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ON INCOME POLARIZATION IN CHINA

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ABSTRACT

In a rare example of an explicit national goal for income distribution besides reducing poverty, China's leadership has recently committed to expanding the middle-income share—moving to a less polarized "olive-shaped" distribution. Recognizing the potential trade-offs, the paper asks whether China's experience indicates that income-polarization was a by-product of past economic progress, including poverty reduction. The paper does not find robust time-series evidence of polarizing effects alongside either economic growth or population urbanization (including among those below the national median). There was strong co-movement between polarization and inequality. Larger urban-rural gaps in mean incomes are strongly polarizing in China.

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1. Introduction

Beyond the popular goal of "ending poverty," national leaders rarely articulate a reasonably well-defined goal for the national distribution of income. In an exception, at a prominent and widely-reported meeting in August 2021 of the Chinese Community Party's Central Committee for Financial and Economic Affairs, President Xi Jinping argued that the goal of "common prosperity" for China required an "olive-shaped distribution structure of large middle and small ends" (Xinhua News Agency 2021). In short, the proposed aim of the Chinese leadership is to "expand the proportion of middle-income groups" (Xinhua News Agency 2021)—what the Economist (2021, p.65) magazine dubbed "fleshing out the olive."

President Xi was clearly not saying that this is the only policy goal for China, even within the gamut of goals related to the distribution of income. (Xi has often emphasized the goal of ending poverty.) So, the question naturally arises as to what trade-offs might exist against other goals. That is a difficult question. Trade-offs can be hard to identify ex-post in observable data, which also reflect past policy choices (given the trade-offs faced at the time) and shocks. Nonetheless, it is of interest to see what the historical experience suggests about trade-offs with regard to this new goal. This requires that we can quantify attainments of the multiple distributional goals, including defining and measuring the idea of "fleshing out the olive."

The well-documented success of China in reducing absolute poverty came (of course) with a rising share of the population living above the absolute poverty line, many of whom joined what can be thought of as China's "middle-class."[1] Naturally, what this means depends on the setting. The prevailing definition of a "middle-income group" can be expected to change over time with rising living standards; what was considered a "middle" income in the China of the 1980s is clearly not the same as today. "Fleshing out the olive" can be interpreted as reducing the spread of incomes relative to the current median, which arguably provides a more relevant reference point than a fixed absolute level of real income.

This perspective suggests that the concept of "polarization" found in economics is relevant to monitoring China's performance in "fleshing out the olive," and identifying potential trade-offs against other goals, including poverty reduction. And there is a measure available in

[1] See Ravallion (2010). For evidence on China's success against poverty see Ravallion and Chen (2007) and Chen and Ravallion (2021).

the literature, namely the Foster-Wolfson (FW) polarization index (Foster and Wolfson 2010).[2] This measures the spread of incomes relative to the median.

While much has been written about poverty and inequality in China, rather little has been said about polarization. Previous studies have found evidence of rising polarization (Bonnefond and Clément 2012; Wang and Wan 2015; Schettinoa et al. 2021). Here we re-examine this finding over a longer period of time, spanning the post-reform period after 1980. This allows us to identify some key sub-periods when polarization was stable and even falling. The variance in the time-series allows us to explore the covariates of polarization. For example, we will be able to see whether there are signs in the historical record that less polarizing periods saw lower rates of economic growth.

Conceptually, polarization is not the same thing as inequality, which suggests the possibility of a trade-off between the two. While it is not something that has attracted much attention in the literature, one might expect that the process of economic development through structural transformation in a country such as China may have a de-polarizing effect, as the poorest move closer to the middle. Nor is this an aspect of the potential distributional changes with development that is likely to be captured well by the standard inequality indices. These potentially de-polarizing gains among the poorer half may, however, come hand-in-hand with polarizing gains among the (primarily urban) upper half, comprising an elite of skilled workers and those who own the capital stock and/or rental properties.

Also relevant in the context of China is the evolution of the large disparities found between mean incomes in urban and rural areas (Ravallion and Chen 2007; Kanbur and Zhuang 2013). This reflects long-standing inequalities in social policies (health, education and social protection) (Knight and Song 1995; Rozelle and Hell 2020) as well as impediments to internal migration, notably through the *hukou* registration system (Young 2013), and administrative land allocation processes (Giles and Mu 2018). Given the large mean income gaps between China's

[2] The main paper outlining the theory of this measure (Foster and Wolfson 2010) first appeared in 1992, but was not published until 2010. (Lambert, 2010, discusses the paper and why it took so long to come out.) Bossert and Schworm (2008) and Gigliarano et al. (2019) provide axiomatic characterizations of a general class of polarization measures in the spirit of the Foster-Wolfson index. An independent strand of the literature was initiated by Esteban and Ray (1994) who proposed measures of polarization that can be applied with multiple groups, and need not be anchored to the median. In Esteban and Ray, polarization is deemed to be greater when the groups are more homogeneous within, more different between, and more equal in size. Being more focused on the middle-class, the Foster and Wolfson approach is more directly applicable to the issues addressed in the present paper.

urban and rural areas, the degree of urban-rural sectoral fractionalization—the extent to which people live in different sectors—may also matter to both income inequality and polarization.

Motivated by these observations, the paper addresses three main questions:

- What do the data tell us about income polarization and how this has evolved in the post-reform period?
- Has China's (impressive) economic growth and poverty reduction come with rising polarization?
- What role has been played by population urbanization and the urban-rural differences in real incomes?

After describing the Foster-Wolfson index, the following section points to some theoretical arguments as to why trade-offs may or may not arise. Then Section 3 provides our new estimates of polarization measures for China back to 1981. These data are then used to address the first two questions above. The third question is taken up in Section 4. Section 5 concludes.

2. Measures and potential trade-offs

When China's leaders talk about "common prosperity" and "fleshing out the olive" this can be taken to mean an increase in the share of the population within some interval containing the population's median income. Let $y(p)$ denote the quantile function, giving the income of percentile p ($0< p \leq 1$) when ranked by household income per capita, with median $m = y(0.5)$.[3] Intuitively, "fleshing out the middle" can be interpreted as reducing the absolute income distances from the median, in units of the median, i.e., by looking at how $S(p) \equiv |y(p) - m|/m$ varies as one moves from the poorest to the richest percentile. The graph of $S(p)$ against p over (0, 1) is dubbed the "first-degree polarization curve" in Foster and Wolfson (2010). The area under the first-degree polarization curve in an interval of width $2p$ centered on the median is their "second-degree polarization curve," defined as $B(p) \equiv \left|\int_p^{0.5} S(x)dx\right|$; this is interpretable as the degree of bimodality (Foster and Wolfson 2010).

[3] Note that $y(p) = F^{-1}(y)$ where $F(y)$ is the cumulative distribution function, giving the probability of observing an income less than y.

The Foster-Wolfson index: The FW index plays a central role in this paper, so it is important to be clear at the outset on how it is defined and interpreted. Foster and Wolfson defined their index as twice the area under the second-degree polarization curve, $B(p)$. Similarly, to the Gini index, one can question whether this properly represents perceptions of polarization. For example, one might want to put a different weight (possibly higher, possibly lower) on median-normalized incomes among the top half of the distribution than the bottom half. While we will rely heavily on the FW index, we also present results using polarization curves to test robustness to the implicit weighting structure in the FW index.

Following Wolfson (1994), the FW index can be explained by reference to the standard diagram of a Lorenz curve ($\mathrm{L}(p)$), as exemplified by Figure 1. The difference in the context of measuring polarization (rather than inequality) is that we focus on the quadrilateral with vertices A, B, C and D, with one side given by the tangent to the Lorenz curve at the median. This can be thought of as having two sub-areas. As usual, the area between the diagonal and the Lorenz curve indicates the extent of inequality, as given by half the Gini index (G). Intuitively, a natural measure of polarization is based on the area that remains once one subtracts half the Gini index from the quadrilateral. The area remaining is half of $1 - 2\mathrm{L}(0.5) - \mathrm{G}$ (on noting that the quadrilateral has an average height of $0.5 - \mathrm{L}(0.5)$ and a width of unity). We also want to normalize the measure by the median, rather than the mean, since the median is taken to be the relevant reference in this context.

