality

[1] Unlike in the income inequality equation, only the center is used as a geographic-dummy variable because of the high correlation between urban-rural income inequality and the western dummy.

The impact of openness (exports and FDI) on economic growth and urban-rural income inequality was then investigated. The system of equations is as follows:

$$gdpgr = f_1(urine, openness, inigdp, popgr, invt, infl, soe, gov, urbangr, center)$$
$$urine = f_2(gdpgr, surlab, openness, infl, soe, gov, agr, center, west)$$

Here, openness enters not only the economic-growth equation but also the income inequality equation. As such, the impact of openness on economic growth and urban-rural income inequality are simultaneously considered. Surplus agricultural labor was also included in the income inequality equation to test its robustness.

Education and technological progress in the Growth-Inequality Nexus

Finally, the roles of education (*edu*) and technological progress (*tech*) are analyzed. For this we have included an additional equation of education/technology equation in the system because it has been argued that economic growth causes education as much as education causes economic growth (Bils and Klenow, 1998), and that the impact of income inequality on economic growth is mainly channeled through its effects on the formation of physical and human capital (Galor and Zeira, 1993). Therefore, the system ends up with a three-equation system, as follows:

$$gdpgr = f_1(urine, edu/tech, inigdp, popgr, invt, infl, soe, gov, urbangr, center)$$
$$urine = f_2(gdpgr, surlab, edu/tech, infl, soe, gov, agr, center, west)$$
$$edu/tech = f_3(cesh, center, west)$$

Here, education and technology variables also enter both the economic-growth equation and the income inequality equation to identify their impacts on urban-rural income inequality as well as on economic growth. Actually, human capital and technical change are the other two standard determinants of economic growth.

To test the impact of different educational-attainment levels, three educational-attainment indicators were used in this work: primary schooling (*edu1*), junior secondary schooling (*edu2*), and higher schooling (*edu3*). The education and technological changes were determined based on the government expenditure on culture, education, science, and public health (*cesh*), and by the geographic dummies.

To find out if there was any changing source of economic growth and urban-rural income inequality in the earlier and later reform periods, the two subperiods in addition to the whole reform

period were analyzed in each of the above three models.

3.2 Data

A panel dataset covering 29 provinces in China in the period 1988-2007 was used to estimate the simultaneous system of equations discussed in the previous sector. Unless otherwise indicated, the data that were used in this study were from various yearly issues of *China Statistical Yearbook*, *China Population Statistical Yearbook*, provincial statistical yearbooks, and China's National Bureau of Statistics. The variables that were used for the estimations are listed below.

(1) *gdpgr* = real per-capita GDP growth rate, calculated based on the per-capita GDP measured at the constant rates.

(2) *urine* = urban-rural income inequality, defined as the ratio of the urban disposable income to the rural per-capita net income (Both the urban and rural incomes are deflated by the provincial urban and rural CPIs, respectively. For Beijing, Tianjin, and Shanghai, the urban and rural CPIs are the same.).

(3) *surlab1* = surplus labor, measured as the proportion of surplus agricultural labor in the total provincial agricultural labor in 1988, estimated using the classical method.

(4) *surlab2* = surplus labor, measured as the proportion of the surplus agricultural labor in the total provincial agricultural labor in 1988, estimated using the international-standard-structure comparison method.

(5) *surlab3* = surplus labor, measured as the proportion of the surplus agricultural labor in the total provincial agricultural labor in 1988, estimated using the sown-land-to-labor-ratio method.

(6) *surlab4* = surplus labor, measured as the proportion of the surplus agricultural labor in the total provincial agricultural labor in 1988, estimated using the arable-land-to-labor-ratio method.

(7) *export* = degree of openness of a provincial economy, measured using the ratio of the total volume of exports to the provincial GDP.

(8) *fdi* = degree of openness of a provincial economy, measured using the ratio of the volume of FDI inflows to the provincial GDP (The data pertaining to Ningxia in 1989 were taken from *Almanac of China's Foreign Economic Relations and Trade* (1990); those pertaining to Ningxia for 1990-1993 and to Xinjiang for 1992 were taken from *China Foreign Economic Statistical Yearbook* (1994); and those pertaining to Qinghai for 1989-1991, 1998, and 2000 are not available. Thus, the averages of the neighboring two years for these five years were used instead.).

(9) *edu1* = proportion of the population with primary-school attainment in the total population aged 6 and above. The Data for 1988, 1991, 1992, 1994, and 1995 are not available.

(10) *edu2* = proportion of the population with junior-secondary-school attainment in the total

population aged 6 and above. The Data for 1988, 1991, 1992, 1994, and 1995 are not available.

(11) *edu3* = proportion of the population with senior-secondary-school and higher-education attainment in the total population aged 6 and above. The Data for 1988, 1991, 1992, 1994, and 1995 are not available.

(12) *tech* = patent, the indicator of the degree of technological progress, measured as the logarithm of the number of patent applications per 10,000 people.

(13) *popgr* = population growth rate.

(14) *inigdp* = log of per-capita GDP in 1988.

(15) *invt* = ratio of the total investment in fixed assets to the GDP (*Total investment in fixed assets* refers to the volume of activities in construction and the purchases of fixed assets of the province and related fees, expressed in monetary terms in that year.).

(16) *infl* = inflation rate, measured based on the overall consumer price index in each province.

(17) *soe* = proportion of the staff and workers in the state-owned entities in the total labor force.

(18) *gov* = ratio of the total government expenditure to the provincial GDP.

(19) *agr* = proportion of the provincial fiscal expenditure on agriculture in the total government expenditure.

