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Sins of the Fathers

The Intergenerational Legacy of the 1959–1961 Great Chinese Famine on Children's Cognitive Development

Chih Ming Tan

Zhibo Tan

Xiaobo Zhang

Development Strategy and Governance Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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AUTHORS

Chih Ming Tan is a Professor and Page Endowed Chair in Applied Economics, Department of Economics, College of Business and Public Administration, University of North Dakota, Grand Forks, USA.

Zhibo Tan is a PhD candidate in the National School of Development at Peking University, Beijing.

Xiaobo Zhang (x.zhang@cgiar.org) is a senior research fellow in the Development Strategy and Governance Division of the International Food Policy Research Institute (IFPRI), Washington, DC, and Porfessor of Economics at the National School of Development, Peking University, Beijing.

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ABSTRACT

The intergenerational effect of fetal exposure to malnutrition on cognitive ability has rarely been studied for human beings in large part due to lack of data. In this paper, we exploit a natural experiment, the Great Chinese Famine of 1959–1961, and employ a novel dataset, the China Family Panel Studies, to explore the intergenerational legacy of early childhood health shocks on the cognitive abilities of the children of parents born during the famine. We find that daughters born to rural fathers who experienced the famine in early childhood score lower in major tests than sons, whereas children born to female survivors are not affected. By careful elimination of alternative explanations, we conclude that the culling effect on the exposed generation is remarkably efficient at mitigating the intergenerational transmission of any scarring effects from the famine. The uncovered gender-specific effect is almost entirely attributable to son preference exhibited by rural famine fathers. Our findings suggest that, at least for cognitive abilities, human populations appear to be extremely resilient to shocks, largely shielding their offspring from being seriously damaged.

Keywords: famine; health; China; intergenerational transmission; epigenetics

JEL Codes: O12, I12, I15, J10, J13

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1. INTRODUCTION

An emerging body of literature has found substantial support for the "fetal origins" hypothesis proposed by Barker (1992) that the in utero nutritional status shapes health outcomes in adult life. As reviewed in Almond and Currie (2011), prenatal exposure to malnutrition has a lasting damaging effect on the health of survivors. However, little is known about the impact on the children of the affected cohort in large part due to lack of data. The question as to whether the effects of health shocks are transmissible from one generation to the next has important implications on understanding intergenerational mobility and inequality.

In this paper, we exploit a natural experiment—the Great Chinese Famine of 1959–1961—to explore the intergenerational legacy of prenatal exposures to the famine on *cognitive abilities*. Specifically, we employ the recently released 2010 and 2012 waves of the China Family Panel Studies (CFPS) administered by Peking University to do so.[1] In comparison with other data sources, the CFPS is novel in that it has direct measures of cognitive abilities (math, verbal, and short-term memory tests) for family members. The CFPS is also based on a nationally representative sample and includes extensive demographic information on respondents and their families that may be used as controls.

We focus on the cognitive outcomes of children born to parents who experienced famine during early childhood (that is, those who were born during 1959–1961) as measured by test scores. We find strong evidence that, relative to the control group (that is, children born to parents who did not experience famine), daughters born to rural male (but not female) famine survivors performed worse in cognitive tests than sons. Why were only the daughters of rural famine fathers and not the children of famine mothers adversely affected? There are several potential explanations.

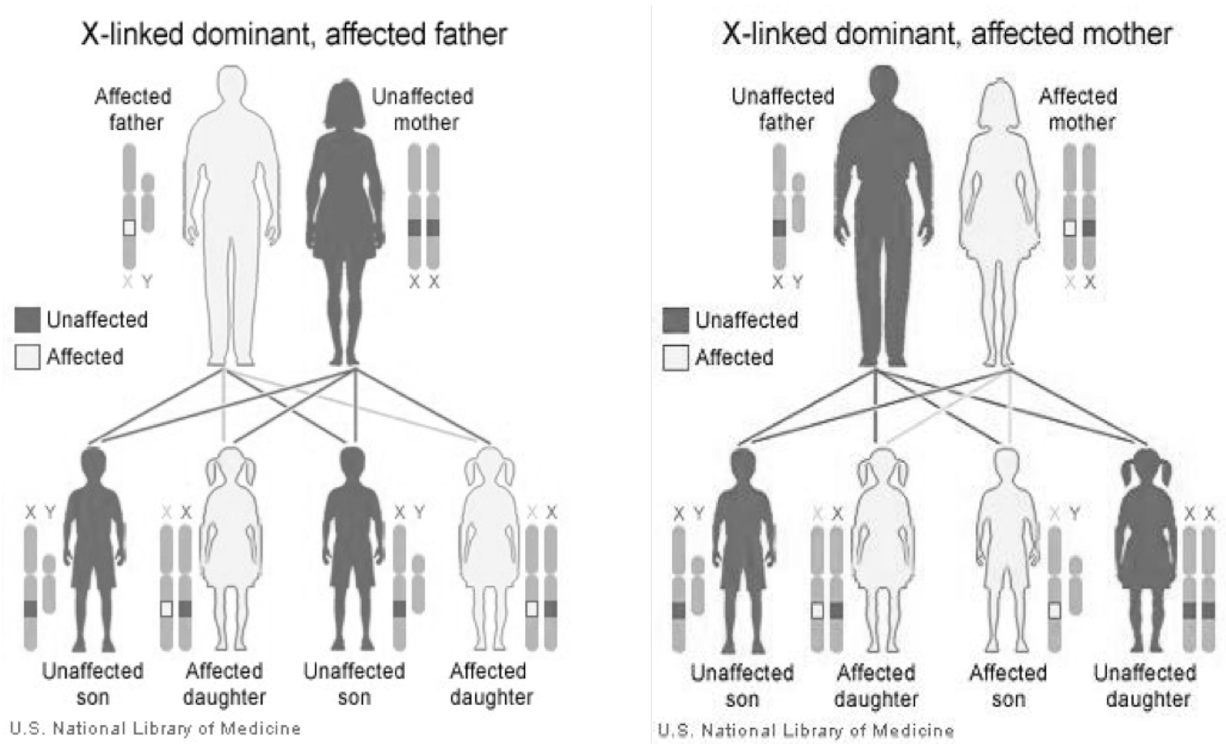
Culling and scarring are the two major effects of famine on survivors. Famines often result in excess mortality, the so-called *culling effect*. The literature has established that the culling effect is particularly strong for males. It is widely documented that male fetuses are more likely to die than their female counterparts in the event of famine. As the fragile die, the fittest survive. Thus the presence of the culling effect implies a healthier survivor cohort. Famine also has a scarring effect. That is, survivors may suffer from lasting ill effects due to early exposure to the famine. It is an empirical question as to which effect dominates in the survivor population. We find that famine exposure in early childhood results in more damage to the cognitive abilities of female survivors than male survivors, suggesting that the culling effect likely dominates the scarring effect for males. This is consistent with other findings in the existing literature (Luo, Mu, and Zhang 2006; Song 2010; Mu and Zhang 2011).

The culling and scarring effects may have some genetic consequences. There is substantial evidence in the biology literature that the X chromosome is responsible for cognitive abilities (Turner 1996; Badcock 2009). There is also evidence that the X-linked genes inherited by daughters from their fathers potentially express themselves differently from those inherited from their mothers. Skuse (2005, R30) finds that "maternally expressed X-linked genes might, therefore, influence hippocampal development, and paternally expressed genes influence the normal development of the caudate nucleus and thalamus in females." Recent work suggests that the thalamus, with its widespread cortical connections, plays a key role in human intelligence (Bohlken et al. 2013).

Since sons inherit the X chromosome only from their mothers while daughters inherit one from their mothers and one from their fathers, as Figure 1.1 makes clear, for the case where the father's X chromosome has been damaged by the famine, we would potentially observe girls with lower cognitive abilities in the second generations (sons would be largely unaffected). Under this hypothesis, if the mother's X chromosome was damaged by the famine, both sons and daughters should be equally affected. However, in our analysis, we do not find any effects for the children of scarred famine mothers.

[1] http://www.isss.edu.cn/cfps/EN/.

Figure 1.1 Transmission of X chromosome from parents to children



Source: U.S. National Library of Medicine (2014).

We conclude that the scarring effect on female famine survivors is probably not large enough to make a dent on the subsequent generation. For the daughters of seemingly unscarred famine fathers to suffer the strongest effects would require evidence for an epigenetic mechanism that the damage to the X chromosome in famine fathers is expressed only in the next generation. We are unaware of any studies to support this view.

A second potential explanation is the sociobiological mechanism. For example, the seminal work by Belsky, Steinberg, and Draper (1991) proposed that early exposures to environmental stressors, such as father's absence before age 7, were responsible for the early onset of puberty in daughters, as well as the latter's precocious sexuality and unstable relationships as adults.[2] However, in our sample, famine fathers actually have higher levels of education than nonfamine fathers. Women born in the famine were married to men who were less educated and drank more compared with the famine fathers (the comparison group). Hence, if fathers' negative characteristics were responsible for their daughters' outcomes, then daughters born to famine mothers should have performed worse in test scores than those born to famine fathers. But that is not the case in terms of the results.

[2] There is some evidence that the father–daughter linkage may have genetic roots. Comings et al. (2002), for example, find that a variant X-linked androgen receptor (AR) gene that is passed on from fathers to their daughters but not to their sons explains why fathers who are predisposed to behaviors such as family abandonment tend to have daughters who experience early puberty and also exhibit more aggressive and impulsive behavior, such as precocious sexuality, increased number of sexual partners, and sexual compulsivity. However, these recent findings do need to be treated with some caution. A replication exercise by Jorm et al. (2004) for the associations found in Comings et al. (2002) with the AR allele failed to produce substantively similar findings. Mustanski et al. (2004) also suggest that the relationship between the absence of fathers and adolescent development may be complex and may depend on gene–environment correlations. They give the example of mothers who enter puberty early being more likely to bear children earlier, which, in turn, predisposes the parental match to early separation. At the same time, these mothers' offspring inherit genes predisposing them toward early puberty.