Combining these observations, the FW polarization index can be written as: [4]

$$\mathrm{P} \equiv 2\int_0^1 B(p)dp = 2\left(\frac{\mu}{m}\right)(\mathrm{T} - \mathrm{G}) \geq 0 \qquad (1)$$

where μ is the overall mean and $\mathrm{T} \equiv 1 - 2\mathrm{L}(0.5) = 1 - \mu^L/\mu = (\mu^U/\mu) - 1$, where μ^L and μ^U are the mean incomes of the lower half (those with incomes less than m) and upper half respectively. The re-scaling by μ/m (itself a standard measure of skewness) in equation (1) is equivalent to re-normalizing the gap between T and G by the median instead of the mean.

[4] We scale the index by 2 as done by Wolfson (1994) to make it closer in scale to the Gini index though (of course) this does not alter the proportionate changes over time. Foster and Wolfson (2010) do not do this re-scaling.

Potential trade-offs: The fact that China's leadership is emphasizing this new distributional goal suggests that there is at least a perception that China will need to give something up to attain it. Why might this be the case?

An obvious starting point for thinking about potential trade-offs is a measure of overall social welfare, combining equity and efficiency goals. An example is the Sheshinski-Sen index of social welfare, denoted $\mathrm{SW} \equiv (1 - \mathrm{G})\mu$.[5] The FW polarization index can then be written as:

$$P = 2(\mathrm{SW} - \mu^L)/m \qquad (2)$$

Here we immediately see a potential tension between the goals of reducing polarization and increasing social welfare. An increase in social welfare will be polarizing unless it comes with a sufficient gain in either the overall median or the mean income of the poorer half. Social welfare gains (due to higher incomes and/or lower inequality) that stem solely from changes among the top half of incomes will be polarizing.

Poverty reduction has been a stated goal for China since the 1950s. So, it is of interest in this setting to see whether a trade-off can arise between reducing polarization and reducing poverty, which remains a concern in China.[6] This will depend on how both mean income and inequality change with polarization. As noted, a growth process that only benefits the upper half of the distribution will clearly be polarizing.[7] On the other hand, a distribution-neutral growth process—whereby $y(p)$ increases by the same proportion across all p—will leave the polarization index unchanged. Yet such a growth process can be effective in reducing absolute and weakly-relative poverty, as well as enriching the middle class in absolute terms.

The outcome for measures of poverty will also depend on how incomes are weighted below the poverty line. Take, for example, the squared poverty gap introduced by Foster et al. (1984), which weights all proportionate poverty gaps ($(1 - y(p)/\mathrm{z}$, where z is the poverty line) by the gaps themselves, so the resulting measure becomes sensitive to inequality among the poor.

[5] See Sheshinski (1972) and Sen (1976). The corresponding social welfare function is essentially a rank-weighted mean income. Schmidt and Wichardt (2019) provide a utilitarian social welfare interpretation of this index when people care about relative income.

[6] Absolute income poverty measures for China judged by the World Bank's $1.90 line have fallen to 3.5% in 2014; however, a weakly-relative assessment consistent with how the official poverty lines have evolved over time indicates a poverty rate of 10% in that year; see Chen and Ravallion (2021).

[7] Note that, since the FW index is the area under the 2nd degree polarization curve, the index must rise if the mean of the top half rises (all else constant).

To make the example sharper for the present purpose, suppose also that the poverty line is the median, which corresponds to the World Bank's $1.90 a day line in the mid-1990s in China (Chen and Ravallion 2021). Then an income transfer from someone just below the poverty line to the poorest person would reduce the poverty measure but increase the FW polarization index.

Counter arguments to the trade-off idea can also point to the literature on economic growth. One strand of the literature has argued that a larger middle-class share (by various measures) can promote economic growth and poverty reduction.[8] Here too, we will not find an aggregate trade-off. This effect may well take time to emerge; it does not seem likely that year-to-year changes in the extent of polarization could generate contemporaneous changes in the rates of economic growth.

Turning to inequality, a source of a trade-off with polarization arises from the difference in how the two measures deal with inequality among those either below or above the median. To see this more clearly, note that equation (1) can also be written as:

$$\mathrm{P} = 2\left(\frac{\mu}{m}\right)(\mathrm{G_B} - \mathrm{G_W}) \tag{3}$$

where $\mathrm{G_B}(=(\mu^U - \mu^L)/(4\mu))$ is the Gini index between the top and bottom halves and $\mathrm{G_W}(=\mathrm{G}-\mathrm{G_B})$ is the Gini index within these two (non-overlapping) groups. An increase in the latter, holding mean income constant within each of the halves, will be de-polarizing.

Co-movement of the polarization and inequality indices can still be expected with Lorenz-dominating shifts in distribution. To illustrate, suppose that the new Lorenz curve is:[9]

$$\mathrm{L}^*(p) = \mathrm{L}(p) - \beta[p - \mathrm{L}(p)] \text{ for } \beta > 0 \tag{4}$$

Clearly, this will also increase the area of the quadrilateral, and (hence) T in equation (1). β gives the proportionate change in the Gini index; $(\mathrm{G}^*/\mathrm{G}) - 1 = (\mathrm{T}^*/\mathrm{T}) - 1 = \beta$ (where the asterisk denotes the new value). It is readily verified that $(\mathrm{P}^*/\mathrm{P}) - 1 = \gamma/(1-\gamma) > 0$ where $1 > \gamma \equiv$

[8] On the role of the middle class in promoting entrepreneurship and growth see Acemoglu and Zilibotti (1997), Murphy et al. (1989) and Doepke and Zilibotti (2005). Easterly (2001) finds evidence that a larger income share controlled by the middle quintiles promotes economic growth. Ravallion (2012) provides cross-country evidence that a larger middle class helps assure faster subsequent poverty reduction.

[9] This is the representation of shifting Lorenz curves assumed by Kakwani (1993) in deriving the point elasticities of various measures of poverty with respect to inequality.

$\frac{\beta}{1+\beta}\frac{\mu}{m} > 0$.[10] So, both polarization and inequality increase. In the limiting case in which there is no skewness ($\mu = m$) they increase by the same proportion, β. More generally, with positive skewness ($\mu > m$), the proportionate rate of increase in the polarization index will exceed that in the inequality index.

The type of equi-proportionate, Lorenz dominating, shift in distribution represented by equation (4) is rather special, and may not be widely applicable.[11] Consider instead a developing country in which the poorest live in rural areas, with an income below that of the urban poor, who still live below the median. As in China, the country has implemented restrictions on internal migration. Some observers have recommended relaxing the *hukou* restrictions as a means of de-polarization.[12] However, the impediments to migration generated by the *hukou* system may well be inequality increasing but polarization decreasing. To see how, let us assume that the restrictions are only binding on those in the lower half of the national distribution who are mostly in rural areas but would be better off migrating to urban areas.[13] To assess the impact of the restrictions on migration, imagine that reforms liberalizing internal migration mean that some of the rural poor migrate to urban areas, gaining as a result. However, the greater competition for unskilled jobs in urban areas brings down the wage rate for that work, or the incumbent urban poor find that they have to share limited resources with the new rural migrants, thus lowering the incomes of the urban poor. To keep the argument simple for expository purposes, assume that the income gain to rural migrants is equal to the loss to the urban poor, keeping the overall mean constant. Then relaxing this migration policy entails an inequality-decreasing redistribution (in the Pigou-Dalton sense) among the lower half of the distribution. In short, equation (4) is replaced by:

$$\mathrm{L}^*(p) = \mathrm{L}(p) + \beta[p - \mathrm{L}(p)] \text{ for } \beta > 0 \text{ and } p < 0.5 \qquad (5.1)$$

$$= \mathrm{L}(p) \text{ for } p \geq 0.5 \qquad (5.2)$$

[10] The case that $\gamma > 1$ is ruled out given that $\mathrm{P}^* > 0$.
[11] Ravallion et al. (1991) found that equation (4) provides a good fit to how global Lorenz curves had been evolving up to the 1980s, although the changes in distribution could be very different in specific countries. However, since then, we have seen rising "high-end" inequality, often with intersecting Lorenz curves (Ravallion 2018).
[12] See, for example, the discussion in Wang and Wan (2015). In recent years some provinces have been relaxing *hukou* restrictions to allow rural migrants to more easily obtain urban registration; see, for example, Zhang (2021). However, the *hukou* restrictions remain in the large cities.
[13] This is consistent with survey-based evidence on the incomes or rural migrants in Chinese cities (Li and Li 2007).

