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Education fever: Inequality, fertility and growth

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Education fever: Inequality, fertility and growth

Mark Gradstein*

Abstract

Demand for skilled labor and social status accorded by educational achievements induce a race to acquire education, dubbed "education fever". In conjunction with credit market constraints and in the context of quantity-quality tradeoff, this, in turn, may reduce fertility, especially in well-educated families, and create cross section inequality while limiting intergenerational mobility. The resulting inequality is persistent which, in turn, may have adverse implications for economic growth. It is argued that these phenomena are consistent with recent economic and social developments in China.

Keywords: Education fever, human capital, fertility, inequality, China
JEL classification: D13, J13, O11, Z13

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Non-technical summary

Focus

Demand for skilled labor and social status accorded by educational achievements induce a race to acquire education, dubbed "education fever". In conjunction with credit market constraints and in the context of quantity-quality trade-off, this, in turn, may reduce fertility, especially in well-educated families, and create cross section inequality while limiting intergenerational mobility. The resulting inequality is persistent which, in turn, may have adverse implications for economic growth. It is argued that these phenomena are broadly consistent with recent economic and social developments in China.

Contribution

We explore the effects of education fever on income inequality, fertility, and economic growth prospects. The analytical model yields closed form solutions with explicit relationships between variables of interest. Its calibrations to China's economy indicates likely effects social norms and policy changes may have on long term development of the country.

Findings

Education fever, the social status motive to strive for educational achievements, prevalent among richer families, results in persistently high inequality, low intergenerational mobility, and low fertility – all of which may have long run growth implications. Calibrations to China's economy reveal that income inequality, whose evolution is well matched by the calibrated model, is very sensitive to social norms and policies restricting education fever. In particular, the private tutoring ban of 2021, if strictly enforced, may go a long way to reducing long run inequality.

1. Introduction

In many countries, education, beyond its consumption and human capital benefits, is also valued as a marker of social status. Recent skill biased technical changes and globalization have enhanced the demand for skilled workers and intensified the pursuit of educational attainment. In the US context, the resulting rat race and its implications, in particular, for inequality, social mobility, and welfare, are well discussed in Markovits (2019) according to which failure to achieve high valued education results in low social status, leading to "political humiliation". This, in turn, leads to grueling competition for places in elite high schools and colleges across the US. While the phenomenon as such was recognized already sometime ago, also on a global scale and its implications for economic growth addressed in the literature (Dore, 1976; Gradstein and Justman, 1995), it seems that its manifestations have intensified more recently, in particular, because of increased globalization.

Specifically, "education fever" is pronounced in some East Asian nations.[1] Indeed, Hong Kong, Taiwan, and South Korea occupy three top places in PISA 2022, an internationally comparable study of academic achievements by teenagers, and this is just one measure of reflection of educational achievements of East Asian students. In International Mathematics Olympiads, China's students have consistently outperformed students from other countries since its first showing in 1985 (https://www.imo-official.org/), and similar is the case with Olympiads in other scientific subjects. Some scholars suggest that this drive for schooling has deep rooted historical origins in ancient China, with the imperial civil service examination *Keju* that began in 605 AD in Sui Dynasty having had a tremendous influence on Chinese

[1] Thus, the term was first coined in the context of South Korea.

society as well on neighboring countries.[2]

The deep-rooted cultural emphasis on education complemented structural changes in China's economy in recent decades. Increased openness to world trade induced a huge inflow of physical capital, enhancing the demand for high skilled labor, which led to a significant increase in the demand for tertiary education. College admission is both a bridge to successful life for high school students in China and is a symbol of success. For example, Chen et al. (2020) provide carefully corroborated evidence pertaining to the persistent effect of the *Keju* tradition on modern schooling. Both anecdotal and academic accounts attest to education having become a social status symbol in modern China (Zheng, 2017; Zhou and Wang, 2018), so much that parents make significant material sacrifices, foregoing family consumption in order to pursue educational attainment for their children.

The full range of social implications of educational attainments carrying such an immense weight in the light of high demand for education on one hand and constraints whose intensity is inversely related to family on the other hand, is not entirely clear and is subject to informed speculations. One potential concern is that it may exacerbate income inequality between those who can and are willing to invest in education and the rest. Another issue is related to the quality-quantity tradeoff and its implications. Specifically, to the extent that education drive channels resources to schooling and reduces fertility, this may result in population decrease, with potentially detrimental effects, among others, on innovation, and economic growth.[3] Rising inequality and reduced social mobility resulting from differential drive to invest in

[2] As an illustration of the imprint of the system on state bureaucracy, in Tang Dynasty, the vast majority of the prime ministers were from *Jinshi* (a successful candidate in the highest imperial examinations). While the imperial civil service examination has been abolished for over a hundred years now, its influence on Chinese culture and education still exists, and grueling college entrance examination in China nowadays can be seen as extension and variation from the imperial civil service examination.

[3] See Heckman and Yi (2012) for an insightful analysis of looming issues in this regard.

education are other concerns that may also have consequences for productivity and growth.

In this paper, we purport to study the implications of a drive to pursue academic achievements for income inequality, fertility, human capital accumulation, and economic growth. To this end, we entertain an augmented version of a standard analytical model of an economy populated by households with different endowments of human capital and income, whereby family size and human capital investment decisions are endogenously determined. One novel feature of the augmented model, tailored to reflect the education fever effect, is social status as derived from a family's education spending in relation to the average in one's cohort; further, its differential value hinges upon such spending exceeding or being below the average.[4] This provides high powered incentives to invest in human capital. Further, this feature coupled with our focus on households differing with respect to human capital enables us to explore its implications for persistence of income inequality, in addition to exploring those for aggregate economic growth.

Our analysis reveals that richer families spend on education more and have a smaller number of children than poor families. Consequently, differential social status does lead to persistent income gap between the rich and the poor. Provided that the marginal productivity of education spending is sufficiently high, the rich also attain a higher level of human capital than the poor. The aggregate effects of status differentials are generally ambiguous, and we provide conditions under which they may spur accumulation of human capital and of a population group, despite reduced fertility. Yet, inequality in the acquisition of human capital that results as a consequence of large status

[4] Cf., "Apart from economic payoffs, social status (social rank) seems to be the most important incentive and motivating force of social behavior. This concern for social status is perhaps more conspicuous in those societies, like the American, where the ruling ideology encourages a striving for upward social mobility, for movement to higher social status positions." Harsanyi (1980).

differentials could be detrimental for productivity growth.

