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Income inequality in China by industry

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ABSTRACT

This paper is to investigate the reasons of income inequality across provinces. Using 1988 and 2013 CHIP individual data from 14 provinces and 13 sectors (16 sectors in 2013), the province level natural log of income differences increased by 3.06 between 1998 and 2013. The average schooling increased by 1.79 years and the share of agricultural sector decreased by 41% during this period. However, the overall individual level income variance increased from 0.16 in 1988 to 0.64 in 2013. The increase in within-sector income variance is responsible for the increased variances. In my analysis, I assume the education effect, return to schooling and sector share shift can contribute to the income variances. Among these three factors, the increase in return to schooling and sector share shift from agricultural sectors to other sectors are attribute to the income inequality.

CHAPTER 1. INTRODUCTION

During the economic transition over the past 4 decades, income inequality in China kept a very clear increasing trend. Based on the original Ravallion and Chen data for the 1981-2001 period and the latest data released by the NBSC for the period from 2003 to 2015, "income inequality in China substantially increased from its nadir of 28.3 points in 1983 to its peak of 49.1 points in 2008, then fall down slightly to 46.2 points in 2015" (R. Molero-Simarro, 2017: p. 108). There are some literatures study the inequality in China. Khan et al. (1992) decompose the urban Gini index by income source based on CHIP survey data, and find that the contributors are wage (34%) and house subsidies (24%). R. Molero-Simarro (2017) investigate the inequality from the evolution of functional distribution of income and find out the increase of capital income share in top income urban household. Meng (2004) finds that during the marketization of urban sectors, the increase in unemployment led to a fall in urban worker's income and then reduced the inequality in the urban labor market. Shi et al. (2016) investigate the evolution of urban inequality from the angle of wage structure between 1995 and 2013, and find that regional gap and inequality of human capital are major contributors to overall wage inequality. Ma and Li (2016) evaluate the effect of minimum wage on urban inequality from 1993 to 2013 and find that the increase of minimum wages had a positive effect on the wage levels of the low-wage group only from 2007–2013; there was no such effect from 1993–1995 and from 1998–2002. Song (2017) study the household consumption inequality in urban China over 1995-2013 using 1995, 2002 and 2013 CHIP data. She found that the increase in consumption expenditure per capita increased remarkable after 2002. However, the consumption inequality increases over the period. She also found the inequality of basic food consumption is much smaller than the overall consumption and

decreasing steadily. By contrast, clothing consumption inequality is much larger and increasing sharply with the time. The inequality of housing consumption is decreasing and is much larger in the upper half than in the lower half. In addition, the share of food expenditure decreases steadily to 25% as the overall consumption level moving up. The share of clothing in overall consumption remains about 7% over time but exhibits downward sloping. The share of housing consumption sharply increased to 38% in 2013. All those evidences imply the increase in income gap between the poor and the rich.

In this paper, I focus on the income variances across industry sectors instead of the urban- rural gaps. During the globalization, the evolution of inequality, especially the structural change in the labor market, deserves intensive study. First, the urbanization process will continue for a long time in China. The farming activities is no longer an only sector in the rural area. With the investment in less-developed provinces, labor-intensive industries are declining, and the knowledge-intensive industries emerges. The employment structure change will play an important role in the evolution of overall inequality in China. There have been some studies on China's structural change, but few has attempted to bring the shift share for each industry and the evolution of income inequality together. Second, most existing studies focus on explaining the low return to schooling during the economic transition or expanding college access in recent years, but few attentions has been paid to associate the return to schooling with the structural change in employment.

To investigate the structural change effect on income inequality, I use the CHIP data in 1988 and 2013, to make the inequality decomposition and regressions possible. I assume the transition from farming to manufacturing and then to service or high skilled sectors will increase the overall income inequality.

The paper proceeds as follow. Chapter 2 provides some background for the industrial distribution, education and return to education. Chapter 3 introduces the data. Chapter 4 gives the decomposition of variables over time. Chapter 5 is to investigate the determinations of income variances. Chapter 6 summarizes.

CHAPTER 2. SOURCES OF INEQUALITY AND HYPOTHESES

2.1 Industrial Distribution

Since the economic reform started in 1978, China has received a large part of international direct investment flows. The introduction of foreign ownership through foreign direct investment (FDI) pushed the economy from collective towards marketization. In 1985, labor mobility across areas was relaxed and local governments were mandated to accept rural migrants into cities as part of their non-agricultural population. In mid-1990s, several policies were made to encourage more high-technology and more capital intensive FDI projects. In 1980, the first four Special Economic Zones (SEZs) were established in Guangdong and Fujian provinces and offered special incentive policies for FDI in these SEZs. The purposes are to attract overseas capital and also as a showcase for the potential impacts of reform. While FDI in-flows were highly concentrated within these provinces, the amounts remained rather limited (Cheung and Lin, 2004). After 1984, Hainan Island and fourteen coastal port cities across ten provinces were opened, which were essential to support an export-oriented strategy. The realized value of inward FDI to China reached 3.49 billion dollars in 1990. Since SEZs and their positive economic impacts were solely a costal endeavor, the expected spillover effects from coastal to inland provinces failed to materialize. In reaction to the widening regional gap, more broadly-based economic reforms and open door policies were pushed forward in the 1990s. In 1992, Deng Xiaoping adopted a new approach which turned away from special regimes toward more nation-wide implementation of open policies. And the decentralization of state control, privatization of the state sector began to accelerate. Since 1992 inward FDI in China has accelerated and reached the peak level of 45.5 billion dollars in 1998. After a drop due to the Asian crisis, FDI inflows into China surged again, so

that “by 2010 China had accumulated FDI stock of 579 billion, well ahead of other large developing and transition economies” (OECD, 2016: p. 10). In 1998, all state enterprises, except a few large monopolies, were liquidated and sold to private investors. “China’s entry to the WTO in 2001 is likely to deepen China’s integration in the international segmentation of production processes and as such should reinforce the FDI attractiveness position of China” (Madariaga, 2007: p. 839).