(20) *urbangr* = urbanization, defined as the growth rate of the proportion of the nonagricultural population in the total provincial population.

(21) *cesh* = logarithm value of the per-capita public expenditure on culture, education, science, and health.

(22) *center* = geographic dummy for the central provinces, including Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, and Guangxi.

(23) *west* = geographic dummy for the western provinces, referring to Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.

4. Empirical Results

4.1 Basic Model: Growth and Inequality with Surplus Labor

The estimation results for the basic model is presented in Table 5 with each part of A, B, and C results with the whole, earlier, and later reform periods, respectively. In each table, the model, 1, 2, 3, and 4, respectively, correspond with the result with each different method of estimating the size of surplus labor. The overall results shown in Table 5A are encouraging, with over 20% of the variation in economic growth explained by the independent variables, and with over 60% of the variation in the

urban-rural income inequality explained by the independent variables. The F-statistic is significant at the 1% level, and the signs of the coefficients are basically expected.

Consistent with the economic theory, population growth and investment had a significant impact on economic growth in expected ways. From the perspective of government intervention in the economy, the provinces with larger state sectors and more government spending had lower economic growth, as expected (except for model 1). The reported minus sign of the initial GDP indicates that the economic growths are converging across the provinces. Geographically, there is no evidence that the provinces located in the central areas experienced lower economic growth; the western-dummy variable was excluded from the economic-growth equation because of the high correlation between urban-rural income inequality and the western dummy. It can be supposed, however, that if the western dummy will be included instead of urban-rural income inequality, its sign may become negative, with some significance level. This can be explained by the significant and negative impact of urban-rural income inequality on economic growth in model 1. It also indicates that a higher income inequality reduces economic growth but that the impact is not robust, as can be seen in models 2-4. In addition, it was found that the urbanization and macroeconomic conditions, measured based on the inflation rate, do not contribute to economic growth.

As far as the urban-rural income inequality equation is concerned, economic growth is positively related to urban-rural income inequality, except for model 2. A key variable of this paper, surplus agricultural labor, is positively related to urban-rural income inequality in whatever case, thus confirming Lewis's dual-economy theory. The estimated coefficients suggest that an increase in surplus agricultural labor is associated with a 0.3-4.5% increase in the urban-rural income inequality. Two other robust variables affecting the urban-rural income inequality is the inflation rate and government spending. As did other transition countries, China experienced a relatively high inflation rate during its reform era, especially in its early part. The rates were higher, though, in the rural areas than in the urban areas. As inflation may have a strong redistributive impact through its effect on the farmers, whose nominal incomes are not adjusted proportionally to price increases, unlike the urban residents, this income-inequality-increasing impact of inflation is expected.[2] Government spending was found to worsen the urban-rural income inequality, which is consistent with the fact that public spending on education, health, and social welfare was directed towards the urban residents rather than

[2] In reality, the assets of the urban residents are more diversified (stocks, equities, private housing, and business ventures) whereas the rural farmers depend mainly on their farm incomes, which are usually fixed at a nominal term and are adjusted slowly to the inflation rate.

towards the poor rural farmers. On the other hand, although not robust, the government spending on agriculture was found to narrow the urban-rural divide, thus confirming some effect of the government's policy of increasing the incomes of the farmers. The geographic dummies are positively and significantly associated with the income gap between the urban and rural sectors. Further, as indicated by the coefficients of the location dummy variables, the income disparity between the urban and rural sectors is more severe in the western regions than in the central regions, which in turn is more severe than that in the coastal regions. This result is consistent with those obtained by Li and Yue (2004) and Wan et al. (2006). Finally, the size of the state sector (or privatization) was found not to have a significant impact on the urban-rural income gap.

The results obtained when the earlier-reform-period data were used are presented in Table 5B. In the economic-growth equation, the results for the initial income, population growth, investment, and government spending are robust. Moreover, urbanization was found to be helpful in accelerating economic growth. Here, urban-rural income inequality was found not to be detrimental to economic growth.

The following are some of the findings from the urban-rural income inequality equation. The urban-rural income gap increased with the economic growth in the earlier reform period, providing some evidence for the Kuznets hypothesis. Surplus agricultural labor still has a significant impact on urban-rural income inequality. In addition to the economic growth and surplus agricultural labor, the inflation rate, the western dummy, and the size of the state sector are also significant in all the specifications. The estimated positive sign of the size of the state sector indicates that privatization helps reduce the urban-rural income gap. This result is consistent with those obtained by Wan et al. (2006), who explained the result as pointing to the role of TVEs in narrowing the urban-rural income gap. Government expenditure and government spending on agriculture were found to be significant only in model 2.

In the later reform period, fixed investment and privatization were helpful to economic growth, and population growth and the widening urban-rural income gap were detrimental thereto (except for model 2), as can be seen in Table 5C. On the other hand, surplus agricultural labor and government spending are positively and significantly correlated to the urban-rural income gap in all the models. This significant impact of public spending on the urban-rural divide reveals the urban bias in the government spending. Unlike the results for the earlier reform period, economic growth has no significant impact on the urban-rural income inequality in the later reform period. Geographically, the inland regions, especially the western region, experienced more severe urban-rural income disparity. Finally, a positive coefficient of the central-region dummy variable in the inequality equation seems

to be consistent with some impact of the recent policy initiative called "'strategy for rapid prosperity of the central region.

