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More unequal yet more alike, the changing patterns of family formation, generational mobility and household income inequality in China: a counter-factual analysis

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Abstract

China's household income inequality has grown steadily over the last 30 years. While many analyses focus on the effects of policies relating to urban-rural and inland-coastal distinctions, growth in inequality has prevailed on both sides of those respective divides suggesting something more fundamental is at play. Here, certain patterns of family formation and human capital transfer are shown to engender increases in household income inequality measures. A unique data set, linking grandparents, parents and children, yields evidence of structural change toward such patterns over successive cohorts of households. Influenced by such events as the Cultural Revolution, the One Child Policy and the Economic Reforms, people intensified positive assortative matching behaviors and polarizing human capital transitions. Social class designations became less important and educational class designations became more important. A counterfactual analysis verified the impact of these changes on household income inequality in urban China, revealing increasing similarity between cohorts amidst growing inequality.

Keywords Inequality · Intergenerational mobility · Education · Social classes

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1 Introduction

China's rapid economic growth since the early 80's has been attended by an equally strident increase in inequality. National Gini coefficients below 0.3 in the early 1980's rose to values above 0.5 in 2010 (Xie and Zhou 2014), Fig. 1 highlights the World Banks Chinese Gini coefficient. The rise has been persistent but uneven across many divides, Li (2012) reports rural (urban) Gini's of 0.24 (0.15) and 0.37 (0.34) in 1981 and 2011 respectively. Rural-urban disparities account for the National Gini being higher than its urban and rural counterparts, indeed they account for most of China's inequality (Yang 1999). Consequently, changes in divide disparities in social and economic structure and policy treatment have been sought as sources of increased inequality (Rozelle 1994; Yang 1999; Kanbur and Zhang 1999; Gustafsson and Shi 2002; Meng et al. 2005; Wu and Perloff 2005; Hertel and Zhai 2006; Chen and Zhou 2007; Ravallion and Chen 2007; Benjamin et al. 2008; Deng et al. 2013; Cheng and Wu 2017). However, although urban inequality is lower than rural, there is good reason to focus on the urban situation. Its trend is steeper (Ravallion and Chen 2007), furthermore, extensive urbanization over the last 3 decades has increased the "urban" component weight substantially.[1] Increased returns to education and shifts in occupations have been cited as sources of increased urban inequality (Meng 2004; Wan 2004; Zhang et al. 2005; Goh et al. 2009; Zhong 2011; Meng et al. 2013). Here, roots founded in fundamental structural changes in the nature of the family are explored.

Several epochs in China's post Second World War history have had profound effects on the nature and attributes of families, the way they were formed, their procreation and generational transmission patterns and ultimately their income generation capability. In the aftermath of the Communist Revolution, families were socially classified which influenced their income generating capability. Later the Cultural Revolution saw changes in the circumstances of those who were previously privileged, limiting educational opportunities. Later still, the One Child Policy affected the nature of the family, limiting size and changing the pattern of partner choice. Soon after the Economic Reforms opened up opportunities for those segments of society well placed to take advantage. These events can be seen to have had differential effects on households of different vintages, with each vintage household income distribution, reflecting of the fashions and constraints of its formation epoch, having an inherently different structure and inequality level. At a given point in time the overall household income distribution will be a mixture of the distributions of different vintages. Had there been no vicissitude in such fashions and constraints, this overall income distribution, and its structural inequality, could look very different from what it turned out to be.

A rich data set of urban Chinese households linking grandparents, parents and children, the 2002 Chinese Household Income Project (Li et al. 2008), is employed to explore structural changes in family formation and its intergenerational transmission processes as drivers of change in urban inequality over family cohorts. Using the head of households age to determine household vintage, a counterfactual analysis of cohort vintage effects is employed in a subgroup decomposition of the Gini coefficient in Urban China. Paralleling similar work on US data (Chiappori et al. 2017), the results indicate sources of increased urban inequality as increased dependency of household incomes on household human capital

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[1]The 1981 urban population accounted for roughly 20% of 1.001 billion Chinese, by 2011, it had risen to 51% of 1.347 billion.
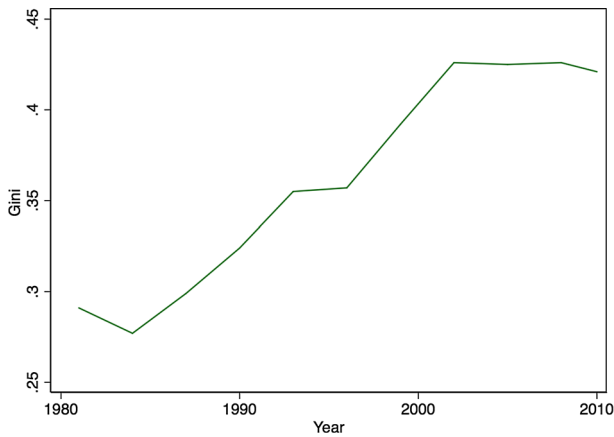
Fig. 1 Gini Coefficient of China

and diminished dependency on social class. Increased positive assortative partner matching in the Post Cultural Revolution Era increased the disparity in household incomes and aggregated human capital stocks. This in turn increased variation in the parental circumstances of children whose educational outcomes were themselves highly dependent upon such circumstances. Paradoxically, this made successive cohort income distributions more alike in the face of growing inequality. Thus, while household cohort income distributions were converging, the overall household income distribution, of which they are the exhaustive components, were diverging, illustrating the idea that polarization and inequality are conceptually independent and can move in opposite directions.

On a note of caution, observe that the regime changes, the Cultural Revolution, The One Child Policy and the Economic Reforms, took place rather abruptly and were in place for a limited amount of time in the grand scheme of things. Since social institutions like marriage patterns and intergenerational transfers respond fairly slowly to stimuli, it is unlikely that measured levels could be considered long run equilibrium responses. However considerable structural change in patterns was in evidence in the data. Section 2 provides an historical context for considering the effects of changing partner assortative matching and intergenerational transition patterns on household income generation and inequality. Algebraic relationships between these changing patterns and their effects on the Gini coefficient, together with some tools for measuring the extent of such changes and a decomposition of the Gini coefficient suitable for the purpose at hand, are developed in Section 3. Section 4 examines the empirical existence of such changes and, after examining some empirical models of household size, household income and husband-wife educational relationships, Section 5 explores their impact on the Gini coefficient counterfactually. Conclusions are drawn in Section 6.