Thus, FDI plays a major role in transforming the Chinese economy. The role of foreign companies is to bring in new production and managerial technologies, together with local labor, to increase capital and improve the overall productivity of the economy. In addition, it creates employment opportunities. “Foreign firms employed around 20 million workers (three percent of China’s total employment) at the end of the 1990s” (Madariaga, 2007: p. 840). Furthermore, foreign investment enterprises (FIEs) modifies China’s industrial structure because FDI incorporates much more equipment and technology knowledge. An important difference in industrial structure between FIEs and domestic firms is that FIEs are relatively more concentrated in the newly developing and fast-growing industries such as information technology and electronic equipment. By contrast, domestic firms are more present in the conventional basic capital-intensive and large-scale industries.

As mentioned above, the direction of FDI is encouraged by exogenous geographical and political factors. The SEZs were attracting more foreign investment enterprises ahead of other regions because of their accessibility to port infrastructures and foreign markets. Hence, I assume that the labor market structural change caused by the economic policies (labor force moving from low-skilled sectors to high-skilled sectors) would cause the income inequality. I would expect the more opened (coastal) provinces had more concentration in manufacturing

industries at the beginning of reform and then transit to service sectors. The other regions had more farming activities at the beginning of reform will transit to conventional industry sectors. Overall, the different speed of economic reform across provinces could result in the income inequality.

2.2 Human Capital Investment

The geographical dispersion of China's investment in human capital is large. As shown in Table 1, the proportion of population with more than twelve years schooling (at least some college degree) was 4% in 2000 and had risen to 10% in 2010, this is due to the sharp increase in the enrollment and public funding for college students starting in 1999. The proportion of population with high school degree was 13% in 2000 and had risen to only 15% in 2010. The proportion of individuals who had at least a high school education was approximately 31% in coastal region, 27% in the northeast, 24% in the interior regions, but 19% in the west in 2010. The Chinese government made a law for nine-years of compulsory education (six years of primary education plus three years of secondary education) in 1986. The ratio of high school enrollment (three years later) to middle school enrollment increased from 26% in 2000 to only 51% in 2015 (National Bureau of Statistics of China, Various Years), which means only one of two children can get into high school if we assume the compulsory education applied to all children. In 2015 the high school enrollment rate is approximately 58%, which means there are 7% of students don't even graduate from middle school.

The Chinese government and society appear to have failed to keep enough of the country's young people in school during the recent decades of economic growth. The low rate of high school attendance can be attributed to high and rising costs. Academic high

school tuition fees in China are not free and are among the highest in the world (Liu et al. 2009). College tuition fees also are burdensome for students from poor rural areas and they often do not qualify for need-based financial aid. More importantly, rural families encourage poor exam performance students to drop out from school because of high opportunity cost from staying in school. The parents would suggest their children to find jobs in cities because of increasing demand and wages of low-skills workers in urban area. Another thoughts are related to the poor teaching quality in the rural area. The annual college entrance exam (commonly known as Gaokao) is the only way for entrance into almost all higher education institutions at the undergraduate level. It is usually taken by students in their last year of high school. By the time students are ready to take the exam, most of rural students have dropped out of the system. Since it is based on test scores only, the remaining students in the rural area are not competitive in this exam compared to the urban students. In addition, major cities like Beijing and Shanghai are given higher quotas for admittance to college because the educational resources are not distributed evenly across China. Hence, the rural students are being discriminated in higher education. And that's why they choose to drop out of school. In the short run, drop-out students can gain from migration to cities earlier than other students stay in school. In the long run, as too many people drop out of school too soon and the low-skilled jobs that may have been plentiful, the migrant workers without secondary skills must struggle in the cities.

Table 2 shows the schooling gap between urban and rural required by each occupation for the young generation aged 25-35 in 2013 and the average schooling for all individuals in 1988. The education gap between urban residents and rural residents varies between 1.4 to 3.9 years across industries. Only the sectors require higher skills (ie., IT,

Financial industry, Education) have slightly less education gap. The last column shows the average schooling in 1988. Since the compulsory education start after 1986, the young generation's average schooling in 2013 can roughly reflect the results of this policy. We could see that the agriculture sectors gain from this policy and the education increased by 3.2 years for rural workers and 5.9 for urban workers compared to the average schooling in 1988. For other sectors, the improvement in schooling are subtle in rural area. In contrast, the education level in urban areas have increased more than rural area in all sectors, which implies the higher human capital investment in more developed regions. Since we assume a positive relationship between education and wage, I assume the provinces with more percentage of rural residents have lower education level and less developed.

Human capital has a direct role in production through the generation of worker skills. Fleisher and Chen (1996) find the regional inequality of investment in Chinese higher education can explain the high and rising regional income inequality. Hence I assume that the discrepancy of education obtained will result in regional inequality in China.

2.3 Return to Schooling

Campos et al. (2016) analyzes the impact of education on income inequality between ethnic minorities and Han in China by using the data from the China Health and Nutrition Survey (CHNS) over the period 1993–2011. They found that there exists significant income inequality to the disadvantage of ethnic minorities but the return to education for ethnic minorities is high, which implies that a portion of the income gap can be overcome with additional education. They found that in general one additional year of education will increase earned incomes of ethnic minorities by 26.3–28% and in particular by 13.5–14.4% for women from an ethnic minority group, by 10.4–14% for ethnic minorities

with urban household registration, and by 10.8% for ethnic minorities with rural household registration.

Belskaya et al.(2014) evaluates whether the expansion of higher education is economically worthwhile based on a recent surge in the number of campuses and college graduates in Russia. They find that college expansion attracts individuals with lower returns to college, but the returns for marginal students who are directly affected by college expansion vary considerably depending on the scale of expansion and the type of location where new campuses are opened. Marginal individuals in smaller cities and locations without college campuses receive the largest benefits from new campuses.

In China, higher education expanded almost six-fold in the decade 1988-2008. J. Knight et al. (2017) shows that the share of higher education graduates in total employment rose by 8 percentage points, but the graduate unemployment rate rose by only 1.4 percentage points. This implies that the higher education wage premium have been depressed by supply shock. Compared to high school leavers, the average hourly wage for the entry cohort of higher education graduates and university graduates fall over the five years. There's the same pattern in the proportion of the "good job" for the entry cohort of higher education graduates and university graduates. In addition, the unemployment rate increased only for these cohorts.

Keng, Lin and Orazem (2017) also investigated the expansion of college access and education quality on income inequality in Taiwan. They found that increasing college access alone will not lower inequality, the variance of wage income increased by 7 percent due to the surge of weakly- trained college graduates. As a result, firms substitute more experienced college-trained workers for their less experienced counterparts, leading to falling college

premia for young college graduates. Hence, the college-high school wage gaps of young and older workers have moved in polarizing directions.