It is evident that, while relaxing the restrictions on migration in this model will reduce inequality, polarization will increase, as measured by the FW index. (Noting that μ, m and $L(0.5)$ are all unaffected, so the lower G must imply a higher P.) That also holds if mean income rises in that the gains to the rural migrants exceed the losses to the urban poor. This is not to say that the restrictions should be maintained, but rather to point out the potential for a trade-off with the aim of reducing polarization.

The same argument can be made regarding other policy changes. Consider, for example, a change in income tax policy, transferred income from the rich to those middle-income groups living a little above the median. Indeed, suppose one equalized all incomes among the top half in Figure 1, as indicated by the bold dashed line. The new distribution will have less inequality but be more polarized, with the bottom half having the same incomes (relative to the mean) as before but the top half having a common income well above the median.

Again, this illustrates the potential for a trade-off between the aim of reducing polarization and policy reforms that may well be deemed desirable from other perspectives. Whether we see signs of a trade-off in the data—a negative relationship between two desired outcomes—will also depend on how the trade-offs and governmental preferences change over time, leading to changing policies; there may be a trade-off at one point in time, yet we see a positive relationship among the politico-economic equilibria. This assumes that reducing polarization was valued by Chinese policy makers in the past. That can be questioned in the current context, given that the Chinese leadership is announcing a new effort to reduce polarization. Then, what we observe in the historical record can be taken to be indicative of likely trade-offs now confronting policy makers in attempting to reduce polarization.

3. Polarization in China

We now turn to the empirical evidence, drawing on China's experience since 1981, shortly after the economic reform process began, led by Deng Xiaoping. National household survey data on the distribution of income became available soon after.

Data and methods: To estimate the polarization indices back to the 1980s, we use the distributional data from China's National Bureau of Statistics (NBS). The micro data are not publicly available, so we rely on tabulations of the distribution of income as found in the annual

household survey yearbooks. This allows us to span over three decades, covering a period that picks up some important reversals in the overall trajectory of rising polarization.

The NBS data use a fairly standard household income definition, with both formal and informal sources (including imputed incomes in kind from own-farm production). Following Chen and Ravallion (2008, 2010) we allow for a higher cost-of-living in urban areas and we use separate consumer price indices for urban and rural areas. The polarization and inequality indices are calculated from our estimates of parameterized Lorenz Curves.[14] The Lorenz curves are then aggregated consistently to a population-weighted national Lorenz curve.[15] Table 1 provides our estimates of the decile shares by year.

As in most household surveys, there are concerns about income under-reporting by China's rich. Piketty et al. (2019) have made calculations of top income shares in China drawing on income tax records. These suggest larger income shares held by high-income households than found in the NBS household surveys. (For example, for 2014, we find that the richest 50% have 77% of total income, while Piketty et al. find that it is 85%.) The Piketty et al. calculations are only possible for those reporting income taxes, which is likely to be upper-income urban households in the formal sector of the economy. Since we do not know the extent of income under-reporting at low and middle-income levels, we cannot be sure that this higher level of inequality suggested by the Piketty et al. (2019) is correct; it may be that the proportionate adjustments would turn out to be similar at lower incomes, although the absolute corrections are clearly lower. Nonetheless, the pattern over time that we find in inequality measures based on the NBS survey data turns out to be very similar to that in Piketty et al (2019), including the turning points (Ravallion and Chen 2021). It can also be noted that relying on the survey data alone has attractions of internal consistency and construct validity in this context, as discussed in Ravallion (2021).

Results on polarization and covariates: Table 2 provides our estimates of the polarization index for China, alongside the Gini index, with their urban and rural breakdowns. Figure 2 plots the national measures and the urban-rural breakdown of the FW index. (The Figure also provides the fractionalization index, which we return to in Section 4.)

[14] Ravallion and Chen (2021) describe the data and methods of estimating the Lorenz curves further.
[15] Population weighting requires that NBS provides average household size by each per-capita-income-group. At the time of writing (September 2021) this data was not available in all years, including since 2014.

Both the polarization and inequality measures show a strong positive trend over the period, with annual rates of increase of 0.53 percentage points (pp) and 0.48 pp for the Gini index and FW index respectively (using regressions of each index on time, with robust standard errors of 0.10 and 0.09 pp respectively[16]). However, we see a marked turning point (TP) in polarization in 2009, trending downward since. This is also true for inequality, though the strict TP is in 2008. The FW index fell faster than the Gini index after the latest TP. There was also an earlier TP in the mid-1990s, but this did not last long.

It is clear from Figure 2 that the polarization index comoves strongly with the inequality index. The correlation coefficient is 0.99 in the levels, and the year-to-year changes in the logs of the two indices are also highly correlated (r=0.95).[17] The changes have the same sign in 22 of the 27 years. The two main "inverted U" TPs also line up well, namely 1993-95 and 2008-09.

Despite the conceptual difference between polarization and inequality measures, it is clearly not the case that China's development path has been inequality increasing but de-polarizing.[18]

It is of interest to see how income levels have changed relative to the median, which also allows us to test whether the patterns we find in the data are robust to the choice of polarization index. Figure 3 gives the (first-degree) polarization curves for 1984 (the least polarized year based on the FW index), 2009 (the latest TP year) and the final year, 2014. We see that the post-2009 reversal to the upward trend in polarization was coming almost solely from the top half of the distribution. The curves for the lower half in 2009 and 2014 are virtually indistinguishable. The finding that polarization rose up to 2009 and then fell is robust to the choice of index. (Note that 1st degree dominance implies 2nd degree dominance.)

Our data indicate that the Sheshinski-Sen measure of social welfare is increasing over time, but falling relative to the median (Figure 4). This has helped mitigate the rise in polarization (recalling equation 2). The overall increase in polarization is thus driven by the

[16] All standard errors reported in this paper are robust to the presence of both heteroskedasticity and autocorrelation of unknown form, following Newey and West (1987).
[17] For both series, the Augmented Dickey-Fuller (ADF) test rejects the null hypothesis of a unit root at the 5% level. Nonetheless, it is of interest to see if the year-to-year changes are correlated.
[18] This echoes the concerns found in the literature on the "disappearing middle class" in rich countries such as the U.S. (Levy and Murnane 1992), which can be thought of as a polarizing change in the distribution (Wolfson 1994).

decline in μ^L relative to the median. Both μ^L and m rose over time, but m rose faster. Furthermore, the changes over time in μ^L/m are highly (negatively) correlated with the Gini index of overall inequality (r=-0.98). The turning points against the trend of rising polarization stem from new gains in the mean for the poorest half relative to the median.

It may be conjectured that rising polarization reflects China's high rate of economic growth, suggesting a trade-off. Figure 5 presents the levels relationship between the polarization index and mean income. There is a strong indication of an inverted-U relationship with the mean. (A very similar pattern is found using GDP per capita instead of the survey-based mean incomes in Figure 5.) The turning point is in 2009, with falling polarization alongside rising mean incomes since then. One might conjecture that the type of distributional change indicated by Figures 2 and 5 supports concerns about a declining middle-income share during China's spectacular growth process, at least until recently.

However, this pattern in the data could well be spurious given that these are serially dependent and trended variables. To explore this further, Table 3 provides regressions of the (log) polarization index on both current and lagged log mean income allowing for serial dependence and an independent time trend in the polarization measures (in obvious notation):

$$lnP_t = \alpha_0 + \alpha_1 lnP_{t-1} + \beta_0 ln\mu_t + \beta_1 ln\mu_{t-1} + \gamma t + \varepsilon_t \qquad (6)$$

The results point to a more parsimonious specification with $\alpha_1 = 1$ and $\beta_0 + \beta_1 = 0$, which we also give in Table 3. Thus, we focus on the correlation of growth rates ($\Delta lnP_t \; and \; \Delta ln\mu_t$).[19]

We find a negative coefficient between ΔlnP_t and $\Delta ln\mu_t$ (r=-0.42). However, this turns out to be mainly driven by the sharp fall in the FW index at the beginning of the series, which is an outlier (Table 3, Col. 3). There is also a concern about correlated measurement errors in the polarization index and the survey means. If instead we use growth rates for GDP per capita from the National Accounts (based on administrative data and so largely independent of the survey data), the correlation with changes in polarization is even weaker (Table 3, Cols. 4 and 5). So, our data show that there is no robust correlation (either way) between changes in the (log) polarization index and growth rates in the survey means.

[19] One cannot reject the null hypothesis of a unit root in the levels of log mean income (using ADF), but one can reject it on taking the first differences.