2 Background

The 1949 agrarian revolution in China saw the founding of a "new" social class system. In a society that was primarily agrarian, as much as half of the farmland was seized from landlords and redistributed to the formerly landless peasants (Walder and Hu 2009; Clark 2014). In this early stage of the revolution the entire population (the "grandparents" in this

study) was formally classified into 12 ordered social classes according to family employment status, income sources and political loyalties at the time. The classes ranged from landless peasants through landlord classes to the aristocracy of the revolution, the revolutionary "fighters". An entire household was assigned a class label which would be inherited through the male line and remained with the offspring regardless of their political stance or behavior and became a primary criterion in their job search/promotion opportunities.

Later, the Cultural Revolution 1966-76 (the educational period of many parents in this study) saw changes in the way human capital was generationally augmented within the family. An attempt at eliminating "the distinction between town and country, industry and agriculture, physical and mental labor", saw mass school closures in urban areas (Deng and Treiman 1997; Meng and Gregory 2002) and a purge of intellectual "elites". The policies were designed to curtail the generational transmission of social status and educational advantage by social and educational elites, in essence an equal opportunity policy that levels down. Academics were ostracized and all levels of schools were closed (However, Meng and Gregory 2002 suggest that the largest negative impact was faced by children from lower educational achievement and lower social class families). When higher education institutions reopened after 1972, children from formerly lower social designations were given preference over those from higher social designations in educational and occupational opportunities. Higher education institutions did not resume recruiting based on merit until the Cultural Revolution ended (Clark 2014).

The loss of schooling effects of the Cultural Revolution may be seen in the average number of years of schooling and average level of schooling profiles experienced by the birth cohorts who would have been educated in the period of the Cultural Revolution. Essentially the cohort born between 1948-1955 possibly missed senior high school due to the Cultural Revolution and the cohort born between 1956-1963 who missed part of primary school and junior high school or experienced a lower quality of school in the Cultural Revolution. From Fig. 2, the effects may be seen to have predominantly impinged upon educational growth trends in males, the growth trends in education for both genders diminished but for males it became negative over the 1945-1952 period so the male-female education gap was narrowed significantly. Over the same time period variations in educational attainment levels
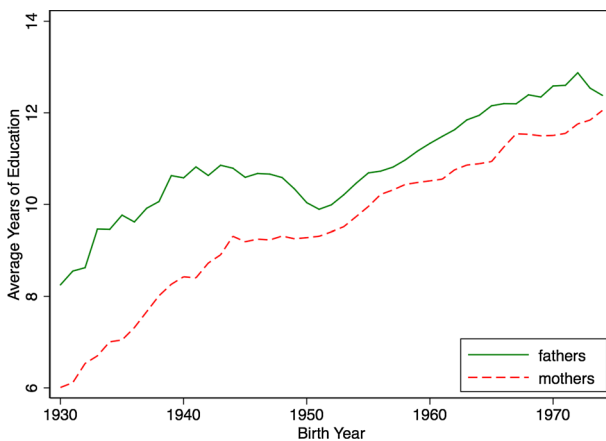

Fig. 2 Average Years of Education by Birth Year

and education years across both genders diminished greatly, a consequence of the Cultural Revolution, it represents an equalization of circumstances for future generations.

1980 onwards saw the profound growth spurt precipitated by the Economic Reforms, which increased investment in child education, especially children born to parents who suffered the effects of the cultural revolution (Anderson and Leo 2009). It also saw the effects of the One Child Policy which changed the way people chose partners. With procreation, child rearing and family income production each being part of household production, under a regime which constrains one or more of them (procreation and child rearing) relative to other outputs, potential partners with specialized procreation and child rearing skills become less attractive relative to partners with specialized income generating skills. Theoretically and empirically this resulted in an increase in the extent to which people chose partners similar to themselves in income generating dimensions relative to choosing partners on the basis of other dimensions such as social class (Becker 1981; Anderson and Leo 2013).

3 Relationships between Income inequality, family formation and human capital transmission

To understand the impact on inequality of paradigm shifts in marital matching and intergenerational transition behaviors that took place across cohorts, algebraic connections between matching intensity, generational dependencies and the Gini coefficient are outlined together with tools for measuring such intensities and dependencies and a decomposition of the Gini coefficient that will illuminate the between cohort effects.

3.1 Family formation

When partners choose each other on the basis of similarity of their respective characteristics (for example pairing on the basis of similarity of education levels or social class) it is said to be a positive assortative match (see for example Chiappori et al. 2017, Choo and Siow 2006). It can be shown that Intensified positive assortative marital matching on any characteristic that is aggregative for the household and positively related to income, increases the household income Gini coefficient.

Increased (rank) correlation of spousal characteristics is frequently used to identify intensified assortative matching on a discrete (continuous) measure. To demonstrate that increased spousal correlation increases the Gini, a simple mean preserving correlation increasing partner swap is contrived and shown to increase the Gini coefficient of household income. Let z be the ordered vector of husbands incomes (education levels) and y be the associated wives incomes (education levels) so that the vector of household incomes (education levels) $x = z + y$. Let r_z and r_y be the vectors of corresponding ranks of z and y. Letting μ_w denote $E(w)$, note that $\mu_x = \mu_z + \mu_y$. Letting subscripts of income and education variables correspond to elements of the referenced vector, suppose the element $x_m = z_m + y_m$ i.e. the husband in the m'th household has the average husbands' income and, for convenience suppose $z_{m-1} < z_m < z_{m+1}$ so that $r_{zm+1} = r_{zm-1} + 2$ (where r_{zm} corresponds to the m'th element of the rank vector of z), and suppose further $y_{m-1} = y_{m+1} + \delta$ with $\delta > 0$ so that $r_{ym-1} = r_{ym+1} + K$ where K is an integer greater than 1. In essence assume spousal rankings are negatively correlated around the m'th observation. When husbands and wives in the $m-1$ and $m+1$ observations swap spouses, there will be increased positive assortative matching in terms of increased positive association in the correlation for continuously measured characteristics and rank correlation for discretely measured characteristics of