Table 5A Growth, surplus labor, and urban-rural income inequality: Whole period

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	z value	Coefficient	z value	Coefficient	z value	Coefficient	z value
gdpgr								
urine	-2.699	(-2.79)***	-0.793	(-0.92)	-1.052	(-1.26)	-1.091	(-1.32)
inigdp	-2.938	(-3.45)***	-1.601	(-2.11)**	-1.807	(-2.43)**	-1.837	(-2.49)**
popgr	-1.622	(-9.15)***	-1.591	(-9.29)***	-1.548	(-8.88)***	-1.540	(-8.82)***
invt	0.188	(10.23)***	0.183	(10.32)***	0.190	(10.56)***	0.190	(10.59)***
infl	0.003	(0.57)	-0.003	(-0.81)	-0.003	(-0.70)	-0.003	(-0.67)
soe	-0.028	(-1.64)	-0.045	(-2.78)***	-0.042	(-2.62)***	-0.042	(-2.60)***
gov	-0.085	(-1.28)	-0.192	(-3.17)***	-0.185	(-3.10)***	-0.183	(-3.09)***
urbangr	0.048	(1.37)	0.051	(1.50)	0.046	(1.33)	0.048	(1.36)
center	-0.341	(-0.80)	0.075	(0.19)	0.053	(0.13)	0.049	(0.12)
constant	32.758	(5.29)***	23.334	(4.20)***	24.635	(4.52)***	24.821	(4.59)***
urine								
gdpgr	0.020	(2.04)**	0.008	(0.85)	0.021	(2.26)**	0.023	(2.47)**
surlab1	0.045	(7.84)***						
surlab2			0.032	(13.49)***				
surlab3					0.006	(12.33)***		
surlab4							0.003	(11.78)***
infl	0.002	(6.61)***	0.003	(7.83)***	0.003	(7.42)***	0.003	(7.16)***
soe	0.000	(0.02)	0.001	(0.60)	0.003	(1.35)	0.003	(1.26)
gov	0.033	(6.83)***	0.034	(7.78)***	0.033	(7.28)***	0.033	(7.39)***
agr	-0.018	(-1.71)*	-0.035	(-3.67)***	0.006	(0.62)	0.012	(1.22)
center	0.094	(1.43)	0.111	(2.04)**	0.453	(8.58)***	0.459	(8.60)***
west	0.785	(8.43)***	0.635	(7.49)***	0.977	(12.19)***	1.034	(12.82)***
constant	0.289	(1.23)	1.210	(5.81)***	0.573	(2.71)***	0.624	(2.93)***
R^2								
gdpgr	0.240		0.357		0.346		0.344	
urine	0.609		0.673		0.660		0.653	
observations	580		580		580		580	
provinces	29		29		29		29	

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 5B The results with earlier period

	Model (1)	Model (2)	Model (3)	Model (4)

	Coefficient	z value	Coefficient	z value	Coefficient	z value	Coefficient	z value
gdpgr								
urine	-1.476	(-0.94)	-0.953	(-0.73)	-1.733	(-1.40)	-1.911	(-1.48)
inigdp	-5.130	(-3.76)***	-4.768	(-4.07)***	-5.372	(-4.76)***	-5.576	(-4.80)***
popgr	-1.731	(-6.30)***	-1.706	(-6.36)***	-1.697	(-6.29)***	-1.703	(-6.30)***
invt	0.285	(7.73)***	0.302	(8.37)***	0.286	(7.91)***	0.283	(7.82)***
infl	-0.003	(-0.53)	-0.006	(-0.98)	-0.002	(-0.43)	-0.002	(-0.32)
soe	-0.012	(-0.22)	-0.024	(-0.46)	-0.008	(-0.16)	-0.005	(-0.09)
gov	-0.315	(-3.52)***	-0.341	(-4.00)***	-0.304	(-3.60)***	-0.299	(-3.51)***
urbangr	0.351	(2.91)***	0.303	(2.63)***	0.375	(3.25)***	0.378	(3.26)***
center	-0.322	(-0.48)	-0.064	(-0.10)	-0.391	(-0.63)	-0.476	(-0.76)
constant	43.231	(4.88)***	40.734	(5.26)***	44.707	(5.95)***	46.117	(5.99)***
urine								
gdpgr	0.050	(4.76)***	0.038	(4.03)***	0.044	(4.52)***	0.046	(4.60)***
surlab1	0.042	(5.41)***						
surlab2			0.030	(9.73)***				
surlab3					0.006	(9.06)***		
surlab4							0.003	(8.03)***
infl	0.001	(1.76)*	0.001	(2.67)***	0.001	(1.97)**	0.001	(1.91)*
soe	0.016	(3.20)***	0.017	(3.98)***	0.018	(4.05)***	0.016	(3.47)***
gov	0.014	(1.37)	0.016	(1.75)*	0.011	(1.19)	0.014	(1.44)
agr	-0.013	(-0.90)	-0.032	(-2.45)**	0.005	(0.38)	0.010	(0.80)
center	0.103	(1.15)	0.100	(1.36)	0.448	(6.27)***	0.456	(6.18)***
west	0.736	(5.93)***	0.575	(5.28)***	0.911	(8.67)***	0.975	(8.99)***
constant	-0.636	(-1.71)*	0.173	(0.54)	-0.251	(-0.77)	-0.082	(-0.24)
R^2								
gdpgr	0.417		0.424		0.411		0.407	
urine	0.510		0.608		0.585		0.562	
observations	290		290		290		290	
provinces	29		29		29		29	

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 5C The Results with Later period