We apply the derived insights to the case of China's economy in the past decades and argue that its development is broadly consistent with the model implications. In particular, China has been characterized by education fever, with parents willing to invest massively in their children's human capital; fertility has been on steep decline; and yet, aggregate measures of human capital have been increasing, while inequality (especially along the urban-rural dimension) has been on the rise, with intergenerational persistence in education and income (Li et al., 2014). Our analytical insights suggest that such a large extent of inequality in the acquisition of human capital induced by high status differentials could potentially be an obstacle for China's productivity growth in the long run.

Related literature

This paper is related to several literature strands. One is the work on the nexus of human capital, demography, and economic growth, featuring endogenous fertility decisions, some of the seminal fundamental references being Galor (2011); Galor and Weil (2000); Galor and Zeira (1993) and Galor and Moav (2002).[5] Within this strand, Dahan and Tsiddon (1998) and De la Croix and Doepke (2003) are probably most closely related to our paper in linking education and fertility decisions to inequality and growth. Doepke and Tertilt (2016) contains a very informative literature review on the nexus of relationship between household economics and macroeconomy. Those papers' frameworks, however, are not concerned with inequality persistence, and status concerns are absent there. They could be perceived as providing

[5] Dahan and Tsiddon (1998), De la Croix and Doepke (2003), Hazan and Berdugo (2002), Hazan and Zoabi (2015), and Strulik (2024) represent (an incomplete list of) more recent contributions in this vein.

transitional path underpinnings for the explored nexus of relationships; in fact, Dahan and Tsiddon (1998), specifically focus on the pattern of the relationship along the transition path. In contrast, here the specific nature of status concerns generates persistent inequality, which, in turn, has a bearing on long run productivity.

The social status dimension has also been extensively researched in social sciences. Kawamoto (2009) explores the consequences of social status concerns for income inequality; Corneo and Jeanne (2010) study their implications in the context of economic growth, as do Dioikitopoulos and Varvarigos (2023). Fershtman et al. (1996) argue that such concerns could be detrimental for growth as wealthier but less able individuals "buy" their way into status clubs; Futagami and Shibata (1998) and Tournemaine (2008) are more related to this paper's framework in exploring status effects for long run growth in the context of quantity-quality tradeoff. All these papers, however, abstract from persistent inequality generated and emphasized here.

Gershman (2014) and Hopkins and Kornienko (2006) are examples of studies that explore the effect of inequality induced by differential impact of social status on growth. While the general idea is related to this paper's interest, the details are very different. For example, Gershman (2014) explores the consequences of, what could be termed, zero sum thinking, namely, when envy may drive mutually destructive as opposed to productive efforts. This mechanism is very much different from this paper's framework, which abstracts from destructive behavior focusing instead solely on productive accumulation. Kim et al. (2024) incorporate status concerns in their model of South Korean economy, and their calibrations reveal that these are significant and matter for fertility and education spending decisions in that context, the focus of the paper being the effect of various policies on stabilizing falling fertility. Our setup differs in at least three ways. First, our simple framework

is amenable to generating closed form solutions, which make some of the analytics more transparent. Second, the source of persistent inequality here is the particular nature of social status concerns, as opposed to (mainly) ability differences in Kim et al. (2024).[6] Finally, and most importantly, we explore the implications of status concerns, via fertility and human capital decisions and the resulting inequality, on productivity growth, from which Kim et al. (2024) abstracts. As we view this aggregate implication of status concerns as an important contribution of this paper's framework, its focus, therefore, is quite different from that of Kim et al. (2024).[7]

Also relevant are empirical studies, more in detail reviewed below, that document the rise of income inequality in China (e.g., Piketty et al., 2019); reduction in fertility there (e.g., Zhao and Zhang, 2018), its being an effect of educational expansion (Zhang and Zhao, 2023); and the rise in measures of human capital (Li et al., 2014), alongside with educational inequality (Heckman and Yi, 2012). These studies provide empirical underpinnings and factual relevance for the below arguments, in addition to informing our discussion of the application of our analysis to China.

The rest of the paper proceeds as follows. The next section presents the setup, whose basic analysis is contained in Section 3. Section 4 discusses implications for economic growth and includes an extension that explores the implications of ethnic differentials that emanate from status concerns. Section 5 deals with an application of our framework to China, in particular, calibrating the intertemporal evolution of income inequality there and Section 6 concludes.

[6] While social status concerns feature prominently in Kim et al. (2024) their modelling cannot alone generate inequality persistence.

[7] Our framework is also related to De la Croix and Doepke (2003) which however, abstracts from status concerns.

2. Analytical framework

Consider an economy of successive generations operating in discrete time periods, $t = 0, 1, 2, \ldots$ populated by households indexed by i each endowed with one unit of time and characterized by levels of human capital and income, initial values of which are given. We let $n_{i,t+1}$ denote the number of children in household i, and $l_{it} = 1 - \delta n_{i,t+1}$ is the fraction of time devoted to work, δ being the time cost of child rearing. $s_{i,t+1}$ will denote the amount of parental spending on schooling of a child, and

$$(1) h_{i,t+1} = {s_{i,t+1}}^{\theta}, 0 < \theta < 1$$

denotes the resulting level of human capital. Income, y_{it} is produced by human capital and time at work,

$$(2) y_{it} = A_t h_{it} l_{it}$$

where $A_t > 0$ is a TFP coefficient that will be elaborated upon later. For now we point out that this coefficient embodies knowledge relevant for production, such as scientific or managerial one and is assumed to be exogenously given, to be endogenized later.

Parents determine the amount of resources devoted to schooling of a child, $s_{i,t+1}$, the number of children, $n_{i,t+1}$ (hence, the total amount of family resources devoted to schooling, $s_{i,t+1} n_{i,t+1}$), and, ultimately, the allocation of household income between family consumption and schooling, respecting the budget constraint:

$$(3) y_{it} = A_t h_{it} l_{it} = A_t h_{it}(1 - \delta n_{i,t+1}) = c_{it} + s_{i,t+1} n_{i,t+1}$$

Credit constraints implied by equation (3) carry two important implications for the subsequent analysis. One is the quantity-quality tradeoff parents face when choosing family size and schooling investment. Another is the inequality in human capital investment decisions.