husbands and wives. Consider RN, the numerator of correlation coefficient before and RN^*, the numerator of the correlation coefficient after the swap;[2]

$$RN = \sum_{i=1}^{n}(z_i - \mu_z)y_i \text{ and}$$

$$RN^* = \sum_{i=1}^{n}(z_i - \mu_z)y_i - (z_{m+1} - \mu_z)y_{m+1} - (z_{m-1} - \mu_z)y_{m-1}$$
$$+ (z_{m+1} - \mu_z)y_{m-1} + (z_{m-1} - \mu_z)y_{m+1}$$
$$= RN + \delta\{(z_{m+1} - \mu_z) - (z_{m-1} - \mu_z)\}$$
$$\text{where} \delta\{(z_{m+1} - \mu_z) - (Z_{m-1} - \mu_z)\} > 0$$

For discretely measured characteristic assume for simplicity there are no ties in either husbands or wives' characteristics and consider Spearman's Rank Coefficient SR before (SR) and after (SR^*) the swap.

We know that

$$SR = 1 - \left(\frac{6\sum_{i=1}^{n}(r_{zi} - r_{yi})^2}{n(n^2 - 1)}\right).$$

Note that

$$SR^* - SR = \frac{6}{n(n^2 - 1)} \times \left((r_{zm+1} - r_{ym+1})^2 + (r_{zm-1} - r_{ym-1})^2\right.$$
$$\left. - (r_{zm+1} - r_{ym-1})^2 - (r_{zm-1} - r_{ym+1})^2\right),$$

where $(r_{zm+1} - r_{zm-1}) = 2$ and $(r_{ym-1} - r_{ym+1}) = K \geq 1$.

The above equation then yields:

$$SR^* - SR = \frac{6}{n(n^2 - 1)} \times 4K > 0$$

For convenience write $GINI$ (before) and $GINI^*$ (after the swap) then the effect on household inequality in terms of the GINI may be seen as follows:

$$GINI = \frac{1}{\mu n^2}\sum_{i=1}^{n}\sum_{j=1}^{n}|x_i - x_j| = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{n}\sum_{j=1}^{n}\frac{|x_i - x_j|}{\mu}$$
$$= \frac{1}{n}\sum_{i=1}^{n}\frac{1}{n}\frac{|nx_i - \sum_{j=1}^{n}x_j|}{\mu} = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{x_i}{\mu} - 1\right|. \tag{1}$$

Note that:

$$GINI^* - GINI = \left|\frac{x_{m-1}^*}{\mu} - 1\right| + \left|\frac{x_{m+1}^*}{\mu} - 1\right| - \left|\frac{x_{m-1}}{\mu} - 1\right| - \left|\frac{x_{m+1}}{\mu} - 1\right|$$
$$= \left|\frac{x_{m-1} - \delta}{\mu} - 1\right| + \left|\frac{x_{m+1} + \delta}{\mu} - 1\right| - \left|\frac{x_{m-1}}{\mu} - 1\right| - \left|\frac{x_{m+1}}{\mu} - 1\right|$$
$$= \frac{2\delta}{\mu} > 0$$

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[2] $RN = \sum_{i=1}^{n}(z_i - \mu_z)(y_i - \mu_y) = \sum_{i=1}^{n}(z_i - \mu_z)y_i - (\sum_{i=1}^{n}(z_i - \mu_z)) \times \mu_y = \sum_{i=1}^{n}(z_i - \mu_z)y_i$ because $(\sum_{i=1}^{n}(z_i - \mu_z)) \times \mu_y = 0$.

Table 1 Transition Types

Polarizing Transition	Converging Transition	Upward Transition	Static dependent (Imobile) Transition	Static independent (Mobile) transition
$\begin{bmatrix} 1 & 0.3 & 0 \\ 0 & 0.4 & 0 \\ 0 & 0.3 & 1 \end{bmatrix}$	$\begin{bmatrix} 0.5 & 0 & 0 \\ 0.5 & 1 & 0.5 \\ 0 & 0 & 0.5 \end{bmatrix}$	$\begin{bmatrix} 0.5 & 0 & 0 \\ 0.3 & 0.5 & 0 \\ 0.2 & 0.5 & 1 \end{bmatrix}$	$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$	$\begin{bmatrix} 1/3 & 1/3 & 1/3 \\ 1/3 & 1/3 & 1/3 \\ 1/3 & 1/3 & 1/3 \end{bmatrix}$

Since $\frac{x_{m+1}}{\mu} > 1$ and $\frac{x_{m-1}}{\mu} < 1$.

Essentially intensified positive assortative matching on any variate that is positively associated with income will increase household income inequality.

3.2 Human capital transmission

With regard to the passing on of human capital, generational transition matrices may be construed as blueprints of the way in which human capital qualities are passed on through generations. When a society statically replicates itself, the Generational Transition matrix is said to be stationary (examples are the identity matrix or the perfect equality of opportunity matrix) and successive generations distributions will be identical. Transition matrices that change the anatomy of the arrival (inheritors) distribution from that of the departure (parents) distribution by moving inheritors into new positions relative to their ancestor's position in the departure distribution are not static matrices. Anderson (2018) characterized such transition matrices as polarizing or converging, when respectively the net transfer of mass is from the center of the departure distribution to the peripheries of the arrival distribution, or from the peripheries of the departure to the center of the arrival distribution. Based upon functions of cell values and initial class sizes, the paper provides indexes on [0,1], measuring the extent to which a given transition matrix exhibits polarizing, converging, upward or downward transitional properties.[3] Table 1 exemplifies matrices with such typologies. When incomes have a monotonic non-decreasing dependency upon human capital qualities, polarizing transitions can be seen to make future generations' outcomes more unequal and converging transition matrices can be seen to be making future generations' outcomes more equal, static transition matrices result in no change in the attainment distribution over time.

