Determinants of Children's Growth in Height at the Individual, Family, and Community Level: The Case for Contemporary China

Shige Song

Institute of Sociology,
Chinese Academy of Social Sciences

1. Introduction: Height, Growth, and Gender Inequality

Children's height is an important indicator of health status and living standards (Waterlow et al. 1977). Age- and sex- standardized measurements in height can be compared among different groups to assess similarities and differences in socioeconomic development, patterns of resources allocation, and institutional settings that have health implications (Burgard 2002; Thomas et al. 1990, 1991). Gender difference in children's height, however, has rarely been the focus of social scientific inquiry, presumably because gender difference in children height is assumed to be largely genetically determined.

It is true that genetic factors play important roles in determining children's height, but it is also true that whether children can fully achieve their genetic potential in height depends on non-genetic factors: nutrition, exposure to infectious diseases, and access to medical facilities (Alter 2004; Eveleth and Tanner 1990). In other words, differences in children's height include two components: a genetic component and a non-genetic (socioeconomic, normative, and institutional) component. In an ideal society where every child can fully achieve his/her genetic potential, comparing boys' and girls' growth trajectory in height may not reveal much information other than their genetic differences. In societies where not every child achieves his/her genetic potential, as long as the selection process through which each child's growth is determined is random and unrelated to socioeconomic, normative, and institutional factors, comparing boys' and girls' growth trajectory in height does not reveal much about the underlying social processes either. Only when the selection process through which some children can fully achieve their genetic potential in height while others cannot, or some children can achieve more than others, is determined by socioeconomic, normative, or institutional factors, can comparing boys' and girls' development in height yield valuable information about the underlying social processes.

Son preference is one such factor. Son preference dates back to two thousands years ago in China and was reinforced by a patrilineal and patrilocal familial system and supported by the imperial state (Wang et al. 1995, Pp. 47). In the traditional Chinese society, since only sons could carry the family name, only sons could inherit family patrimony, and only sons could sacrifice to the ancestry spirits, having at least one son constituted the bottom line of the majority of Chinese families' fertility preferences. Female infanticide was sometimes practiced by parents to achieve desired number of children and desired sex composition of children (Hudson and Boer 2004; Wang et al. 1995). The Communist government, which came into national power in 1949, launched a series of political campaigns to eliminate these old practices and to promote the new ideology of gender equality, trying to persuade parents that daughters were just as valuable as sons (Croll 1981); but old habits died hard, especially when part of the old problems, such as the disadvantageous position of women in virtually every aspect of socioeconomic life over men, from obtaining higher education (Bauer et al. 1992; Hannum and Xie 1994; Zhou et al. 1998) to getting a well-paid job (Bauer et al. 1992; Gustafsson and Li 2000; Lin and Bian 1991; Rozelle et al. 2002), to having more say in the political system (Stacey 1983), persisted in the new society.

As results, son preference survived in many parts of China during the past half century, especially in rural areas (Graham and Xu 1998; Li and Cooney 1993; Poston 2002). An indication of the prevalence of son preference is the unbalanced sex ratio at birth in recent decades (Hudson and Boer 2004; Ren 1995; Zeng et al. 1993), which strongly suggests the possibility of female infanticide or sex selective abortion. Both infanticide and sex selective abortion are extreme forms of son preference. They both are illegal and may incur severe punishments once caught. Because of the highly sensitive nature of these topics, accurate and reliable individual-level information is extremely difficult to get and prone to measurement errors (either due to recall error or because of human maneuver). These two factors together make it difficult for researchers to identify causes and patterns of these behaviors. Son preference may also lead to less extreme gender discriminative behaviors, for example, gender selective child neglect, which may not influence gender differential mortality pattern, but will certainly influence gender differing growth pattern. Also, measurement on children's height is neither controversial nor sensitive, and it will not implicate parents for any criminal activities. Furthermore, with proper training and careful supervision, measurement errors can be reduced to a very low level when measuring children's height, especially when repeated measurements are taken. In that sense, investigating gender difference in children's growth is a good way to access the patterns of son preference in contemporary Chinese society, which in turn may shed some lights on the difficult issue of identifying the prevalence and determinants female infanticide and gender selective abortion.

I aim to study how son preference influences children's growth in height in the contemporary Chinese society in this research. I focus on two type of factors: socioeconomic status and institutional arrangement. I choose to look at three socioeconomic factors: educational attainment, cadre membership, and household registration type. Educational attainment is considered to be the engine for upward mobility in modern societies (Treiman 1970). Better education leads to better occupation and higher income, even in state socialist societies like China (Walder 1995). Cadres belong to a small group of political elites. Compared to professionals, cadres are recruited through different mechanism using different criteria. While professionals are recruited mainly based on their educational credential, cadres are recruited based on their political loyalty and educational credential is of only secondary importance (Walder 1995). The household registration system in China was originally designed to prevent excess rural to urban migration in the late 1950s. During the past half century, It has been continuously strengthened and reinforced and has become one of the most important and largely ascriptive stratification criteria in China (Cheng and Selden 1994; Knight and Song 1999; Wu and Treiman 2004). Since son preference has deep root in the traditional Chinese society and the traditional Chinese culture, and is considered to be "backward" and "incompatible" with the new society and the new ideology, the influence of son preference should be negatively correlated with levels of "modernity" and "political consciousness", where "modernity" is measured by educational attainment and urban household registration and the "political awareness" is measured by cadre membership. If it is the case, children from families with urban household status and better educated parents not only grow better than children from rural families with poorly educated parents, but also show less gender differences in their grow trajectories.

The importance of the one-child-per-couple family planning policy on family life in China has been discussed in details (Banister 1987; Scharping 2003; Tien 1991). Researchers have not reached consensus on the effect of this unprecedented social engineering project on children's well-being. On the one hand, using evidence from a study of infant mortality *after birth*, Ren (1995) establishes direct link between the one-child family planning policy and the rising female infant mortality in the reform period by cross-temporal comparisons. On the other hand, using evidence from a study of infant mortality *at birth*, Zeng et al. (1993) argue that the rising sex ratio is the result of the persistent son preferences and gender bias in the traditional culture and has nothing to do with the official one-child policy. In order to alleviate and eventually solve the problem, they argued, the one-child policy should be further extended and strengthened. The essence of this debate is the different conception of the relationship between individuals and the state in the contemporary Chinese society. If the state is so powerful that it can superimpose its political will on each individual and closely monitor the outcome while individuals are no more than passive recipients of state policies, extending and strengthening the one-child policy might be the way to eliminate parents' discrimination against female children. Otherwise, implementing a state policy is a bargaining process among individuals, the state, and its agents. Unpopular state policy will be compromised during implementation if not before that, not matter how strict it looks on paper (Greenhalgh 1993). If this is the case, the effectiveness of strengthening the one-child policy to eliminate son preference is not clear. It is worth noting that the implementation of the one-child varies from place to place, which makes cross-sectional comparison possible.