The third potential explanation has to do with economic reasons. It is possible that there are aggregate economywide or region-specific factors that yield different returns to human capital by gender. Consequently, parents may be motivated to invest more in or to engage in early intervention for affected children of one gender as opposed to the other. But if that were the case, then we would see similar gender differential effects for children regardless of being born to rural famine fathers or mothers in the same region. Yet our results do not in fact reveal such similar effects.

The final explanation is related to son preference. At the time of famine, families with strong son preference would tend to allocate their limited resources more in favor of their sons than other families, and are thereby more likely to have survivor sons. It is conceivable that these male survivors, having grown up in a family with strong son preference, may take more early remedial interventions in favor of their sons, potentially at the expense of their daughters, to undo the damage from their exposure to famine. To test this hypothesis, we examine the intergenerational impact of first-generational famine exposure on families with only one child as opposed to many, and also on families with only sons or daughters in comparison with families with children of both sexes. We find negative effects on girls born to famine fathers only if they have brothers, suggesting the persistence of intrahousehold son preference. We conclude therefore that the pattern of intergenerational effects of famine is most likely explained by a combination of the weak scarring effects on the exposed generation and the stronger son preference of male survivors.

The rest of the paper is organized as follows. We provide a literature review in Section 2. Section 3 details our methodology and describes the data. Section 4 discusses our findings. Finally, Section 5 concludes.

2. LITERATURE REVIEW

We now review the existing literature on famine and early childhood malnutrition paying particular attention to the work related to the Great Chinese Famine of 1959–1961. Since large-scale randomized controlled trials on human beings are infeasible for a direct test of this hypothesis, researchers have relied on exogenous shocks, such as famines, to identify the negative effects of exposure to early childhood malnutrition on subsequent health and economic outcomes for the affected individuals.3

A seminal work in this area is Stein et al. (1972) on the lasting health impact of exposure to the 1944–1945 Dutch famine in early childhood. They found no significant effects for the incidence of famine experienced in utero or during early childhood on the cognitive abilities of male survivors at age 19—measured in terms of IQ and mild or severe forms of mental retardation. However, subsequent work has found evidence that by middle age this cohort experienced significantly higher-than-average levels of health disorders, including higher rates of obesity (Ravelli et al. 1999) and glucose intolerance (Ravelli, van de Meulen, and Michels 1998), lower quality of self-reported health and higher rates of coronary heart disease morbidity (Roseboom et al. 2001; Bleker et al. 2005), and higher incidences of adult psychological disorders (Neugebauer, Hoek, and Susser 1999; Brown et al. 2000; Hulshoff et al. 2000).

More recently, researchers have found that childhood exposure to famines has persistent long-run negative consequences in other countries. For instance, children in rural Zimbabwe who were exposed before the age of 3 to the effects of drought and civil war were significantly shorter at adolescence and had lower schooling attainment (Alderman, Hoddinott, and Kinsey 2006). Neelsen and Stratmann (2011) highlighted the adverse yet heterogeneous effects of the 1941–1942 Greek famine on survivors below the age of 2 at the time of famine—that is, the cohort exposed to famine during infancy (first year of life) performed much worse in terms of educational attainment than those exposed during the second year of life. Employing data from the Ghana Education Impact Evaluation Survey, Ampaabeng and Tan (2013) show that the 1983–1984 famine in Ghana significantly lowered IQ and academic scores of math and English comprehension tests for survivors who were between the ages of 0 and 2 during the time of the famine.

A particularly fruitful context for famine studies has been China. The Great Chinese Famine of 1959–1961 has been argued to be one of the most severe in human history in terms of loss of life—resulting in between 15 and 30 million excess deaths (Ashton et al. 1984; Riskin 1990; Ravallion 1997) and around 30 million lost or postponed births (Ashton et al. 1984; Yao 1999). In perspective, the upper bound of excess deaths translated to 5 percent of the entire population. There was also substantially large geographic variation in famine severity with rural areas and provinces that showed highest support for the Party's policies (as measured by Party membership density; Kung and Lin [2003]), such as Henan, Sichuan, Anhui, Shandong, and Gansu, performing worse.

There is strong evidence that exposure to the famine had significant negative long-run consequences for survivors. Survivors of the 1959–1961 birth cohorts have been shown to register less favorably on a range of adult health and economic outcomes, including anthropometric health measures such as height (Chen and Zhou 2007; Meng and Qian 2009) and obesity (Luo, Mu, and Zhang 2006), incidence of disability (Mu and Zhang 2011), risk of mental illness (Huang et al. 2012), educational attainment (Meng and Qian 2009), labor market experiences (Almond et al. 2010; Meng and Qian 2009), wealth (Almond et al. 2010), and marriage market outcomes (Almond et al. 2010; Brandt, Siow, and Vogel 2008). The famine also appears to have had a differential impact on male and female survivors. As Almond et al. (2010, 332) report, using data from the China Population Census 2000, "men were 9 percent more likely to be illiterate, 6 percent less likely to work, and 6.5 percent less likely to be married if exposed to the Famine in utero. Women were 7.5 percent more likely to be illiterate and 3 percent less likely to work, and tended to marry men with less education, if exposed in utero. We also find fetal

[3] Other work in the development literature has also looked at other forms of early health shocks that are potentially not as severe as a deep famine spanning multiple years—for example, fasting by mothers during Ramadan (Almond and Mazumder 2011).

exposure to the Famine substantially reduced the cohort's sex ratio (fewer males), suggesting greater male vulnerability to maternal malnutrition."

Whereas the long-run negative effects on survivors of early childhood exposure to famine have been well documented, the question as to whether those effects for the human population persist across generations is an open one.[4] A small number of recent works examined the intergenerational persistence of early health shocks based on the China Health and Nutrition Survey, focusing primarily on general health measures. To our knowledge, no studies have examined the intergenerational impact on cognitive abilities in China. For instance, An and Li (2013) find that children born to parents who both were exposed to the Great Chinese Famine were significantly shorter (adjusted for age) than children born to other parents. In addition, Fung and Ha (2010) show that although the children of famine-exposed parents had lower weight adjusted for age, their schooling attainment was no different from other children. Kim and Fleisher (2010) also find no significant negative effects on second-generation schooling and work status, but a negative impact on wages and work hours. Finally, using the China Population Census 2000, Almond et al. (2010) found that, consistent with the Trivers–Willard (1973) hypothesis, mothers who had been exposed prenatally to famine were more likely to give birth to daughters. Overall, most of the empirical studies on intergenerational transmission do not look at the gender-specific intergenerational transmissions and none of them has examined the impact on cognitive ability.

Since cognitive ability is an integral part of human capital, our paper is also related to the broad economics literature on international mobility (Black and Devereux 2011; Clark 2014). For example, Clark (2014) used the persistent overrepresentation of individuals with rare (high-status) surnames in occupations with high social status to show that patterns of social mobility are actually relatively invariant over time. He posits "a social law . . . a universal constant of intergenerational correlation of 0.75, from which deviations are rare and predictable." The focus on surnames potentially attributes the low social mobility in many societies to inherited advantages from fathers to sons as the major cause. However, as shown in the biological literature, sons' cognitive skills should be more associated with the X chromosomes of their mothers. The high persistence of the father–son link may therefore not be due to purely genetic reasons. Black, Devereux, and Salvanes (2005) also show that only mothers' education has a causal impact on sons' education level, and the impact of fathers on children is more muted. Following Black, Devereux, and Salvanes, we also explore the dyadic relationships between children's cognitive abilities and those of the affected famine parents.

[4] There are reasons to believe that direct linkages might exist across generations in terms of health. Jirtle and Skinner's (2007) comprehensive review of epidemiological evidence from mice studies provides not only strong support for the fetal origin hypothesis but also evidence that some of these environmental effects are passed on to subsequent generations. They further suggest that the transmission mechanism is epigenetic in origin. The Överkalix cohort studies by Pembrey et al. (2006) have also provided evidence for sex-specific, male-line transgenerational effects of limiting food supplies whereby grandsons (but not granddaughters) of paternal grandparents who faced limited food supplies in early childhood experienced higher mortality risk ratios.

3. DATA AND METHODOLOGY

We now describe the data we used for our analysis and our baseline exercise. Our main dataset in the empirical analyses is the CFPS, which is a panel survey dataset conducted in 2010 and 2012. The CFPS data collection effort was funded by the 985 Program of Peking University and carried out by the Institute of Social Science Survey of Peking University. The aim was to characterize the transitions of social, economic, demographic, education, and health situations in China and provide the data foundations for academic and public policy research. The CFPS 2010 covers 14,798 families and 33,600 adults from across 25 provinces of China.

This dataset has two advantages. First, it carries out a cognitive test of the respondents, which is a direct measurement of cognitive ability. Previously, people have employed indirect outcome indicators, such as literacy or schooling attainment, to measure cognitive ability. Specifically, the CFPS 2010 prepared a series of mathematics and word recognition questions for the respondents to answer, while the CFPS 2012 replaced those tests with short-term memory and logic tests. The questions are arranged in ascending order of difficulty within groups of questions indicated by the highest education level of the respondent. The ultimate test score is the order (rank) of the hardest question that the respondent is able to answer correctly; if the respondent fails to answer any question in his education group correctly, his score is the lowest for his education level minus 1. For example, a person with middle-school education will begin to answer from the 9th question. If the hardest question that the respondent is able to answer correctly is the 11th question, his test score is 11. If he fails to answer questions 9, 10, and 11 consecutively, his score is 8 (9 – 1).

Second, the CFPS provides detailed individual, family, and community information about the respondents, which allows us to introduce a rich set of controls when analyzing the effects of parental exposure to famine on children's cognitive ability. For example, the CFPS asks about the time to the nearest hospital and the distance to the nearest high school, two important determinants of whether the respondent (or his or her family) can get access to medical service and education systems conveniently, which in turn potentially affects cognitive development. Furthermore, the height, weight, and health status of the respondent are also available from the CFPS 2010, which enable us to exclude the impact of potential (early) health interventions on cognitive ability.

In this paper, we are particularly interested in the potential heterogeneous impact of the famine along two dimensions. First, we want to know whether the effect on children of male survivors (famine fathers) is different from that for female survivors (famine mothers). Thus, we separate the father and mother samples. Second, we are interested in whether there is heterogeneous impact across the genders of children. We therefore allow for the famine effect to vary across female and male children of famine survivors in our analysis.