Explicit analysis of the effects of such transfers on inequality is facilitated by considering a rearrangement of the Gini coefficient interpreted as the average over all agents of a "relative to the mean" distance measure of each agent from all other agents. For grouped data, where π_i is the proportion of the population receiving income X_i, $i = 1, ..., K$, note the group GINI is written as:

$$GINI = \frac{1}{\mu} \sum_{i=1}^{n} \sum_{j=1}^{n} \pi_i \pi_j |X_i - X_j| = \sum_{i=1}^{n} \pi_i \sum_{j=1}^{n} \pi_j \left(\frac{|X_i - X_j|}{\mu} \right)$$

$$= \sum_{i=1}^{n} \pi_i \frac{\left| \sum_{j=1}^{n} \pi_j X_i - X_m \right|}{\mu} = \sum_{i=1}^{n} \pi_i \left| \frac{X_i}{\mu} - 1 \right|. \tag{2}$$

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[3]Detailed calculation is presented in Electronic Supplemental Material Section C.

Now consider the effect on these formulations of the Gini coefficients in the context of generational transition matrices with respect to educational attainments or income which are polarizing. It can be shown that any net transfer of mass from the center to the peripheries of a distribution will increase its Gini coefficient.

In terms of the grouped Gini for convenience suppose that n is odd and that μ is the mean of the distribution where $m = (n + 1)/2$, thus $X_m = \mu$. Let's consider a shift of mass such that $\pi_m^* = \pi_m - \delta_{k1} - \delta_{k2}$, $\pi_{m+k1}^* = \pi_{m+k1} + \delta_{k1}$ and $\pi_{m-k2}^* = \pi_{m-k2} + \delta_{k2}$ for all δ_{k1}, δ_{k2} positive. Letting GINI* and GINI be the respective grouped Gini coefficients after and before the transfer, then from Eq. 2

$$GINI^* - GINI = \sum_{i=m-k2}^{m+k1} (\pi_i^* - \pi_i) \left| \frac{X_i}{\mu} - 1 \right|$$
$$= \delta_{k2} \left| \frac{X_{m-k2}}{\mu} - 1 \right| + \delta_{k1} \left| \frac{X_{m+k1}}{\mu} - 1 \right| > 0$$

In effect the resultant income or educational attainment distributions become more unequal.

3.3 Gini decomposition

The separate contributions of the cohorts to overall inequality will be examined via a cohort decomposition of the Gini coefficient. Following Mookherjee and Shorrocks (1982) and Anderson and Thomas (2017), when a population (with overall mean income μ) is composed of subgroups indexed $k = 1, ..., K$, with means μ_k, Ginis G_k, and population proportions w_k, the decomposition may be written as follows:

$$GINI = \sum_{k=1}^{K} w_k^2 \frac{\mu_k}{\mu} G_k + \frac{2}{\mu} \sum_{k=2}^{K} \sum_{j=1}^{k} w_k w_j |\mu_k - \mu_j| + NSF \quad (3)$$

where $NSF = \frac{2}{\mu} \sum_{k=2}^{K} \sum_{j=1}^{k-1} w_k w_j \int_0^\infty f_k(y) \int_0^\infty f_j(x)(x - y)dxdy$. NSF may be construed as a "Non-Segmentation Factor" measuring the extent to which distributions overlap or have elements in common. NSF and the middle component, which measures the distance between subgroups, respectively relate to the identification and alienation components in the Duclos et al. (2004) polarization index, highlighting the distinction between polarization and inequality which sees the possibility of a society becoming more polarized yet more equal at the same time.

When there is no overlap between any subgroups so that $f_k(x) = 0$ for all $f_j(x) > 0$ and $f_j(x) = 0$ for all $f_k(x) > 0$ for all possible pairs j and k, $NSF = 0$. This is the perfect segmentation case of Mookherjee and Shorrocks (1982) wherein Gini is just the sum of the within and between subgroup inequality components i.e. $GINI = \sum_{k=1}^{K} w_k^2 \frac{\mu_k}{\mu} G_k + \frac{2}{\mu} \sum_{k=2}^{K} \sum_{j=1}^{k} w_k w_j |\mu_k - \mu_j|$ making the Gini subgroup decomposable. Noting that all three components of $GINI$ are non-negative and that $0 \leq NSF \leq GINI$. $SI = 1 - NSF/GINI$ constitutes a Segmentation Index reflecting the lack of commonality amongst the subgroups. Finally note that equality of opportunity can be evaluated by measuring the lack of distributional variability. This can be measured by a collection of

outcome distributions conditioned on circumstance classes by measuring the overlap of the extreme distributions (Anderson et al. 2017).

4 Empirical analysis

To evaluate their overall effects on inequality, the extent to which marital matching and polarizing human capital transitional patterns have intensified is first examined. To see if positive assortative marriage matching patterns have intensified over the period, the rank correlations of partners educational and social class status of three marriage cohorts, those that took place, before, during and after the Cultural Revolution, are considered. For an analysis of changing generational transitional patterns household income to child educational achievements and household social class to child educational achievement transitions for the three cohorts are considered following Anderson (2018). This is followed by a counterfactual study of the household income generation process.

A rich data set on Urban households, drawn from the 2002 Chinese Household Income Project (Li et al. 2008), provides information on grandparent's social class designation given in the late 1940s, parent's educational status and child's (grandchildren's) educational status facilitating measurement of the transition from Grandparents Social class to parent's educational status and ultimately a child's educational status. Grandparent social classification (*Chengfen*) was C1: Poor Peasant or Landless (53.96%), C2: Lower Middle Peasant (14.14%), C3: Upper Middle Peasant (4.81%), C4 : Rich Peasant (2.01%), C5: Landlord (2.82%), C6: Manual Worker (8.21%), C7: Office Worker (3.30%), C8: Enterprise Owner (0.43%), C9 : Petty Proprietor (3.75%), C10: Revolutionary Cadre (1.38%), C11: Revolutionary Army Man (1.03%), C12: Other (4.16%). To simplify analysis, and because some cells were very small this categorization was condensed to 5 social classes. SC1 = {C1}, SC2 = {C2, C6}, SC3 = {C3, C9, C12}, SC4 = {C4, C7, C11}, SC5 = {C5, C8, C10}. The first group SC1 is poor peasant or landless persons, which accounts for roughly half of the population. SC2 is comprised of lower middle peasant and manual workers because they each have low social status. SC3 is made up of self-sufficient upper middle peasants and petty proprietors, also included in this group is the unidentified "other" because their education label is similar to the other 2 member classes. SC4 is comprised of rich peasant, office worker and revolutionary army man who have relatively more resources and typically has less manual labor obligations. SC5 is made up of Landlords, Enterprise owners and Revolutionary Cadres.