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	z value	Coefficient	z value	Coefficient	z value	Coefficient	z value

gdpgr								
urine	-2.837	(-2.47)**	-0.395	(-0.56)	-1.745	(-1.69)*	-1.825	(-1.75)*
inigdp	-1.562	(-1.22)	0.142	(0.19)	-0.570	(-0.52)	-0.623	(-0.57)
popgr	-1.687	(-8.51)***	-1.468	(-10.08)***	-1.612	(-8.91)***	-1.642	(-8.94)***
invt	0.138	(5.83)***	0.151	(9.21)***	0.162	(7.65)***	0.164	(7.70)***
infl	0.034	(2.25)**	0.004	(0.46)	0.009	(0.71)	0.010	(0.73)
soe	-0.054	(-3.79)***	-0.088	(-7.92)***	-0.078	(-5.55)***	-0.077	(-5.39)***
gov	0.021	(0.23)	-0.043	(-0.70)	0.039	(0.44)	0.042	(0.48)
urbangr	0.008	(0.41)	0.020	(1.26)	0.015	(0.86)	0.017	(0.95)
center	0.205	(0.39)	1.100	(3.17)***	0.830	(1.77)*	0.809	(1.70)*
constant	17.720	(2.32)**	10.295	(2.16)**	15.109	(2.23)**	15.380	(2.25)**
urine								
gdpgr	-0.001	(-0.04)	-0.029	(-1.62)	0.008	(0.48)	0.013	(0.77)
surlab1	0.021	(1.66)*						
surlab2			0.030	(8.09)***				
surlab3					0.005	(8.43)***		
surlab4							0.003	(8.87)***
infl	0.006	(3.05)***	0.005	(3.45)***	0.001	(0.75)	0.000	(0.30)
soe	0.002	(0.41)	-0.007	(-2.07)**	-0.001	(-0.19)	0.000	(0.03)
gov			0.038	(5.14)***	0.041	(5.51)***	0.042	(5.77)***
agr	-0.007	(-0.40)	-0.047	(-3.03)***	0.003	(0.23)	0.009	(0.66)
center	0.246	(2.38)**	0.278	(3.56)***	0.442	(5.38)***	0.438	(5.36)***
west	1.122	(8.13)***	0.841	(7.16)***	1.043	(9.07)***	1.077	(9.41)***
constant	0.278	(0.48)	1.408	(3.14)***	1.297	(2.85)***	1.380	(3.05)***
R^2								
gdpgr	0.268		0.633		0.470		0.456	
urine	0.566		0.662		0.661		0.664	
observations	290		290		290		290	
provinces	29		29		29		29	

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

4.2. Impact of Openness

The role of China's economic opening was then estimated by employing two measures: exports and FDI. The results presented in Table 6A show that China's economic opening had both economic-growth-enhancing and income-inequality-increasing effects. Surplus agricultural labor still has a significant impact on urban-rural income inequality. There is some evidence that a higher urban-rural

income inequality reduces economic growth, as can be seen in model 1. There is also some evidence that the growing urban-rural income inequality is positively linked with economic growth.

The results for openness in the economic-growth equation indicate the effectiveness of the open-door policy in facilitating economic growth. As is generally known, China's economic growth has relied heavily on exports since its economic reform. The promotion of FDI inflow, another important part of China's economic opening, is considered another factor contributing to the economic growth in China. Foreign enterprises have also played an important role in promoting exports.

What then are the impacts of the open-door policy on income inequality in China? The results presented in the table 6 show that openness is positively related to urban-rural income inequality, indicating that the income gap between the urban and rural sectors in China widened with the openning. This result is consistent with those obtained by Lu and Chen (2006). Using the provincial panel data from 1987 to 2001, they found that China's economic opening is contributing to the rising urban-rural income inequality in the country.

Table 6A Impact of openness on economic growth and urban-rural income inequality: Whole period

	Model (1)		Model (2)	
	Coefficient	z value	Coefficient	z value
gdpgr				
urrine	-2.079	(-2.30)**	-0.987	(-1.14)
export	0.060	(4.88)***		
fdi			0.214	(4.79)***
inigdp	-3.054	(-3.68)***	-2.197	(-2.88)***
popgr	-1.676	(-9.65)***	-1.573	(-9.44)***
invt	0.193	(10.86)***	0.171	(9.81)***
infl	0.001	(0.24)	-0.004	(-1.08)
soe	0.016	(0.81)	-0.040	(-2.57)***
gov	-0.112	(-1.77)*	-0.128	(-2.10)**
urbangr	0.040	(1.17)	0.044	(1.33)
center	0.352	(0.88)	0.428	(1.07)
constant	28.164	(4.92)***	26.236	(4.72)***
urine				
gdpgr	0.021	(2.24)**	0.016	(1.52)
surlab1	0.048	(8.27)***	0.047	(8.00)***
export	0.006	(3.38)***		
fdi			0.016	(2.05)**
infl	0.003	(6.85)***	0.002	(6.12)***
soe	0.004	(1.54)	-0.001	(-0.43)
gov	0.032	(6.71)***	0.033	(6.79)***
agr	-0.015	(-1.44)	-0.018	(-1.73)*
center	0.162	(2.41)**	0.161	(2.24)**

west	0.829	(8.99)***	0.867	(8.81)***
constant	-0.213	(-0.80)	0.324	(1.38)
R^2				
gdpgr	0.322		0.376	
urine	0.617		0.612	
observations	580		580	
provinces	29.000		29.000	

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 6B Impact of openness on economic growth and urban-rural income inequality: Earlier period