We restrict our sample to rural areas because the famine mainly struck there due to urban-biased policy. As argued in Chen and Zhou (2007), the strict *hukou* system (household registration) in that period prevented rural people from migrating to the urban areas.

Formally, our baseline econometric specification is as follows:

$$y_i = \beta_1 cohort_i \times excess\_mortality_p + \beta_2 cohort_i + \beta_3 excess\_mortality_p + X_i^T \gamma + \varepsilon_i, \quad (1)$$

where y_i is the test score for individual *i* (with higher scores indicating better cognitive ability), and $cohort_i$ is a dummy variable that equals 1 if the respondent's father (mother) was born during 1959–1961, that is, the famine years, and equals 0 otherwise. Recall that our aim is to investigate the cognitive impact of the famine on the children of famine survivors who had experienced famine in the fetal stage. Considering that the famine ended in most provinces in 1961 but in some provinces in 1962, and people born in 1962 might or might not have been conceived during the famine years, we exclude the children whose parents were born in 1962 from our sample. We choose the children whose parents were born during 1963–1965 as the control group. The children themselves (both cohorts) were in early adulthood (aged 16–30) at the times of the surveys. Our proxy for famine intensity in province *p* ($excess\_mortality_p$), taken from Lin and Yang (2000), is defined as the difference between the highest mortality rate in 1959–1961 and the average mortality rate in 1956–1958 in the province.

The main coefficient of interest in our analysis is β_1 of equation 1. While the level term, β_2, captures the intrinsic difference in cognitive test scores between the children of famine survivors and nonfamine survivors, the coefficient to the interaction term of $cohort_i$ and $excess\_mortality_p$, β_1, captures the diverse impact of the Great Famine on the cognitive development of descendants of famine survivors relative to nonfamine survivors. Note that the partial effect of the intensity of famine on the former group is given by $(\beta_1 + \beta_3)$ while that for the latter is given by just β_3. Since the latter group has not experienced the famine, we expect β_3 to be insignificant from 0. This then constitutes a natural falsification test. A negative β_1 would then imply a detrimental effect of the Great Famine on the children of famine survivors.

The set X_i denotes the set of controls including the individual, family, and community characteristics of the respondent. In terms of individual characteristics, we control for gender, age, birth order, log of height, log of weight, and health status (in good health) of the respondent. We also include the square and cubic terms of age to capture the potential nonlinear effect of age on cognitive ability. Since parents' age difference may affect children's cognitive performance, we include the age difference between fathers and mothers as a robustness check. Finally, we also include region and ethnicity fixed effects to allow for systematic differences in cognitive test scores across different regions and ethnic groups in China.

Birth order might affect cognitive ability because the youngest child potentially receives more attention from parents and may get access to better education considering the rapid development of China's education system in the past 30 years. Height and (to a lesser extent) weight are highly correlated with nutrition in early childhood, which is a critical determinant of cognitive development. We also employ a survey question to get a respondent's current health status. The question, "in good health," is a subjective evaluation by the respondent, which equals 1 if the health status is moderate or good and 0 otherwise. Other family-level control variables that might affect the level of investment in the child include the number of siblings, parents' education level, and family income per person. At the community level, we include time to nearest hospital and distance to nearest school as those variables capture the local accessibility of medical services and education.

Table 3.1(a) provides summary statistics for the key variables, while Table 3.1(b) provides a breakdown of the key demographic and family characteristics of households with various parental pairs. Figure 3.1 shows the trend in the difference in the math test scores for children of rural fathers born in areas that experienced severe famine in 1959–1961 compared with those born in regions with less severe famine. What stands out in the figure is the sharp spike in the mean difference of math test scores for the daughters of fathers who were born during the famine, the peak of which was in 1960 and 1961, between severe and less severe provinces. Of course, the figure just presents suggestive evidence on the link between fathers' fetal exposures to famine and daughters' worse math performance. In the next section, we will provide more quantitative evidence to substantiate the causal relationship.

Table 3.1a Summary statistics of key variables

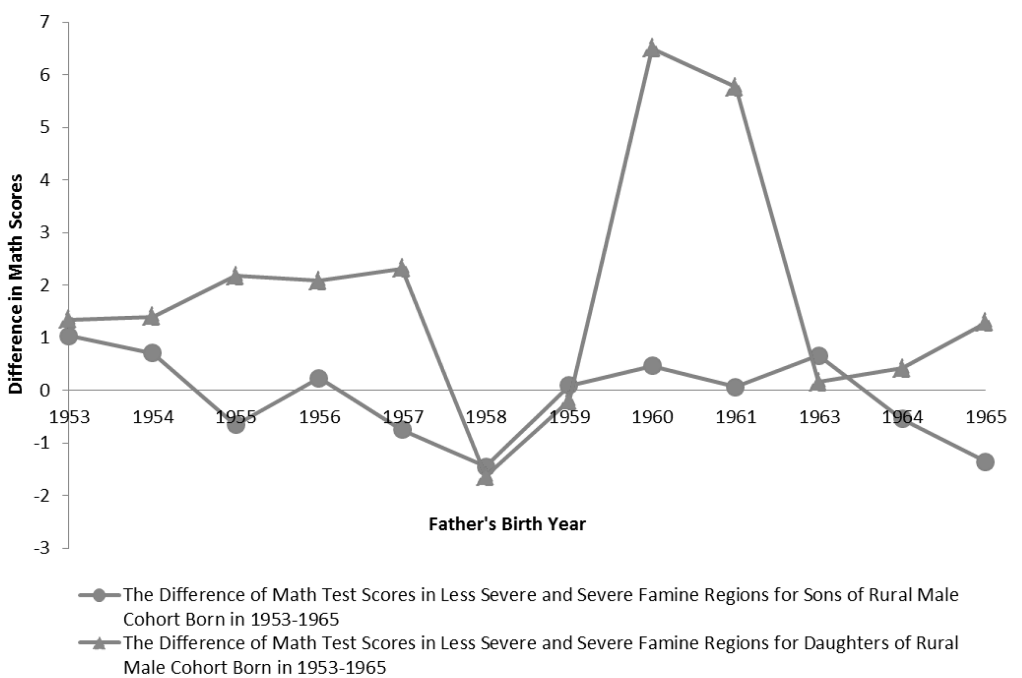
	All		Boys		Girls	
Variable	Mean	Std.	Mean	Std.	Mean	Std.
Math test scores	15.244	5.632	15.194	5.810	15.309	5.397
Word test scores	25.034	7.182	24.733	7.468	25.425	6.780
Famine	15.542	13.177	15.541	12.989	15.543	13.432

Table 3.1b Mean of key characteristics in different groups

Characteristic	FF-NFM	FM-NFF	FF-FM	NFF-NFM
Log family income per capita	8.69 (261)	8.68 (225)	8.74 (118)	8.76 (1,112)
Father's years of education	7.84 (254)	6.89 (215)***	8.55 (114)**	7.72 (1,077)
Mother's years of education	5.61 (263)	5.32 (222)	5.72 (118)	5.54 (1,100)
Spirit drunk last week (50 gram)	4.80 (261)	5.78 (225)	5.62 (118)	4.24 (1,110)
Age of children	22.32 (267)***	24.13 (226)***	23.96 (118)***	20.87 (1,117)
Number of children	1.59 (267)***	1.52 (226)***	1.37 (118)	1.29 (1,117)
Number of boys	0.79 (267)**	0.83 (226)***	0.84 (118)**	0.70 (1,117)
Number of girls	0.85 (267)***	0.96 (226)***	0.91 (118)***	0.69 (1,117)
Boys/girls	0.93	0.86	0.92	1.01

Source: China Family Panel Studies (2010).
Notes: FF-NFM indicates that father was born during 1959–1961 and mother was not ; FM-NFF indicates that mother was born during 1959–1961 and father was not; FF-FM indicates that father and mother were both born during 1959–1961; NFF-NFM indicates that neither father nor mother were born during 1959–1961. The number in parentheses indicates the sample size. ***, **, and * indicate that the mean difference between the corresponding group and the NFF-NFM group is significantly different at the 1%, 5%, and 10% level, respectively.

Figure 3.1 Math test scores for children of rural male cohort born in 1953–1965



Source: China Family Panel Studies (2010).
Notes: The severe and less severe groups are categorized by the median value of famine severity variable at the provincial level. Famine severity is measured as the difference between the highest mortality rate at the provincial level during 1959–1961 and the average mortality rate during 1956–1958. Horizontal axis refers to fathers' birth year.

4. FINDINGS

Baseline Findings for the Second Generation

We first carry out a simple difference-in-differences exercise comparing the intergenerational cognitive effect of fathers in severe and less severe regions who experienced famine in early childhood (that is, those born in the years 1959–1961) as opposed to those who have never experienced famine (that is, those born in the years after the famine [1963–1965]). We report the difference-in-differences results in Table 4.1. The results show a significant negative effect on math test scores for the children of fathers who experienced famine during early childhood with the effect being particularly large and significant for their daughters. In a similar difference-in-differences exercise (results not reported) for the children of famine mothers, however, we do not find significant effects for children of either gender.

Table 4.1 Difference-in-differences estimates of the intergenerational impact of famine on math scores (children of rural fathers)

	Level of famine severity		
	Severe	**Less severe**	**Difference**
Cohort	**(1)**	**(2)**	**(1) – (2)**
Panel A: All sample			
1959–1961 cohort	13.01	14.68	-1.67**
1963–1965 cohort	15.85	15.68	0.17
Difference of the above two rows	-2.84***	-1.00*	-1.84**
Panel B: Boys' sample			
1959–1961 cohort	13.58	13.83	-0.25
1963–1965 cohort	16.07	15.52	0.55
Difference of the above two rows	-2.49***	-1.69**	-0.80
Panel C: Girls' sample			
1959–1961 cohort	12.23	15.82	-3.59***
1963–1965 cohort	15.57	15.87	-0.30
Difference of the above two rows	-3.34***	-0.05	-3.29***

Source: China Family Panel Studies (2010).