Based upon the highest category an individual attained the educational categories were 1 if never schooled, 2 if classes for eliminating illiteracy, 3 elementary school, 4 if junior middle school, 5 if senior middle school (including professional middle school), 6 if technical secondary school, 7 if junior college, 8 if college/university, 9 if graduate. Educational categories 1 through 9 were condensed to EDC1 = {1,2,3}, EDC2 = {4}, EDC3 = {5}, EDC4 = {6}, EDC5 = {7}, EDC6 = {8}, EDC7 = {9}. Information was available on 6610 parent - grandparent pairings and 1514 parent–child pairings (only children over 22 years old were used under the assumption they would have completed their education). Family cohort membership is determined by the age of the household head (father) at the time of the survey. Those whose household heads are born before 1948 are deemed to be the Pre Cultural Revolution Cohort of households (the education of these heads would not have been influenced by the vagaries of the Cultural Revolution). Those households whose heads are born between 1948 and 1963 are deemed the Cultural Revolution Cohort households and those born after 1963 are deemed the Post Cultural Revolution cohort, these household heads

Table 2 Spearman's Rank Correlation and Difference Analysis

Education				Social class		
Panel A: Spearman's Rank Correlation Coefficients						
Cohort	Pre CR	CR	Post CR	Pre CR	CR	Post CR
Index	0.5398	0.5341	0.6536	0.2880	0.2848	0.2377
(Variance)	(0.0003)	(0.0001)	(0.0004)	(0.0003)	(0.0001)	(0.0001)
Panel B: Difference Analysis: Cohort Comparison						
Cohort	Pre CR	CR	Post CR	Pre CR	CR	Post CR
Pre CR	–	−0.0057	0.1138***	Pre CR	–	−0.0032	−0.0503**
		(0.0185)	(0.0235)			(0.0187)	(0.0237)
CR		–	0.1195***	CR		–	−0.0471**
			(0.0206)				(0.207)

"CR" is short of Cultural Revolution cohort.

The standard error for Spearman's Rank Correlation is $0.6325/\sqrt{n-1}$ and for the differences it is $\sqrt{0.4001 * \left(\frac{1}{n_1-1} + \frac{1}{n_2-1} \right)}$ where nk is sample size for the k'th cohort. For the Scaled coefficient the standard error is scaled by the corresponding scaling factor

would have completed their education after the Cultural Revolution and made their marriage choices after the implementation of the one child policy.

4.1 Changing marriage matching patterns over eras

Differences in matching patterns in terms of social class and education class over the three Eras are compared by employing Spearman's Rank Correlation Coefficient (Spearman 1904) of husbands and wives' education or social classes as a positive assortative matching index. In a balanced marriage market with effective market clearing under positive assortative matching, the rank correlation coefficient will be 1. However, if the marriage market is unbalanced (i.e. insufficient numbers of a particular type on one side of the market to match with those on the other side), there may be cause for concern since the statistic would understate the extent of positive assortative matching (i.e. be less than 1) even though the market cleared perfectly according to the positive assortative matching rule (Becker 1981). This may be circumvented by rescaling the coefficient by its maximum possible value based on the assumption that everyone makes their best feasible match.[4] It would then record a value of 1 if market clearing was effective. Given the well documented significant gender imbalance in China (approximately 118 boys are born for every 100 girls compared to a global average of 103 to 107) this is an important prospect.

Table 2 Panel A reports the corresponding matching indices and Panel B show if they are statistically different from each other. Husband and wife scaled educational and social status correlations did not change significantly between the Pre Cultural Revolution and Cultural

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[4]The maximum value can be obtained by separately sorting husbands and wives matching index, pair husbands and wives according to rank and calculate the Spearman's rank correlation index for such a pairing.

Table 3 Inherited Social Class-Education Transition Indices

Cohort	Mobility	Upward	Polarize
Pre CR	0.7853967	0.4892344	0.3560291
CR	0.9073940	0.5875000	0.3319542
Post CR	0.6947007	0.7428458	0.3893200

Note: "CR" is Cultural Revolution Cohort

Revolution eras. The significance of the unscaled Spearman statistic and non-significance of the scaled Spearman statistic suggests that the Pre Cultural Revolution-Cultural Revolution change in educational matching had more to do with the increased capacity for matching as evident in diagram Fig. 2. However, both scaled and non-scaled educational class correlations increased substantially in the post Cultural Revolution period whereas the corresponding social class correlations diminished significantly suggesting education matching and social class matching behaviors reflect different objectives or responses in the Post Cultural Revolution era. This is consistent with the theoretical reasoning in Anderson and Leo (2013) which predicts intensified positive assortative matching on education relative to social status when household production of children is rationed, as was the case in the Post Cultural Revolution era.

4.2 Changing generational transition patterns over eras

Changes in transitional structures affect the income distribution both indirectly and directly. While inherited social class may affect incomes through its effect on educational classification, educational classification cannot affect exogenously determined social class but it can influence income status. Study of social and educational class transitions to income classes is facilitated by a semi-parametric decomposition of the household income distribution which produces individual household income class membership probabilities in a 5 income class model.[5] Details of various transition matrix typologies, their mobility and polarizing properties and associated indices drawn from Anderson (2018) are outlined and discussed in Electronic Supplemental Material Section C, they are reported in the following. The indices all lay on the unit interval and are asymptotically normally distributed. On the null hypothesis that mobility does not favor a direction or polarizing/converging trend, it can be shown that both Upward Mobility and Polarizing/Converging indexes are $N(0.5, (0.25/n))$ where n is the sample size yielding standard errors of 0.01223, 0.00824 and 0.01410 for Pre CR, CR and Post CR cohorts respectively for all of these indices.