In the present research, I choose to focus on one indicator of the one-child policy: whether one can have a second child if the first one is a girl. If the one-child policy has successfully reduced son preference, as suggested by Zeng et al. (1993), gender difference in children's height would be lower in places where second birth is strictly forbidden regardless of the sex of the first child than in places where second birth is allowed if the first child is a girl. If, on the contrary, gender difference in children's height is higher in places where second birth is strictly forbidden regardless the sex of the first child than in places where second birth is allowed if the first child is a girl, the above claim does not hold.

To summarize the above discussion, here are some research questions I aim to address in the present research:

1. Are boys on average longer than girls?
2. Do boys on average grow faster than girls?
3. Are children from higher status background longer than children from lower status background?
4. Do children from higher status background grow faster than children from lower status background?
5. Do children from higher status families show less gender difference in height?
6. Do children from higher status families show less gender difference in growth trajectory?
7. Does family planning policy increase children's height?
8. Does family planning policy help children grow faster?
9. Does family planning policy increase gender difference in children's height?
10. Does family planning policy reduce gender difference in growth trajectory?

2. Research Design

To address the above-mentioned research questions, both multi-wave cross-temporal measurements of height and individual growth modeling technique are needed. I will discuss them in details in the following sections.

2.1. The China Health and Nutrition Survey

The China Health and Nutrition Survey (CHNS) data is the only publicly available panel data that is suitable for answering research questions concerning "individual change" in China. CHNS is conducted by the Carolina Population Center at the University of North Carolina at Chapel Hill, the National Institute of Nutrition and Food Safety, and the Chinese Center for Disease Control and Prevention. This is a panel research with a multistage clustered sample of 3,800 households and 16,000 individuals from nine provinces in China. Five waves of data have been made publicly available. They were sequentially collected in 1989, 1991, 1993, 1997, and 2000. The CHNS survey consists a household survey, a community survey, a food market survey, and a health and family planning facility survey. CHNS contains detailed physical examination information, which makes it especially suitable to tackle research questions like those raised in the present research.

Four levels of nesting structure can be identified in the CHNS data. Form top to bottom, they are: community-level, household-level, individual-level, and measurement-level, where each community contains multiple households, each household contains multiple individuals, and each individual may have more than one (up to five) measurement. The CHNS research group recently released several "official" longitudinal data sets constructed by linking records from all five waves of data, including a longitudinal physical examination data set. This official longitudinal physical examination data can be considered as two-level data because level-1 (observational level) units are nested within level-2 (individual-level) units. The data does not contains observation-specific information such as weight and height, but also contains level-2 information such as gender. I use this two-level longitudinal data as the basis of the present analysis. I then merge the household-level and the community-level information into this two-level longitudinal data using community ID, household ID, and individual ID.

The first step is to exclude those who are not "children" from the data set. Physical examination information were separately recorded for children and adults in and only in the original 1989 survey. I adopt the criterion used there, that those who were age seven and below in 1989 should be considered as "children". This means two things. First, all the 1,744 children who were included in the 1989 wave are matched and kept in the data. Second, those children who were not included in the original 1989 wave are included if they were age seven or less in 1989[1]. Here are some simple descriptions of variables used in the later

[1]That is, a child aged 9 in 1991 will be included in the data even if s/he was not included in the 1989 wave. Similarly, children aged 11 in 1993, children aged 15 in 1997, or children aged 18 in 2000 will be included in the data, no matter whether they were in the 1989 original sample. The last row in Table 1

analysis:

HEIGHT: This is the dependent variable. It is measure of children's height at each measurement occasion. This is a continuous variable.

AGE: This is the only level-1 (measurement-level) covariate. It measures children's calendar age at each measurement occasion. This is also a continuous variable. For easier interpretation of the coefficients, I centered the age variable around one. That is, instead of including the raw score of AGE in the model, I use $AGE - 1$.

BOY: This is the only level-2 (individual-level) covariate. It is a dichotomous variable that indicates whether the respondent is a boy.

EDU: This is one of the level-2 (household-level) covariates. It is a continuous variable that measures the *household heads'* educational attainment in year of schooling. It is worth noting that this is not the commonly used variable "parents' education" because the household heads are not necessarily children's parents. This is a continuous variable. As hinted before, this variable is an indicator of children's background. Education should increase children's height but decrease gender differences in height.

CAD: This is another household-level covariates. This variable indicates whether the household head is cadre of not. This is a binary variable. Cadre membership is not only indicator of political power, but also indicator of political loyalty. Children from cadres family should grow better and show less gender differences in growth.

URB: This is one of the level-3 (community-level) covariates. It indicates respondent's household registration status: whether it is agricultural or non-agricultural. This is a binary variable. Holing everything else constant, children with non-agricultural household registration should grow better than children with agricultural household registration while should show less gender difference in growth.

S.B.: This is another community-level covariate. It measures the implementation of the "one-child-per-couple" family planning policy. This is a binary variable with value one indicates "if the first born child is a girl, it is permitted to have a second child" and value zero indicates otherwise. The effect of this variable is of most interest in the present research. There are competing hypotheses about both the effect of *S.B.* on children's overall growth and on gender difference in children's growth, as summarized in earlier sections.

---

shows that more children have been added in each subsequent wave.

2.2. Dealing with Missing Values

Both household-level covariates and community-level covariates have significant amount of missing values (up to more than 15%). Traditional methods to deal with missing values, listwise deletion or pairwise deletion, are both inefficient and problematic in the sense that they make model comparisons very difficult because different models are based on different sub-samples. In addition, if the missing observations are not missing completely at random (*MCAR*), these methods will give biased estimates and invalid inferences. Other *ad-hoc* methods, including simple mean imputation, regression mean imputation, creating an extra category to represent the missing value, also suffer from various kinds of problems and do not provide a satisfactory solution (Allison 2001).