Notes: We restrict the sample to children whose fathers were born during the Great Famine (1959–1961) and postfamine period (1963–1965) and whose mothers were not born in the famine years. Famine severity is measured as the difference between the highest mortality rate at the provincial level during 1959–1961 and the average mortality rate during 1956–1958. The severe and less severe famine provinces are defined according to the median value of famine at the provincial level. The severe provinces include Anhui, Guizhou, Sichuan, Qinghai, Gansu, Henan, Hunan, Guangxi, Shandong, and Hubei, while the less severe provinces include Liaoning, Yunnan, Jiangsu, Fujian, Guangdong, Hebei, Jilin, Jiangxi, Heilongjiang, Beijing, Zhejiang, Shaanxi, Shanxi, Shanghai, and Tianjin. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

The findings for the simple difference-in-differences exercise are upheld by the results based on our baseline specification, which are reported in Table 4.2. Table 4.2 shows the regression results for the intergenerational impact of the famine on the math test scores of children whose fathers were born in the rural area during 1959–1965 (spanning the years of the famine and after except for 1962). Consistent with our hypothesis, we find a negative coefficient for the interaction between famine severity and the father being born during the famine years of 1959–1961 (corresponding to β_1 of equation 1 above) for the entire set of children. This finding is true regardless of whether we explicitly exclude provincial fixed effects (column 1 of Table 4.2) or include them (column 2 of Table 4.2).

Table 4.2 Intergenerational impact of famine on math scores for the children of rural fathers: Baseline results

Dependent variable: Math test scores (the higher the better)						
	All		Boys		Girls	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Famine×Father born in	-0.057*	-0.073**	-0.012	-0.028	-0.097**	-0.109**
1959–1961	(0.032)	(0.034)	(0.037)	(0.043)	(0.045)	(0.051)
Father born in 1959–1961	0.329	0.471	-0.774	-0.706	1.338	1.640
	(0.742)	(0.761)	(0.763)	(0.830)	(1.147)	(1.220)
Famine	0.010		0.022		-0.019	
	(0.025)		(0.032)		(0.022)	
Boy dummy	-0.823*	-0.764				
	(0.419)	(0.471)				
Age	22.808***	21.927***	23.556**	23.897**	20.605***	22.193***
	(7.125)	(7.210)	(11.226)	(11.082)	(6.920)	(7.361)
Age square	-1.024***	-0.978***	-1.081**	-1.093**	-0.911***	-0.976***
	(0.321)	(0.325)	(0.506)	(0.499)	(0.316)	(0.336)
Age cubic	0.015***	0.014***	0.016**	0.016**	0.013**	0.014**
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
Father below middle	-1.901***	-1.697***	-1.917***	-1.809***	-2.107***	-1.745***
school (dummy)	(0.401)	(0.394)	(0.492)	(0.449)	(0.529)	(0.581)
Mother below middle	-0.809**	-0.921**	-1.165**	-1.286**	-0.211	-0.313
school (dummy)	(0.299)	(0.332)	(0.475)	(0.513)	(0.368)	(0.436)
Number of siblings	-0.457*	-0.471	-0.476	-0.631	-0.455*	-0.359
	(0.250)	(0.285)	(0.413)	(0.477)	(0.264)	(0.346)
Birth order	-0.985***	-0.976***	0.006	0.129	-1.746***	-1.815***
	(0.308)	(0.297)	(0.343)	(0.302)	(0.390)	(0.374)
Time to nearest	0.085	-0.087	0.348	0.218	-0.033	-0.317
hospital (log)	(0.223)	(0.162)	(0.273)	(0.238)	(0.284)	(0.249)
Distance to nearest	-0.335**	-0.313**	-0.434**	-0.413**	-0.122	-0.025
high school (log)	(0.135)	(0.129)	(0.204)	(0.198)	(0.231)	(0.214)
Family income per	0.571***	0.450**	0.579**	0.488*	0.545*	0.346
person (log)	(0.185)	(0.181)	(0.265)	(0.259)	(0.294)	(0.284)
Log height	11.885***	12.190***	20.320**	23.270***	8.080**	8.664**
	(3.659)	(3.807)	(8.738)	(7.184)	(3.056)	(3.243)
Log weight	-0.791	-0.938	0.062	-0.130	-2.070	-2.293
	(1.024)	(1.140)	(1.094)	(1.301)	(1.565)	(1.786)
In good health (dummy)	1.282	1.391	3.188*	3.430**	-1.468	-1.397
	(1.107)	(1.146)	(1.599)	(1.641)	(1.077)	(1.148)
Province dummies	No	Yes	No	Yes	No	Yes
Observations	968	968	547	547	421	421
Adjusted R^2	0.207	0.227	0.214	0.241	0.248	0.264
AIC	5884.9	5837.3	3366.1	3321.0	2510.5	2471.3

Source: China Family Panel Studies (2010).

Notes: Ethnicity fixed effects are controlled in all the regressions. Due to space limit, they are not reported. The variable "Father below middle school" indicates that father's education level is primary school or below. "In good health" is a subjective evaluation of respondent, which equals 1 if the health status is pretty good or good and 0 otherwise. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

When we examine the breakdown of the findings by the gender of the children, we find substantial gender difference. The findings are shown in columns 3 and 4 of Table 4.2 for male offspring and columns 5 and 6 of Table 4.2 for female offspring. Whereas father's exposure to famine during early childhood lowers math test scores for both male and female offspring, only the impact for girls is statistically significant. The magnitude is also large. An increase of famine intensity by one standard deviation will increase the difference in math test scores between daughters whose fathers were born during the Great Famine and those whose fathers were not by 9.6 percent. In fact, we find that in provinces where the famine was severe (as defined in Table 4.1), the difference in math test scores between girls of famine and nonfamine fathers is a massive 27 percent, while in less severely exposed provinces, the difference is not significant.

Robustness and Falsification Checks

We next conduct a sequence of robustness checks and falsification tests. First, we want to rule out that the observed pattern is driven by an existing trend prior to the famine across regions. In Table 4.3, we regress math test scores of children whose fathers were born in 1953–1959 on a set of cohort fixed effects and their interactions with the famine variable. None of the coefficients for the cohort and their interaction terms with famine is statistically significant. It is apparent from the table that there are no pre-existing differences in math test scores across the children of birth cohorts from 1953 to 1958 (relative to the base cohort of 1959).

Table 4.3 Intergenerational impact of famine on math scores for the children of rural fathers born in 1953–1958: No trend in the prefamine period

Dependent variable: Math test scores (the higher the better)						
	All		Boys		Girls	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Famine× Cohort 1953	-0.033	-0.023	-0.028	-0.024	-0.083	-0.047
	(0.060)	(0.069)	(0.059)	(0.068)	(0.120)	(0.123)
Famine× Cohort 1954	-0.032	-0.011	-0.019	-0.008	-0.114	-0.074
	(0.069)	(0.079)	(0.063)	(0.077)	(0.127)	(0.143)
Famine× Cohort 1955	0.015	0.010	0.037	0.029	-0.034	-0.014
	(0.058)	(0.065)	(0.048)	(0.062)	(0.114)	(0.121)
Famine× Cohort 1956	-0.029	-0.000	-0.042	-0.020	-0.070	-0.028
	(0.068)	(0.068)	(0.062)	(0.062)	(0.138)	(0.144)
Famine× Cohort 1957	-0.024	-0.027	-0.022	-0.040	-0.056	-0.049
	(0.062)	(0.069)	(0.063)	(0.066)	(0.102)	(0.115)
Famine× Cohort 1958	0.081	0.087	0.059	0.068	0.071	0.077
	(0.067)	(0.066)	(0.094)	(0.093)	(0.098)	(0.105)
Cohort 1953	1.237	1.069	1.286	1.356	1.647	0.779
	(1.699)	(1.905)	(1.524)	(1.674)	(2.496)	(2.681)
Cohort 1954	0.887	0.780	1.332	1.513	1.056	0.237
	(1.285)	(1.372)	(1.065)	(1.176)	(2.039)	(2.270)
Cohort 1955	-0.623	-0.348	-0.820	-0.255	-0.023	-0.050
	(1.297)	(1.385)	(1.121)	(1.350)	(1.794)	(1.891)
Cohort 1956	0.843	0.293	1.140	0.908	1.382	0.574
	(1.158)	(1.078)	(1.101)	(1.068)	(1.718)	(1.728)
Cohort 1957	-0.012	0.245	0.028	0.619	0.346	0.252
	(1.251)	(1.326)	(1.512)	(1.513)	(1.706)	(1.815)
Cohort 1958	-0.533	-0.565	-0.148	-0.273	-0.211	-0.233
	(0.746)	(0.711)	(1.009)	(1.070)	(1.126)	(1.227)
Famine	0.021		0.044		0.031	
	(0.047)		(0.045)		(0.102)	

Table 4.3 Continued

Dependent variable: Math test scores (the higher the better)						
	All		Boys		Girls	
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	No	Yes	No	Yes	No	Yes
Observations	999	999	586	586	413	413
Adjusted R^2	0.185	0.212	0.143	0.193	0.250	0.267
AIC	6033.3	5971.1	3525.7	3466.4	2507.1	2467.4

Source: China Family Panel Studies (2010).

Notes: The table tests whether the difference in math test scores between different areas and cohorts already exists before the famine. The cohort 1959 is used as the base group. See the notes in Table 4.1 for the definition of the famine severity variable. The control variables, which are the same as those in Table 4.2, are included but not reported here. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

It is possible that the calculation of excess mortality at the province level may be subject to measurement error. To address this possibility, we investigate what happens when we employ the reduction in the cohort size of 1959–1961 relative to 1956–1958 at the county level as an alternative measurement for the severity of famine. In this case, the data for the cohort size are from the 1 percent sampling of the China Population Census 2000. We report the corresponding results based on the county-level famine measure in Table 4.4. The results are qualitatively similar to what was found using the province-level famine measure.

Table 4.4 Robustness check: Using changes in county-level cohort size as a measure for the famine severity

Dependent variable: Math test score (the higher the better)						
	All		Boys		Girls	
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Famine× Cohort 1959–1961	-4.053*	-3.732*	-0.013	-2.026	-8.269**	-5.929*
1959-1961	(2.555)	(2.152)	(3.230)	(3.414)	(3.670)	(3.571)
Cohort 1959–1961	0.639	0.461	-1.009	-0.577	2.505*	1.840
	(0.985)	(0.884)	(1.099)	(1.091)	(1.380)	(1.470)
Famine	0.811		-0.817		2.194	
	(1.585)		(1.728)		(1.969)	
Boy dummy	-0.821*	-0.786*				
	(0.419)	(0.461)				
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
County dummies	No	Yes	No	Yes	No	Yes
Observations	968	968	547	547	421	421
Adjusted R^2	0.206	0.225	0.212	0.241	0.241	0.259
AIC	5887.9	5842.4	3365.0	3319.0	2512.5	2474.0

Source: China Family Panel Studies (2010).