We normalize the population size in period 0 to one, assuming that, initially, the population consists of two groups, indexed $j = r, p,$ with $h_{r0} > h_{p0} \geq 0,$ with their respective size $q_{r0} = 1 - q_{p0} < 0.5$. The population demographics will endogenously evolve over time; for example, group size evolves as follows: $q_{j,t+1} = q_{j,t} n_{j,t+1}$.

Whereas the above is all fairly standard (e.g., De la Croix and Doepke, 2003, Galor and Moav, 2002, Galor and Weil, 2000), we now augment the setup by assuming that education spending is the determinant of social status. In particular, we assume that a person's social status is derived as a function of own parents' spending on education relative to the population average; in general, $SS_{i,t+1} = g(s_{i,t+1}, s_{t+1})$, where s_{t+1} is the average level of education spending per worker in one's cohort, and the function g increases in the first argument and decreases in the second.[8] We specifically assume:

$$(4) SS_{i,t+1} = \gamma_{high} log\left(\frac{s_{i,t+1}}{s_{t+1}}\right) \text{ if } s_{i,t+1} \geq s_{t+1}, = \gamma_{low} log\left(\frac{s_{i,t+1}}{s_{t+1}}\right) \text{ if } s_{i,t+1} < s_{t+1}, \gamma_{low} < \gamma_{high}$$

which implies that status is derived from own education spending relative to the cohort average, more so when it exceeds the cohort average. While the absolute values of γ_{high} and γ_{low} reflect the weights of social status, it is the differential, $\gamma_{high} - \gamma_{low}$, interpreted as the marginal value of social status, that will be important.[9]

The discontinuity in the social status function implied by (4) will play an important role in generating persistent inequality, which is an essential feature of the framework. One possible reason for such, in particular, in the context of education, has to do with social interactions with peers. This is very

[8] Alternatively, one could think of status being determined as a function of human capital. As this would lead to very similar analysis, we prefer the somewhat simpler formulation.

[9] The specialized case in (4) enables us to derive closed form solutions, but the main results remain intact under more general specifications, provided only that there is a discrete wedge between households whose education spending exceeds the average and those whose spending is below the cohort's average.

well articulated in Rivera (2016), where it is shown how social class determines educational paths, which leads to social connections useful to land lucrative jobs. Lombardo (2021), incorporates this insight in economic modelling, albeit in a different way from that pursued here. Michelman et al. (2022), explores one specific channel for valuable social interactions in college, exclusive clubs at Harvard, showing that, following graduation from elite private schools, students were better positioned to be admitted relative to a comparison group with stronger academic records, and, further, club membership at college provided additional benefits in terms of earnings upon graduation. Such interactions seem to be no less important in China as well. *Guanxi*, specifically, alumni networks among graduates of elite universities are very powerful and place an important role in cultivating social capital in its members (Ruan, 2017). More generally, the crucial point here is that being above average delivers additional benefits – whether it is achieving a higher education ladder or in the job market – relative to being below it.[10]

Parents derive utility from family consumption, the number of children, the amount spent on their education,[11] and their status derived from human capital, as defined in (4). We then write:

$$(5) U_{it} = \log(c_{it}) + \alpha \log(n_{i,t+1}) + \beta \log(s_{i,t+1}) + SS_{i,t+1}$$

In each period, the parents choose family consumption, investment in schooling, and the number of children, so as to maximize their utility subject to the budget and production constraints. We are interested in a time consistent equilibrium sequence of such decisions.

[10] Of course, the average is just a convenient benchmark, and its alternative stipulations would yield similar results.

[11] This reflects parental altruism. The level of human capital of all offsprings in a family will be the same.

3. Analysis

We first consider a one period equilibrium, then embed it in the multiperiod setup to analyze the economy's intertemporal evolution. Substituting the constraints we re-write parental utility:

(6) $U_{it} = \log\left(A_t h_{it}(1 - \delta n_{i,t+1}) - s_{i,t+1} n_{i,t+1}\right) + \alpha \log\left(n_{i,t+1}\right) + \beta \log\left(s_{i,t+1}\right) + SS_{i,t+1}$

where $SS_{i,t+1}$ is given by (4).

Assuming internal solutions, the first order conditions with respect to $n_{i,t+1}$ and $h_{i,t+1}$ are:

(7a) $-\frac{1}{c_{it}}\left(A_t h_{it}\delta + s_{i,t+1}\right) + \frac{\alpha}{n_{i,t+1}} = 0$

(7b) $-\frac{1}{c_{it}}\left(n_{i,t+1}\right) + \frac{\beta + \gamma_{i,t+1}}{s_{i,t+1}} = 0, \gamma_{i,t+1} = \gamma_{high}\ if\ s_{i,t+1} \geq s_{t+1};\ \gamma_{i,t+1} = \gamma_{low}\ if\ s_{i,t+1} < s_{t+1}$

Solving this system, we obtain: [12]

(8) $s_{i,t+1} = \frac{(\beta + \gamma_{i,t+1}) A_t h_{it} \delta}{\alpha - (\beta + \gamma_{i,t+1})}$, $n_{i,t+1} = \frac{\alpha - (\beta + \gamma_{i,t+1})}{\delta(1+\alpha)}$

Plugging these values back into the utility functions, we obtain that the higher current human capital level h_{it} the more advantageous it is to invest in that of own children in order for them to achieve social status. As there are two population groups that differ with respect to human capital initially, it is then clear that only the well endowed parents will achieve one for their children by making schooling investment above the average; and so will be the case throughout. It then follows that

(9) $s_{r,t+1} = \frac{(\beta + \gamma_{high}) A_t h_{rt} \delta}{\alpha - (\beta + \gamma_{high})}$, $h_{r,t+1} = \left[\frac{(\beta + \gamma_{high}) A_t h_{rt} \delta}{\alpha - (\beta + \gamma_{high})}\right]^{\theta}$, $n_{r,t+1} = n_r = \frac{\alpha - (\beta + \gamma_{high})}{\delta(1+\alpha)}$;