Observe from Table 3, that social class to education class mobility was at its highest for the cultural revolution cohort, a direct effect of the Cultural Revolution, mobility was significantly progressively upward over the three cohorts but the transitions were never polarizing indeed they were significantly convergent or equalizing. Turning to the social class–income class transitions, Table 4 indicate that mobility was invariably quite high implying that income distributions of the various social classes were very similar, put another way social class had little impact on the shape of the income distribution over all cohorts. Transitions were invariably upward and progressively so over the cohorts, though they were never polarizing, and none of the differences were profoundly significant.

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[5]Details in Electronic Supplemental Material Section D.

Table 4 Inherited Social
Class-Income Transition indices

Cohort	Mobility	Upward	Polarize
Pre CR	0.8793059	0.6654964	0.3145048
CR	0.8280157	0.6948723	0.3072642
Post CR	0.8475474	0.7265366	0.2834459

Note: "CR" is Cultural
Revolution Cohort

A very different story emerges for education class to income class transitions reported in Table 5. Transition matrices characterize a very immobile society (and increasingly so over the cohorts) suggesting that a household's place in the income distribution is very much governed by its educational status and increasingly so. Transitions are typically upward but to a diminishing extent. Most significantly for present purposes transitions are always polarizing and increasingly so over more recent cohorts. In effect social class appears to have a weaker direct effect on household incomes than does educational classifications. However educational outcomes are dependent on social class and changes in the way social class translates to educational class influences the income distribution indirectly.

Lefranc et al. (2008, 2009) propose evaluating the presence of equality of opportunity by evaluating the extent of second order dominance relationships between the various conditional outcome distributions with absence of dominance supporting the equality of opportunity hypothesis. Strictly speaking this is not possible here because only ordinal outcome classifications are being considered and only first order dominance comparisons can be made. However, some insight on the differences across regimes can be gleaned from examining the first order comparisons and noting that dominance at the first order implies dominance at the second order. Turning to the cumulative household distributions conditioned on social class and education class of the household in Tables A4b and A5b respectively, note that income distributions for higher social classes do not always dominate those of lower social classes both overall and across the three cohorts. Indeed, the high value of the overlap measure of the extreme distribution comparison[6] indicates small differences between the income distributions of various social classes. On the other hand, income distributions for higher education classes always dominate lower education classes for all conditional distributions in all cohorts (except for the lowest educational class in the Post Cultural Revolution cohort), that is to say there is a strict ordering of income class outcomes by educational class. Furthermore, the overlap between the extreme income distributions conditional on educational classes is much lower indicating greater variation in the conditional income distributions by educational class. This reflects the lack of mobility indicated in Table 4 which is characteristic of a society where educational rather than social status governs income status.

5 Household income generation and inequality

To examine the effect of these phenomena on inequality, a counterfactual analysis of the income generating process is performed. The nature of household income production is first analyzed.

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[6]For a measure of the lack of variation in the collection of conditional distributions, see (Anderson et al. 2017).

Table 5 Educational-Income Transition Indices	Cohort	Mobility	Upward	Polarize
	Pre CR	0.4276802	0.7327413	0.6351860
	CR	0.4189770	0.6771935	0.6824907
Note: "CR" is Cultural Revolution Cohort	Post CR	0.3871865	0.5284033	0.7040519

5.1 Household income generation

A sense of the influence on household income production of the nature of the family is provided by simple regression equations for household size, parental educational differences and Adult Equivalized Household Income[7] on a variety of factors, the equations are respectively reported in Tables 6, 7 and 8.

The size of a household turned out to be a concave function of vintage (age of household head) and negative in the relevant range, it switched to a convex function for vintages in the range affected by the Cultural Revolution, so generally older households were larger. Higher social class families were significantly smaller with an implied elasticity of -0.01. The overall effect of education is to engender slightly smaller families though the larger the father-mother educational gap the larger the family size, an effect which outweighs the positive effect in the income equation so the net effect is negative, consistent with the idea of parental complementarity in family production which would predict positive assortative matching in income. Although the household income equation suggests some substitutability in household income production, positive assortative matching appears to prevail and increases in extent for younger cohorts. A simple regression reported in Table 7 reflects the extent to which positive assortative matching intensified over the period in question with older vintage families (vintage is age of household head) exhibiting larger educational differences on average.

The household income regression reported in Table 8 reveals a strong dependence on the educational status of both parents throughout the eras. In the Pre Cultural Revolution cohort mother's educational status has a bigger impact than fathers' educational status on household income. This difference disappears in the Cultural Revolution era and is re-established in the post Cultural Revolution era. Except for the Cultural Revolution era, there does appear to be some substitutability of parental education in income production with respect to education with a significantly negative cross partial derivative which, following Becker (1981), suggests that the propensity for positive assortative matching is not as strong as would otherwise be the case (but recall income production is not the only household objective). Absolute differences in mother father education levels, reflecting the positive assortative matching effect, appears to have little impact on income generation in this era.

Household income is a weakly increasing concave function of household vintage (head of household's age) a life cycle income pattern which is positive for all households whose head is < 75. Equivalized Household income is decreasing in household size, (not surprising given adult equivalization) however in the Cultural Revolution and Post Cultural Revolution eras the value of the parameter diminishes somewhat to the point where its effect is eliminated for the youngest households. Having a head who was potentially affected by the cultural revolutions educational exigencies and the social class of the family does not

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[7]Adult Equivalization uses the square root rule (Brady and Barber 1948) essentially it is household income divided by the square root of the number of people in the household.

Table 6 Household size equation reparametrized

Dependent variable:		
$\ln(\sqrt{\text{household size}})$	Coefficient	t-statistics
Vintage	0.0224[b]	(2.193)
Vintage^2	−0.000299[c]	(−2.935)
Father edu	−0.0443[b]	(−2.196)
Father edu×Mother edu	−0.00180	(−0.845)
edu difference	0.0435[c]	(3.928)
Social Class	−0.0322[b]	(−2.536)
CR	3.871[c]	(2.673)
Father edu×CR	0.0148	(0.593)
Father edu×Mother edu×CR	−0.000632	(−0.230)
Social Class×CR	0.0289[a]	(1.724)
vintage×CR	−0.165[c]	(−2.635)
vintage^2×CR	0.00165[b]	(2.448)
Constant	3.043[c]	(12.37)
Provincial Fixed Effects	Yes	
Observations	6,599	
R-squared	0.032	

[c] p<0.01, [b] p<0.05, [a] p<0.1

Note: CR is Cultural Revolution Dummy

Father edu × CR is the interaction term of Father's education and CR dummy

appear to significantly affect household income except through the fathers' social class. The interaction of class and the Cultural Revolution dummy is significantly positive indicating that the higher social class of a family head (who potentially missed years of education), the higher would household income be. In a similar fashion the post Cultural Revolution dummy and social class interaction appears to enhance the income generation prospects of a household.