In this chapter, I will investigate if the structural change can be associated with rising wage premium for higher education. As mentioned above, the employment structures in China are shifting from labor-intensive industries to knowledge-intensive industries. The increasing labor demand of technology and high-skilled sectors during the globalization favor workers with higher education. Meanwhile, the expansion of college access and lower education quality can also reduce the advantages of college graduates. As suggested by Belskaya, the location of workers does make a difference. I assume the provinces with more universities (more college graduates) but lower concentration in higher-skilled industries will have lower wage premium because of the supply shock. To specify the structural change on income across provinces, I will estimate return to schooling using sectors and provinces as income determinants.

CHAPTER 3. DATA DESCRIPTION

Individual data from Chinese Household Income Project (CHIP 2013 and CHIP 1988) are employed in this chapter to compare the provincial income inequality between 1988 and 2013. This survey contains fourteen provinces in common of two databases. Working individual aged 18-65 are used as samples. The individual employment rate across industry sectors is used to summarize the density of industries in each province. In addition, the annual income and schooling years for each individual are used to estimate the return to schooling. Hence, the provincial average income is computed by the average annual income for each sector and then summarized by the labor share of sectors.

CHAPTER 4. VARIABLES DECOMPOSITION

4.1 Decomposition of Shift Employment Share of Sectors

Table 3 shows the share of labor by industry in 1988, 2002 and 2013. We can see that the good-producing industries decreased substantially from 74% in 1988 to 49% in 2002, then decrease to 44% in 2013. The decline trend mainly caused by the decrease in agricultural sector (from 45% in 1988 to 4% in 2013). Since economic reform, the labor market in China has undergone major structural change. The most significant shift share is the farming to nonfarming transition. Compared to other OECD countries, China has relatively higher deduction in the employment rate in the agriculture sector (China decreased by 20% and the average OECD members decreased by 3% between 1999 and 2013 (Word bank, 2017)).

As opposed to the decline trend of other OECD countries, the employment rate in industry sector in China increased since 1999 and exceed the average OECD level at 2009 then stay stable at 24% after 2010 (Word bank, 2017). From CHIP survey (in Table 3), the construction sector increased by 12%. Since China enter WTO in 2001, the labor share in manufacturing increased from 24% in 1988 to 29% in 2002 but decreased to 22% in 2013 because of the increase in labor cost compared to other Asian countries. During the same time, the labor share of manufacturing in United States decreased slightly from 100 points in 1988 to 92 points in 2002, then decrease sharply to 67 points in 2013 (US bureau of Labor Statistics) as a result of competition from globalization. Manufacturing is an important driver for economic growth in China, and China's exports depends on continued exports of manufacturing products. Most provinces have the manufacturing sector as its major sector.

The decrease in labor share of manufacturing industries can also imply the replacement of human capital by advanced techniques.

The service-providing industries increased sharply from 26% in 1988 to 51% in 2002, then continue to increase to 56% in 2013. Trade, Restaurants & Catering, Materials Supply and Marketing sectors increased from 8% in 1988 to 13% in 2002 and reach 17% in 2013. Personal Service and Counseling Services increased from 1% to 7% in 2002 and reach 10% in 2013. In addition, there are three new industries: IT, computer service and software; Leasing and business services; and Production and Supply of Electricity gas and water, which account for 6% of the labor share. Although it's still far away from other OECD countries, China has higher growth in service sectors (from 26% in 1991 to 45% in 2013 (Word bank, 2017)).

In the United States, the share of middle skilled jobs (manufacturing, operatives-assemblers, secretarial, clerical) decreased by 10% at the same time as the low skilled (local food and personal services) and high skilled jobs (managers, professionals) were increasing during 2002-2014 (Huffman, 2017). If China's structural change follow western country's change pattern, the employment in manufacturing sectors will continue to decrease. High-skilled sectors would replace the low-end jobs, the workers with less skills were most likely get laid off and lost the earning power. The modern information technology and software automation have resulted in computerization of routine tasks and rapid displacement of labor in repetitive production and monitoring tasks. For example, online trading platform could replace the traditional bank teller; online shopping and Virtual Reality could reduce the physical stores and the automation could replace the manufacturing workers. Hence, the low-skilled labor force needed by physical retail trading, residential service and banking sectors

will be declining. Instead, these conventional industries require more high-skilled managerial workers to control the software or information technology. This also implies the difficulty for migrants from less-developed provinces or from rural originally participating in lower-skilled job to move to higher-skilled job in cities. Hence, the workers need to be upskilled to adapt themselves to the new environment.

Next, I will decompose the shift share into two parts:

$$\Delta E = \sum_{j=1}^{J} \Delta E_j = \sum_{j=1}^{J} \theta_j \left(\sum_{p} \Delta E_{j_p} E_p + \sum_{p} E_{j_p} \Delta E_p \right)$$

Where E_p is the proportion of all employment in province p.

E_{j_p} is the proportion of employment in sector j in province p.

E_j is the proportion of employment in sector j in total employment.

θ_j are the proportion of all country employment in sector j, where $\sum_{j=1}^{J} \theta_j = 1$.

The first term (within term) is the change in sector share due to growing share of this sector in employment within provinces, holding relative provincial demand for labor fixed (ie, individual provinces have increased their demand for this sector compared to other provinces, even if they did not change their overall share of the workforce).

The second term (between term) is the change in shares due to changes in employment between provinces, holding the mix of sectors within each province fixed (ie, sector share rises because provinces that hire this sector are growing).

Table 4 displays the shift share results. The changes in share across sectors are mainly due to the within-term changes (decrease by 17%). On average, the weighted average labor share of goods-producing industries decreased by 25% but the service-producing industries increased by 8%. Hence, we can conclude that the structural transition is from primary industry to secondary and tertiary industries.

Bai and Qian (2010) also used the Solow (1958) decomposition method to quantify the two forces driving the movement in the aggregate labor share (of national income) during 1978 and 2007 in China: structural transformation (estimated by value-added share change of each sector, use the income approach) and labor share changes within sectors. They found the two effects are both negative and together drive down aggregate labor share of 5.48 percentage points from 1995 to 2003. They specified that "structural transformation from agriculture to non-agriculture sectors has shown negative impact on aggregate labor share since the mid-1980. Industry takes the major role in the within-sector change effect on aggregate labor share" (*op.cit.*: 651). They also questioned the China's national income accounts as the "NBS counts mixed income of rural household from agriculture as labor compensation" and "overstated the labor share in agriculture". In this chapter, I did not use income approach to weight the sector share and the sector share is calculated by the employment rate across provinces. My results verified that the labor share decrease in agricultural sectors drive down the aggregate labor share. The within-sector change effect dominates the aggregate changes. The employment share transit from agricultural sector to construction and service sectors can explain the aggregate labor change.