Notes: Famine = (cohort size in 1956–1958 – cohort size in 1959–1961)/cohort size in 1956–1958. Cohort size is from the 2000 1% population census. Massive migration did not take place until the late 1990s. Even at the time, most of the migrants were younger than 30 years old. Ethnicity fixed effects are controlled in all regressions. Due to space limit, they are not reported. The dummy variable "Cohort 1959–1961" indicates children whose fathers were born during 1959–1961. The same set of control variables as in Table 4.2 are included but not reported. Robust standard errors clustered at the county level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Another source of measurement error may stem from migration. The observed population in 2010 might not have been born in the same place. The problem has two facets: migration of parents and migration of their children. Massive migration did not take place until the late 1990s, and most of the migrants were younger than 30 years old (Meng 2012). Since the 1959–1961 and 1963–1965 cohorts were already more than 30 years old in the late 1990s, the issue of migration is not a big problem for famine parents. However, migration of children potentially poses a challenge for our baseline analysis. If cognitively higher functioning children tend to migrate to the urban area, the observed rural sample is then composed of cognitively weaker children, thereby more likely to exaggerate the negative impact of the famine. Fortunately, the CFPS 2010 asks the respondents about where they are currently living and their birthplace so that we can deal with the migration problem directly. In Table 4.5, we report results for the cases by excluding respondents whose current domiciles are different from their birthplaces from the sample. The results continue to hold.

Table 4.5 Additional robustness check: Dropping migrants from the rural sample

Dependent variable: Math test scores (the higher the better)						
	All		Boys		Girls	
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Famine× Cohort	-0.058*	-0.074**	-0.019	-0.041	-0.096*	-0.097*
1959–1961	(0.033)	(0.035)	(0.040)	(0.042)	(0.051)	(0.057)
Cohort 1959–1961	0.320	0.477	-0.645	-0.489	1.214	1.314
	(0.723)	(0.744)	(0.810)	(0.876)	(1.113)	(1.197)
Famine	0.008		0.029		-0.031	
	(0.025)		(0.033)		(0.023)	
Boy dummy	-0.969*	-1.055*				
	(0.521)	(0.535)				
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	No	Yes	No	Yes	No	Yes
Observations	920	920	522	522	398	398
Adjusted R^2	0.212	0.229	0.217	0.241	0.258	0.267
AIC	5583.1	5535.7	3213.2	3167.0	2357.3	2322.1

Source: China Family Panel Studies (2010).

Notes: We drop observations whose living place is different from the birth place. See the notes in Table 4.1 for the definition of the famine severity variable. Ethnicity fixed effects are controlled in all regressions. Due to space limit, they are not reported. The dummy variable "Cohort 1959–1961" indicates children whose fathers were born during 1959–1961. The same set of control variables as those in Table 4.2 are included but not reported. Robust standard errors clustered at the county level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

It may also be the case that the CFPS is not a representative sample of the Chinese population (even though it was explicitly constructed to be the case). To check against this possibility, we conduct a similar baseline analysis using data from the China Population Census 2000. Unfortunately, the census data do not have many good measures of cognitive abilities. We chose the dependent variable to be the illiteracy dummy and checked whether our baseline findings continue to hold when we use this dataset (that no one disputes in terms of representativeness). As Table A.1 of the appendix shows, our baseline findings are qualitatively robust. The negative cognitive effects are found to be statistically significant at the 5 percent level only for children of fathers who experienced the famine during early childhood. The impact is much larger for daughters than for sons.

It is also possible that the findings are specific to the math test and that alternative measures for children's cognitive ability may yield substantively different results. As Table A.2 of the appendix shows, however, the findings for the math test are similar to those obtained when we use the word recognition test scores from the CFPS 2010 as an alternative measure of cognitive ability. There are also preliminary data (not yet publicly available) from the 2012 wave of the CFPS on scores for a short-term memory test. We carry out a similar baseline regression exercise for this cognitive dependent variable; see Table A.3 of the appendix. The results for the short-term memory test are consistent with what we obtained with the math test scores for the CFPS 2010 data. Yet again, sons of famine fathers do better on the test than daughters of famine fathers. In both cases, similar to the math test results, the magnitude of the (statistically significant) intergenerational effects is large. An increase of famine intensity by one standard deviation will increase the difference in word test scores between daughters whose fathers were born during the famine and those whose fathers were not by 30.7 percent. For the short-term memory test, sons of famine fathers achieve a 5 percent higher score than those of nonexposed fathers.

We note that similar findings are not present when we consider the set of rural famine mothers. We show corresponding regression results for the math and word test scores (Table A.4 of the appendix) as well as short-term memory test scores (lower panel of Table A.3) for children born to rural mothers. In all cases, we find no intergenerational effect from mothers to their children of either gender. The intergenerational transmission of the negative effects of early health shocks to parents (fathers, in particular) is therefore gender specific (affects only daughters significantly).

As we noted in Section 3, the coefficients to the famine variable (corresponding to β_3 of equation 1 above) in columns 1, 3, and 5 of Table 4.2 describe the effects of the severity of famine on children of fathers who were born *after* the famine years. A natural falsification check would be that these coefficients should be insignificant from 0. We see from Table 4.2 that this is in fact the case. As a further falsification test, we also conduct the same analysis as in our baseline exercise on the urban sample. Because the famine mainly took place in the rural regions, the negative intergenerational effects we observe in the rural areas should not be observed for children of parental cohorts born in the famine years but living in urban areas. Reassuringly, we find the expected patterns in the falsification test (see the upper panel in Table 4.6).

Table 4.6 Falsification test

Dependent variable: Math test score (the higher the better)						
	All		Boys		Girls	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Children of male cohort born in 1959–1961 and 1963–1965 in cities						
Famine× Cohort 1959–1961	-0.074	-0.058	-0.100	-0.125	-0.065	-0.060
	(0.055)	(0.061)	(0.064)	(0.082)	(0.058)	(0.063)
Cohort 1959–1961	1.094	0.840	1.491	1.420	0.558	0.679
	(0.642)	(0.657)	(0.972)	(0.925)	(0.559)	(0.603)
Famine	0.017		0.027		0.017	
	(0.029)		(0.042)		(0.016)	
Boy dummy	-0.702	-0.358				
	(0.959)	(1.099)				
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	No	Yes	No	Yes	No	Yes
Observations	259	259	125	125	134	134
Adjusted R^2	0.230	0.243	0.275	0.434	0.100	0.053
AIC	1373.2	1339.4	684.6	623.6	703.9	680.9

Table 4.6 Continued

Dependent variable: Math test score (the higher the better)						
	All		Boys		Girls	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Children of rural male cohort born in 1963–1965 and 1966–1968						
Famine× Cohort	-0.021	-0.023	-0.012	-0.012	-0.047	-0.043
1963–1965	(0.023)	(0.023)	(0.034)	(0.038)	(0.027)	(0.026)
Cohort 1963–1965	0.633	0.535	1.022	1.150	0.271	0.200
	(0.530)	(0.522)	(0.659)	(0.752)	(0.630)	(0.537)
Famine	0.027		0.038		0.021	
	(0.016)		(0.026)		(0.017)	
Boy dummy	-0.594	-0.421				
	(0.553)	(0.566)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	1321	1321	714	714	607	607
Adjusted R^2	0.173	0.204	0.135	0.186	0.247	0.258
AIC	7823.8	7917.9	4380.2	4312.1	3604.6	3566.1

Source: China Family Panel Studies (2010).

Notes: Ethnicity fixed effects are controlled in all regressions. Due to space limit, they are not reported. Cohort 1959–1961 (dummy) indicates children whose father was born during 1959–1961. Cohort 1963–1965 (dummy) indicates children whose father was born during 1963–1965. Other controls same as those in Table 4.2 are included but not reported here. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

The observed results may also be due to the systematic difference in mothers' age in the famine father and mother samples. Since men tend to marry younger women, mothers are on average younger in the famine father sample than those in the famine mother sample. If a child's cognitive performance is associated with mother's age at his or her birth, then the difference in mothers' age between the two samples may result in a systematic bias. To address this concern, one method is to run a falsification test by comparing two postfamine cohorts, 1963–1965 and 1966–1968. If mothers' age is a driving factor, it will manifest in the falsification exercise as well. As shown in the lower panel of Table 4.6, none of the coefficients for the 1963–1965 cohort and its interaction term with famine is statistically significant, largely dismissing this concern. Another method to deal with this concern is to control the age difference between fathers and mothers. As shown in Table A.5 of the appendix, the basic patterns remain robust when we include this control variable. Therefore, the systematic difference in mother's age in famine fathers' and famine mothers' samples is not a big challenge to our baseline results.

Endogeneity

Although our approach of using the excess death rate as a proxy for the intensity of famine is consistent with most of the existing work in the literature, the use of that proxy has several known drawbacks. The proxy's purpose is to measure the severity of malnutrition experienced during the famine. Although malnutrition would certainly be a cause of excess mortality, other factors associated with the incidence of famine in a given region could contribute to (or detract from) excess mortality too. Such factors include migration into or out of a region (although that factor is less important in the Chinese context due to the existence of strict regional migration restrictions in the form of the *hukou* system) and the degradation of medical and social services, among others. The excess death rate therefore is likely to be endogenous.