I use multiple imputation in the present research, a technique that has been widely considered to be less problematic in handling missing values than the above mentioned *ad-hoc* methods, when the missing data can be assumed to be missing at random (*MAR*)[2] (Allison 2000; Little and Rubin 2002; Schafer 1997). The basic idea of multiple imputation is to replace missing values with predicted values generated from parametric or nonparametric statistical models (imputation models), for several times; then average coefficients estimated from these imputed data sets to get the final point estimates and standard errors. The major advantage of multiple imputation over single imputation methods is that by imputing the data and estimating the model for several times, it avoid the problem of reducing standard errors and increasing test statistics. Multiple imputation involves the following basic steps (Allison 2000):

1. Impute missing values using an appropriate model that incorporates random variation.
2. Do this M times (usually three to five times), producing M "complete" data sets.
3. Perform the desired analysis on each data set using standard complete-data methods.
4. Calculate point estimates as well as standard errors using results from these M models[3].

---

[2]Missing at random (*MAR*) is a weaker assumption than missing completely at random (*MCAR*). *MAR* assumes that the probability of missing data on a variable is unrelated to the value of this variable or to the values of any other variables in the data set. *MCAR* assumes that the probability of missing data on a variable is unrelated to the values of this variable, after controlling for other variables in the analysis. *MAR* is likely to hold in many situations. However, there is no statistical methods to test whether data is missing at random or not.

[3]The formula for calculating point estimates and standard error from multiply imputed data sets is given in Rubin (1976) and Rubin (1987).

Different algorithms and software packages exist for multiple imputation. I use the method of "chained equation" (Raghunathan et al. 2001) that has been programmed in Stata (Royston 2004). I generate five imputed data sets in Stata, translate them into multilevel modeling software package HLM (Raudenbush et al. 2001), conduct the analysis in HLM, and use HLM's built-in capability to handle multiply imputed data sets to get the final results.

2.3. Statistical Methodology

As discussed earlier, four conceptual levels can be distinguished in the CHNS data. Ideally, each conceptual level corresponds to a technical level in statistical analysis. However, as pointed out by Hox (2002), multilevel statistical model with three or more technical levels quickly become over-complicated and often cause numerical problems in estimation, especially when multiple random intercepts and random slopes are considered. Preliminary analyses show that even a simple unconditional 4-level model has hard time converging. Based on practical considerations, only three technical levels are considered and the community level is collapsed into the household level. As it will become clear soon, other compromises are needed in order to make the model estimable.

Growth modeling can be done in either hierarchical linear modeling framework (*HLM*) or structural equation modeling framework (*SEM*) (Duncan et al. 1999; Singer and Willett 2003). *SEM* is more flexible in handling different types of variance and covariance structures while *HLM* is more flexible in handling a variety of data structures (unbalanced design, missing data, individually varying time points, etc.) (Raudenbush 2001). I choose *HLM* as the primary analytical tool for the present research.

Let Y_{ijk} denotes measurement of height of child j from household k taken in year i, let AGE denotes the child's age, the unconditional three-level growth model looks like this:

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk}(AGE)_i + \mu_{ijk} \tag{1}$$

$$\pi_{0jk} = \beta_{00k} + \eta_{0jk} \tag{2}$$

$$\pi_{1jk} = \beta_{10k} + \eta_{1jk} \tag{3}$$

$$\beta_{00k} = \gamma_{000} + \upsilon_{00k} \tag{4}$$

$$\beta_{10k} = \gamma_{100} + \upsilon_{10k} \tag{5}$$

In the level-1 equation, equation (1), each child's height is modeled as function of AGE, his/her own age at the time of measurement, plus random noises. In the level-2 equation,

equation (2) and (3), both intercept and slope of the level-1 equation are allowed to vary randomly between children. In the level-3 equation, equation (4) and (5), intercepts in the level-2 equation are allowed to randomly vary across households. This simple three-level model can be extended and tailored to answer a variety of research questions regarding individual growth.

The first extension is to add level-2 (that is, individual-level) variable BOY into the model. Now the level-2 equations become:

$$\pi_{0jk} = \beta_{00k} + \beta_{01k}(BOY)_j + \eta_{0jk} \tag{6}$$

$$\pi_{1jk} = \beta_{10k} + \beta_{11k}(BOY)_j + \eta_{1jk} \tag{7}$$

Exploratory analysis shows that it is necessary to fix all but one random components υ in level-3 equations to avoid numerical problems, which leads to restricted level-3 equations as follows:

$$\beta_{00k} = \gamma_{000} + \upsilon_{00k} \tag{8}$$

$$\beta_{01k} = \gamma_{010} \tag{9}$$

$$\beta_{10k} = \gamma_{100} \tag{10}$$

$$\beta_{11k} = \gamma_{110} \tag{11}$$

Asking question 1 & 2 translates to a test of whether γ_{011} and γ_{111} are significantly different from zero. Household-level and community-level variables can be added to the model to investigate question 3 – 11. Now the level-3 equations become:

$$\beta_{00k} = \gamma_{000} + \gamma_{001}EDUC + \gamma_{002}CADRE + \gamma_{003}URBAN + \gamma_{004}S.B. + \upsilon_{00k} \tag{12}$$

$$\beta_{01k} = \gamma_{010} + \gamma_{011}EDUC + \gamma_{012}CADRE + \gamma_{013}URBAN + \gamma_{014}S.B. \tag{13}$$

$$\beta_{10k} = \gamma_{100} + \gamma_{101}EDUC + \gamma_{102}CADRE + \gamma_{103}URBAN + \gamma_{104}S.B. \tag{14}$$

$$\beta_{11k} = \gamma_{110} + \gamma_{111}EDUC + \gamma_{112}CADRE + \gamma_{113}URBAN + \gamma_{114}S.B. \tag{15}$$

This is the "full" model in the sense it includes all the terms that are of potential interest. Simpler and easier to understand models can be obtained by utilizing the usual model selection techniques. All the research questions raised in earlier sections can be mapped into one or more parameters in this full model. For example, *Question 3* translates to a test of whether γ_{001}, γ_{002}, and γ_{003} are significantly greater than zero (for girls), and whether $\gamma_{001}+\gamma_{011}$, $\gamma_{002}+\gamma_{012}$, and $\gamma_{003}+\gamma_{013}$ are significantly greater than zero (for boys). Similarly, research *question 4* translate to test of whether γ_{101}, γ_{102}, γ_{102}, and $\gamma_{101}+\gamma_{111}$, $\gamma_{102}+\gamma_{112}$, and $\gamma_{103} + \gamma_{113}$ are significantly greater than zero; research *question 5* translates to test of whether γ_{011}, γ_{012} and γ_{013} are significantly different from zero[4]; research *question 6* translates to test of whether γ_{111}, γ_{112}, and γ_{112} are significantly different from zero[5]; research *question7* translates to test of whether γ_{004} is significantly different from zero (for girls) and whether $\gamma_{004} + \gamma_{014}$ is significantly different form zero (for boys), and so on.