4.2 Decomposition of Change in Income across Provinces

The decomposition model displays as follows:

$$\Delta \text{lny} = \sum_{p} \theta_p \, (\Delta lny_p) = \sum_{p} \theta_p \, (\sum_{j} \Delta lny_{p_j} Share_{p_j 1988} + \sum_{j} lny_{p_{j 2013}} \Delta Share_{p_j})$$

Where lny_p is the average income in province p.

lny_{p_j} is the average income in sector j in province p.

$Share_{p_j}$ is the proportion of employment in sector j in province p.

θ_p are the proportion of all country employment in province p, where $\sum_{p=1}^{P} \theta_p = 1$.

The first term (within term) is the change in average income due to raised income level within this sector, holding relative sectoral demand for labor fixed (ie, individual sectors have increased their remuneration for employees compared to other sectors, even if they did not change their overall share of the workforce).

The second term (between term) is the change in average income due to changes in employment shares between sectors, holding the mix of wage within each sector fixed (ie, income rises because sectors that offer higher remuneration are growing).

Table 4 displays the change in average income for the decomposition across provinces between 1988 and 2013. Compared to 1988, the average income grows by 3.06. 89% of the income increase in China are due to the within-term changes. Due to the increased labor productivity and technology improvement after economic reform, the companies are willing to offer higher remunerations. The shift share can also contribute to 11% of the income increase. The employees in Chongqin and Sichuan are more likely to be affected by the sector change. Or we can say the provinces with more farming to nonfarming transition have higher between term effects. From the province perspective, most provinces

have the income growth more than 3. Only Liaoning, Guangdong, Sichuan and Yunnan provinces have income growth less than 3. Among these provinces, Yunnan (2.41) has the lowest income growth and Jiangsu (3.37) has the highest income growth.

4.3 Decomposition of Change in Average Schooling across Provinces

The decomposition model displays as follows:

$$\Delta\text{Edu} = \sum_{p} \theta_p \, (\Delta Edu_p) = \sum_{p} \theta_p \, (\sum_{j} \Delta Edu_{p_j} Share_{p_j 1988} + \sum_{j} Edu_{p_{j2013}} \Delta Share_{p_j})$$

Where Edu_p is the average schooling in province p.

Edu_{p_j} is the average schooling in sector j in province p.

$Share_{p_j}$ is the proportion of employment in sector j in province p.

θ_p are the proportion of all country employment in province p, where $\sum_{p=1}^{P} \theta_p = 1$.

The first term (within term) is the change in average education due to raised requirement for education level within this sector, holding relative sectoral demand for labor fixed (ie, individual sectors have increased their demand for higher educated employees compared to other sectors, even if they did not change their overall share of the workforce).

The second term (between term) is the change in average education due to changes in employment shares between sectors, holding the mix of skills within each sector fixed (ie, education rises because sectors that hire higher educated employees are growing).

Table 5 displays the change in average education for the decomposition across provinces between 1988 and 2013. Compared to 1988, the average education grows by 1.79

years. The within-sector and between sector components are almost equally responsible for the increase in education. The education change in Liaoning, Anhui, Hubei and Hunan are more likely to be affected by the sector shift share. The education change in Beijing, Henan and Gansu are more likely to be affected by the higher skills requirements within sectors. Among these provinces, Shanxi (0.27 years) has the lowest education improvement and Chongqin (4.08 years) has the highest education improvement. However, the average income improved by 3.03 in Shanxi and 3.04 in Chongqin, which means the return to schooling are quite different across provinces.

Table 6 represents the average schooling and lny by sectors. Geological Prospecting, Scientific and Technical Services sector (13.96 years in 2013, 10.52 in 1988) and Finance sectors (13.80 years in 2013, 10.65 in 1988) have the relatively higher average schooling. This is very low education requirement compared to other countries. The samples used to calculate the average education are all adults aged 18-65. During Cultural Revolution (1966-76), the higher education system was almost shut down. Until late 1977, the national higher education entrance examination was officially resumed but less than 1% of Chinese people had attended higher education. From the CHIP 2013 database, the average education level for older workers (aged 50-65) is around two years lower than the young workers (aged 18-35). It's surprised that the average education level only increased by 2 years within almost two generations. From the return to schooling perspective, the sector with highest education level does not imply the highest wage. In addition, the return to schooling is not distributed equally across industries. From table 7, we could roughly estimate the Health, sports and social welfare sector has the highest return to schooling, Transport, communications, post and telecommunications sector has the lowest return to schooling between 1988 and 2013. Hence,

in the following CHAPTER, I will estimate the return to schooling in 1998 and 2013, separately and further investigate the impact of (1) changes in human capital investment (estimated by schooling), (2) changes in return to human capital and (3) changes in densities of each industry sectors (structural change) on income variances.

CHAPTER 5. VARANCE DECOMPOSITION APPROACH

We are interested in monitoring how the changing shares of industry sectors composition contribute to the income inequality. Keng and Orazem (2017) uses the variance decomposition approach to decompose the changing variance of household income into three components: changing group population share, changing within-group income variance, and changing between-group income variance. In this chapter, I am going to use the same method to decompose the changing variance of individual income into three components: changing employment share of each sector, changing within-sector income variance, and changing between-sector income variance. The changing variance is based on two years: (1) 1988: in the beginning period of reform and increased basic education investment, FDI mainly in coastal/SEC area; and (2) 2013: 35 years after the economic reform and surge of high-knowledge/tech intensive industries

The decomposition for the total variance in income σ_Y^2 is given as (suggested by Keng and Orazem, 2017):

$$\sigma_{lnY}^2 = \sum_p \theta_p * \{\sum_{j=1}^k \alpha_{jp}\sigma_{lnY_{jp}}^2 + \sum_{j=1}^k \alpha_{jp}\left(\overline{lnY_{jp}} - \overline{\overline{lnY_p}}\right)^2\}$$

where $\sigma_{lnY_{jp}}^2$ is the within sector *j* variance of individual income in province *p*; α_{jp} is the sector *j* employment share of all labor force in province *p*; $\overline{lnY_{jp}}$ is the mean individual income for sector *j* in province *p*; and $\overline{\overline{lnY_p}}$ is the overall mean individual income in province *p*. The first term shows how much of the variance is due to inequality within sectors while the second term denotes how much of the income variance is due to inequality between

sectors. The country-level variance σ^2_{lnY} is the weighted average using employment proportion as weights: θ_p.