Nor do we find any sign of an aggregate trade-off between a rising middle-class share and the pace of poverty reduction. Indeed, changes over time in the log FW index are positively correlated with all the (absolute and relative) poverty measures provided by Chen and Ravallion (2021).[20] (This also holds using the squared poverty gaps.) This pattern in the data is hardly surprising given the high correlation that we find between changes in the Gini and FW indices.

Recalling equation (3), we find that both $G_B\mu/m$ and $G_W\mu/m$ exhibit TPs, though these are stronger for the former, such that, when one takes the difference, we see the TPs in the FW index (Figure 6). Furthermore, the re-normalized between-group Gini moves very similarly to the overall Gini in Figure 1; indeed, the correlation coefficient is 0.996.[21] It is striking that just three statistics—the means for the lower and upper halves and the median—can reproduce China's Gini index so closely.

So, we find that our series for China's overall Gini index and its polarization index are both closely approximated by the income gap between the top half and the bottom half normalized by the median. This is what creates the high correlation between the FW index and the Gini index.

4. Polarization and dualism

There are two aspects of dualism that are relevant here, one concerning the urban-rural gap in mean incomes and the other concerning population urbanization. We consider these in turn.

Figure 2 also provides the urban and rural polarization indices. Rural polarization exceeds that in urban areas as a whole although there is strong co-movement (r=0.93).[22] Notice that the turning point in the national polarization index is much weaker within urban and rural areas separately. This suggests that it is the between-sector effect on polarization that is driving the turning point in the national polarization index.

[20] The correlation coefficients are 0.53 and 0.49 for the changes in the logs of the absolute poverty rate using the World Bank's $1.90 a day line and the Government of China's 2011 official poverty line respectively. The corresponding correlation coefficients for the Chen-Ravallion weakly relative poverty lines and strongly relative measures using 60% of the median are 0.62, and 0.60 respectively.

[21] The regression coefficient of the overall Gini on $G_B\mu/m$ is 0.87 with a robust standard error of 0.03.

[22] Our longer time series does not confirm the finding of Bonnefond and Clément (2012) that rising polarization has been more evident in urban areas than rural areas. We see it in both.

This is corroborated by Figure 7, which plots the growth rates in the polarization index on the growth in the urban-rural gap in (log) mean incomes, $ln(\mu_U/\mu_R)$ where μ_U and μ_R are the urban and rural mean incomes respectively. Table 4 provides dynamic regressions, allowing for serial dependence in the polarization index as well as a time trend. The parameter values are suggestive of a more parsimonious difference specification in Figure 7. The correlation coefficient is 0.83 and the elasticity of the polarization index to the urban-rural income gap is 0.54 (with a robust standard error of 0.12).

There is a concern about the fact that both variables in Figure 7 are calculated from the same survey data, creating the potential for a spurious correlation. On the one hand there will be the usual attenuation bias due to measurement errors in a regressor. Additionally, and probably in the opposite direction, there will be a potential bias due to correlated measurement errors; if one survey round overestimates mean (say) urban income then it will also over-estimate the extent of polarization (and inequality). To address this issue, Table 4 also gives a Two-Stage Least Squares estimator using the growth rate of the primary sector (mainly agriculture) of GDP as the instrumental variable (IV). (The first stage is very strong, with the IV having a t-ratio of -10.07.[23]) Note that this estimator is only being used here to address the concern that correlated measurement errors may be generating a spurious correlation. The key assumption for this to work is that the measurement errors in the national accounts series for the primary sector output are uncorrelated with those in the surveys. This cannot be assured, but a lower correlation is likely given that the national accounts rely heavily on administrative data, collected independently of the household surveys. Using the IV method, the elasticity of the polarization index to the urban-rural income gap drops from 0.54 (using OLS) to 0.31 (with a robust standard error of 0.05), but it remains significantly different from zero.

In the light of equation (3), one can interpret the elasticity of the polarization index to the urban-rural income gap as the difference between the share-weighted elasticity of the (median-normalized) between-Gini component ($G_B\mu/m$) and that of the within-Gini component ($G_W\mu/m$). Then we have:

[23] The regression coefficient of the growth rate of the log urban-rural income ratio on the growth rate of primary sector GDP is -1.312, with a robust standard error of 0.130; overall R^2 is 0.578, with F=16.433).

$$\frac{\Delta ln\mathrm{P}}{\Delta ln(\mu_{\mathrm{U}}/\mu_{\mathrm{R}})} = \frac{\Delta ln\mathrm{G_B}\mu/m}{\Delta ln(\mu_{\mathrm{U}}/\mu_{\mathrm{R}})} + \frac{2\mathrm{G_W}\mu/m}{P}\left(\frac{\Delta ln\mathrm{G_B}\mu/m}{\Delta ln(\mu_{\mathrm{U}}/\mu_{\mathrm{R}})} - \frac{\Delta ln\mathrm{G_W}\mu/m}{\Delta ln(\mu_{\mathrm{U}}/\mu_{\mathrm{R}})}\right) \quad (7)$$

The regression-based elasticity of the between-group component w.r.t. the urban-rural income ratio is 0.58 (a robust standard error of 0.13), while it is 0.63 (0.15) for the within component. Since the elasticities are similar, we can infer from (7) that the overall elasticity is determined mainly by the between-group elasticity. (For example, at the midpoint of the series, in 2000, the second term on the RHS of (7) has a value of only -0.05.) In other words, the way that the urban-rural income gap matters to polarization in China is largely determined by how it impacts the inequality in mean incomes between the top half and the bottom half of the national distribution.

Turning to the second aspect, in a dualistic economy, population urbanization is generally seen as poverty-reducing nationally.[24] Let s denote the share of the population living in urban areas. This rose from 20% in 1981 to 57% in 2014 (despite the aforementioned restrictions on migration). The correlation between the urban population share and the FW index is high (r=0.85), but the changes over time are virtually orthogonal (r=0.04). We also see a strong correlation between polarization and with urban-rural fractionalization, as measured by $2s(1-s)$ (r=0.94).[25] However, this too is mostly due to their common trends; the correlations in first differences is only 0.33. The TP for fractionalization (at an urban population share of 50%) is in 2011, after the latest TPs for polarization.

In this context, a key variable is the urbanization of those below the median. Let s^L denote the urban population share for those living below the national median. In 1981, $s^L = 0.02$; a remarkable 98% of the poorest half of China's population lived in rural areas. By 2014, s^L had risen to 31%, though with fluctuations, up and down. Given that China started this period with virtually all the rural population below the national median, and virtually all of the urban population above it, and that the bulk of rural migrants probably still live below the national median, the share of the urban population living below the national median, denoted $\varphi^L \equiv s^L/(2s)$, probably provides a good indicator of the extent of pro-poor rural migration, as influenced (in part at least) by the policy impediments to migration. Figure 8 plots φ^Lover time.

[24] For an overview of the arguments from the literature see Ravallion (2016, Chapter 8).
[25] Here fractionalization indicates the probability that any two randomly selected people will be in different sectors, one urban, the other rural. This is at a minimum when everyone is one of the two, and it is maximized when $s = 0.5$.

As noted in Section 2, policies to encourage rural-to-urban migration are desirable for reducing poverty but may well increase polarization in the context of a dualistic developing country such as China. We do not observe (in a systematic way) the changes in the extent of the restriction on migration or administrative land allocation, but we can use φ^L as a plausible proxy. Controlling the urban-rural mean income gap ($ln(\mu_U/\mu_R)$), we find a strongly positive partial correlation between the FW polarization index and φ^L; the partial regression coefficient of lnP on log φ^L is 0.12 with a robust standard error of 0.03.[26]

While this is suggestive of a possible trade-off between pro-poor urbanization and polarization there are two reasons for caution. First, the above test holds the urban-rural mean income gap constant. To the extent that urbanization among the poorer half of the population reduces that income gap, the effect on polarization is theoretically ambiguous. Second, as with the overall urbanization rate, common time trends may be confounding the picture. Taking the differences in logs, the rate of urbanization among the poorer half ($\Delta ln\varphi^L$) is negatively correlated with changes in the (log) FW index (r=-0.54). So, the evidence of that urbanization among the poorest half came with greater overall polarization must be considered weak at best.