Since it is evident that marriage matching patterns and generational transition patterns differed significantly across the cohorts, a counterfactual study of cohort Gini coefficients was performed. Matching and generational transition models were estimated for the Pre Cultural Revolution cohorts and matches and educational endowments projected for households in Cultural Revolution and Post Cultural Revolution cohorts as though they were made in the Pre Cultural Revolution fashion. The consequent "counterfactual" Gini Coefficients were then computed and compared with the true Gini coefficients for those eras.

Table 7 Absolute Education Class Difference

Variables	Coefficient	t-statistics
Vintage	0.0250[c]	(2.591)
Vintage^2	−0.000181[a]	(−1.871)
Constant	0.154	(0.650)
Provincial Fixed Effects	Yes	
Observations	6,684	
R-squared	0.006	

[c] p<0.01, [b] p<0.05, [a] p<0.1

Table 8 The Structure of Household Income Generation

Variables	Coefficient	t-statistics
Vintage	0.0122[a]	(1.687)
Vintage^2	−4.35e-05	(−0.635)
Mother edu	0.183[c]	(6.924)
Father edu	0.149[c]	(5.502)
family size	−0.189[c]	(−16.30)
Father edu×Mother edu	−0.0124[b]	(−2.552)
Father−Mother edu difference	0.0339[b]	(2.239)
Social Class	−0.00997	(−0.937)
CR	0.246	(1.228)
Mother edu×CR	−0.0949[b]	(−2.436)
Father edu×CR	−0.0663[a]	(−1.682)
family size×CR	0.0455[c]	(2.604)
Father edu×Mother edu×CR	0.0162[b]	(2.334)
Father-Mother edu difference×CR	0.00420	(0.228)
Social Class×CR	0.0332[c]	(2.611)
postCR	−0.149	(−0.429)
Mother edu×postCR	−0.0636	(−1.017)
Father edu×postCR	−0.0495	(−0.789)
family size×postCR	0.133[c]	(5.034)
Father edu×Mother edu×postCR	0.0121	(1.159)
Father-Mother edu difference×postCR	−0.0156	(−0.622)
Social Class×postCR	0.0363[b]	(−2.186)
Constant	7.880[c]	(34.97)
Provincial Fixed Effects	Yes	
Observations	6,137	
R−squared	0.378	

[c] $p<0.01$, [b] $p<0.05$, [a] $p<0.1$

Note: "CR" is Cultural Revolution Dummy

"post CR" is post Cultural Revolution Dummy

5.2 Marital matching counterfactual analysis

The Pre Cultural Revolution matching model was based upon writing a wives' educational status as a quadratic function of wives age, social class and husbands' educational status and reported in Table 9. Then wives' educational status and income was projected for Cultural Revolution and Post Cultural Revolution cohorts under the assumption that matching patterns were the same in those cohorts as in the Pre Cultural Revolution Cohort. Household incomes were reconstituted using projected wives' incomes and Counterfactual Gini coefficients recalculated for the Cultural Revolution and the Post Cultural Revolution Cohorts and compared with the original "True" cohort Gini coefficients. As may be observed the counterfactual analysis generates a significant reduction in the Gini coefficients as predicted (Table 10).

Table 9 Wife's education year – Pre Cultural Revolution cohort	Variables	Coefficient	t-statistics
	Wife's age	0.7622^c	(4.17)
	Wife's age^2	-0.0071^c	(-4.63)
	Husband eduYears	0.3117^c	(3.58)
	Husband eduYears^2	0.0093^c	(2.2)
	Wives Social Class	0.7577^c	(2.19)
	Wives Social Class ^{2}	-0.0848	(-1.48)
	Husband eduYears $\times$ Wives Social Class	0.0084	(0.43)
	Constant	-16.6073^c	(-3.04)
	Provincial Fixed Effects	Yes	
	Observations	1519	
^{c} p<0.01, ^{b} p<0.05, ^{a} p<0.1	R$-$squared	0.37	

5.3 Intergenerational transition analysis

The impact of changes in the structure of intergenerational transition across cohorts was studied in a similar fashion where the grandparent – parent transmission mechanism for the Pre Cultural Revolution was assumed to prevail in the Cultural Revolution and Post Cultural Revolution eras. A grandparent – parent generational regression for both genders that was quadratic in both grandparents' educational class and family social class with cohort and provincial fixed effects was estimated and reported in Table 11 with the following results. Again the counterfactual Gini analysis indicates a significant reduction in inequality had transition patterns remained the same in the Cultural Revolution and Post Cultural Revolution cohorts as they were in the Pre Cultural Revolution cohorts. The estimated counterfactual Gini's are reported in Table 12.

5.4 Decomposition analysis

To see the overall effect on inequality of intensified positive assortative marriage matching and polarizing generational transmissions, the counterfactual income distribution over all 3 groups can be constructed and the corresponding overall Gini computed and compared with the true Gini. Furthermore, Gini coefficients can be decomposed into a sum of 3 components representing within cohort inequality, between cohort inequality and a component representing the extent to which the cohorts are not distinct or segmented facilitating a more detailed comparison. Details of these measures are reported in Table 13.