Table 7 reports the average values for the decomposition across provinces in 1988 and 2013. Over twenty-five years, the overall individual income variance increased 4 times. The within-sector components increased more than 5 times and its share in variance jumped from 64% to 91%. However, the between sector component remain at 0.06. Hence, the income variances within the industry sectors is responsible for the increase in individual income variance. For each province, we can also see the remarkable increase in income variance result from within-sector component. In addition, the between sector variance can also explain the increase in individual variance in most provinces except Anhui, Hubei, Hunan and Gansu, where we can observe decreased between sector variances.

To illustrate the role of education effect, return to schooling effect and the sector share change on the increased income variances between 1988 and 2013, we set $\sigma^2_{lnY_p}$ in 1988 as the base case and change one variable each time to separate the three factors. First, we specify a baseline equation for the wage as a function of education, and control for industry sector and province only. Since I emphasis the effect of structural change on income, other control variables will be investigated in the next paper. Province level income can be summarized as the product of share of industry sectors and sector level income.

$$lny_{ipjt} = \beta_{ipjt} * edu_{ipjt} + \gamma_{ipjt} * Sector + \delta_{ipjt} * Province \quad \text{(a)}$$

$$\overline{lny_{pjt}} = \frac{1}{n} * \sum_i lny_{ipjt} \quad \text{(b)}$$

$$\overline{lny_{pt}} = \sum_j \alpha_{pjt} * \overline{lny_{pjt}} \quad \text{(c)}$$

In equation (a), lny_{ipjt} is the log of annual income for individual i, in sector j, year t and province p. edu_{ipjt} is the schooling years completed for individual i and β_{ipjt} is return to schooling. $Sector$ and $Province$ are both dummy variables. In Eq. (c), lny_{pt} is the average income in province p. α_{pjt} is the share of industries j in province p and lny_{pjt} is the average income for n individuals in sector j in province p.

The baseline equations enable us to measure provincial income by estimating three variables: $edu_{ipjt}, \beta_{ipjt}\ and\ \alpha_{pjt}$. We can make variation on one variable use different data after fixing all other variables to get the different results.

Education effect Method: To demonstrate the role of the education effect on the income variance, we start from the actual individual income in 1988 and then construct counterfactual series of income use the individual schooling data from CHIP 2013 database instead of the schooling data in 1988 to estimate the individual income variances. First, estimate the regression coefficients ($\widehat{\beta_{ipj1988}}, \widehat{\gamma_{ipj1988}}$ and $\widehat{\delta_{ipj1988}}$) in equation (a11) using CHIP 1988 individual survey data. Second, apply these coefficients to equation (a12) to estimate $\widehat{lny_{ipj2013}}$ using CHIP 2013 individual schooling data for each individual in 2013. $\overline{\widehat{lny_{pj2013}}}$ could be computed by average $\widehat{lny_{ipj2013}}$ for n individuals in industry sector j in province p (b1). By using the 1988's industry share α_{pj1988} to equation (c1), we can get the estimated average income in province p. (CHIP 2013 has three new industry sectors: IT, computer service and software; Leasing and business services; Production and Supply of Electricity gas and water. Individuals from new industries in 2013 are excluded in computing the average income because we only have return to education $\beta_{ipj1988}$ for the industries existing in 1998.)

$$lny_{ipj1988} = \beta_{ipj1988} * edu_{ipj1988} + \gamma_{ipj1988} * Sector + \delta_{ipj1988} * Province \quad (a11)$$

$$\widehat{lny_{ipj2013}} = \widehat{\beta_{ipj1988}} * edu_{ipj2013} + \widehat{\gamma_{ipj1988}} * Sector + \widehat{\delta_{ipj1988}} * Province \quad (a12)$$

$$\overline{lny_{pj2013}} = \frac{1}{n_{pj2013}} * \sum_i \widehat{lny_{ipj2013}} \quad (b1)$$

$$\overline{lny_p} = \sum_j \alpha_{pj1988} * \overline{lny_{pj2013}} \quad (c1)$$

Return to schooling Method: Similarly, we construct counterfactual series of income using the estimated return to schooling from CHIP 2013 database to estimate the individual income variances. First, estimate the regression coefficients in equation (a21) using CHIP 2013 individual survey data. Second, apply these coefficients to equation (a22) to estimate $\widehat{lny_{ipj2013}}$ using CHIP 1988 individual schooling data for each individual in 1988. Since the share of industries in each province are set to be unchanged, we could average $\widehat{lny_{ipj2013}}$ for n_p individuals in province p to calculate the province level income (equation c2).

$$lny_{ipj2013} = \beta_{ipj2013} * edu_{ipj2013} + \gamma_{ipj2013} * Sector + \delta_{ipj2013} * Province \quad (a21)$$

$$\widehat{lny_{ipj1988}} = \widehat{\beta_{ipj2013}} * edu_{ipj1988} + \widehat{\gamma_{ipj2013}} * Sector + \widehat{\delta_{ipj2013}} * Province \quad (a22)$$

$$\overline{lny_p} = \frac{1}{n_{p1988}} * \sum_i \widehat{lny_{ipj1988}} \quad (c2)$$

Sector share Method: To demonstrate the share change effect, we construct the counterfactual income variance by altering the sector employment share to be α_{jp} in 2013. That is, change α_{pj1988} to be α_{pj2013} in equation (c).