To address the issue of endogeneity, we propose instrumental variables (IVs) that take advantage of the unique institutional features of the Chinese administration during the famine years. Specifically, our IVs target the performance assessment system the central government imposed on provincial governors and secretaries. Some studies (Li and Yang 2005; Kung and Chen 2010) have shown that the origins of provincial governors matter greatly to the famine severity. Governors accumulated promotion capital from the central government when they met what were radical and, in many cases, unattainable grain production targets under the Great Leap Forward movement in 1958. Governors were therefore motivated to inflate grain output figures (resulting in excessive grain procurements by the central government) or redistribute grains to other provinces to win favor with the central government, or both. With distorted information, the central government, as a consequence, failed to take relevant steps to lower the output target and transfer grains to the provinces suffering from severe famine (Cai 2000). As Meng, Qian, and Yared (2011) point out, the inflated grain output and the subsequent overprocurement of grains produced a striking geographic pattern of famine that had reversed previous mortality trends under normal conditions. Regions that had historically produced more grain and had experienced historically lower mortality rates suffered more during the famine.

Our IV strategy builds on the story of Meng, Qian, and Yared (2011) and is related to the approach by Meng and Qian (2009) as well as the broader literature on official incentives and economic performance in China (Li and Zhou 2005). When a governor had strong local ties, he potentially had better information about the actual degree of famine in his province (for example, by hearing from his relatives or close friends who were experiencing the famine firsthand). However, the governor could also count on his strong local ties to allow him to get away with activities such as counterfeiting output information, thereby aggravating the severity of the famine (via overprocurement) in that province. We therefore instrument famine intensity with a dummy variable denoting whether the birthplace of the provincial governor/secretary who was in charge of the province during the famine period was, in fact, in that province. We also employ alternative weather-related IVs that are standard in the literature including flood incidence from trend and rainfall deviation from trend, although there appears to be little evidence that weather conditions were primary determinants of the famine (Lin and Yang 2000).

We present the first-stage and second-stage results of our two-stage least-squares (2SLS) regressions in Table 4.7(a) and Table 4.7(b), respectively. Table 4.7(a) establishes that governor's birthplace is a valid IV for famine severity. In the first-stage regression, governor's birthplace is significantly associated with the severity of famine. Its interaction with the cohort dummy also predicts the interaction of famine severity and the cohort dummy. One may suspect that some provinces may always have governors born locally due to some unobserved factors, which may be also correlated with the outcome variables. We check the birthplaces of provincial governors for later years and do not find any systematic patterns. We also ran a placebo test for the IVs. If we use the birthplace of governors in nonfamine years as an instrument, the instrument does not have any predicative power on the famine severity observed in 1959–1961.[5] For the second-stage regressions, Table 4.7(b) shows that the endogeneity tests reject the null hypothesis of exogeneity in some specifications, validating the use of 2SLS. Furthermore, Hansen statistics do not reject the null hypothesis of correct specification in all cases. Our 2SLS estimates not only qualitatively affirm those of our baseline (ordinary least squares) results but also yield much larger negative impact on daughters (three times as large).

A second drawback of employing a mortality variable as a measure of famine intensity is potential mortality selection. In this case, our concern is with potential mortality selection for the children of famine survivors. If an effect of famine on survivors is that only relatively strong children of theirs survive compared with the children of the nonexposed parents, then this selection could result in potential bias in the estimation of the intergenerational cognitive impact of early exposure of the parents' generation to famine.

[5] The results are not reported due to space limitations. They are available upon request.

Table 4.7a Intergenerational impact of famine on math test scores (rural fathers to children): First-stage results

	All			Boys			Girls		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variable	**Famine × cohort 1959–1961**	**Famine**	**Famine × cohort 1959–1961**	**Famine × cohort 1959–1961**	**Famine**	**Famine × cohort 1959–1961**	**Famine × cohort 1959–1961**	**Famine**	**Famine × cohort 1959–1961**
Governor birthplace×	7.184***	-4.531**	6.995***	7.412***	-2.596	7.463***	6.528***	-7.164**	6.340***
Cohort 1959–1961	(1.596)	(2.094)	(1.587)	(1.698)	(2.268)	(1.649)	(1.894)	(3.159)	(1.879)
Secretary birthplace×	2.625	1.171	2.751	1.730	-1.321	2.518	4.184	5.033	3.764
Cohort 1959–1961	(7.727)	(2.675)	(7.733)	(7.852)	(2.538)	(7.799)	(7.439)	(3.649)	(7.794)
Governor birthplace	-0.049	12.165**		0.149	12.066**		-0.312	12.739**	
	(0.443)	(5.090)		(0.478)	(4.803)		(0.446)	(5.431)	
Secretary birthplace	0.158	1.545		0.243	2.520		0.150	-0.370	
	(0.416)	(7.423)		(0.543)	(7.044)		(0.292)	(8.254)	
Cohort 1959–1961	8.111	0.505	8.920*	8.931*	0.037	9.308*	7.282	0.854	8.284*
	(5.363)	(0.529)	(5.518)	(5.459)	(1.364)	(5.424)	(5.306)	(1.183)	(5.703)
Boy dummy	0.147	-0.205	0.117						
	(0.528)	(1.090)	(0.373)						
Province dummies	No	No	Yes	No	No	Yes	No	No	Yes
Observations	968	968	968	547	547	547	421	421	421
Adjusted R^2	0.58	0.69	0.69	0.57	0.71	0.69	0.59	0.68	0.70

Source: China Family Panel Studies (2010).

Notes: Provincial governor's birthplace equals 1 if the province he was in charge of during famine period happens to be his birth province and 0 otherwise. The definition for provincial secretary's birthplace is similar. The same control variables as those in Table 4.2 are included but not reported. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Table 4.7b Intergenerational impact of famine on math test scores (rural fathers to children): 2SLS regressions

Dependent variable: Math test score (the higher the better)						
	All		Boys		Girls	
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Famine× Cohort 1959–1961	-0.251**	-0.239*	-0.165	-0.189	-0.390**	-0.321**
	(0.127)	(0.133)	(0.138)	(0.141)	(0.198)	(0.164)
Cohort 1959–1961	3.206*	2.863	1.781	1.733	5.074**	4.481**
	(1.897)	(1.940)	(2.294)	(2.247)	(2.284)	(1.953)
Famine	0.072		0.148*		-0.029	
	(0.076)		(0.086)		(0.073)	
Boy dummy	-0.792*	-0.745				
	(0.438)	(0.471)				
Province dummies	No	Yes	No	Yes	No	Yes
Hausman-Wu statistics	2.35	2.83*	2.10	2.21	3.80**	2.72
Cragg-Donald Wald F	26.91+	54.29+	15.39-	30.81+	12.09-	25.07+
Hansen J statistics	4.05	0.11	1.32	0.21	4.29	0.02
Observations	968	968	547	547	421	421
Adjusted R^2	0.202	0.225	0.187	0.239	0.232	0.261

Source: China Family Panel Studies (2010).

Notes: Provincial governor's birthplace and provincial secretary's birthplace are used as instrumental variables. Provincial governor's birthplace equals 1 if the province he was in charge of during famine period happens to be his birth province and 0 otherwise. The definition for provincial secretary's birthplace is similar. The same control variables as those in Table 4.2 are included but not reported. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively. + indicates that the statistic is larger than the threshold of $r = 0.10$ and significance level at 5%, and - indicates that the statistic is larger than the threshold of $r = 0.15$ but smaller than the threshold of $r = 0.10$ and significance level at 5%, tabulated by Table 2 of Stock and Yogo (2002).

We (partially) address the issue of mortality selection by appealing to the strategy proposed by Meng and Qian (2009). We compare the famine effect across particularly fit individuals (for whom the survivor bias would conceivably be less relevant) according to the outcome variables by running quantile regressions for the upper quantiles (for example, 80th percentile and 90th percentile); see Table 4.8. As Meng and Qian point out, we have to be cautious about interpreting the upper quantile effects as the mean effect since there is no way of distinguishing possible heterogeneous effects for individuals at different quantiles of the distribution of outcomes from potentially similar patterns arising from survivor selection. Nevertheless, it is at least comforting that we find that our main results generally hold in the upper quantiles, and, in particular, that our finding of the differential (stronger) effect for daughters is quantitatively larger at the 90th percentile. Overall, these results provide some support (conditional on this caveat) for the proposition that our baseline findings are not driven by survivor bias.

Table 4.8 Intergenerational impact (rural fathers to children) of famine on math test scores: Quantile regressions

Dependent variable: Math test score (the higher, the better)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Quantile	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
				Whole sample					
Famine× Cohort 1959-1961	-0.039	-0.050	-0.080*	-0.052**	-0.048	-0.062*	-0.071**	-0.084***	-0.047
	(0.059)	(0.042)	(0.042)	(0.025)	(0.038)	(0.038)	(0.035)	(0.029)	(0.036)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	968	968	968	968	968	968	968	968	968
				Boys' sample					
Famine× Cohort 1959-1961	0.102*	0.002	0.021	0.007	-0.030	-0.027	-0.043	-0.050	-0.033
	(0.060)	(0.073)	(0.086)	(0.053)	(0.042)	(0.042)	(0.073)	(0.063)	(0.054)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	547	547	547	547	547	547	547	547	547
				Girls' sample					
Famine× Cohort 1959–1961	-0.063	-0.060	-0.080**	-0.117	-0.138*	-0.108**	-0.076***	-0.067	-0.148***
	(0.087)	(0.059)	(0.041)	(0.079)	(0.076)	(0.054)	(0.026)	(0.119)	(0.053)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	421	421	421	421	421	421	421	421	421

Source: China Family Panel Studies (2010).

Notes: We report the results based on the specification of column 1 of Table 4.2. See the notes in Table 4.1 for the definition of the famine severity variable. Ethnicity fixed effects are controlled in all regressions. Due to space limit, they are not reported. The dummy variable "Cohort 1959–1961" indicates children whose fathers were born during 1959–1961. The same set of control variables as in Table 4.2 are included but not reported. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Mechanisms

We now explore the possible mechanism that drives our findings for the intergenerational effect. We first investigate the impact of the famine on the cognitive abilities of the first generation (famine survivors), which will help us understand the mechanisms more clearly and put our findings in line with other studies. Table 4.9 (panel A) shows the impact of famine on the math test scores of all famine survivors, as well as separately for male and female survivors. Table 4.10 (panel A) shows the corresponding results using a measure of cognitive disability from the China National Survey of Disabled People in 2006.[6] The results in both cases are consistent. The impact of the famine on the cognitive abilities of male survivors is insignificant, whereas the impact on female survivors is negative and significant at the 1 percent level. However, even in the case of female survivors, the magnitude of the impact is modest compared with those for the second generation. For instance, for the math test, we find that an increase of famine intensity by one standard deviation will increase the difference in math test scores between female famine survivors and nonfamine females by around 5.9 percent.