	Model (1)		Model (2)	
	Coefficient	z value	Coefficient	z value
gdpgr				
urine	-1.092	(-0.76)	0.157	(0.11)
export	0.062	(3.02)***		
fdi			0.230	(3.24)***
inigdp	-5.004	(-3.92)***	-3.698	(-3.05)***
popgr	-1.800	(-6.70)***	-1.675	(-6.33)***
invt	0.256	(7.06)***	0.206	(5.21)***
infl	-0.004	(-0.76)	-0.009	(-1.51)
soe	0.031	(0.53)	-0.025	(-0.48)
gov	-0.331	(-3.86)***	-0.329	(-3.85)***
urbangr	0.336	(2.90)***	0.341	(3.00)***
center	0.063	(0.10)	0.132	(0.21)
constant	38.673	(4.74)***	33.911	(4.25)***
urine				
gdpgr	0.045	(4.31)***	0.041	(3.61)***
surlab1	0.041	(5.45)***	0.040	(5.54)***
export	0.006	(2.37)**		
fdi			0.020	(2.14)**
infl	0.001	(1.40)	0.000	(0.68)
soe	0.019	(3.75)***	0.015	(3.30)***
gov	0.005	(0.49)	0.006	(0.55)
agr	-0.001	(-0.07)	-0.011	(-0.81)
center	0.173	(1.92)*	0.201	(2.16)**
west	0.797	(6.53)***	0.869	(6.69)***
constant	-0.867	(-2.31)**	-0.454	(-1.24)
R^2				
gdpgr	0.439		0.443	
urine	0.537		0.548	
observations	290		290	

provinces	29	29

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively..

Table 6C Impact of openness on economic growth and urban-rural income inequality: Later period

	Model (1)		Model (2)	
	Coefficient	z value	Coefficient	z value
gdpgr				
urine	-2.237	(-2.41)**	0.416	(1.30)
export	0.029	(2.45)**		
fdi			0.069	(1.58)
inigdp	-1.547	(-1.43)		
popgr	-1.547	(-9.01)***	-1.468	(-11.93)***
invt	0.131	(6.84)***	0.145	(12.91)***
infl	0.023	(1.78)*	0.007	(1.55)
soe	-0.054	(-3.08)***	-0.093	(-10.20)***
gov	0.095	(1.25)	-0.093	(-2.74)***
urbangr	0.009	(0.51)	0.020	(1.21)
center	0.922	(2.34)**	1.267	(5.36)***
constant	17.199	(2.90)***	9.299	(6.13)***
urine				
gdpgr	-0.037	(-1.81)*	-0.050	(-2.27)**
surlab1	0.035	(2.47)**	0.066	(4.23)***
export	0.004	(1.57)		
fdi			0.010	(0.63)
infl	0.004	(1.82)*	0.007	(3.11)***
soe	-0.004	(-1.02)	-0.013	(-3.01)***
gov	0.041	(5.13)***	0.038	(4.46)***
agr	-0.005	(-0.28)	-0.016	(-0.83)
center	0.285	(2.84)***	0.174	(1.48)
west	0.884	(5.94)***	0.848	(4.94)***
constant	0.630	(0.83)	0.068	(0.10)
R^2				
gdpgr	0.463		0.682	
urine	0.592		0.591	
observations	290		290	
provinces	29		29	

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 6B and 6C show the results for the earlier and later reform periods, respectively. A comparison of the two tables will readily reveal that while the measures of openness, exports, and FDI had a significant impact on economic growth in the earlier reform period, FDI lost its significance in

the later reform period. This result is consistent with that obtained by Jin et al. (2008). On the other hand, while positive signs remain, the significant impact of exports and FDI on the urban-rural income inequality in China disappeared in the later reform period. This implies that the underlying factors contributing to the urban-rural income inequality were changed during the two subperiods, and that some other factors affecting urban-rural income inequality emerged in the later reform period. Finally, most importantly, now growth is shown to reduce the inequality when openness is controlled.

4.3 Education and Technological Progress

Finally, the roles of education and technology were determined. Education was measured using various educational-attainment levels: primary schooling, junior secondary schooling, and higher schooling. *Technological progress,* on the other hand, was the number of patent applications per 10,000 people. The main findings from the economic-growth equation in Table 7A are that while primary schooling has a positive and significant impact on economic growth, the other educational-attainment levels and technology have no significant impact on it, and that economic growth was facilitated by greater physical investments and privatization but decreased with more government spending and higher population growth. Some other findings in relation to urban-rural income inequality are that surplus agricultural labor, junior secondary schooling, inflation rate, and government spending are positively and significantly related to urban-rural income inequality whereas government spending on agriculture is negatively and significantly related to it. As far as the education-and-technology equation is concerned, education and technological progress increased with more government spending on culture, education, social welfare, and health. Geographically, while lower education is well developed in the central region, the same cannot be said of technology. In the western region, all education levels and technology are not sufficiently developed.

Table 7B and 7C show that while education and technology had no significant impact on economic growth in the earlier reform period but that they became significant in the later reform period. Education and technology (except primary schooling) also increased the income disparity between the urban and rural sectors in the later reform period, implying the increasingly important role of education and technology in China. Furthermore, from the estimation coefficients and significance level, it can be conjectured that the higher the educational attainment is, the larger the urban-rural income inequality in the country. Combining Table 6C and 7C can lead to the conclusion that education and technology played more important roles than openness did in the growing urban-rural income inequality in China in the later reform period. However, when these higher education and technology variables are controlled, economic growth is now shown to rather reduce the inequality in

late period, which is just the opposite to the case in earlier period.