From Table 7, the actual individual income variance has grown by 4 times from 0.16 to 0.64 between 1988 and 2013. From Table 8, the first counterfactual series (Education

effect) suggests that the individual income variance would have decreased to 0.03 if the only factor changed is average schooling. Although all provinces have improved their education investment, the return to education in 1988 is only 0.005. The low return to schooling explains the low volatility of individual income. In addition, the variance of individual education decreased from 16.87 in 1988 to 11.54 in 2013. The increased education investment in less-developed areas can also contribute the lower income variances. From the province perspective, Shandong, Chonqin and Sichuan have higher income variance than 1988. These three provinces have relatively higher education improvement than other provinces. However, the between-sector variation increased because almost all the labor force goes to farming in 1988, which resulted in lower province level income relative to sector level income (higher $\overline{lnY_{jp}} - \overline{\overline{lnY_p}}$). The second counterfactual series (Return to schooling) indicates that the individual income variance would have grown to 0.23 if the only factor changed is return to schooling. The overall return to schooling jumps to 0.071 in 2013. The higher income variances compared to 1988 are mainly due to the higher education variance in 1988 and higher return to schooling in 2013. And the third counterfactual series (Sector share) indicates that the individual income variance would have grown to 1.10 if the only factor changed is the share. Since we are using the sector share in 2013, the provinces with large movements from farming to nonfarming sectors during 1988 to 2013 will have large income variation because they are dominated by between sector variation (for example, Shandong has 88% decrease in agricultural but 5.78 increase in income variance, and Hunan has 87% decrease in agricultural but 3.95 increase in income variance). Hence, from the direction of variance movements we could conclude that the return to schooling and share change are two key reasons for the increased income variance in 2013.

CHAPTER 6. CONCLUSION

In recent decades China has experienced remarkably high and sustained economic growth rate. High growth rate depends on the industrial revolution from farming to nonfarming sectors, improvements in educational attainment and return on schooling. Although the return to schooling increased from 0.005 in 1988 to 0.071 in 2013, the average schooling years only increased by 1.8 years to 9.8 years in 2013. The increase in return to schooling can be explained by the economic transformation from labor intensive sectors to knowledge intensive sectors and rapid economic growth. Although the nine-year compulsory schooling policy improved the average schooling, the low requirement only eliminate illiteracy and far away from the quality-oriented education. If the increase in education investment could be matched with the increase in return to schooling, the income growth would be faster.

From the individual level perspective, the income inequality is widening since the economic transition in what was already considered to be one of the most unequal economies in the world. The individual level income variance increased from 0.16 in 1988 to 0.64 in 2013. The inequality decomposition suggests that it is mainly attribute to the within-sector income gap. In addition, I am trying to use three effects: schooling, return to schooling and employment share change to explain the inequality. From the movement of the variance, we found that the increased return to schooling and shift share from agricultural sectors to other sectors can mainly contribute to the increase in inequality.

Table 1. Education investment by provinces

	2010			2000		
Province	<9 years	10-12 years	>12 years	<9 years	10-12 years	>12 years
Liaoning	72%	16%	12%	80%	13%	7%
Jilin	72%	18%	10%	79%	16%	5%
Heilongjiang	75%	15%	10%	80%	15%	5%
Beijing	45%	22%	33%	58%	24%	18%
Tianjin	60%	22%	18%	69%	22%	9%
Hebei	78%	14%	8%	86%	11%	3%
Shandong	76%	15%	9%	85%	11%	4%
Shanghai	55%	22%	23%	65%	24%	11%
Jiangsu	71%	18%	11%	82%	14%	4%
Zhejiang	76%	14%	10%	85%	12%	3%
Fujian	76%	15%	9%	86%	11%	3%
Guangdong	72%	19%	9%	82%	14%	4%
Hainan	75%	17%	8%	83%	14%	3%
Shanxi	74%	17%	9%	84%	12%	4%
Inner Mongolia	73%	16%	11%	81%	15%	4%
Henan	78%	15%	7%	86%	11%	3%
Shaanxi	72%	17%	11%	82%	13%	5%
Anhui	81%	12%	7%	89%	9%	2%
Jiangxi	79%	13%	8%	86%	11%	3%
Hubei	72%	18%	10%	83%	13%	4%
Hunan	75%	17%	8%	85%	12%	3%
Guangxi	81%	12%	7%	87%	10%	3%
Chongqin	77%	14%	9%	88%	9%	3%
Sichuan	81%	12%	7%	89%	8%	3%
Guizhou	86%	8%	6%	91%	7%	2%
Yunnan	85%	9%	6%	90%	8%	2%
Tibet	89%	5%	6%	95%	4%	1%
Gansu	78%	14%	8%	86%	11%	3%

Table 1. Education investment by provinces continued

Qinghai	79%	12%	9%	85%	11%	4%
Ningxia	76%	14%	10%	84%	12%	4%
Xinjiang	76%	12%	12%	81%	13%	6%
Average	75%	15%	10%	83%	13%	4%
Northeast	73%	16%	11%	80%	14%	6%
North coast	65%	18%	17%	74%	18%	8%
East coast	68%	17%	15%	77%	17%	6%
South Coast	75%	16%	9%	83%	13%	4%
Huanghe middle	74%	16%	10%	83%	13%	4%
Changjiang middle	77%	15%	8%	86%	11%	3%
Southwest	82%	11%	7%	89%	8%	3%
Northwest	80%	11%	9%	86%	10%	4%

* Data is from 2010 and 2000 China Population Census.

Table 2. Schooling years by industries:

		schooling years for aged 25-35 in 2013			1988
	Sectors	urban	Rural	urban-rural	All individuals
Goods-Producing Industries	Agriculture, Forestry, Animal Husbandry, Fishing	11.7	9	2.7	5.8
	Construction	12.9	9.1	3.9	8.7
	Manufacturing	12.4	9.5	3	9.3
	Mining	11.9	9.6	2.3	10
Service-Providing Industries	Trade, Restaurants & Catering, Materials Supply and Marketing	12	9.9	2.1	9.4
	Personal Services and Counseling Services	11.8	9.5	2.3	8.6
	Education, Culture, and Art	15	13	1.9	12
	Party, Government, or Social Organs	14.5	11.8	2.6	11.2
	Finance, Insurance	15	13.3	1.7	11.4
	Real Estate and Public Utilities	13.7	12.3	1.4	10
	Health, Sports, and Social Welfare	14.8	11.7	3.1	11.9
	Transport, Communications, Post and Telecommunications	12.4	9.7	2.7	9.6
	Geological Prospecting, Scientific and Technical Services	15.9	13.2	2.7	12.8
	IT, computer service and software	14.3	12.3	1.9	
	Leasing and business services	12.2	10.1	2.2	
	Production and Supply of Electricity gas and water	14	10	3.9	
	China	13.2	9.9	3.3	8.2