[12] We assume α large enough to ensure internal solutions.

$$s_{p,t+1} = \frac{(\beta+\gamma_{low})A_t h_{pt}\delta}{\alpha-(\beta+\gamma_{low})}, h_{p,t+1} = [\frac{(\beta+\gamma_{low})A_t h_{pt}\delta}{\alpha-(\beta+\gamma_{low})}]^{\theta}, n_{p,t+1} = n_p = \frac{\alpha-(\beta+\gamma_{low})}{\delta(1+\alpha)}$$

The average level of human capital in each population group evolves as follows:

$$(10) H_{j,t+1} = h_{j,t+1}n_{j,t+1} = {s_{j,t+1}}^{\theta} n_j$$

and straightforward differentiations reveal that $\frac{\partial s_{r,t+1}}{\partial \gamma_{high}}, \frac{\partial h_{r,t+1}}{\partial \gamma_{high}} > 0, \frac{\partial n_r}{\partial \gamma_{high}} < 0, \frac{\partial s_{p,t+1}}{\partial \gamma_{low}}, \frac{\partial h_{p,t+1}}{\partial \gamma_{low}} > 0, \frac{\partial n_p}{\partial \gamma_{low}} < 0.$

A higher status value increases the amount spent on education, hence, the level of human capital, at the expense of the number of kids.

Further,

$$(11) Sign(\frac{\partial H_{r,t+1}}{\partial \gamma_{high}}) = Sign(\theta \frac{\partial s_{r,t+1}}{\partial \gamma_{high}} n_r + {s_{r,t+1}}^{\theta} \frac{\partial n_r}{\partial \gamma_{high}}), and\ Sign(\frac{\partial H_{p,t+1}}{\partial \gamma_{low}})$$
$$= Sign(\theta \frac{\partial s_{p,t+1}}{\partial \gamma_{low}} n_p + {s_{p,t+1}}^{\theta} \frac{\partial n_p}{\partial \gamma_{low}})$$

which are positive when the marginal productivity of education spending is high and the human capital effect dominates, and negative otherwise, when the fertility effect dominates; see the appendix for the proof.

We then have:

Proposition 1. A higher absolute status value has a positive effect on an individual human capital level of spending and a negative effect on fertility. Consequently, the aggregate level of human capital of each of the population groups increases (decreases) in status value when the elasticity of human capital with respect to spending is large (small) enough.

The opposing effects of status value on education spending and fertility imply

that, generally, the ultimate effect on aggregate human capital is ambiguous and depends on the elasticity of education spending. In particular, provided that the elasticity is high, the aggregate level of human capital may increase in response to an increase in social status value, despite the associated decrease in fertility. One interpretation of this result is that status concerns have an "extensive margin" effect on reducing fertility and an "intensive margin" effect of enhancing education spending, and the ultimate outcome depends on the relative importance of these two effects.

A steady state of distribution is defined as human capital and fertility ratios between the two population groups that are constant over time.[13] Now, fertility levels in each group are constant throughout, and with respect to human capital ratios we obtain the following steady state values:

$$(12)\ h_r/h_p = [\frac{(\beta+\gamma_{high})}{\alpha-(\beta+\gamma_{high})}/\frac{(\beta+\gamma_{low})}{\alpha-(\beta+\gamma_{low})}]^{1/(1-\theta)}$$

or, recalling the constant fertility levels, we can write

$$(12')\ h_j = [\frac{\alpha}{n_j\delta(1+\alpha)}-1]^{1/(1-\theta)}, j=p,r$$

where the ratio h_r/h_p increases (decreases) in γ_{high} (γ_{low}).

It then follows that the income ratio between the two groups also tends to the steady state, given by

$$(12")\ \frac{y_r}{y_p} = \frac{h_r}{h_p}\frac{1-\delta n_r}{1-\delta n_p}$$

Where the numerator (denominator) increases with status concerns of the rich (poor), and direct comparisons yield:

Proposition 2. In each period, and in the steady state of the distribution, the

[13] The levels of human capital in each group depend on total factor productivity.

households with initially high level of human capital have fewer children and more human capital and income than less well initially endowed ones.

This result, in particular, indicates that income inequality is persistent, despite diminishing returns to scale in the production of human capital. The reason for this is the difference in the value of social status: when $\gamma_{high} = \gamma_{low}$, income convergence takes place, and the larger status differentials the higher is the steady state income inequality. This, while important in itself, may have implications for the economy's growth as will be made clear next. While inequality persistence could be generated via certain types of market imperfections or externality effects, differential social status concerns can be viewed as an additional, novel mechanism in this regard. This mechanism is also consistent, in the US context at least, with the prevalence and persistence of social and economic dominance by certain ethnic groups (see Baltzell, 1964, for such an account of the Protestant elite).

4. Growth implications

A potential concern in regard to education fever is that the resulting increase in the amount of resources devoted to schooling would lead to a decline in fertility because of the quality-quantity tradeoff, which would then have an ambiguous impact on the accumulation of knowledge and potentially slow down the rate of economic growth (provided that the elasticity of education spending is small enough). Another issue is that of an unequal accumulation of human capital, with potential detrimental effects on growth. To explore these possibilities, we turn to the determination of productivity, which thus far has been assumed exogenous.

In particular, we now specify:

$$(13)\ \frac{A_{t+1}-A_t}{A_t} = {A_t}^{-\tau} f\left(H_{r,t+1}, H_{p,t+1}\right), \tau > 0$$

where f increases in both arguments.[14]

Thus, productivity depends on aggregate human capital in the population groups, and its intertemporal evolution hinges upon the composition of average human capital accumulation of the two population groups. Note that the latter depends both on human capital and population changes of each group, see equation (10). The value of human capital for productivity expresses itself not only through innovations, but also via the ability to adopt existing inventions at a low cost. In its absence, from (13), productivity declines. The stipulation that human capital enhances TFP is pertinent in the application to China considered below, whereby Fleisher et al., 2010, find a robust support for this relationship. Drawing on Proposition 1, the rate of productivity growth, being dependent on human capital in the population, responds to the increase in absolute values of status value in two opposite ways: the fertility effect tends to slower it, while the human capital effect tends to speed it up. As indicated in Proposition 1, the ultimate aggregate human capital, hence, productivity effect, depends on the elasticity of education spending, represented by the parameter θ.