5. Conclusions

There are potential trade-offs between reducing income polarization and other valued goals. Some policies that are good for fighting poverty and inequality could well be polarizing. Policy makers need to be aware of these potential trade-offs. In addition to arguing that the Foster-Wolfson index is a close match to the spirit of the idea of "fleshing out the olive"—and so provides a valuable tool for monitoring progress in attaining that goal—the paper has looked for signs of such trade-offs in the aggregate time series data for China since 1981.

A focus on polarization begs some new policy questions that have so far been largely ignored. A prominent example in contemporary China is the Central Government's goal of eliminating the *hukou* registration system—the internal "passport" system in China that restricts the access of rural migrants to urban services and markets. While ongoing reforms to the *hukou* system would undoubtedly help reduce poverty, the impact on polarization is unclear, given that the bulk of both the personal benefits and the costs of relaxing *hukou* restrictions may well fall

[26] The coefficient on $ln(\mu_U/\mu_R)$ is 0.93 (s.e.=0.06), with R^2=0.96.

on the lower side of the median, suggesting that these reforms could be polarizing. The potential for such polarizing effects of relaxing *hukou* restrictions would need to be balanced against other considerations, including poverty reduction.

However, the paper has found rather little evidence in the time-series data assembled here of any negative co-movement between polarization (on the one hand) and economic growth or reducing poverty and inequality (on the other). Granted, polarization rose with rising average incomes up to 2009, but this appears to be spurious, reflecting common time trends. Periods of higher poverty reduction or higher economic growth did not typically see more rapid polarization. And there is strong co-movement between the Gini index and the Foster-Wolfson polarization index. Nor do we find that periods of a more rapid rise in the urbanization of the poorer half of the population (who started off almost only in rural areas) tended to be more polarizing.

To the extent that reducing polarization is a new policy goal for China, the historical record does not point to any serious trade-offs with past goals going forward, including with economic growth and poverty reduction. The recent reversal in the generally upward path for polarization in China has been driven almost entirely by attenuated median-normalized incomes among the upper half.

Of special relevance to thinking about the policy options in reducing polarization is our finding that the rise and fall in China's national polarization index is largely accountable to the evolution of the gap between urban and rural mean incomes. Here too, the historical record provides little support for the idea that reducing urban-rural disparities would be polarizing—indeed, the data suggest the opposite. However, potential trade-offs would need to be considered further in the context of specific policy efforts, such as in expanding social service coverage in rural areas, also taking account of how those efforts are financed.

Figure 1: Relationship between the Foster-Wolfson polarization index and the Lorenz curve

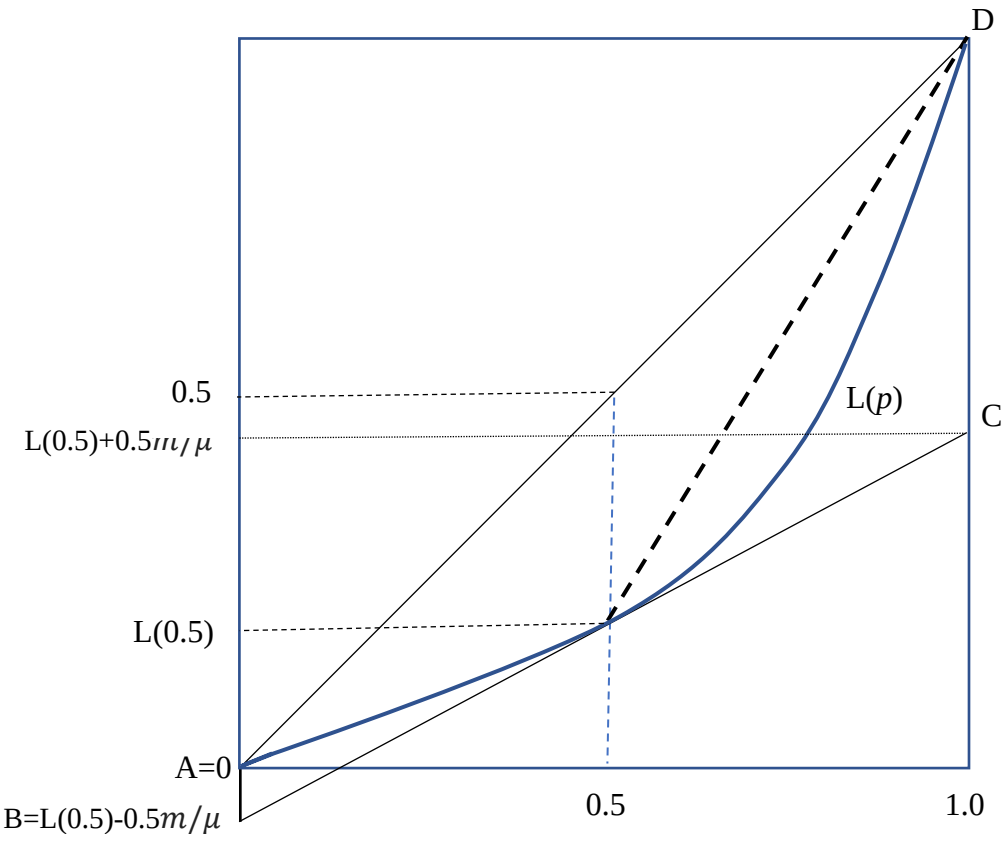
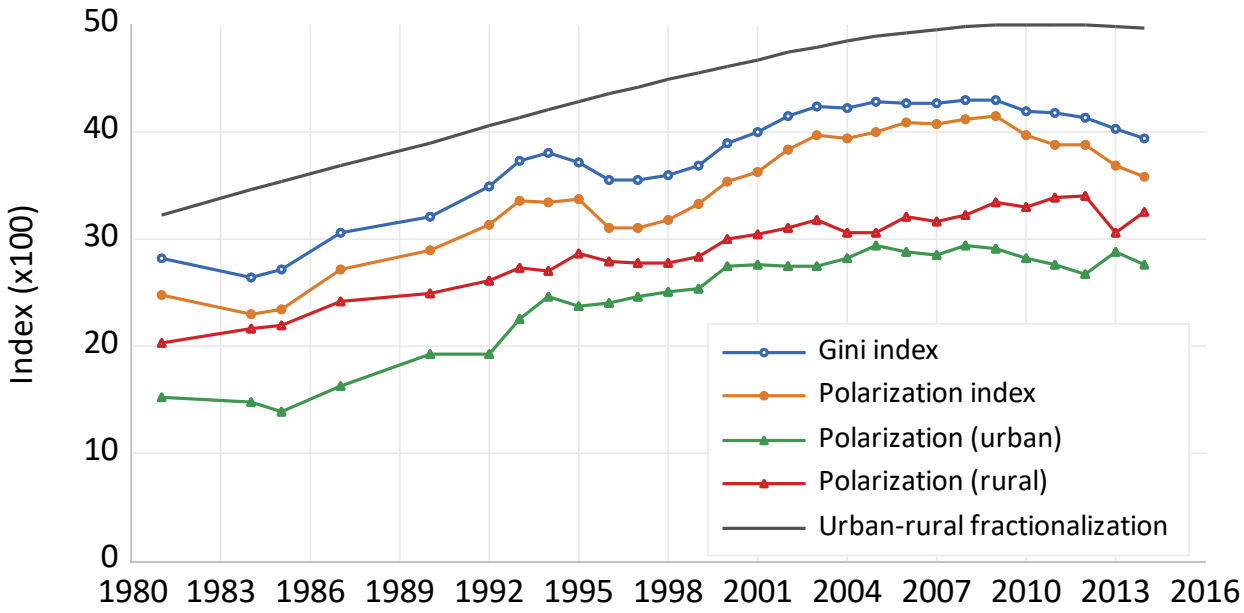
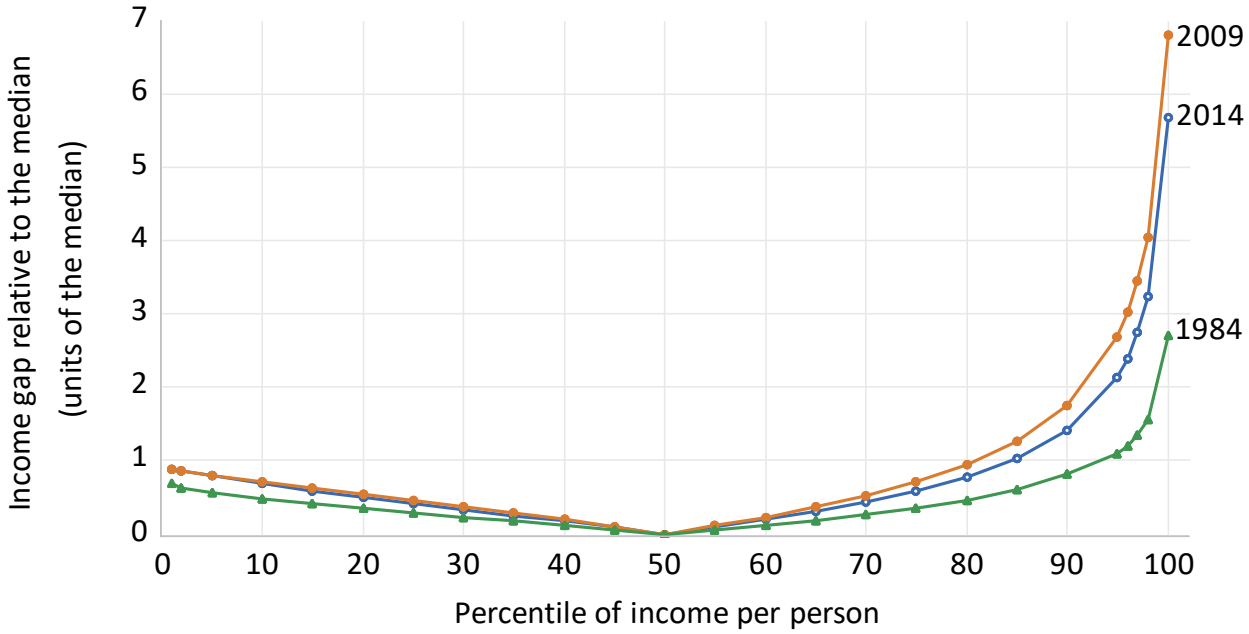