3. Analysis

3.1. Descriptive Analysis

Figure 1 shows individual growth curves for some randomly picked children. In this figure, dots represent the raw data points and smoothed lines are constructed using locally weighted scatterplot smoothing technique (Cleveland 1979). They (along with individual growth curves for other children not shown here) reveal that a linear growth curve as in equation (1) provides parsimonious yet reasonably close representation of the growth trajectory for most children. Table 1 reports OLS estimates (of both *AGE* slope and intercept) from linear individual growth model for randomly selected subset of the children. The same information is also depicted visually in figure 2. From both the table and the figure, it is clear that there are some between-individual variations, but the overall linear growth trend is very clear. Individual linear growth model through OLS is closely related to the full-blown multilevel growth model. In fact, the latter is just a weighted average of the former, sometimes called shrinkage estimates of Empirical Bayes estimates.

Table 2 reports summary statistics of main variables used in the multilevel growth modeling by wave. More children join the research in each subsequent wave; as they grow older (from mean age of 3. 72 in 1989 to 10.79 in 2000), their average height also increases, from 89.79cm in 1989 to 134.76cm in 2000. Children's gender composition, household heads' educational composition, household heads' cadre membership composition remains relatively stable from wave. The other two variables: household registration status and second birth

[4]The interpretation of γ_{011}, γ_{012} depends on the value of γ_{010}, the direction and magnitude of the gender difference in height at age one. For example, if γ_{010} is positive, which means that boys are in general longer than girls at age one, a positive γ_{011} means that gender difference in height among children aged one are higher among households whose heads are better educated than among households whose heads are not well educated; in other words, in this hypothetical example, higher socioeconomic status increases gender inequality in children's height at age one.

[5]The substantive interpretation of γ_{111} and γ_{112} depends on γ_{110}, the sign and magnitude of gender difference in the growth trajectory, as discussed above.

policy, show significant cross-wave fluctuations. Changes in the household registration status composition is result of changes in sampling points, while changes in the second birth policy composition is probably the mixture of changes in sampling points and changes in local family planning policy.

Table 3 reports results from five multilevel linear growth models. The first model is a unconditional three-level growth model. The only covariate in this model is children's age (centered around one). This is a baseline model that can be used to compare with other models. The second model extends the first model in that it allows both the growth intercept and the growth slope vary between boys and girls. The third model extends Model 2 to include all three socioeconomic status variables: $EDUC$, $CADRE$, and $URBAN$, as shown in equation (12) to (15), to answer research *question 4* to research *question 7*. After excluding non-significant terms, Model 4 reports only the significant terms in Model 3. Model 5 is all terms in Model 4 plus significant effects of the second child policy variable. The following discussion will be focused on Model 3, 4, and 5.

3.2. Son Preference, Socioeconomic and Institutional Determinants of Children's Growth in Height

First glance at Model 3 reveals several things. First, all three socioeconomic status variables increases children's height at age one (.23 for $EDUC$, 1.41 for $CADRE$, and 2.58 for $URBAN$), although the effect of $CADRE$ is not significant at level .05. Second, both household heads' cadre membership and urban household registration status decrease gender difference in children' height (-.34 for $CADRE$ and -1.26 for $URBAN$) while household heads' education increases gender difference in children's height (.02). But none of these effects are significant at the level of .05. Third, all three socioeconomic status variables increases growth slope for children (.01 for $EDUY$, .04 for $CADRE$, and .19 for $URBAN$), but none of these effects are significant at level .05. Fourth, both household heads' education and cadre membership decrease gender difference in the growth slope for children (-.01 for $EDUY$ and -.03 for $CADRE$) while urban household registration status increases gender difference in growth slope for children. But none of these effects are significant at the level of .05.

After tinkering with the variables, Model 4 seems to achieve a good balance between accuracy and parsimony. Model 4 also reveals several things. First, all three socioeconomic status variables significantly improve children's height at age one. Holding everything else constant, one years' increase in household head's education leads to an increase of .25cm in children's height; children from cadre households are about 1.38cm higher than children from non-cadre households; and urban children are about 2.53cm higher than rural children. Second, urban household registration significantly changes the pattern of gender difference in children height at age one. Holding everything else equal, rural boys are .51cm taller than rural girls while urban boys are .68cm shorter than urban girls at age one. Third, urban children grow faster than rural children (for .21cm per year) and there is no significant gender difference in growth slope.

Model 5 is just Model 4 plus a three-way interaction among AGE, BOY, and $S.B.$, which represents the level of gender difference in the grow slope in children's height, added by different family planning policy. Comparing coefficient in Model 4 and Model 5 reveals that there are not many real differences between the corresponding coefficients in these two models. How significant change is that the non-significant coefficient, γ_{110} in Model 4 becomes significant at level .05 in Model 5. This coefficient represents gender difference in growth slope. Without taking into consideration of the second birth policy, Model 4 says that boys grow slightly faster than girls, but the effect is not statistically significant at level .05. After taking into consideration of the second birth policy, now it says something quite different. In places where second birth is not allowed, boys grow significantly faster than girls (.14cm per year); in places where second birth is allowed if the first birth is a girl, boys only grow marginally faster than girls (.01cm per year). Figure 3 displays the predicted values for growth in height for three groups of children: boy in places where second birth is allowed, boys in places where second birth is not allowed, and girls[6]. Since changes of interest is relatively small compared to the overall growth in children's height, the three lines are somewhat cluttered together. To make the visual display clearer, I re-draw the graph by presenting the difference in predicted height between boys and girls. Figure 4 reveals several important patterns. First of all, boys are taller than girls on average, no matter what the local second birth policy is. Second, while the local second birth policy does not have significant effect on girls' growth, it influences boys' growth greatly. In places where second birth is allowed if the first child is a girl, difference between boys' and girls' height remain largely stable during the age range under investigation (age 0-18), between .62cm to .80cm. In places where second birth is generally not allowed, on the contrary, difference between boys' and girls' height increases rapidly with age, from .62cm at age 0 to 3.14cm at age 18.