The nature of aggregation of the two groups' human capital is also important. To illustrate, suppose that it satisfies a version of CES function:

$$(13')f\left(H_{r,t+1}, H_{p,t+1}\right) = {H_{r,t+1}}^{\mu} + {H_{p,t+1}}^{\mu}, 0 \le \mu \le 1$$

where the parameter μ captures the degree of diminishing marginal product of human capital. This follows the specification in Jones (2014), which stipulates a less than perfect elasticity of substitution between human capital levels, such

[14] For a positive τ this captures the "ideas gets harder to get" paradigm. Recalling that fertility rates are constant over time but differ across population groups, (13) also implies that TFP changes are responsive to demographic composition changes.

as skilled and unskilled.

Then the productivity growth rate is

$$(14)\ \frac{A_{t+1}}{A_t} - 1 = {A_t}^{-\tau}[{H_{r,t+1}}^{\mu} + {H_{p,t+1}}^{\mu}],$$

where $H_{r,t+1} = \left(\frac{(\beta+\gamma_{high})A_t h_{rt}\delta}{\alpha-(\beta+\gamma_{high})}\right)^{\theta} (\frac{\alpha-(\beta+\gamma_{high})}{\delta(1+\alpha)})$,

$H_{p,t+1} = \left(\frac{(\beta+\gamma_{low})A_t h_{pt}\delta}{\alpha-(\beta+\gamma_{low})}\right)^{\theta} (\frac{\alpha-(\beta+\gamma_{low})}{\delta(1+\alpha)})$.

Recalling Proposition 1, the bracketed expression above increases with the absolute social status values provided that the elasticity of education spending is high enough. Let $\gamma'_{high} = \gamma + \varepsilon, \gamma'_{low} = \gamma - \varepsilon, \gamma > \varepsilon > 0$, so that higher values of ε represent a larger status differential. Taking the derivative, we obtain:[15]

$$(15)\ \frac{\partial\left(\frac{A_{t+1}}{A_t} - 1\right)}{\partial\varepsilon} = {A_t}^{-\tau}\mu[{H_{r,t+1}}^{\mu-1}\frac{\partial H_{r,t+1}}{\partial\varepsilon} + {H_{p,t+1}}^{\mu-1}\frac{\partial H_{p,t+1}}{\partial\varepsilon}]$$

Suppose first that $\mu = 1$, so that human capital levels of the population groups are perfect substitutes. As follows from Proposition 1, when the marginal productivity of education spending θ is large, $\frac{\partial H_{r,t+1}}{\partial\varepsilon} > 0, \frac{\partial H_{p,t+1}}{\partial\varepsilon} < 0$.

Further, since for μ=1 (14) can be rewritten as:

[15] For simplicity, one may think of the expression that follows as being evaluated at the steady state of the distribution.

$$(16)\ \frac{A_{t+1}-A_t}{A_t}$$

$$= {A_t}^{\theta-\tau}[q_{rt}\left(\frac{(\beta+\gamma_{high})h_{rt}\delta}{\alpha-(\beta+\gamma_{high})}\right)^{\theta}(\frac{\alpha-(\beta+\gamma_{high})}{\delta(1+\alpha)})$$

$$+ q_{pt}\left(\frac{(\beta+\gamma_{low})h_{pt}\delta}{\alpha-(\beta+\gamma_{low})}\right)^{\theta}(\frac{\alpha-(\beta+\gamma_{low})}{\delta(1+\alpha)})],$$

it follows that the economy can potentially exhibit increasing rate of productivity growth, provided that $\theta \geq \tau$; when this is the case, human capital and incomes grow as well.[16]

The linear aggregation of the population groups' human capital levels as in the above analysis is an important limitation on the generality of the conclusions. An alternative specification of (13) entails decreasing marginal effects of the respective levels on productivity, or less than perfect substitutability between human capital levels, $\mu < 1$. Arguably, this is a more empirically relevant case to consider, as the marginal return to education is generally considered to be a decreasing function, see e.g. Psacharopoulos and Patrinos (2004). In such a case, even when the elasticity of education spending θ is high, inequality in human capital accumulation between the population groups derived in the previous section constitutes a potential obstacle to productivity improvements, so that (15) can be negative for sufficiently large degrees of curvature, i.e., when μ is small enough.

Proposition 3. When human capital levels are perfect substitutes, provided that the marginal productivity of education spending is high enough, an increase in status differentials results in higher productivity and income growth. With less than perfect substitutability, inequality can constitute an impediment for productivity growth, and an increase in status differential may

[16] A growing population ($n_r, n_p > 1$) reinforces the case for productivity improvements over time; with declining population, the case is less clear cut.

potentially exacerbate it.

While status differentials may enhance aggregate human capital acquisition, the resulting inequality in its accumulation can be detrimental.[17]

5. An application: China's education, inequality, and fertility

In this section, we apply the above theoretical insights to the specific case of China. As described in the introduction, education fever – spending a large amount of resources on school preparatory chores – has become a mainstay in China,[18] especially among well-to-do urban families. Because of a high barrier at the university level, students compete to get into high schools that offer the best preparation, which determines a child's future from an early age. *Guanxi*, social networking in the context of prestigious universities alumni, acts as an "old boys' club" in securing career benefits for its member (Ruan, 2017). Admission to prestigious universities, therefore, carries additional advantages – somewhat similar to exclusive clubs and fraternities in US colleges (Michelman et al., 2022).

Two major reforms took place in the Chinese education system since 1978. One was its transformation to an elite education model, whereby schools are classified into key (prioritized, based on academic achievements) or non-key, and the former are further divided into national, provincial, and district priorities. Middle and high schools select outstanding students for their key classes. Parents are eager to get their children selected, which has led to the proliferation of after-school "shadow" education, including private tutoring and

[17] This result is important, in particular in light of the application to China considered below, because of the rapid rise in inequality there in recent decades; specifically, as will be argued below, China's inequality levels have gone up from being among the lowest to those among the highest in the world in the course of several decades. The appendix considers an extension and application of the basic framework to the case of ethnic inequality; the possibility of its persistence is indicated – again, because of the differential status effect.