Table 7A Education and technology on growth and urban-rural inequality: Whole period

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	z value	Coefficient	z value	Coefficient	z value	Coefficient	z value
gdpgr								
urine	-1.319	(-1.85)*	1.196	(2.32)**	0.170	(0.29)	0.199	(0.33)
edu1	0.106	(1.97)**						
edu2			0.030	(1.25)				
edu3					-0.030	(-0.86)		
tech							-0.428	(-1.09)
inigdp	-2.076	(-2.82)***						
popgr	-1.500	(-8.63)***	-1.372	(-8.34)***	-1.290	(-7.64)***	-1.512	(-9.10)***
invt	0.154	(8.81)***	0.162	(10.04)***	0.160	(10.16)***	0.182	(10.39)***
infl	0.012	(2.80)***	0.004	(1.02)	0.009	(2.13)**	-0.003	(-0.69)
soe	-0.020	(-1.38)	-0.039	(-2.76)***	-0.057	(-4.15)***	-0.071	(-3.22)***
gov	-0.112	(-1.70)*	-0.286	(-6.32)***	-0.190	(-3.46)***	-0.266	(-5.53)***
urbangr	0.026	(0.90)	0.036	(1.29)	0.034	(1.23)	0.049	(1.47)
center	-0.296	(-0.61)	0.736	(2.42)**	0.833	(2.80)***	0.314	(0.84)
constant	12.615	(2.34)**	5.347	(2.90)***	8.809	(6.15)***	13.188	(8.28)***
urine								
gdpgr	0.011	(0.73)	-0.013	(-0.85)	-0.020	(-1.46)	-0.005	(-0.45)
surlab1	0.046	(6.37)***	0.051	(5.81)***	0.043	(2.87)***	0.041	(4.36)***
edu1	-0.003	(-0.23)						
edu2			0.015	(2.38)**				
edu3					0.017	(1.51)		
tech							0.001	(0.01)
infl	0.002	(2.92)***	0.003	(3.71)***	0.003	(3.29)***	0.003	(5.44)***
soe	-0.003	(-1.18)	0.002	(0.80)	0.000	(-0.16)	-0.003	(-0.87)
gov	0.042	(7.53)***	0.021	(3.40)***	0.027	(3.88)***	0.023	(4.64)***
agr	-0.029	(-1.87)*	-0.033	(-2.23)**	-0.028	(-1.95)*	-0.021	(-1.95)*
center	0.103	(1.26)	0.129	(1.56)	0.217	(2.51)**	0.151	(2.25)**
west	0.751	(6.05)***	1.063	(8.53)***	0.984	(8.55)***	0.905	(9.57)***
constant	0.807	(0.81)	-0.314	(-0.77)	0.482	(1.04)	0.852	(2.58)***
edu/tech								
cesh	5.619	(15.92)***	12.696	(25.68)***	8.370	(22.58)***	1.139	(33.05)***
center	3.321	(5.47)***	2.850	(3.36)***	-0.662	(-1.04)	-0.516	(-8.83)***
west	-5.751	(-9.26)***	-10.098	(-11.61)***	-4.079	(-6.24)***	-0.886	(-14.74)***
constant	61.913	(35.24)***	-4.438	(-1.80)*	-19.191	(-10.40)***	-4.960	(-29.94)***
R^2								
gdpgr	0.432		0.524		0.531		0.374	
urine	0.614		0.523		0.529		0.588	
edu/tech	0.534		0.703		0.615		0.759	
observations	435		435		435		435	
provinces	29		29		29		29	

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 7B Education and technology on growth and urban-rural inequality: Earlier period

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	z value	Coefficient	z value	Coefficient	z value	Coefficient	z value
gdpgr								
urine	3.897	(1.57)	2.841	(1.07)	2.330	(1.19)	0.981	(0.67)
edu1	0.197	(0.99)						
edu2			0.049	(0.36)				
edu3					0.043	(0.28)		

tech							0.102	(0.10)
popgr	-0.808	(-2.09)**	-1.156	(-2.89)***	-1.329	(-3.36)***	-1.490	(-5.21)***
invt	0.169	(4.03)***	0.193	(3.13)***	0.199	(3.84)***	0.187	(4.44)***
infl	0.014	(1.38)	0.007	(0.91)	0.005	(0.68)	-0.003	(-0.40)
soe	-0.167	(-2.34)**	-0.028	(-0.32)	0.001	(0.01)	-0.034	(-0.67)
gov			-0.409	(-3.92)***	-0.434	(-4.00)***	-0.346	(-3.96)***
urbangr	0.657	(2.66)***	0.467	(2.66)***	0.381	(2.11)**	0.485	(3.76)***
center	1.054	(1.03)	1.198	(1.62)	1.240	(1.67)*	0.407	(0.56)
constant	-12.717	(-0.75)	-0.576	(-0.10)	0.894	(0.27)	9.351	(3.38)***
urine								
gdpgr	0.051	(3.06)***	0.057	(4.03)***	0.051	(3.76)***	0.043	(3.59)***
edu1	-0.079	(-3.60)***						
edu2			-0.042	(-7.04)***				
edu3					-0.062	(-7.29)***		
tech							-0.566	(-8.85)***
infl	-0.001	(-0.78)	0.001	(1.06)	0.001	(1.19)	0.003	(5.49)***
soe	0.022	(3.24)***	0.018	(2.92)***	0.019	(3.20)***	0.011	(2.35)**
gov			0.032	(2.56)***	0.049	(3.73)***	0.028	(2.69)***
agr	0.001	(0.02)	-0.033	(-1.79)*	-0.051	(-2.58)***	-0.026	(-1.70)*
center	0.189	(1.19)	0.097	(0.97)	0.060	(0.61)	-0.113	(-1.32)
west			0.329	(2.06)**	0.503	(3.43)***	0.433	(3.66)***
constant	6.815	(3.46)***	1.927	(4.15)***	0.844	(2.03)**	-0.149	(-0.42)
edu/tech								
cesh	4.964	(5.50)***	14.347	(9.68)***	10.913	(12.43)***	1.113	(12.83)***
center	2.188	(1.81)*	2.897	(1.76)*	1.948	(1.99)**	-0.334	(-3.58)***
west	-9.279	(-7.88)***	-8.131	(-5.01)***	-1.309	(-1.36)	-0.675	(-7.37)***
constant	63.926	(16.82)***	-12.887	(-2.04)**	-29.890	(-8.00)***	-5.000	(-13.62)***
R^2								
gdpgr	0.394		0.481		0.493		0.382	
urine	0.104		0.531		0.557		0.442	
edu/tech	0.465		0.561		0.586		0.568	
observations	145		145		145		145	
provinces	29		29		29		29	

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively..