Figure 2: Fractionalization, inequality and polarization in China



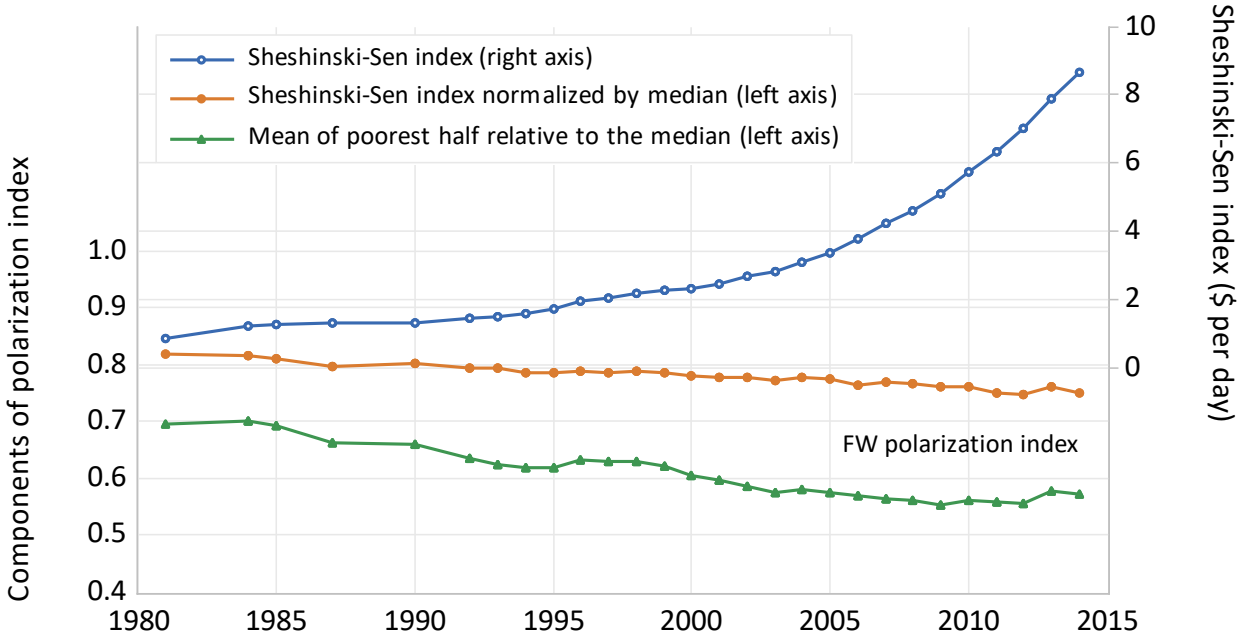
Note: Authors' calculations

Figure 3: Polarization curves for China



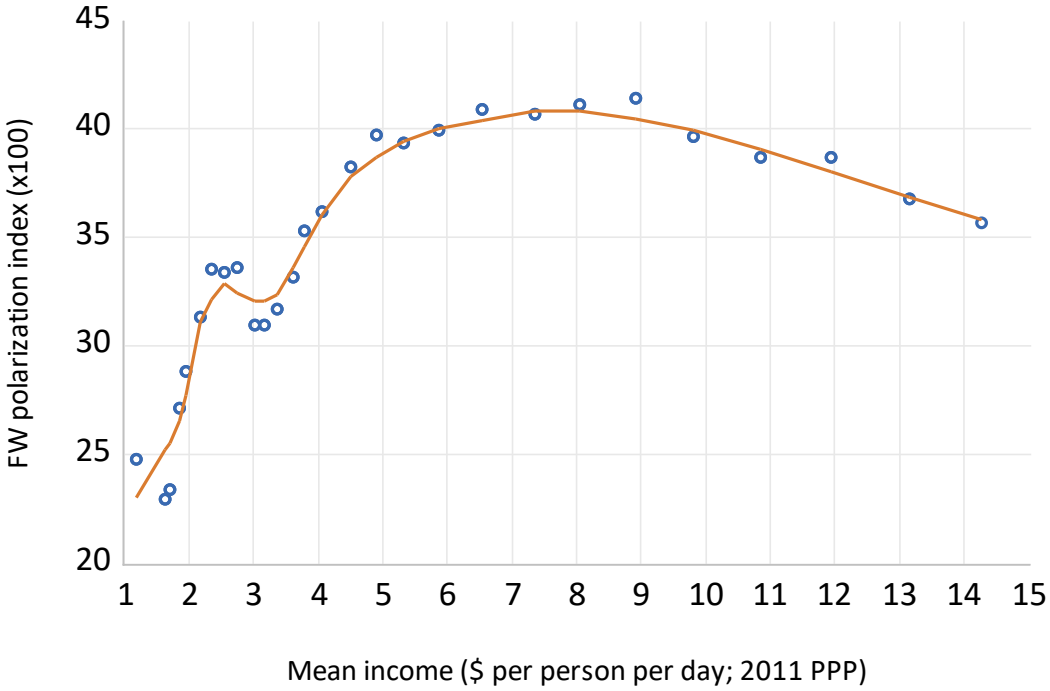
Note: The graph of $|y(p) - m|/m$ against p where $y(p) = F^{-1}(y)$, $F(y)$ is the cumulative distribution function (giving the probability of observing an income less than y) and m is the corresponding median. Authors' calculations.