[6]There is no significant difference between girls in these two different places,as depicted in Model 4 and Model 5. Thus the two lines for girls has been combined into one.

4. Discussion

It is not surprising to see that household socioeconomic status helps children's growth, as revealed by coefficients γ_{001}, γ_{002}, γ_{003}, and γ_{103}. What is interesting is the determinants of gender difference in children growth. As depicted in both Model 4 & 5, among the three household socioeconomic factors, education, cadre membership, and household registration status, only household registration status has significant influence. The most fundamental difference between urban household registration holder and rural household registration holder is their relationship with the state. From the very beginning of the household registration system, urban residents are considered to be part of the state's redistribution system, that is, the state assumed the responsibility to provide to this small portio of population job security, low-cost or free housing, medical care, school for children, retirement pension, etc., virtually everything from birth to death. While at the same time, rural residents can enjoy none of these. In the post-reform era, the basic rural old-age support system and rural collective medical system were both destroyed, rural residents really have to watch for themselves. Under this situation, son preference in rural areas, unlike in urban areas, is not only to meet "cultural" needs but also to meet "economic" and "social" needs (White 1987). This is both a good news and a bad news. On the one hand, these results suggest that son preference is not something mysteriously imbedded in the traditional Chinese culture that cannot be eliminated; instead, son preference is associated with a specific way of life. With rapid urbanization and industrialization, it is possible that son preference will diminish with the old village life. On the other hand, the economic reform is destroying the old redistribution system, and more and more people were throwing into the market. Will this suddenly intensified pressure create a new life style that cultivate son preferences?

The effect of the family planning policy on gender difference in children's growth is even more interesting. How does the findings in the present research contribute to the debate about whether the one-child policy inhibit the traditional son preference and improve female children's well-beings? The answer is more complicated than it first appears to be. On the one hand, more strict one-child policy (i.e. no second birth allowed regardless of the sex of the first birth) does seem to improve children's overall condition, which in turn helps them grow better (as the contrast between the two lines for boys in Figure 4 reveals). This is either because there are fewer children in these places (because of the policy), or because the government tend to invest more in these places (more hospitals, better trained medical personnel, etc.). In any event, children in these places have larger share of *per capita* resources. On the other hand, the improvement in children's growth due to more strict one-child policy is for boys only and does not benefit girls at all, and all of the extra resources gained by the more strict one-child policy implementation are used exclusively on boys. This is revealed by the lack of significance of the interaction between AGE and $S.B.$. As results, gender difference in children's growth in places where second birth is not allowed is much greater than in places where second birth is allowed if the first birth is a girl, as the contrast between "boy, second birth is allowed" and "girl", and between "boy, second birth is not allowed" and "girl" shown in Figure 4. This leads to the most important conclusion in the present research, that more strict implementation of the one-child policy increases gender difference in children's growth, and intensifies son preferences.

Table 1. Some Individual Linear Growth Curve Estimates

	Age		Intercept	
ID	Coef.	S.E.	Coef.	S.E.
21	8.17	2.66	74.41	12.73
26	7.04	0.13	78.44	0.85
45	6.47	0.08	82.46	0.56
48	6.68	.	84.58	.
153	6.86	.	73.79	.
178	5.57	0.32	85.31	2.06
215	2.19	1.16	96.76	7.31
221	7.65	.	82.12	.
235	7.35	0.42	73.32	2.72
238	6.51	0.68	80.91	5.09
241	5.92	0.59	75.11	4.91
244	5.55	1.18	85.29	10.33
253	4.71	0.92	96.69	9.70
256	5.73	0.71	80.82	5.50
259	3.62	0.70	105.96	7.31
268	4.50	0.41	96.24	3.11
271	5.08	0.18	87.43	1.48
274	6.93	0.86	82.70	5.36
277	4.12	0.48	96.23	5.21
280	8.94	0.78	82.32	1.95

Table 2. Summary Statistics of Variables Used in the Model

Variable	1989	1991	1993	1997	2000
HEIGHT	89.79	100.55	109.96	125.50	134.76
	(14.82)	(17.16)	(20.76)	(23.50)	(26.33)
AGE	3.72	5.13	6.53	9.24	10.79
	(1.69)	(2.20)	(2.63)	(3.60)	(4.31)
EDUC	7.34	7.31	6.99	7.35	7.89
	(3.80)	(3.67)	(2.38)	(3.86)	(3.71)
BOY	.53	.53	.53	.53	.53
CADRE	.06	.07	.06	.07	.05
URBAN	0	0	.28	.29	.29
S.B.	.56	.48	.41	.50	.46
N.	1,666	2,066	2,219	2,661	2,973

Table 3. Growth Curve Analysis using Multiply Imputed Data, N. of Imputation = 5

Variable	Parameter	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	γ_{000}	78.38	78.21	75.89	75.76	75.66
		(.21)	(.35)	(.92)	(.51)	(.51)
AGE	γ_{100}	6.06	6.02	5.90	5.95	5.95
		(.03)	(.04)	(.11)	(.05)	(.05)
BOY	γ_{010}		.32	.36	.51	.62
			(.38)	(1.02)	(.40)	(.40)
EDUC	γ_{001}			.23	.25	.26
				(.10)	(.04)	(.04)
CADRE	γ_{002}			1.41	1.38	1.29
				(1.21)	(.57)	(.57)
URBAN	γ_{003}			2.58	2.53	2.82
				(1.10)	(.77)	(.80)
S.B.	γ_{004}					
BOY × AGE	γ_{110}		.07	.14	.08	.14
			(.05)	(.13)	(.05)	(.06)
BOY × EDUC	γ_{011}			.02		
				(.12)		
BOY × CADRE	γ_{012}			-.34		
				(1.60)		
BOY × URBAN	γ_{013}			-1.26	-1.19	-1.75
				(1.34)	(.60)	(.67)
BOY × S.B	γ_{014}					
AGE × EDUC	γ_{101}			.01		
				(.01)		
AGE × CADRE	γ_{102}			.04		
				(.18)		
AGE × URBAN	γ_{103}			.19	.21	.17
				(.13)	(.08)	(.08)
AGE × S.B	γ_{104}					