[6] The survey was conducted jointly by the National Bureau of Statistics, the Ministry of Civil Affairs, and the China Federation of Disabled People in 2006. It covers 31 provinces, autonomous regions, and municipalities. Eliminating abnormal values resulting from input errors, the dataset ends with 2,369,496 individuals. The sample is quite random and representative. The survey includes individuals' basic information and their economic, social, and disability status. Basic information refers to an individual's age, gender, and family address. Economic and social status is reflected by school attainment, personal income, and marital status. Disability information is more detailed, consisting of disability status, pathogenic causes and degree of severity, and his or her most urgent requirement. All of the disabilities are classified into five categories: visual, hearing and speech, cognitive, mental, and physical disability.

Table 4.9 Impact of famine on math test scores of rural famine survivors in different samples

Dependent variable: Math test scores (the higher the better)						
	All		Males		Females	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All famine survivors						
Famine×Born in 1959–1961	-0.018	-0.017	0.002	0.000	-0.046***	-0.037***
	(0.011)	(0.010)	(0.016)	(0.017)	(0.011)	(0.008)
Born in 1959–1961	1.318	1.046	1.380	0.965	1.587	1.207
	(0.816)	(0.797)	(0.964)	(0.956)	(0.953)	(0.922)
Famine	0.005		0.004		0.007	
	(0.006)		(0.007)		(0.010)	
Male dummy	0.677***	0.672***				
	(0.204)	(0.186)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	2951	2951	1469	1469	1482	1482
Adjusted R^2	0.731	0.735	0.684	0.691	0.745	0.752
AIC	15144.3	15081.5	7579.3	7516.8	7564.5	7501.2
Panel B: Married famine survivors						
Famine×Born in 1959–1961	-0.018	-0.017	0.004	0.003	-0.049***	-0.038***
	(0.012)	(0.011)	(0.018)	(0.018)	(0.011)	(0.009)
Born in 1959–1961	1.239	0.918	0.921	0.507	1.938*	1.496
	(0.832)	(0.803)	(1.025)	(1.018)	(0.970)	(0.933)
Famine	0.005		0.003		0.009	
	(0.006)		(0.007)		(0.010)	
Male dummy	0.662***	0.665***				
	(0.191)	(0.171)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	2819	2819	1407	1407	1412	1412
Adjusted R^2	0.728	0.733	0.678	0.685	0.744	0.751
AIC	14495.7	14426.0	7257.9	7199.5	7228.8	7164.1
Panel C: Married famine survivors with children						
Famine×Born in 1959–1961	-0.018	-0.017	0.004	0.004	-0.050***	-0.038***
	(0.012)	(0.011)	(0.018)	(0.018)	(0.012)	(0.010)
Born in 1959–1961	1.304	0.969	1.019	0.578	1.981*	1.512
	(0.839)	(0.810)	(1.068)	(1.061)	(0.987)	(0.954)
Famine	0.005		0.002		0.009	
	(0.006)		(0.007)		(0.010)	
Male dummy	0.655***	0.655***				
	(0.198)	(0.180)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	2799	2799	1395	1395	1404	1404
Adjusted R^2	0.728	0.733	0.677	0.684	0.744	0.751
AIC	14397.9	14326.6	7194.3	7136.3	7189.2	7117.3

Table 4.9 Continued

Variable	All (1)	All (2)	Males (3)	Males (4)	Females (5)	Females (6)
Dependent variable: Math test scores (the higher the better)						
Panel D: Married famine survivors whose children took the test						
Famine×Born in 1959–1961	-0.034*	-0.037*	-0.017	-0.022	-0.047*	-0.042*
	(0.019)	(0.019)	(0.024)	(0.026)	(0.027)	(0.025)
Born in 1959–1961	1.490	1.184	1.796	1.318	1.462	0.964
	(0.933)	(0.891)	(1.118)	(1.170)	(1.298)	(1.318)
Famine	0.005		-0.001		0.010	
	(0.010)		(0.011)		(0.014)	
Male dummy	0.767***	0.769***				
	(0.217)	(0.225)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	1707	1707	870	870	837	837
Adjusted R^2	0.721	0.724	0.667	0.675	0.745	0.750
AIC	8773.8	8735.0	4506.5	4455.1	4270.1	4232.2

Source: China Family Panel Studies (2010).
Notes: Ethnicity fixed effects and same control variables as those in baseline regressions are included. Due to space limit, they are not reported. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Table 4.10 Impact of Great Famine on first-generation cognitive disability: Disability survey data

	All (1)	All (2)	Males (3)	Males (4)	Females (5)	Females (6)
Dependent variable: Cognitive disability (dummy)						
Panel A: All famine survivors						
Famine× Born in 1959	0.474***	0.544***	0.222	0.276	0.704***	0.794***
1959—1961	(0.165)	(0.158)	(0.244)	(0.234)	(0.204)	(0.199)
Born in 1959–1961	1.952	1.166	12.330	12.363	-7.442	-10.037
	(12.894)	(13.179)	(12.757)	(12.897)	(20.839)	(21.407)
Famine	-0.122		-0.335*		0.078	
	(0.209)		(0.163)		(0.265)	
Male dummy	-9.228***	-9.510***				
	(2.691)	(2.758)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	127578	127578	62789	62789	64789	64789
Adjusted R^2	0.003	0.003	0.002	0.003	0.003	0.004
AIC	1910907.7	1910773.2	922770.6	922692.4	984252.0	984178.3

Table 4.10 Continued

Dependent variable: Cognitive disability (dummy)						
	All		Males		Females	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Married famine survivors						
Famine× Born in 1959– 1959– 1961	0.404***	0.454***	0.006	0.021	0.744***	0.836***
	(0.124)	(0.124)	(0.123)	(0.122)	(0.204)	(0.197)
Born in 1959–1961	-0.055	-0.912	16.163**	16.158**	-14.012	-16.808
	(10.856)	(10.968)	(6.560)	(6.480)	(19.442)	(20.125)
Famine	-0.004		-0.107*		0.092	
	(0.140)		(0.062)		(0.238)	
Male dummy	-18.530***	-18.708***				
	(2.626)	(2.678)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	119756	119756	58318	58318	61438	61438
Adjusted R^2	0.002	0.003	0.000	0.001	0.003	0.004
AIC	1753607.6	1753517.1	782609.0	782559.1	931092.0	931016.2
Panel C: Married famine survivors with children						
Famine×Born in 1959–1961	0.415*	0.451**	-0.010	-0.004	0.834**	0.916**
	(0.204)	(0.197)	(0.145)	(0.142)	(0.398)	(0.380)
Born in 1959–1961	0.008	-0.660	21.489***	22.001***	-19.887	-23.288
	(12.790)	(12.961)	(7.356)	(7.230)	(22.287)	(22.996)
Famine	-0.018		-0.055		0.016	
	(0.115)		(0.043)		(0.213)	
Male dummy	-18.118***	-18.367***				
	(2.603)	(2.684)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	103628	103628	51679	51679	51949	51949
Adjusted R^2	0.002	0.002	0.000	0.001	0.002	0.003
AIC	1511115.6	1511051.0	687102.3	687068.2	785664.0	785597.4

Source: China Family Panel Studies (2010).
Notes: Born in 1959–1961 is a dummy that equals 1 if the person was born during 1959–1961 and equals 0 if the person was born during 1963–1965. The dependent variable is multiplied by 10,000. Age, its square and cubic terms, ethnicity Han dummy, education level, and log family income per person are controlled in all the regressions. Due to space limit, they are not reported. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively

We also rule out any strong selection effects in the marriage/mating market for first-generation survivors. Even though there may be strong scarring effects on the first generation that does not necessarily mean the impact carries over to the next generation. Heavily scarred first-generation survivors may fail on the marriage/mating market and produce no children. This failure would mitigate the transmission of first-generation shocks to future generations of the population. Alternatively, if there is strong assortative matching in the marriage/mating market, then the worst-scarred survivors may end up with the least fit mates. In this case, the intergenerational transmission of shocks to the first generation may be reinforced.

To analyze the effect of marriage/mating selection on survivors, we need to compare (1) the outcomes of survivors who got married with people not exposed to the famine (see panel B of Tables 4.9 and 4.10), and (2) the outcomes of survivors who got married and had children with the corresponding nonexposed control group (see panel C of Tables 4.9 and 4.10). In both cases, we found little evidence of marriage/mating selection in terms of any systematic patterns of marriage failure in the survivor population. However, when we compare the household characteristics of married famine male survivors and married famine female survivors with those of the control group, we do find that married famine female survivors experience less desirable matches on the marriage market; see Table 3.1(b).

Because in the CFPS, it is possible that a parent took the test but his or her child did not due to their being out of the home, there might also be systematic differences between parents whose children took the test and those whose children did not. To exclude that possibility, in panel D of Table 4.9, we further restrict the sample to those parents whose children took the test. The basic patterns continue to hold, and thus sample selection is not a serious issue considering the similar patterns across different samples.

Because only female survivors showed (modest) scarring effects from exposure to the famine, and their children appear not to show any intergenerational impact, we conclude that the culling effect of the famine was sufficiently strong so that the scarred surviving females were not badly scarred enough to experience discrimination on the marriage market (as shown), and evidently were not sufficiently deeply scarred in order to transmit a significant impact to their children. The question remains therefore as to why male survivors who appear to be unscarred by famine exposure nevertheless go on to have daughters who are disadvantaged.

A leading hypothesis is son preference by this group of parents. To examine the possibility of son preference, we investigate the intergenerational impact of first-generational famine exposure on families with only one child as opposed to many (see Table 4.11 for famine fathers and Table A.6 of the appendix for famine mothers) and also on families with only sons or daughters in comparison with families with children of both sexes (see Table 4.12 for famine fathers and Table A.7 of the appendix for famine mothers). For famine fathers, we find that for the case where the family has only one child, regardless of whether that child is a boy or a girl, the child does not do worse than the corresponding control group. It is only in the case when the famine father's family has more than one child and in the case when there are both sons and daughters in the family where we see the negative intergenerational impact of first-generation famine exposure on girls. We do not see impact on the second generation across any family types for famine mothers. It appears therefore that our baseline findings for the intergenerational impact of famine exposure reported earlier in the subsection "Baseline Findings for the Second Generation" are entirely driven by the low performance of girls in families with both sons and daughters. The evidence therefore points to the conclusion that the intergenerational effects are a result of rural fathers who experienced famine in childhood exhibiting strong son preference (while rural mothers who experienced famine in childhood have no preferences or have preferences that are too weak to make a difference).