[18] While restrictions were recently imposed on private tutoring, their effect is yet to be seen.

extracurricular activities.[19] Another transition that took place was from planned to market funded system, whereby the central government provides funding for key schools, while most other schools are financed by local governments. This has resulted in regional disparities in funding and outcomes, especially between urban and rural schools;[20] additionally, a portion of education spending is funded through tuition fees, which has further enhanced unequal opportunities.[21]

Income inequality has steeply increased in China over the past several decades.[22] As has been pointed out by several observers, while in 1970s, its level was on par with inequality levels of Nordic countries, and among the lowest worldwide (Gini of about 0.25), nowadays, with the Gini coefficient of more than 0.45, it exceeds that of the USA.[23] The share of national income earned by the top 10 percent of the population has increased from 27 percent in 1978 to 41 percent in 2015, while the share earned by the bottom 50 percent dropped in the same period from 27 percent to 15 percent (Piketty et al., 2019). It has been documented that a large portion of this increase can be attributed to the growing urban-rural divide, which is also reflective of education differentials. For example, Heckman (2005), finds enormous regional differences in school financing, resulting in cross sectional and intergenerational inequalities. Guo and Li (2024) show an increase in the urban-rural measures of educational attainment since early 2000s.[24] They

[19] According to some estimates, 93% of China's households entertain private tutoring, more than twice than in the USA.
[20] See Cheng (2009) documenting urban-rural differences in education outcomes.
[21] The toll of extreme competitiveness in schooling, physical and mental, has been noticed recently, giving rise to educational policy reform dubbed Double Reduction Policy, introduced in 2021, which limits private tutoring and the amount of homework. Its effectiveness and implications, however, have not been thoroughly assessed yet.
[22] There are some indications that it is now plateauing, see Kanbur et al. (2021).
[23] Xie and Zhou (2014), estimate the Gini coefficient in 2010 at between 0.50-0.55. Importantly, they attribute the rise in inequality to the urban-rural divide.
[24] See also Connelly and Zheng (2003), and Hannum and Wang (2006).

argue that the *hukou* system of household residence registration, which severely limits geographical and social mobility, creates regional disparities in school financing and incentives to pursue advanced schooling (see Rozelle and Hell, 2020, for its detailed analysis).[25]

China's dramatic reduction in fertility was noted early on (Lavely and Freedman, 1990).[26] Two main explanations for this trend have been family planning policies and socioeconomic changes, with influential observers arguing that the second one having become more prominent recently (Zhao and Zhang, 2018).[27] In particular, several recent studies (Baizan and Nie, 2024, Chen and Guo, 2022, Liu et al., 2024, Zhang and Zhao, 2023) present evidence that educational expansion has resulted in reduced fertility. The dramatic expansion of education in China has had an intergenerational effect. As is shown in Cui et al. (2019), parental education has had beneficial effects on children in terms of their human capital development, and, among other dimensions, on their schooling aspirations, consistent with our findings of persistent intergenerational inequality in human capital and also supported by findings in Qin and Wang (2016), where a high degree of intergenerational persistence in human capital accumulation is documented. Using a variety of measures of human capital, Li et al. (2014) find that these have exhibited an upward trend, despite the decline in fertility, which supports the view that the latter may not be necessarily a harbinger of economic decline, provided that it

[25] Gong (2016) finds a significant detrimental impact of human capital inequality on economic growth in China over the past decades, and several studies have noted a limited extent of social mobility and a large degree of intergenerational transmission of incomes in China, , relative to other countries (see Fan, 2016, Qin and Wang, 2016). Further, as noted in Chen et al.(2015), educational social mobility went down in recent decades. Jin et al.(2011) argue that inequality is associated with status seeking.

[26] It went steeply down from the rate of almost 6 in 1970 to 2.7 at the end of the decade. After hovering at slightly above 2 in 1980s, fertility levels dropped to below replacement of 2.1 from the early 1990s, with total fertility rates of around 1.5 children per woman in the last decades.

[27] It is noteworthy that other East Asian countries have experience fertility drops in the absence of family planning policies.

is compensated by investment in education.[28]

To quantitatively illustrate the mechanism of the model with respect to the evolution of income inequality, we next calibrate the social status motive and then the elasticity of education spending, and conduct sensitivity analysis with respect to the calibrated values. Specifically, following Jones (2022), we set $\delta = 0.12$. This assumed value is also broadly consistent with macro calibrated estimates (e.g., Doepke, 2005; see Doepke and Tertilt, 2016, for a comprehensive review) as well as with empirical evidence (Aguiar and Hurst, 2007; Ramey and Ramey, 2010), where the share of effective parental time spent on a child rearing typically falls in the 10-15% range. Changes in the value of the share of time spent on child rearing, while affecting the calibrated status motives of the two population groups, does not affect their differential – which is the main input for calibrated income inequality below. The utility weight of the number of children, especially in developing countries, is often assumed or implied to be larger than the utility weight parents assign to their human capital, and both are smaller than the weight of family consumption (Manuelli and Seshadri, 2009; Vogl, 2016). Consistent with these studies and specifically following Strulik (2024), we therefore assume the following parameter values: $\alpha = 0.4, \beta = 0.25$. Based on China's Statistical Yearbook, fertility rates in recent decades have averaged around 1.2 and 1.8 in urban and rural areas, respectively; we take these values as proxies for fertility rates of the rich and the poor in the model. To match these values to the model and, recalling the assumption of monoparental families, we then set $n_r = \frac{1.2}{2} =$

[28] Li et al. (2017) while documenting that China has made strides not only in quantity, but also in the quality of human capital as it relates to economic growth, also note that to maintain and further improve this quality, reforms of the education system might be called for to enhance equality of opportunity. Khor et al. (2016) emphasize the low level of educational attainment at the high school level, especially for rural students and point out that, in the absence of progress on this front, China's further economic development may be in jeopardy.