Table 7C Education and technology on growth and urban-rural inequality: Later period

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	z value	Coefficient	z value	Coefficient	z value	Coefficient	z value
gdpgr								
urine	-0.955	(-1.50)	1.599	(5.55)***	0.768	(2.33)**	1.158	(4.02)***
edu1	0.388	(5.80)***						
edu2			0.111	(6.96)***				
edu3					0.055	(2.09)**		
tech							0.573	(2.26)**
inigdp	-1.854	(-2.04)**						
popgr	-1.656	(-10.07)***	-1.535	(-12.93)***	-1.497	(-12.18)***	-1.513	(-12.99)***
invt	0.124	(6.76)***	0.137	(12.80)***	0.138	(11.94)***	0.137	(12.78)***
infl	0.015	(1.64)	-0.004	(-0.80)	0.005	(0.81)	0.007	(1.24)
soe	-0.037	(-3.11)***	-0.065	(-6.94)***	-0.082	(-8.49)***	-0.081	(-5.07)***
gov	0.026	(0.39)	-0.160	(-5.16)***	-0.132	(-3.79)***	-0.163	(-5.32)***
urbangr	0.008	(0.42)	0.018	(1.16)	0.021	(1.27)	0.017	(1.07)
center	-0.931	(-1.71)*	0.640	(2.99)***	1.126	(5.30)***	1.391	(5.67)***
constant	-15.677	(-3.50)***	2.718	(1.80)*	8.100	(6.10)***	8.022	(5.84)***
urine								
gdpgr	-0.010	(-0.46)	-0.072	(-2.93)***	-0.072	(-2.99)***	-0.081	(-2.96)***
surlab1	0.046	(3.23)***	0.096	(5.88)***	0.102	(4.01)***	0.109	(4.42)***

edu1	0.017	(1.17)						
edu2			0.042	(4.27)***				
edu3					0.055	(2.91)***		
tech							0.518	(3.11)***
infl	0.004	(1.92)*	0.008	(3.39)***	0.006	(2.20)**	0.007	(2.90)***
soe	-0.004	(-0.89)	-0.003	(-0.68)	-0.004	(-0.84)	0.002	(-0.23)
gov	0.039	(4.67)***	0.019	(2.28)**	0.019	(2.02)**	0.024	(2.61)***
agr	-0.012	(-0.67)	-0.007	(-0.30)	-0.001	(-0.05)	-0.003	(-0.14)
center	0.097	(0.89)	-0.003	(-0.03)	0.113	(0.89)	0.383	(3.13)***
west	0.862	(5.25)***	1.158	(6.06)***	0.930	(5.12)***	1.098	(6.25)***
constant	-1.215	(-0.86)	-3.353	(-4.38)***	-1.803	(-2.27)**	-1.576	(-1.60)
edu/tech								
cesh	3.285	(8.45)***	10.222	(15.27)***	9.032	(15.98)***	1.088	(20.62)***
center	2.325	(3.98)***	1.580	(1.57)	-0.951	(-1.12)	-0.770	(-9.69)***
west	-4.881	(-8.36)***	-12.167	(-11.95)***	-4.969	(-5.78)***	-1.187	(-14.85)***
constant	74.185	(36.32)***	9.192	(2.61)***	-22.466	(-7.55)***	-4.528	(-16.30)***
R^2								
gdpgr	0.430		0.677		0.676		0.666	
urine	0.612		0.385		0.406		0.503	
edu/tech	0.475		0.654		0.571		0.783	
observations	290		290		290		290	
provinces	29		29		29		29	

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively..

5. Summary and Concluding Remarks

Since the economic reform was initiated in the late 1970s, China has shown a remarkable economic performance, with an average annual economic-growth rate of around 9%. This rapid economic growth can be attributed to the various reform policies, including economic opening, privatization, enhanced education and technology, and the policy of allowing some people in the country to get rich first. While China has achieved remarkable economic growth, it is also experiencing rising income inequality, especially the urban-rural gaps.

Following the method of Lundberg and Squire (2003), this study has investigated whether and how economic growth and income inequality are simultaneously determined, and more importantly, how they are subject to the following determining factors, such as surplus agricultural labor as an initial condition, openness, and education and technological progress. This study uses a panel dataset covering 29 provinces in China and spanning the period from 1988 to 2007. The period is further divided into two sub-periods: the earlier reform period (1988-1997) and the later reform period (1998-2007), thus allowing for a more pronounced comparative analysis—that is, analyzing the changing determinants of economic growth and income inequality.

In sum, we find that economic growth in China is primarily fixed investment driven for the whole period, is more related to openness in the early period, and more related to education and innovation in the later period. The followings are more specific findings.

(1) The urban-rural income inequality is caused by economic growth during the earlier reform period, but the impact of economic growth on the urban-rural income inequality has become insignificant or even negatively related during the later period when openness, high education or technology variables are controlled, which indicates some evidence of the Kuznets hypothesis. On the other hand, there is some evidence that urban-rural income inequality is detrimental to economic growth in China during the later period, but the impact is not significant during the earlier period.