Table 10 Matching Counterfactual Gini

Cohort	Actual gini	Actual gini S.D.	Counterfactual gini	z-stat
CR(n=3344)	0.3140	(0.0094)	0.2569	-350.234
postCR(n=1131)	0.3037	(0.0162)	0.2690	-71.583

Table 11 Intergenerational Tramsition across cohorts

Dependent Variable:

Father's EduYears			Mother's EduYears		
VARIABLES	Coefficient.	t-stat	VARIABLES	Coefficient.	t-stat
Father's age	-0.0772^a	(-1.7)	Mother's age	0.1434^c	(3.6)
Father's age^2	-0.0002	(-0.36)	Mother's age^2	-0.0022^c	(-5.45)
PGF eduYears	0.1701^c	(5.34)	MGF eduYears	0.2202^c	(6.93)
PGF eduYears^2	-0.0003	(-0.16)	MGF eduYears^2	-0.0019	(-0.93)
PGM eduYears	0.0486	(1.2)	MGM eduYears	0.1398^c	(3.63)
PGM eduYears^2	0.0047^a	(1.66)	MGM eduYears^2	-0.0007	(-0.26)
Social Class	0.6044^c	(3.64)	Social Class	0.5255^c	(3.28)
Social Class^2	-0.0666^b	(-2.31)	Social Class^2	-0.0387	(-1.39)
CR	-0.5828^b	(-2.5)	CR	1.0554	(4.96)
PGF eduYears	-0.0568^b	(-2.09)	MGF eduYears	-0.1088^c	(-3.92)
×CR	-0.0568^b	(-2.09)	×CR	-0.1088^c	(-3.92)
PGM eduYears			MGM eduYears		
×CR			×CR		
Social Class×CR	-0.1476^a	(-1.71)	Social Class×CR	-0.2300	(-2.71)
Post CR	-0.1993	(-0.56)	Post CR	1.5800^c	(4.86)
PGF eduYears	-0.0599^a	(-1.72)	MGF eduYears	-0.0847^b	(-2.36)
×Post CR			×Post CR		
PGM eduYears	-0.0777^a	(-1.88)	MGM eduYears	-0.0026	(-0.06)
×Post CR			×Post CR		
Social Class	-0.0679	(-0.62)	Social Class	-0.1124	(-1.06)
×Post CR			×Post CR		
Constant	14.1580^c	(11.32)	constant	5.5103^c	(5.3)
Provincial FE	Yes			Yes	
Observations	6231			6237	
R-squared	0.14			0.23	

^{c} p<0.01, ^{b} p<0.05, ^{a} p<0.1

Note: GF stands for Grandfather, GM stands for Grandmother

PGF stands for Paternal Grandfather, MGF stands for Maternal Grandfather

PGM stands for Paternal Grandmother, MGM stands for Maternal Grandmother

CR stands for CR cohort dummy, Post CR stands for Post CR cohort dummy

Table 12 Transmission Counterfactual Gini

cohort	Actual Gini	Actual Gini S.D.	Counterfactual Gini	z-stat
CR(n=3344)	0.3140	(0.0094)	0.196147	-720.312
postCR(n=1131)	0.3037	(0.0162)	0.195139	-224.939

Table 13 Gini Decomposition

Indices	Actual	Counterfactual	
		Marriage matching	Intergenerational
Gini over all cohorts	0.30741580	0.27334450	0.22143736
Within cohort component	0.12657076	0.11394637	0.08827589
Between cohort component	0.01426836	0.08726255	0.02677773
Non segmentation factor	0.16657668	0.07213557	0.10638373
Segmentation Index	0.45813884	0.73610014	0.51957640

Note the Counterfactual overall Gini's are significantly lower (Gini standard error = .0073512), signaling the inequality increasing effect of intensified positive assortative matching and polarizing intergenerational transfers. These structural changes increased the within cohort inequality component (especially with respect to intergenerational transitional patterns) but decreased the between group inequality component (especially with respect to changed marriage matching patterns). The diminished segmentation index reveals that, while individually the cohorts experienced increasing inequality, as a collection of groups they were experiencing increasing income commonality. Since the cohorts are associated with vintages it seems that the changes resulted in an increasing overlap of older family and younger family income distributions, i.e. they became more similar.

6 Conclusion

The strident growth in Chinese household income inequality has been ubiquitous in the last 35 years. Here the changing nature of family formation and changes in the way that human capital is passed on through the generations, are examined as sources of growing urban household income disparities. Shaped by historical events, the Cultural Revolution, The One Child Policy and the Economic Reforms, people changed the way they chose partners and invested in children, consequently changing the structure of generational relationships and the social order.

After demonstrating that ceteris paribus certain types of intergenerational transition structure and intensified marital matching behavior engender increases in income inequality, a three cohort study of social class to education, social class to income and education to income transition patterns and marital matching patterns was performed. An urban data set linking grandparents, parents and children across cohorts determined by age of head of household and potential time of marriage in Pre Cultural Revolution, Cultural Revolution Post Cultural Revolution Eras revealed that such matching and transitional patterns prevailed in each Era though they changed over the eras in a fashion that could increase household income inequality. Positive assortative partner matching on education intensified and intergenerational educational transitions were polarizing over the Eras.

In essence a source of increased urban inequality was an increased dependency of household incomes on household human capital, diminished dependency on social class and increased positive assortative matching which increased the disparities in household human capital and concomitantly increased the disparities in household incomes. An interesting sidebar was that, although educational polarization persists throughout the time, there was a substantial narrowing of the educational status in the Cultural Revolution equalizing the

circumstances of later generations. In addition the middle social class is elevated after the Cultural Revolution and ends up dominating both the lower and upper social classes in its education and income outcome distributions.

To examine the ultimate impact of these phenomena on inequality a "counterfactual" analysis was performed wherein matching and transitional patterns that prevailed in the Pre Cultural Revolution Eras were assumed to also prevail in the Cultural Revolution and Post Cultural Revolution Eras. Counterfactual household income distributions were constructed together with their corresponding Gini coefficients and compared with the actual Household Income Gini coefficients that arose. In all cases the counterfactual Gini coefficients were significantly lower than the actual Gini coefficients providing evidence that a source of the ubiquitous increase in inequality was the intensified positive assortative partner choice and polarizing intergenerational transition patterns. Decomposition of the Gini coefficient in terms of the vintage cohorts revealed that, while they individually became more unequal as a consequence of the changes, collectively they were becoming more alike, there was indeed increasing generational similarity amidst growing within cohort inequality.

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