Table 3—Continued

Variable	Parameter	Model 1	Model 2	Model 3	Model 4	Model 5
AGE × BOY × EDUC	γ_{111}			-.01		
				(.02)		
AGE × BOY × CADRE	γ_{112}			-.03		
				(.22)		
AGE × BOY × URBAN	γ_{113}			.03		
				(.16)		
AGE × BOY × S.B.	γ_{114}					-.13
						(.06)
Level-1 Variance	μ_{ijk}	19.95	19.99	20.05	20.05	20.04
		(4.47)	(4.47)	(4.48)	(4.48)	(4.48)
Level-2 Variance	η_{0jk}	104.13	103.57	105.84	105.86	105.88
		(10.20)	(10.18)	(10.29)	(10.29)	(10.29)
Level-2 Variance	η_{1jk}	1.62	1.61	1.28	1.64	1.63
		(1.27)	(1.27)	(1.64)	(1.28)	(1.28)
Level-3 Variance	υ_{00k}	23.33	23.67	19.86	19.83	19.82
		(4.83)	(4.87)	(4.46)	(4.45)	(4.45)
N. of Observations		11,585	11,585	11,585	11,585	11,585
N. of Children		4,419	4,419	4,419	4,419	4,419
N. of Households		3,103	3,103	3,103	3,103	3,103

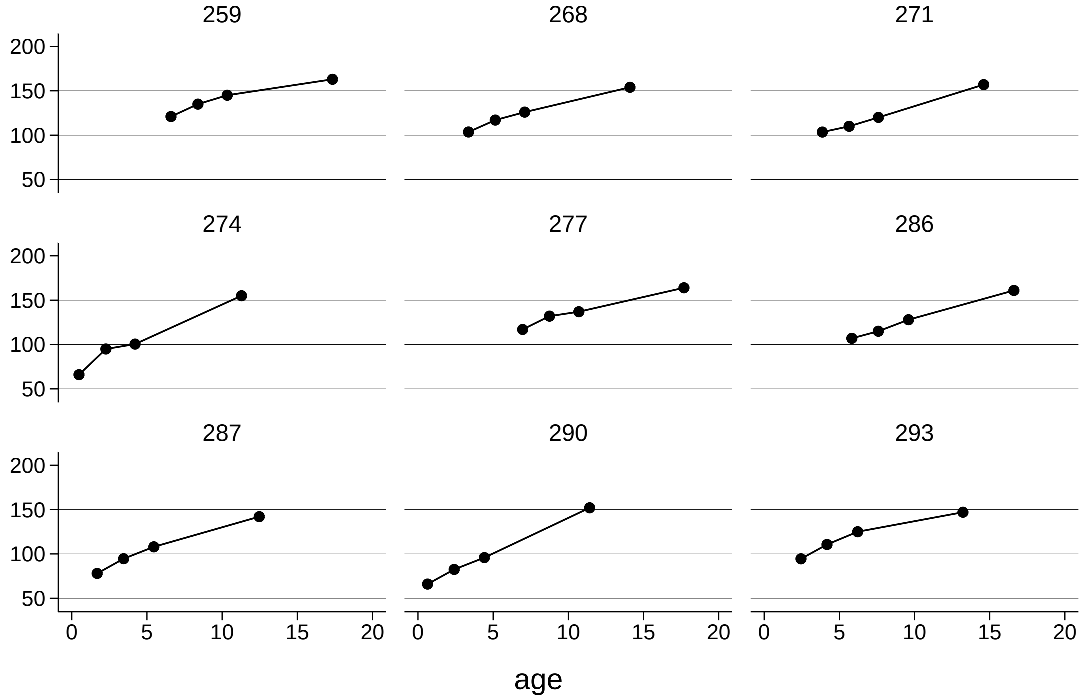

Fig. 1.— Smooth Nonparametric Summary of the Relationship between Children's Height and Age

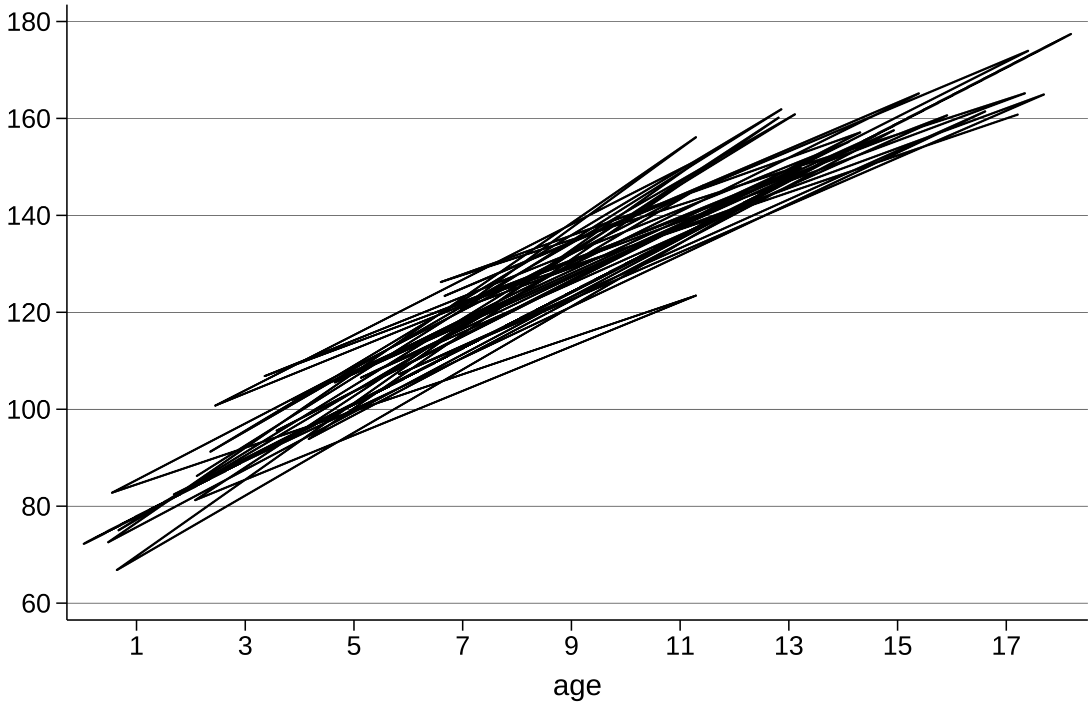

Fig. 2.— Some OLS-fitted Trajectories of Children's Growth in Height between Age 1 and Age 17 in China