(2) Surplus agricultural labor was found to be positively and significantly related to the urban-rural income inequality in China, thus confirming Lewis's dual-economy theory. Their impacts on inequality are the same and robust, regardless of which estimates of the rural surplus labor used. The provinces with greater surplus agricultural labor were found to have more unequal urban-rural income distribution, implying that the reduction of surplus agricultural labor is one of the fundamental ways of reducing income inequality.

(3) Skill-biased technological progress increased the demand for skilled workers and thereby increased their wage premium over the unskilled workers, thus increasing the urban-rural income inequality in China in the later reform period. Education (except primary schooling) also increased the urban-rural income inequality in the country in the later reform period, and the higher the educational attainment was, the larger the urban-rural income disparity. In the later reform period, education and technological progress also facilitated the economic growth.

(4) Openness was the economic-growth-enhancing and income-inequality-increasing factor during the earlier reform period. However, in the later reform period, exports still had a positive and significant impact on economic growth, whereas FDI lost its significance. Furthermore, both exports and FDI had no significant impact on the urban-rural income inequality in the later reform period.

(5) Government expenditure was found to increase the urban-rural income inequality, implying that public spending in China has been directed towards the urban residents rather than towards the poor rural residents. Although not robust, the government support for agriculture was found to help reduce the urban-rural income inequality.

(6) The provinces located in the inland areas experienced greater income inequality. More specifically, the urban-rural divide was found to be more severe in the western region than in the central region, which in turn was more severe than in the coastal region.

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Appendix Table 1 Descriptive statistics of used variables

Variable	Obs	Mean	Std. Dev.	Min	Max
gdpgr	580	9.75	4.23	-4.05	38.15
urine	580	2.62	0.76	1.14	5.36
surlab1	580	23.00	5.11	7.70	28.87
surlab2	580	8.16	10.73	-16.27	26.25
surlab3	580	27.05	41.25	-144.15	64.89
surlab4	580	11.36	77.27	-302.64	74.00
export	580	15.05	17.84	2.04	102.05
fdi	580	3.03	3.84	0.00	24.19
edu1	435	86.77	7.33	58.79	96.50
edu2	435	50.93	12.84	19.14	83.27
edu3	435	17.15	8.45	2.67	53.06
tech	580	-0.43	1.14	-3.55	3.53
cesh	580	4.35	0.73	2.73	7.03
inigdp	580	6.27	0.49	5.53	7.81
popgr	580	1.08	0.88	-1.95	11.21
invt	580	36.28	12.03	15.27	82.52
infl	580	221.11	66.79	100.00	356.20
soe	580	71.37	11.56	28.71	90.50
gov	580	13.51	5.51	4.92	36.01
agr	580	7.89	2.72	2.13	15.43
urbangr	580	2.32	4.26	-21.58	58.58
center	580	0.34	0.48	0.00	1.00
west	580	0.28	0.45	0.00	1.00

Note: See text for the definitions of the variables.

Appendix Table 2 The correlation matrix : Whole reform period (obs=435)

	gdpg	urine	surla	surla	surla	surla	expo	fdi	edu1	edu2	edu3	tech
gdpg	1.00											
urine	0.09	1.00										
surla	-	0.43	1.00									
surla	-	0.58	0.84	1.00								
surla	0.02	0.27	0.09	0.39	1.00							
surla	0.04	0.16	-	0.25	0.96	1.00						
expo	0.22	-	-	-	0.08	0.17	1.00					
fdi	0.32	-	-	-	0.09	0.18	0.61	1.00				
edu1	0.33	-	-	-	-	-	0.31	0.29	1.00			
edu2	0.34	-	-	-	-	-	0.37	0.32	0.83	1.00		
edu3	0.20	-	-	-	-	-	0.42	0.35	0.60	0.87	1.00	
tech	0.41	-	-	-	-	-	0.68	0.48	0.64	0.79	0.80	1.00
cesh	0.43	0.07	-	-	-	-	0.54	0.36	0.53	0.73	0.75	0.82
inigd	0.04	-	-	-	-	-	0.44	0.42	0.34	0.64	0.78	0.65
popg	-	0.02	-	-	0.04	0.03	0.03	-	-	-	-	-
invt	0.46	0.34	-	-	-	-	0.05	0.14	0.22	0.35	0.37	0.36
infl	0.48	0.27	-	-	-	-	0.11	0.19	0.49	0.53	0.48	0.51
soe	-	0.26	0.49	0.40	-	-	-	-	-	-	-	-
gov	-	0.62	0.16	0.22	-	-	-	-	-	-	0.08	-
agr	-	0.39	0.61	0.61	-	-	-	-	-	-	-	-
urba	0.13	-	0.01	0.04	0.11	0.12	0.11	0.10	0.08	0.04	-	0.08
cente	0.02	-	0.35	0.13	-	-	-	-	0.21	0.05	-	-
west	-	0.65	0.35	0.47	0.10	-	-	-	-	-	-	-

	cesh	inigd	popg	invt	infl	soe	gov	agr	urba	cente	west
cesh	1.00										
inigd	0.50	1.00									
popg	-	-	1.00								
invt	0.63	0.15	-	1.00							
infl	0.60	0.15	-	0.58	1.00						
soe	-	-	0.13	-	-	1.00					
gov	0.31	-	0.13	0.54	0.23	0.26	1.00				
agr	-	-	0.10	-	-	0.49	0.34	1.00			
urba	0.05	-	-	0.02	0.04	-	-	-	1.00		
cente	-	-	-	-	-	0.14	-	0.10	-	1.00	
west	-	-	0.15	0.28	0.07	0.43	0.63	0.52	-	-	1.00

Note: See text for the definitions of the variables.