$0.6, n_p = \frac{1.8}{2} = 0.9$ as reflecting the equilibrium fertility rates. We take the human capital ratio between the rich and the poor to be 1.75, which is the ratio between seven and four years of schooling, the average in urban and rural China in 1980, respectively.[29]

Utilizing the above assumed parameter values, the actual fertility rates, along with their equilibrium derived equations as above yields exactly identified $\gamma_{low} = 0.02, \gamma_{high} = 0.07$.[30] Urban families spend almost seventy percent more on education than rural ones (Guo and Li, 2024), which, given lower fertility rates as noted above, implies that their spending per student is about 2.3 as much on average. Given that the urban-rural years of schooling ratio has been relatively stable at 1.75 (the average number of years of schooling recently have been around 14 and 8, respectively) – this implies the elasticity of education spending of $\theta = 0.65$, somewhat lower than the value of 0.8 in Strulik (2024) calibrated for the US economy - which is not surprising because of various inefficiencies, well documented in China's education system, especially in the countryside.

Before proceeding, we provide an overidentifying check, utilizing information on education spending. In particular, we define $\rho_{j,t+1} = \log\left(\frac{s_{j,t+1}}{S_{t+1}}\right)$, where $S_{t+1} = \lambda_p s_{p,t+1} + \lambda_r s_{r,t+1}$ as the group-specific deviation of education spending from the national mean (S_{t+1}).[31] Using the obtained above values, we calculate $\frac{s_{r,t+1}}{S_{t+1}}$ to be about 1.36, indicating that the rich spend more than a third more than the average on education. According to the National Bureau of

[29] This ratio has been relatively the same since then; for example, in 2020, it was 14/8 = 1.75.

[30] From (9), it follows that $\gamma_{high} - \gamma_{low} = (n_p - n_r)\delta(1+\alpha), so\ that\ d(\gamma_{high} - \gamma_{low})/d\alpha = (n_p - n_r)\delta$, which, given the actual fertility rates and the assumed value for the time share spent on child rearing, equals $0.5 \cdot 0.12 = 0.06$, slightly more than 10 percent of the estimated differential. This reflects the relatively low sensitivity of the social status differential with respect to the utility weight of the number of kids; and it is independent of the assumed utility weight of the amount of education spending.

[31] λ_j are the respective population weights; in China, almost 60 percent of the population in recent years have been urban and 40 percent rural – our proxies for the rich and the poor.

Statistics and China Family Panel Studies data, in recent years urban families have spent on education annually about 30 percent more than the national average (roughly 14200 yuan relative to 11000, respectively), implying that the model slightly overestimates the relative education spending of the rich.[32]

We then start the calibration analysis in year 1980, when the transition to the market economy occurred in China and assume that a generation lasts 20 years. Column 2 in Table 1 represents the benchmark case of the evolution of rich-poor income ratio. The estimated inequality ratio of 2.9 in 2020 is similar to the true one of 2.8 as estimated for 2016 (Zhang, 2016). Columns 2-5 show results of sensitivity analyses with respect to the social status parameters. Comparison with the benchmark reveals that incremental decreases (increases) of the social status motive of the rich (poor) result in a substantial reduction of income inequality. For example, when either the social status parameter of the rich incrementally goes down or that of the poor goes up the steady state inequality level (in year 2100) decreases by about twenty percent (cf., columns 3 and 4 versus column 2); and when both take place, it decreases by almost a third, as seen from comparing columns 5 and 2. This indicates a high elasticity of income inequality with respect to the social status motive. Column 6 presents another sensitivity exercise, with respect to the elasticity of education spending that takes there the value of $\theta = 0.55$, some fifteen percent below the benchmark case of 0.65 in column 1.[33] As seen by comparing columns 2 and 6, the inequality effects are robust; for example, the steady state income inequality is reduced in response to the lower elasticity by

[32] I have also performed the joint fit calibration using the three targeted moments: the fertility rates of the rich and the poor, and the deviation of the education spending of the rich from the national average, using standard GMM that minimizes the sum of squared moment residuals under the identity weighting matrix. The generated $(\gamma_r, \gamma_p) = (0.055, 0.014)$, while smaller than the exactly identified values, are reassuringly close to those, with the J statistic indicating a very good fit.

[33] This reduction could be interpreted as resulting from the 2021 crackdown of private tutoring, part of the so called "Double Reduction" education policy, one of the explicit main rationales of which was promoting education equity by levelling the playing field.

more than twenty percent. This indicates that levelling the playing field with respect to schooling expenditures could go a considerable way toward reducing income inequality.[34]

6. Concluding remarks

Demand for skilled labor and social status accorded by educational achievements jointly induce a race to acquire education, a phenomenon that has been dubbed education fever. In conjunction with credit market constraints and in the context of quantity-quality tradeoff, we show that education fever may reduce fertility, especially in well educated families, and create cross section persistent inequality while limiting intergenerational mobility. When productivity depends on the distribution of human capital across households, and the respective human capital levels exhibit complementarity, the resulting inequalities may have adverse implications for productivity growth.

We argue that these phenomena are particularly pertinent to China's economic development. Specifically, education fever and the inequalities it induces are shown to be well consistent with general patterns of China's developments. In particular, the calibrated evolution of income inequality closely matches the observed one. This goes to show that social status accorded by education, in conjunction with credit constraints, may play a significant role in the documented increase in China's income inequality in recent decades.

[34] It is noteworthy in this regard that the current share of private spending on education in China (around 20% out of total education spending) is high relatively to that in developed countries (for example, the OECD average is around 9%; and is even lower in Japan or South Korea), although not unusual for many developing ones.