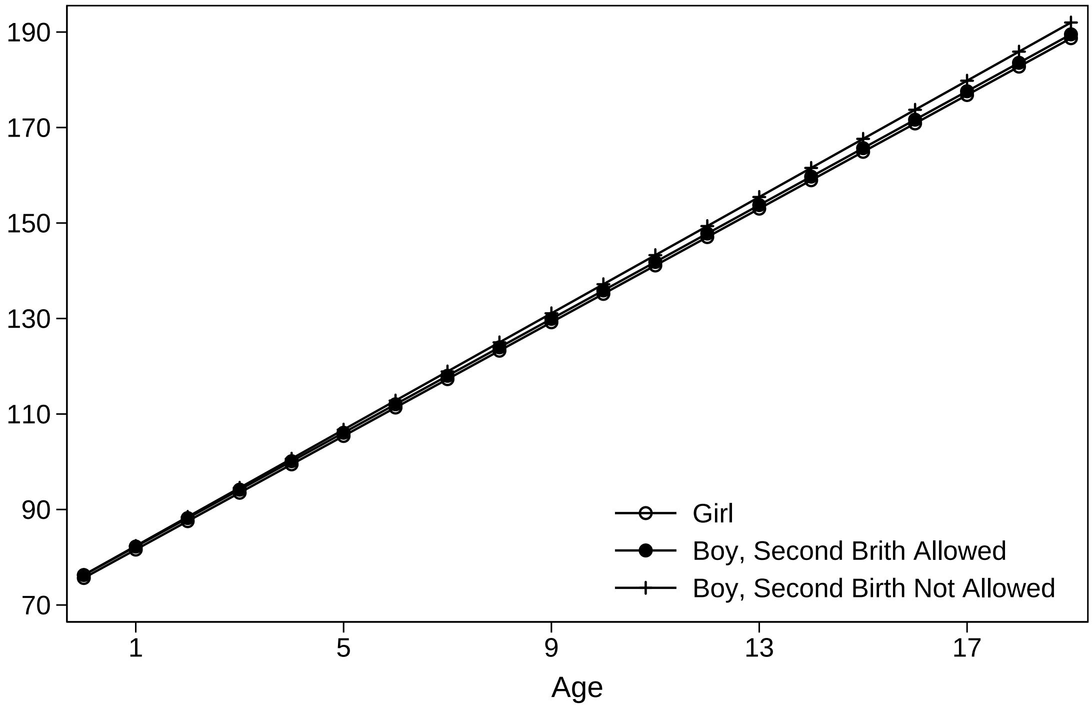

Fig. 3.— Predicted Children's Height by Gender and Family Planning Policy

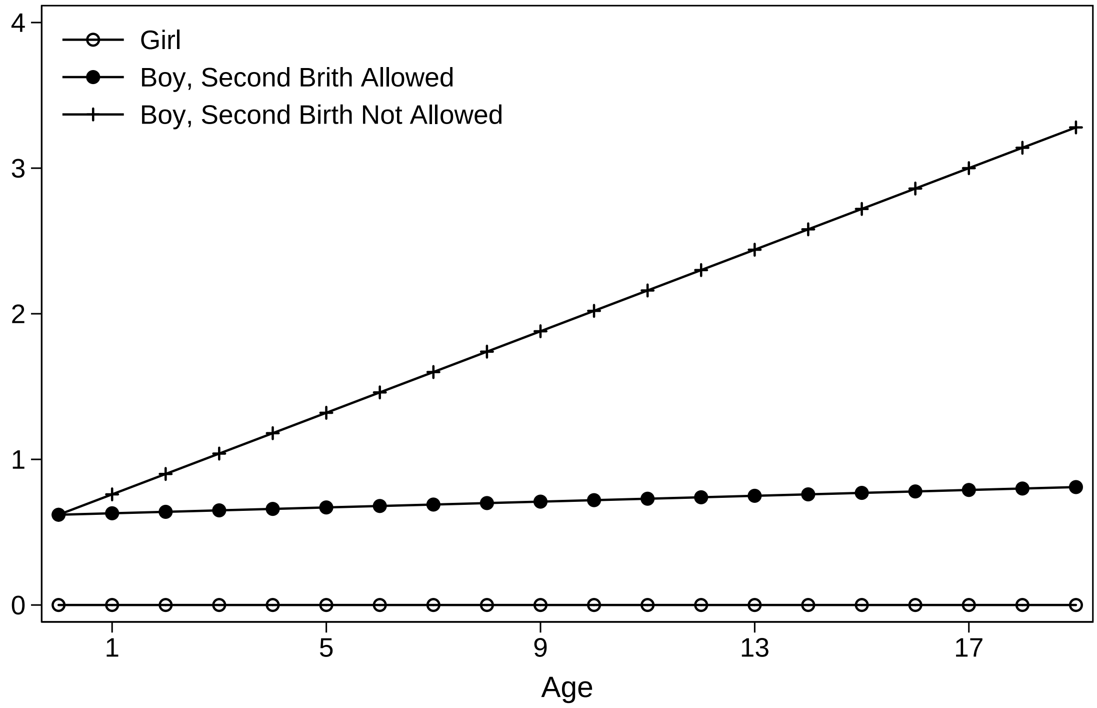

Fig. 4.— Difference in Predicted Height between Boys and Girls, by Family Planning Policy

REFERENCES

Allison, Paul David. 2000. "Multiple Imputation for Missing Data: A Cautionary Tale." *Sociological Methods & Research* 28:301–309.

Allison, Paul David. 2001. *Missing Data*. Thousand Oaks, Calif.: Sage Publications.

Alter, George. 2004. "Height, frailty, and the standard of living: Modelling the effects of diet and disease on declining mortality and increasing height." *Population Studies* 58:265–279.

Anson, O. and S. F. Sun. 2002. "Gender and Health in Rural China: Evidence from HeBei Province." *Social Science & Medicine* 55:1039–1054.

Banister, Judith. 1987. *China's Changing Population*. Stanford, California: Stanford University Press.

Bauer, John, Feng Wang, Nancy E. Riley, and Xiaohua Zhao. 1992. "Gender Inequality in Urban China: Education and Employment." *Modern China* 18:333–370.

Burgard, S. 2002. "Does Race Matter? Children's Height in Brazil and South Africa." *Demography* 39:763–790.

Cheng, Tiejun and Mark Selden. 1994. "The Origins and Social Consequences of China's Hukou System." *The China Quarterly* pp. 644–668.

Cleveland, W. S. 1979. "Robust Locally Weighted Regression and Smoothing Scatterplots." *Journal of the American Statistical Association* 74:829–836.