Figure 4: Social welfare and polarization



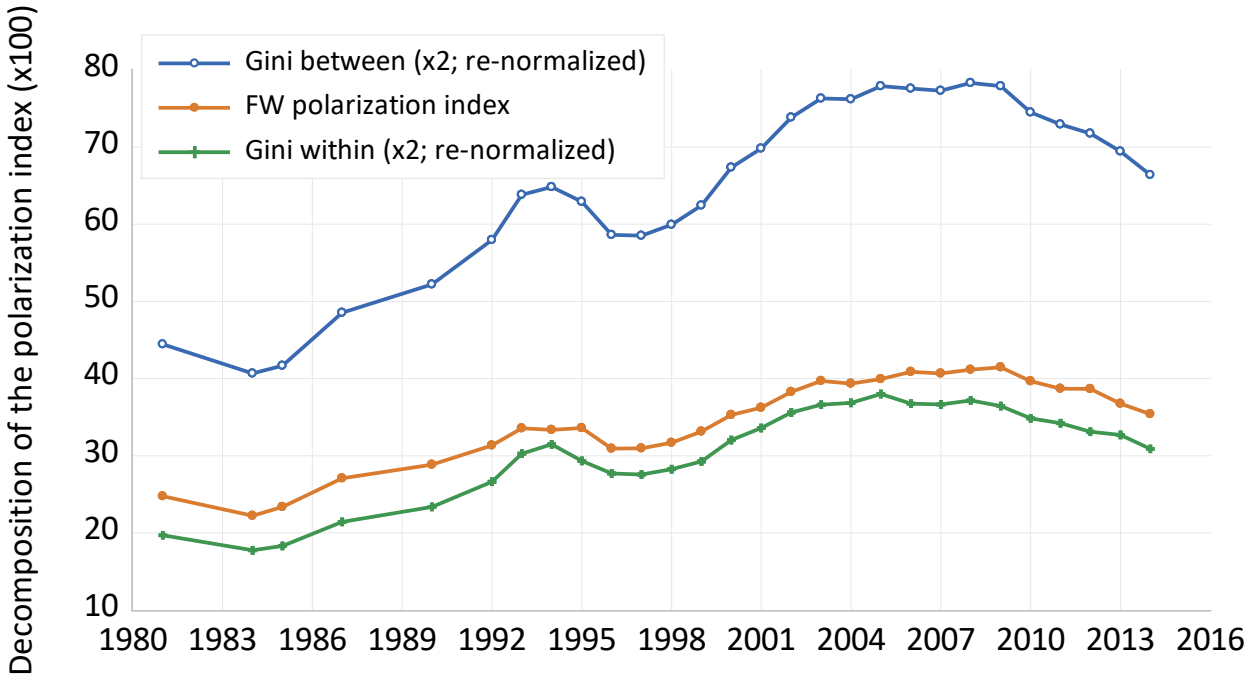
Note: Authors' calculations

Figure 5: Polarization and average household income per capita



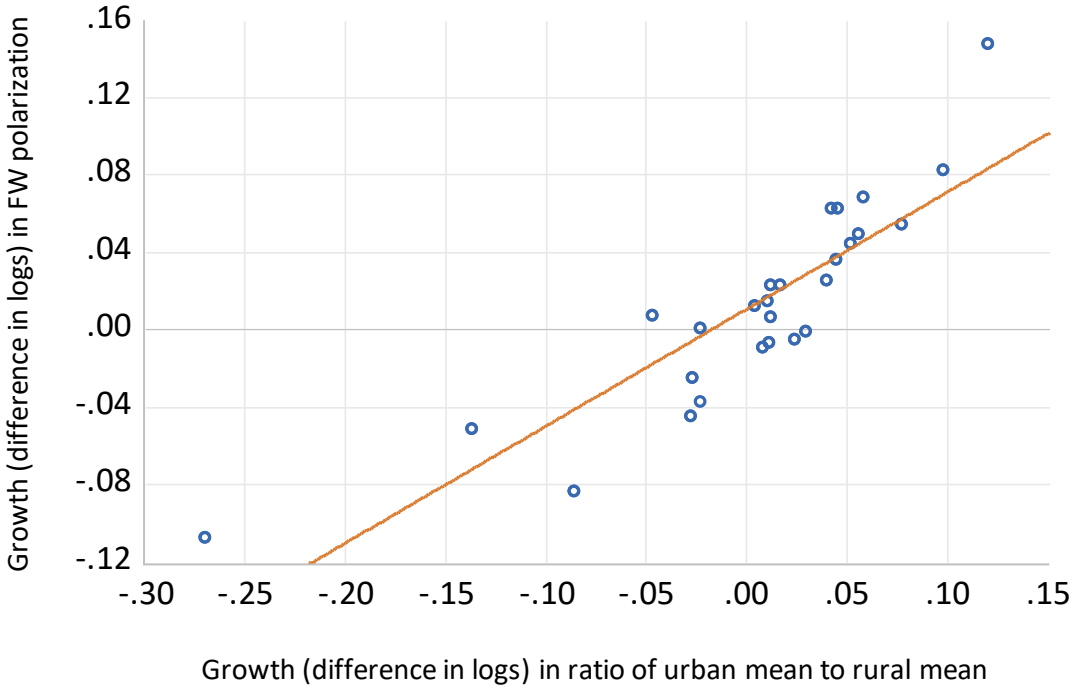
Note: Authors' calculations

Figure 6: Components of the polarization index



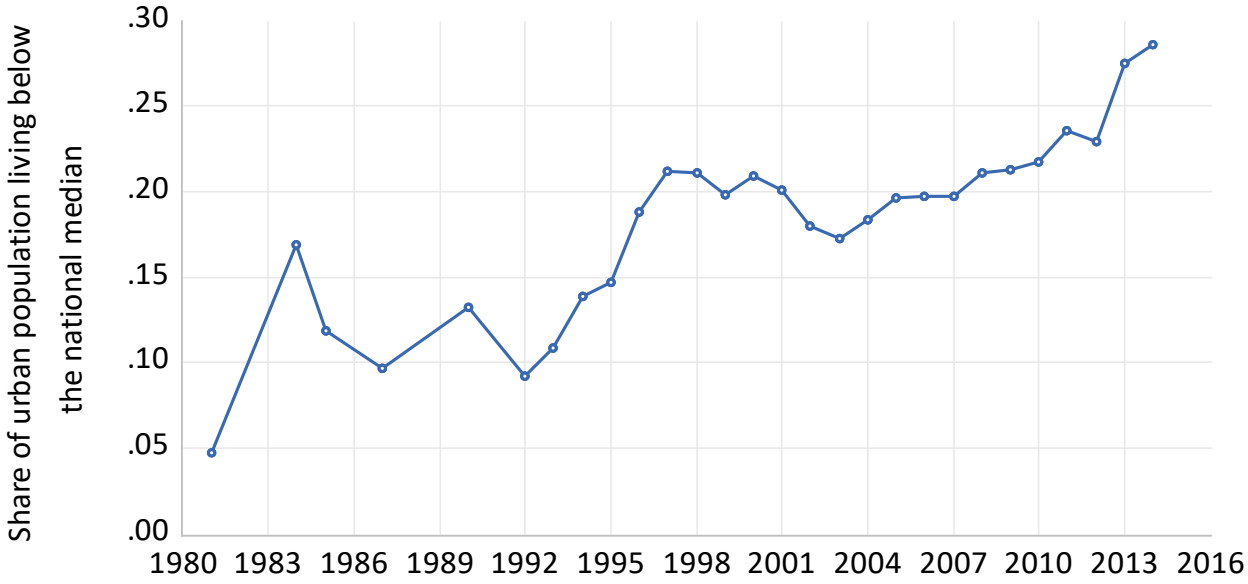
Note: Authors' calculations

Figure 7: Plot of growth in the polarization index against growth in the ratio of the urban mean to the rural mean



Note: Authors' calculations

Figure 8: Share of the urban population living below the national median



Note: Authors' calculations

Table 1: Estimated decile shares of income for China

	Income shares by deciles ranked by income per person (%)									
	1	2	3	4	5	6	7	8	9	10
1981	3.78	5.06	6.17	7.21	8.25	9.37	10.67	12.36	15.01	22.12
1984	3.87	5.37	6.44	7.45	8.49	9.61	10.88	12.41	14.57	20.91
1985	3.69	5.19	6.39	7.46	8.49	9.58	10.81	12.39	14.83	21.17
1987	3.20	4.64	5.86	7.00	8.13	9.35	10.76	12.59	15.45	23.02
1990	3.20	4.47	5.62	6.73	7.87	9.12	10.60	12.56	15.66	24.17
1992	2.78	4.08	5.27	6.42	7.60	8.91	10.47	12.54	15.90	26.02
1993	2.59	3.81	4.95	6.09	7.29	8.62	10.23	12.41	16.01	28.01
1994	2.43	3.73	4.92	6.07	7.26	8.58	10.15	12.28	15.80	28.76
1995	2.48	3.77	4.97	6.15	7.38	8.74	10.37	12.56	16.15	27.43
1996	2.64	4.03	5.26	6.42	7.59	8.87	10.38	12.39	15.68	26.74
1997	2.60	4.02	5.26	6.43	7.61	8.90	10.41	12.42	15.70	26.65
1998	2.64	3.97	5.17	6.33	7.51	8.81	10.36	12.42	15.80	27.00
1999	2.52	3.82	5.01	6.18	7.39	8.74	10.35	12.50	16.04	27.46
2000	2.24	3.53	4.74	5.93	7.17	8.56	10.24	12.50	16.24	28.86
2001	2.12	3.41	4.61	5.81	7.06	8.47	10.16	12.45	16.26	29.65
2002	2.00	3.22	4.40	5.60	6.87	8.32	10.08	12.48	16.52	30.51
2003	1.85	3.07	4.26	5.48	6.78	8.27	10.09	12.57	16.74	30.90
2004	1.95	3.13	4.29	5.48	6.76	8.22	10.01	12.48	16.62	31.06
2005	1.85	3.04	4.21	5.41	6.70	8.17	9.97	12.44	16.62	31.60
2006	1.82	3.00	4.18	5.40	6.72	8.25	10.12	12.70	17.01	30.80
2007	1.75	2.98	4.18	5.42	6.76	8.28	10.15	12.70	16.97	30.81
2008	1.71	2.93	4.13	5.37	6.71	8.25	10.13	12.71	17.02	31.02
2009	1.61	2.88	4.12	5.39	6.77	8.33	10.25	12.86	17.19	30.61
2010	1.68	3.01	4.29	5.57	6.93	8.46	10.31	12.82	16.96	29.97
2011	1.54	3.01	4.36	5.68	7.05	8.57	10.39	12.82	16.82	29.76
2012	1.52	3.02	4.39	5.73	7.13	8.67	10.51	12.96	16.96	29.11
2013	1.84	3.27	4.57	5.85	7.17	8.62	10.36	12.69	16.52	29.10
2014	1.66	3.29	4.70	6.04	7.39	8.86	10.58	12.85	16.54	28.09