APPENDIX

Proof of the claim in Proposition 1. We will show the proof for the rich types, the proof for the poor being similar. As

$$\text{Sign}\left(\frac{\partial H_{r,t+1}}{\partial \gamma_{high}}\right) = Sign\left(\theta {s_{r,t+1}}^{\theta-1}\frac{\partial s_{r,t+1}}{\partial \gamma_{high}} n_r + {s_{r,t+1}}^{\theta}\frac{\partial n_r}{\partial \gamma_{high}}\right)$$

it follows that

$$(A1) Sign\left(\frac{\partial H_{r,t+1}}{\partial \gamma_{high}}\right) = Sign\left\{\theta\frac{\partial s_{r,t+1}}{\partial \gamma_{high}} n_r + s_{r,t+1}\frac{\partial n_r}{\partial \gamma_{high}}\right\}$$

$$= Sign\left\{\theta\frac{\alpha A_t h_{rt}}{(\alpha-(\beta+\gamma_{high}))^2}\frac{\alpha-(\beta+\gamma_{high})}{1+\alpha}\right.$$

$$\left.-\frac{(\beta+\gamma_{high})A_t h_{rt}}{\alpha-(\beta+\gamma_{high})}\frac{1}{1+\alpha}\right\} = Sign\left\{\theta\alpha-(\beta+\gamma_{high})\right\}$$

As the bracketed expression increases in θ, is negative when $\theta = 0$ and positive (because of the assumption made to guarantee internal solutions) when $\theta = 1$, it follows that aggregate human capital increases in the status parameter when the returns on education spending are high enough and decreases otherwise.

Proof of Proposition 2. That the rich have fewer children and a higher level of human capital per child than the poor follows directly from Proposition 1. As having fewer children implies more work time, it then follows that income of the rich exceeds that of the poor.

Proof of Proposition 3. The first part of the proposition is proved in the text. Since the claim in the second part is a possibility result, to prove it we exhibit the following example. Let $\theta = 1$. Then, from (15),

$$(A2)\ Sign\frac{\partial\left(\frac{A_{t+1}}{A_t}-1\right)}{\partial\varepsilon} = Sign\left\{\left[(\beta+\gamma_{high})h_{rt}\right]^{\mu-1}h_{rt}-\left[(\beta+\gamma_{low})h_{pt}\right]^{\mu-1}h_{pt}\right\}$$

It follows that productivity decreases in response to a marginal increase in social status differential whenever $(\beta + \gamma_{high})^{\mu-1} {h_{rt}}^{\mu} - (\beta + \gamma_{low})^{\mu-1} {h_{pt}}^{\mu} < 0$. Suppose that $\frac{h_{rt}}{h_{pt}} = 2$ (so that the level of human capital, say the number of years of schooling, of the rich is twice that of the poor), and let $\frac{\beta+\gamma_{high}}{\beta+\gamma_{low}} = 4$, which reflects the social status differential. Then the threshold value of μ is given by: $4^{\mu-1}2^{\mu} = 1$, and $\mu = \frac{2}{3}$. This example illustrates that a reasonably high level of skill complementarity can potentially induce a productivity decrease for an incremental increase in social status differentials, as is argued in the proposition.[35]

Ethnic inequality. We now extend the model to consider a different dimension along which population groups differ. We refer to this dimension as ethnicity for concreteness, but other related immutable cultural variables, such as religion or language, could be subsumed as well. We, therefore, assume that population is divided, in addition to levels of human capital, into two such categories, labelled $j = A, D$, for simplicity assumed of equal size. Further, the initial distribution of human capital in the former group dominates that in the latter group, $h_{pA0} > h_{pD0}$; $h_{rA0} > h_{pA0}$, and the relative size of those with h_{pA0} *and* h_{pD0} is the same (implying that this holds true with respect to those with h_{rA0} *and* h_{rD0}). The rest is as in the baseline case. (For example, in the China application considered below, Han Chinese is a majority ethnic groups, more urbanized and affluent than other, minority ethnic groups.)

The equilibrium decisions in each period then are as in (8), for each of the four configurations of ethnicity and human capital/income endowment. Clearly, those with initial human capital of h_{rA0} will always have an income

[35] Of course, the larger is skill bias (the higher the value of λ) the smaller μ will be.

level above the average, hence, will have achieved the social status benchmark, and those with human capital of h_{pD0} will be below the average. The economy's intertemporal evolution depends, therefore, among other things, on whether $h_{pA0} > h_{rD0}$ or not. Suppose first that the former holds; it would be useful to think of initial human capital differences within each ethnic group as small and across these groups as large. As the same will hold true with respect to family incomes, then the rich from the D group will not invest enough in education spending to attain the social status threshold, whereas the poor from the A group will. It then follows from (9) that:

$$(A3) h_{iA,t+1} = [\frac{(\beta+\gamma_{high})A_t h_{iAt}\delta}{\alpha-(\beta+\gamma_{high})}]^{\theta},\ n_A = \frac{\alpha-(\beta+\gamma_{high})}{\delta(1+\alpha)};\ h_{iD,t+1} = [\frac{(\beta+\gamma_{low})A_t h_{ipt}\delta}{\alpha-(\beta+\gamma_{low})}]^{\theta},\ n_D = \frac{\alpha-(\beta+\gamma_{low})}{\delta(1+\alpha)}$$

In other words, the A group members attain a higher level of human capital and have a lower fertility rate than the D group members throughout. Further, incomes within each ethnic group converge, and steady state of the distribution reflects differences across those groups. If, in contrast, $h_{pA0} < h_{rD0}$, and, further, the levels of human capital of the poor from both ethnic groups are much lower than those of the rich, then the former fail to attain the social status benchmark, whereas the latter do so. In this case, incomes of households from both ethnic groups initially well endowed with human capital converge to a high level, and those with initially low level of human capital converge to a lower level, hence, ethnic differentials dissipate over time.

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Table 1. Calibrating inequality evolution, $\frac{y_{rt}}{y_{pt}}$.

1	2	3	4	5	6
Year	$\gamma_{low} = 0.02$ $\gamma_{high} = 0.07$	$\gamma_{low} = 0.02$ $\gamma_{high} = 0.06$	$\gamma_{low} = 0.03$ $\gamma_{high} = 0.07$	$\gamma_{low} = 0.03$ $\gamma_{high} = 0.06$	$\gamma_{low} = 0.02$ $\gamma_{high} = 0.07$ $\theta = 0.55$
1980	1.97	1.97	1.97	1.97	1.97
2000	2.4	2.13	2.17	1.99	2.19
2020	2.9	2.22	2.31	2	2.32
2040	3.1	2.3	2.39	2	2.4
2060	3.2	2.34	2.44	2.1	2.44
2080	3.3	2.36	2.46	2.1	2.46
2100	3.3	2.37	2.47	2.1	2.48

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