Croll, Elisabeth. 1981. *The Politics of Marriage in Contemporary China*. Cambridge, UK: Cambridge University Press.

Duncan, Terry E., Susan C. Duncan, Lisa A. Strycker, Fuzhong Li, and Anthony Alpert. 1999. *An introduction to latent variable growth curve modeling: concepts, issues, and applications*. Quantitative methodology series. Mahwah, N.J.: L. Erlbaum Associates.

Eveleth, Phyllis B. and J. M. Tanner. 1990. *Worldwide variation in human growth*. Cambridge [England]; New York: Cambridge University Press, 2nd edition.

Graham, Maureen J. and Xiping Xu. 1998. "Son Preference in Anhui Province, China." *International Family Planning Perspectives,* 24:72–77.

Greenhalgh, Susan. 1993. "The Peasantization of the One-Child Policy in Shaanxi." In *Chinese families in the post-Mao era*, edited by Deborah Davis and Stevan Harrell, pp. 219–250. Berkeley: University of California Press.

Gustafsson, Bjorn and Shi Li. 2000. "Economic Transformation and the Gender Earnings Gap in Urban China." *Journal of Population Economics* 13:305–329.

Hannum, Emily and Yu Xie. 1994. "Trends in Educational Gender Inequality in China: 1949-1985." *Research in Social Stratification and Mobility* 13:73–98.

Hox, J. J. 2002. *Multilevel Analysis: Techniques and Applications*. Quantitative methodology series. Mahwah, N.J.: Lawrence Erlbaum Associates.

Hudson, Valerie M. and Andrea M. den Boer. 2004. *Bare Branches: the Security Implications of Asia's Surplus Male Population*. Cambridge, Mass.: MIT Press.

Knight, John and Lina Song. 1999. *The Rural-Urban Divide: Economic Disparities and Interactions in China*. NY: Oxford University Press.

Li, J. and R. S. Cooney. 1993. "Son preference and the one child policy in China: 1979?1988." *Population Research and Policy Review* 12:108–115.

Lin, Nan and Yanjie Bian. 1991. "Getting Ahead in Urban China." *American Journal of Sociology* 97:657–688.

Little, Roderick J. A. and Donald Rubin. 2002. *Statistical Analysis with Missing Data*. New Jersey: John Wiley & Sons, 2nd edition.

Poston, Dudley L. JR. 2002. "Son Preference and Fertility in China." *Journal of Biosocial Science* 34:333–347.

Raghunathan, T. E., J. M. Lepkowski, J. Van Hoewyk, and P. Solenberger. 2001. "A multivariate technique for multiply imputing missing values using a sequence of regression models." *Survey Methodology* 27:85–95.

Raudenbush, S., A. Bryk, YF. Cheong, and R. Congdon. 2001. *HLM 5, Hierarchical Linear and Nonlinear Modelling*. Lincolnwood: SSI.

Raudenbush, Stephen W. 2001. "Toward a Coherent Fremework for Comparing Trajectories of Individual Change." In *New Methods for the Analysis of Change*, edited by Linda M. Collins and Aline G. Sayer, pp. 33–64. Washington, DC: American Psychological Association.

Ren, Xinhua Steve. 1995. "Sex Differences in Infant and Child Mortality in Three Provinces in China." *Social Science & Medicine* 40:1259–1269.

Royston, P. 2004. "Multiple imputation of missing values." *The Stata Journal* 3:227–241.

Rozelle, Scott, Xiao-yuan Dong, Linxiu Zhang, and Andrew Mason. 2002. "Gender Wage Gaps in Post-Reform Rural China." *Pacific Economic Review* 7:157–179.

Rubin, Donald B. 1976. "Inference and missing data (with discussion)." *Biometrika* 63:581–592.

Rubin, Donald B. 1987. *Multiple Imputation for Nonresponse in Survey*. New York: John wiley & Sons.

Schafer, J. L. 1997. *Analysis of incomplete multivariate data*. London: Chapman and Hall.

Scharping, Thomas. 2003. *Birth Control in China, 1949-2000: Population Policy and Demographic Development*. Chinese worlds. London ; New York: Routledge.

Singer, Judith D. and John B. Willett. 2003. *Applied Longitudinal Data Analysis*. NY: Oxford University Press.

Stacey, Judith. 1983. *Patriarchy and Socialist Revolution in China*. Berkeley and Los Angeles: University of California Press.

Thomas, D., J. Strauss, and M. H. Henriques. 1990. "Child Survival, Height for Age and Household Characteristics in Brazil." *Journal of Development Economics* 33:197–234.

Thomas, D., J. Strauss, and M. H. Henriques. 1991. "How Does Mother's Education Affect Child Height." *Journal of Human Resources* 26:183–211.

Tien, H. Yuan. 1991. *China's Strategic Demographic Initiative*. New York: Praeger.

Treiman, Donald J. 1970. "Industrialization and Social Stratification." In *Social Stratification: Research and Theory for the 1970s*, edited by Edward O. Laumann, pp. 207–234. Indianapolis: Bobbs-Merrill.

Walder, Andrew G. 1995. "Career Mobility and the Communist Political Order." *American Sociological Review* 60:309–28.

Wang, Feng, James Lee, and Cameron Campbell. 1995. "Marital Fertility Control among the Qing Nobility: Implications for Two Types of Preventive Check." *Population Studies* 49:383–400.

Waterlow, J., R. Buzina, W. Keller, J. Lane, M. Nichaman, and J. Tanner. 1977. “The Presentation and Use of Height and Weight Data for Comparing the Nutritional Status of Groups of Children Under the Age of Ten Years.” *Bulletin of the World Health Organization* 55:489–498.

White, Tyrene. 1987. “Implementing the ”One-Child-per-Couple” Population Program in Rural China: National Goals and Local Politics.” In *Policy Implementation in Post-Mao China*, edited by David M. Lampton. Berkeley: University of California Press.

Wu, Xiaogang and Donald J. Treiman. 2004. “The Household Registration System and Social Stratification in China: 1955-1996.” *Demography* 41:363–384.

Zeng, Yi, Ping Tu, Baochang Gu, Yi Xu, Bohua Li, and Yongping Li. 1993. “Causes and Implications of the Increases in China’s Reported Sex Ratio at Birth.” *Population Development Review* 19:283–302.

Zhou, Xueguang, Phyllis Moen, and Nancy B. Tuma. 1998. “Educational Stratification in Urban China: 1949-94.” *Sociology of Education* 71:199–222.