Table 3. Share of labor by industry, 1988, 2002 and 2013

	Sectors	2013	2002	1988
Goods-Producing Industries	Agriculture, Forestry, Animal Husbandry, Fishing	4%	7%	45%
	Construction	15%	11%	3%
	Manufacturing	22%	29%	24%
	Mining	3%	2%	2%
	Sum	44%	49%	74%
Service-Providing Industries	Trade, Restaurants & Catering, Materials Supply and Marketing	17%	13%	8%
	Personal Services and Counseling Services	10%	7%	1%
	Education, Culture, and Art	5%	6%	4%
	Party, Government, or Social Organs	6%	8%	5%
	Finance, Insurance	1%	2%	1%
	Real Estate and Public Utilities	2%	1%	1%
	Health, Sports, and Social Welfare	3%	3%	2%
	Transport, Communications, Post and Telecommunications	7%	7%	4%
	Geological Prospecting, Scientific and Technical Services	0%	1%	2%
	IT, computer service and software	2%	0%	0%
	Leasing and business services	2%	0%	0%
	Production and Supply of Electricity gas and water	2%	2%	0%
	Sum	56%	51%	26%

Table 4. Decomposition of the shift share between 1988 and 2013

		Within	Between	Sum
	Sectors	$\sum_p \Delta E_{j_p} E_p$	$\sum_p E_{j_p} \Delta E_p$	ΔE_j
Goods-Producing Industries	Agriculture, Forestry, Animal Husbandry, Fishing	-41%	0%	-41%
	Construction	12%	0%	12%
	Manufacturing	-2%	-1%	-3%
	Mining	1%	0%	1%
	Average	-25%	0%	-25%
Service-Providing Industries	Trade, Restaurants & Catering, Materials Supply and Marketing	9%	0%	9%
	Personal Services and Counseling Services	9%	0%	9%
	Transport, Communications, Post and Telecommunications	3%	0%	3%
	IT, computer service and software	2%	0%	2%
	Leasing and business services	2%	0%	2%
	Production and Supply of Electricity gas and water	2%	0%	2%
	Others*	4%	0%	4%
	Average	8%	0%	8%
	China	-17%	0%	-17%

*Others include Finance, Insurance, Real Estate and Public Utilities, Health, Sports, and Social Welfare, Geological Prospecting, Scientific and Technical Services, Education, Culture, and Art, Party, Government, or Social Organs sectors. These sectors have very small (~1%) shift share change.

Table 5. Decomposition of the lny change between 1988 and 2013 (Percentage are in parenthesis):

	Within	Between	Sum
Province	$\sum_j \Delta lny_{p_j} Share_{p_j 1988}$	$\sum_j lny_{p_{j2013}} \Delta Share_{p_j}$	Δlny_p
Beijing	3.27 (99%)	0.04 (1%)	3.31
Shanxi	2.91 (96%)	0.13 (4%)	3.03
Liaoning	2.65 (90%)	0.29 (10%)	2.93
Jiangsu	3.19 (95%)	0.18 (5%)	3.37
Anhui	3.01 (93%)	0.22 (7%)	3.22
Shandong	2.64 (84%)	0.49 (16%)	3.13
Henan	2.85 (94%)	0.19 (6%)	3.03
Hubei	2.85 (88%)	0.38 (12%)	3.23
Hunan	2.58 (83%)	0.54 (17%)	3.13
Guangdong	2.69 (96%)	0.12 (4%)	2.81
Chongqin	1.97 (65%)	1.07 (35%)	3.04
Sichuan	1.97 (70%)	0.85 (30%)	2.82
Yunnan	2.21 (92%)	0.19 (8%)	2.41
Gansu	3.08 (93%)	0.24 (7%)	3.33
China	2.73 (89%)	0.33 (11%)	3.06

Table 6. Decomposition of the schooling change between 1988 and 2013 (Percentage are in parenthesis):

	Within	Between	Sum
Provinces	$\sum_j \Delta Edu_{p_j} Share_{p_j 1988}$	$\sum_j Edu_{p_{j2013}} \Delta Share_{p_j}$	ΔEdu_p
Beijing	1.67 (89%)	0.20 (11%)	1.87
Shanxi	0.14 (51%)	0.13 (49%)	0.27
Liaoning	0.07 (12%)	0.47 (88%)	0.54
Jiangsu	0.50 (35%)	0.91 (65%)	1.41
Anhui	-0.02 (-2%)	0.86 (102%)	0.84
Shandong	2.23 (62%)	1.36 (38%)	3.59
Henan	0.91 (71%)	0.36 (29%)	1.27
Hubei	0.14 (13%)	0.90 (87%)	1.04
Hunan	0.88 (27%)	2.37 (73%)	3.25
Guangdong	0.32 (32%)	0.66 (68%)	0.98
Chongqin	1.66 (41%)	2.42 (59%)	4.08
Sichuan	1.73 (53%)	1.50 (47%)	3.23
Yunnan	1.06 (66%)	0.54 (34%)	1.60
Gansu	1.28 (78%)	0.36 (22%)	1.64
China	0.86 (48%)	0.93 (52%)	1.79

Table 7. Average schooling and lny by sectors in 1988 and 2013 (Percentage change are in parenthesis):

		2013		1988		Change	
	Sectors	Schooling	lny	Schooling	lny	Schooling	lny
Goods-Producing Industries	Agriculture, Forestry, Animal Husbandry, Fishing	7.46	9.33	5.75	6.93	1.70 (30%)	2.40 (35%)
	Construction	8.05	9.96	8.91	7.18	-0.85 (-10%)	2.77 (39%)
	Manufacturing	9.42	10.12	9.63	7.08	-0.21 (-2%)	3.04 (43%)
	Mining	9.15	10.21	9.53	7.12	-0.38 (-4%)	3.09 (43%)
	Average	8.76	10.00	7.24	6.99	1.52	3.01
Service-Providing Industries	Trade, Restaurants & Catering, Materials Supply and Marketing	9.4	10	9.74	7.09	-0.34 (-3%)	2.91 (41%)
	Personal Services and Counseling Services	9.29	9.89	8.08	7.05	1.21 (15%)	2.83 (40%)
	Education, Culture, and Art	13.25	10.33	12.42	7.17	0.83 (7%)	3.16 (44%)
	Party, Government, or Social Organs	12.41	10.2	11.59	7.17	0.81 (7%)	3.03 (42%)
	Finance, Insurance	13.8	10.65	11.69	7.04	2.10 (18%)	3.60 (51%)
	Real Estate and Public Utilities	11.37	10.26	10.12	7.03	1.25 (12%)	3.23 (46%)
	Health, Sports, and Social Welfare	12.31	10.15	11.85	7.17	0.46 (4%)	2.99 (42%)
	Transport, Communications, Post and Telecommunications	9.62	10.28	9.8	7.24	-0.19 (-2%)	3.03 (42%)
	Geological Prospecting, Scientific and Technical Services	13.96	10.52	12.39	7.18	1.58 (13%)	3.33 (46%)
	IT, computer service and software	13.16	10.42				
	Leasing and business services	10.54	10.1				
	Production and Supply of Electricity gas and water	10.69	10.25				
	Average	10.58	10.21	10.83	7.14	-0.25	2.98
	China	9.81	10.07	8.24	7.01	1.57	3.06
	Variance	11.54	0.64	16.87	0.16		