Note: Authors' calculations based on distributions of household per capita income produced by China's National Bureau of Statistics. (See text for details.)

Table 2: Foster-Wolfson polarization indices and Gini indices for China

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Mean income ($/day/person; 2011 prices)			Gini index (x100)			Foster-Wolfson polarization index			Median ($/day/p.; 2011 prices)	Urban population share (%)
	National	Rural	Urban	National	Rural	Urban	National	Rural	Urban		
1981	1.18	1.00	1.89	28.18	24.73	18.46	24.75	20.28	15.14	1.03	20.13
1984	1.64	1.49	2.16	26.40	26.69	17.79	22.92	21.61	14.67	1.48	22.22
1985	1.72	1.53	2.35	27.04	27.12	17.05	23.35	21.89	13.81	1.55	22.86
1987	1.86	1.58	2.73	30.51	29.45	20.20	27.09	24.16	16.26	1.62	24.26
1990	1.94	1.60	2.90	32.00	29.87	23.42	28.84	24.90	19.24	1.65	26.45
1992	2.19	1.71	3.41	34.81	32.03	24.17	31.33	26.09	19.17	1.80	28.20
1993	2.34	1.77	3.73	37.27	33.71	27.18	33.55	27.26	22.39	1.85	29.11
1994	2.54	1.90	4.05	38.00	33.84	29.22	33.36	26.87	24.52	2.01	30.04
1995	2.75	2.09	4.25	37.02	33.98	28.27	33.60	28.64	23.58	2.21	30.95
1996	3.01	2.36	4.41	35.43	32.98	28.52	30.94	27.90	23.90	2.47	31.91
1997	3.18	2.50	4.56	35.42	33.12	29.35	30.96	27.70	24.63	2.61	32.89
1998	3.36	2.61	4.82	35.87	33.07	29.94	31.69	27.64	25.01	2.73	33.87
1999	3.6	2.71	5.27	36.84	33.91	29.71	33.16	28.29	25.33	2.90	34.86
2000	3.79	2.76	5.61	38.94	35.70	31.87	35.30	29.99	27.39	2.97	35.89
2001	4.07	2.88	6.09	39.97	36.49	32.32	36.21	30.37	27.50	3.15	37.09
2002	4.52	3.03	6.90	41.35	37.03	32.65	38.27	30.91	27.33	3.41	38.43
2003	4.89	3.16	7.53	42.27	38.04	32.51	39.70	31.72	27.32	3.66	39.77
2004	5.32	3.37	8.10	42.12	36.84	33.32	39.33	30.47	28.08	3.96	41.14
2005	5.88	3.66	8.88	42.83	37.68	34.01	39.92	30.56	29.28	4.35	42.52
2006	6.53	3.97	9.81	42.54	37.33	33.66	40.88	31.17	28.76	4.86	43.87
2007	7.36	4.35	11.00	42.61	37.38	33.26	40.66	31.63	28.47	5.50	45.20
2008	8.06	4.69	11.93	42.96	37.70	34.02	41.16	32.18	29.37	6.00	46.54
2009	8.93	5.10	13.10	42.91	38.41	33.52	41.45	33.37	28.99	6.70	47.88
2010	9.82	5.65	14.12	41.87	37.79	33.01	39.65	32.97	28.08	7.52	49.23
2011	10.85	6.30	15.30	41.67	39.01	32.71	38.71	33.78	27.04	8.44	50.57
2012	11.93	6.70	16.78	41.22	38.66	31.64	38.67	33.89	26.66	9.38	51.89
2013	13.15	8.07	17.63	40.16	36.51	34.01	36.75	30.52	28.67	10.34	53.17
2014	14.26	8.82	18.81	39.38	37.74	32.86	35.69	32.44	27.60	11.54	54.41

Note: Authors' calculations based on distributions of household per capita income produced by China's National Bureau of Statistics. (See text for details.)

Table 3: Testing the effect of economic growth on income polarization
$lnP_t = \alpha_0 + \alpha_1 lnP_{t-1} + \beta_0 ln\mu_t + \beta_1 ln\mu_{t-1} + \gamma t + \varepsilon_t$

Dep.var.:	(1) lnP_t	(2) ΔlnP_t	(3) ΔlnP_t	(4) lnP_t	(5) ΔlnP_t
Constant	-32.162	4.969***	7.136**	-80.476**	5.929**
	(15.933)	(1.908)	(2.781)	(36.300)	(2.579)
lnP_{t-1}	0.758***			0.856***	
	(0.159)			(0.154)	
$ln\mu_t$	-0.438***				
	(0.109)				
$ln\mu_{t-1}$	0.247**				
	(0.120)				
$\Delta ln\mu_t$		-0.465***	0.203		
		(0.075)	(0.417)		
Log current GDP pc				-0.643*	
				(0.365)	
Lagged log GDP pc				0.175	
				(0.353)	
Growth in GDP pc					-0.270
					(0.742)
t	0.017*	-0.002**	-0.004	0.040**	-0.003**
	(0.008)	(0.001)	(0.001)	(0.018)	(0.001)
R^2	0.947	0.355	0.331	0.936	0.167
	27	27	26	27	27
Wald test F	2.737			3.023	
(prob.)	(0.087)			(0.069)	

Note: n=27, except Column (3) which drops 1981 and 1984. Standard errors in parentheses are robust to the presence of both heteroskedasticity and autocorrelation of unknown form (assuming that the autocorrelations fade out for more distant observations); see Newey and West (1987). Wald test for H_0: $\alpha_1 = 1$, $\beta_0 + \beta_1 = 0$.
***: 1% significance; **: 5%; *10%.

Table 4: Relationship between overall polarization and the urban-rural mean income gap
$lnP_t = \alpha_0 + \alpha_1 lnP_{t-1} + \beta_0 ln(\mu_U/\mu_R)_t + \beta_1 ln(\mu_U/\mu_R)_{t-1} + \gamma t + \varepsilon_t$

Dep.var.:	(1) lnP OLS	(2) ΔlnP OLS	(3) ΔlnP 2SLS
Constant	1.157	3.630***	3.721**
	(1.639)	(0.841)	(1.036)
lnP_{t-1}	0.703***		
	(0.140)		
$ln(\mu_U/\mu_R)_t$	0.638***		
	(0.078)		
$ln(\mu_U/\mu_R)_{t-1}$	-0.392**		
	(0.104)		
$\Delta ln(\mu_U/\mu_R)_t$		0.528***	0.415***
		(0.074)	(0.042)
t	-0.000	-0.002***	-0.002***
	(0.001)	(0.000)	(0.000)
R^2	0.984	0.752	0.845
Wald test F	2.724		
(prob.)	(0.088)		

Note: n=27. Robust standard errors in parentheses (Table 3). Column (3) uses the growth rate of primary sector DP per person as the IV. Wald test for H_0: $\alpha_1 = 1$, $\beta_0 + \beta_1 = 0$. ***: 1% significance; **: 5%; *10%.

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