Table 8. Decomposition of the Individual lny Variance: 1988 and 2013 (Percentage are in parenthesis):

	Within		Between		Total	
	$\sum_{j=1}^{k} \alpha_{jp} \sigma^2_{lnY_{jp}}$		$\sum_{j=1}^{k} \alpha_{jp} (\overline{lnY_{jp}} - \overline{\overline{lnY_p}})^2$		$\sigma^2_{lnY_p}$	
Province	1988	2013	1988	2013	1988	2013
Beijing	0.15 (98%)	0.51 (84%)	0.00 (2%)	0.10 (16%)	0.16	0.61
Shanxi	0.15 (84%)	0.68 (89%)	0.03 (16%)	0.08 (11%)	0.18	0.76
Liaoning	0.13 (91%)	0.65 (90%)	0.01 (9%)	0.07 (10%)	0.14	0.72
Jiangsu	0.14 (83%)	0.46 (94%)	0.03 (17%)	0.03 (6%)	0.16	0.49
Anhui	0.10 (57%)	0.57 (93%)	0.08 (43%)	0.04 (7%)	0.18	0.61
Shandong	0.01 (53%)	0.58 (94%)	0.01 (47%)	0.04 (6%)	0.02	0.61
Henan	0.10 (82%)	0.61 (96%)	0.02 (18%)	0.03 (4%)	0.12	0.64
Hubei	0.08 (43%)	0.56 (89%)	0.10 (57%)	0.07 (11%)	0.18	0.63
Hunan	0.03 (29%)	0.65 (95%)	0.07 (71%)	0.03 (5%)	0.09	0.68
Guangdong	0.20 (97%)	0.48 (94%)	0.01 (3%)	0.03 (6%)	0.20	0.51
Chongqin	0.01 (27%)	0.49 (88%)	0.02 (73%)	0.07 (12%)	0.03	0.56
Sichuan	0.01 (27%)	0.69 (92%)	0.02 (73%)	0.06 (8%)	0.03	0.75
Yunnan	0.09 (56%)	0.74 (87%)	0.07 (44%)	0.11 (13%)	0.15	0.85
Gansu	0.14 (28%)	0.58 (87%)	0.37 (72%)	0.09 (13%)	0.51	0.67
China	0.11 (64%)	0.58 (91%)	0.06 (36%)	0.06 (9%)	0.16	0.64

Table 9. Counterfactual Individual lny Variance decomposition across provinces (Percentage are in parenthesis):

	Education effect: $\sigma^2_{lnY_p}$			Return to schooling: $\sigma^2_{lnY_p}$			Sector share: $\sigma^2_{lnY_p}$		
Province	Within	Between	Sum	Within	Between	Sum	Within	Between	Sum
Beijing	0.00 (2%)	0.01 (98%)	0.01	0.04 (26%)	0.11 (74%)	0.15	0.16 (97%)	0.39 (3%)	0.16
Shanxi	0.00 (1%)	0.02 (99%)	0.02	0.04 (21%)	0.15 (79%)	0.19	0.20 (88%)	0.03 (12%)	0.22
Liaoning	0.00 (1%)	0.01 (99%)	0.01	0.03 (18%)	0.14 (82%)	0.17	0.15 (6%)	2.54 (94%)	2.70
Jiangsu	0.00 (1%)	0.02 (99%)	0.02	0.05 (23%)	0.19 (77%)	0.24	0.17 (92%)	0.01 (8%)	0.18
Anhui	0.00 (1%)	0.03 (99%)	0.03	0.06 (20%)	0.25 (80%)	0.31	0.16 (67%)	0.08 (33%)	0.24
Shandong	0.00 (1%)	0.05 (99%)	0.05	0.08 (65%)	0.04 (35%)	0.12	0.04 (1%)	5.74 (99%)	5.78
Henan	0.00 (1%)	0.03 (99%)	0.03	0.06 (21%)	0.22 (79%)	0.28	0.18 (86%)	0.03 (14%)	0.21
Hubei	0.00 (1%)	0.03 (99%)	0.03	0.05 (19%)	0.21 (81%)	0.26	0.09 (59%)	0.07 (41%)	0.16
Hunan	0.00 (1%)	0.05 (99%)	0.05	0.06 (56%)	0.04 (44%)	0.10	0.15 (4%)	3.80 (96%)	3.95
Guangdong	0.00 (1%)	0.02 (99%)	0.02	0.05 (22%)	0.17 (78%)	0.21	0.23 (98%)	0.00 (2%)	0.24
Chongqin	0.00 (1%)	0.05 (99%)	0.06	0.06 (60%)	0.04 (40%)	0.10	0.03 (1%)	3.56 (99%)	3.59
Sichuan	0.00 (1%)	0.05 (99%)	0.05	0.06 (60%)	0.04 (40%)	0.10	0.03 (1%)	3.56 (99%)	3.59
Yunnan	0.00 (1%)	0.02 (99%)	0.02	0.06 (20%)	0.23 (80%)	0.29	0.16 (72%)	0.06 (28%)	0.22
Gansu	0.00 (1%)	0.03 (99%)	0.03	0.06 (19%)	0.27 (81%)	0.33	0.19 (43%)	0.24 (57%)	0.43
China	0.00 (1%)	0.03 (99%)	0.03	0.05 (24%)	0.17 (76%)	0.23	0.15 (14%)	0.95 (86%)	1.10

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