Table 4.11 Intergenerational impact of famine on math scores for the children of rural fathers: China Family Panel Studies 2010 sample

Dependent variable: Math test scores (the higher the better)						
	All		One child		More than one child	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Boy dummy×Famine×	0.051***	0.043**	-0.077	-0.125*	0.054***	0.044**
Father born in 1959–1961	(0.015)	(0.016)	(0.080)	(0.067)	(0.017)	(0.018)
Famine× Father born in	-0.088**	-0.099**	0.054	0.135**	-0.098***	-0.107***
1959–1961	(0.036)	(0.038)	(0.083)	(0.057)	(0.034)	(0.034)
Father born in 1959–1961	0.340	0.484	-0.853	-1.742	0.453	0.608
	(0.744)	(0.764)	(1.672)	(2.144)	(0.793)	(0.841)
Famine	0.010		0.053		0.005	
	(0.025)		(0.035)		(0.030)	
Boy dummy	-1.006**	-0.915*	-2.163	-0.678	-0.802	-0.750
	(0.431)	(0.500)	(1.625)	(1.854)	(0.498)	(0.572)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	No	Yes	No	Yes	No	Yes
Observations	968	968	153	153	815	815
Adjusted R^2	0.208	0.228	0.123	0.263	0.204	0.224
AIC	5882.9	5835.8	922.5	867.5	4979.7	4936.4

Source: China Family Panel Studies (2010).
Notes: Ethnicity fixed effects and same control variables as those in Table 4.2 are included. Due to space limit, they are not reported. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Table 4.12 Intergenerational impact of famine on math scores for the children of rural fathers: Different families

Dependent variable: Math test scores (the higher the better)						
	All		Boys		Girls	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Family Type×Famine×	-0.160**	-0.146*	0.020	0.043	-0.325**	-0.343***
Father born in 1959–1961	(0.068)	(0.072)	(0.075)	(0.091)	(0.119)	(0.112)
Famine× Father born in	-0.038	-0.060	-0.022	-0.043	-0.046	-0.059
1959–1961	(0.038)	(0.041)	(0.040)	(0.044)	(0.056)	(0.060)
Father born in 1959–1961	-0.095	0.158	-0.491	-0.271	0.117	0.378
	(0.705)	(0.733)	(0.968)	(1.033)	(1.044)	(1.071)
Famine	-0.003		0.019		-0.048*	
	(0.027)		(0.033)		(0.027)	
Boy dummy	-1.913***	-2.097***				
	(0.508)	(0.566)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	968	968	547	547	421	421
Adjusted R^2	0.229	0.250	0.207	0.236	0.300	0.327
AIC	5841.1	5789.3	3352.6	3307.5	2467.0	2423.0

Source: China Family Panel Studies (2010).
Notes: Family type equals 1 if the family has both sons and daughters, and equals 0 otherwise. Its level term and same control variables as those in Table 4.2 are included. Due to space limit, they are not reported.

Is son preference by rural fathers entirely attributable to cultural attitudes? The different proclivity of son preference in different minority groups in China provides us with an opportunity to test this hypothesis. However, the drawback of the CFPS 2010 dataset is that it does not cover ethnic minority autonomous regions except for Guangxi. The limited number of minority group people in the CFPS 2010 dataset prevents us from investigating this question thoroughly using the CFPS data. The 1 percent sample of the Population Census 2000, however, covers every province in China and thus presents us with a possible solution. As noted earlier, the weakness of the census data is that the census does not conduct any cognitive tests and the set of controls is much more limited than those in the CFPS as the former's focus is only on demographics. As before, we exploit the illiteracy dummy as our dependent variable in the following exercise.

In order to exclude those people who are illiterate because they are too young, we restrict our sample to those aged 13 to 20.[7] We then include in our baseline regression a dummy variable (ethnicity) indicating ethnic groups that exhibit no son preferences (that is, Hui, Uyghur, Mongolian, Tibetan, Li, and Dai). The classification is from Chen and Chen (2004), who review the sociology and anthropology literature on the fertility culture of the major ethnic groups in China; see also Mu and Zhang (2011). We also interact the ethnicity dummy with the interaction term between famine severity and the father being born during the famine. The coefficient to this two-way interaction then characterizes whether the diverse impact of famine on the children of famine cohorts differs between the ethnic groups having no son preference and the groups that do. We report our findings in Table 4.13. As we can see, the negative effects on daughters (recall that a positive coefficient implies higher rates of illiteracy) are even stronger for the ethnic groups without son preference.

We therefore conclude that the son preference exhibited by rural famine fathers is unlikely to be entirely driven by culture across ethnic groups. Given that famine fathers head households of generally higher socioeconomic status (see Table 3.1[b]), the son preference by such fathers may be a result of the generally higher socioeconomic status of their households (Wei, Fang, and Gong 2014). These fathers may rationally prefer to maximize the outcomes of their sons because they expect a high marginal return on investment in terms of improving their sons' probability of success in the marriage market. The famine mothers belong to socioeconomically less successful households where the returns to such investments may be low.[8]

There is also likely another channel of son preference persistence across generations within a family. Parents with strong son preference might have allocated limited resources in favor of sons at the time of famine to make sure their sons survive the famine. As the male survivors got married and had children, their mothers (now paternal grandmothers) would take care of the grandchildren. Their embedded son preference attitude could play a role in generating gender difference in cognitive ability among their grandchildren. However, we cannot empirically distinguish between these two channels owing to data limitations, although the question deserves future research.

[7] In China, children usually begin their junior middle school at the age of 13.

[8] It is possible that mothers also affect the degree of son preference in the famine fathers' families. However, because men are more susceptible to famine, the cohort size of famine fathers is much smaller. They may have more bargaining power in the family due to their limited number. In terms of personal characteristics, they are not worse than the population average (or even better) due to selection effect, which the summary statistics of Table 3.1 reflect. Similarly, fathers in the famine mothers' families may also influence the degree of son preference in the family. However, in terms of summary statistics from Table 3.1, famine mothers usually end up with worse males. They are more on a par with their husbands, and as a result, the son preference may be weak in the family. A detailed investigation of the bargaining power and diverse degrees of son preference in different families is not the focus of the paper but deserves further research.

Table 4.13 Son preference channel detection: Add the interaction term of dummy variable for ethnicities without son preference

Dependent variable: Child aged 13–20 being illiterate (dummy)						
	All		Boys		Girls	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Famine× Cohort 1959–1961	0.011***	0.009***	0.007**	0.006**	0.015*	0.012*
	(0.004)	(0.003)	(0.003)	(0.002)	(0.008)	(0.007)
Ethnicity×Famine ×Cohort 1959–1961	0.043	0.143	-0.101	-0.056	0.193*	0.379**
	(0.079)	(0.104)	(0.096)	(0.067)	(0.112)	(0.180)
Cohort 1959–1961	-0.080	-0.046	-0.077	-0.061	-0.094	-0.040
	(0.069)	(0.070)	(0.063)	(0.057)	(0.129)	(0.140)
Ethnicity× Cohort 1959–1961	-1.996	-3.116**	-1.194	-1.700	-2.447	-4.589*
	(1.232)	(1.460)	(0.859)	(1.021)	(1.678)	(2.277)
Famine	0.001		-0.002		0.004	
	(0.004)		(0.004)		(0.006)	
Ethnicity×Famine	0.154		0.084		0.271	
	(0.112)		(0.075)		(0.177)	
Boy dummy	-0.157	-0.152				
	(0.098)	(0.101)				
Ethnicity×Boy	-3.611*	-3.584*				
	(2.003)	(1.983)				
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	No	Yes	No	Yes	No	Yes
Observations	145110	145110	75721	75721	69389	69389
Adjusted R^2	0.080	0.082	0.049	0.050	0.117	0.119
AIC	994156.1	993859.6	497230.9	497099.5	490508.2	490316.7

Source: Sampling of 2000 Population Census (1%).

Notes: Ethnicity is a dummy indicating races that have no son preferences (Hui, Uyghur, Mongolian, Tibetan, Li, and Dai). It is from Chen and Chen (2004), which reviews sociology and anthropology literature on fertility culture of the major ethnic groups in China, and used in Mu and Zhang (2011). The dummy variable "Cohort 1959–1961" indicates children whose fathers were born during 1959–1961. Age, its square and cubic terms, household head education, birth order, number of children, and their interactions with ethnicity dummy are included but not reported here due to space limit. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

5. CONCLUSION

In this paper, we examine the intergenerational impact of a severe shock—the Great Chinese Famine of 1959–1961—on the cognitive abilities of the children of famine survivors. We do not observe any significant damage to the cognitive abilities of the first-generation male survivors and we see only small negative effects on female survivors. This is in contrast to studies that focus on anthropometric measures where the scarring effects on survivors are sometimes found to be more prominent.

We find evidence for an intergenerational legacy from the famine only for daughters born to famine fathers. Children born to famine mothers reveal no disadvantage in cognitive ability despite some scarring effect on mothers. The gender difference in the effects on children born to famine fathers can be largely attributed to son preference exhibited in families with fathers who were exposed to the famine in early childhood. Even if there is some negative effect on the daughters of famine fathers, it is unlikely to be passed on to the third generation as shown in the resilient performance among the children of the famine mothers. Overall, our findings suggest that human populations are extremely resilient to severe shocks, such as the Great Chinese Famine, in that most offspring of the cohort born during shocks are insulated from damage to their cognitive abilities.

This raises some hopes for the offspring of the poor in developing countries. Despite the poor's daily struggle for survival, they have passed cognitive genes to their offspring largely intact. With adequate food and nutrition, their offspring have the potential to thrive and become productive citizens.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1 Impact of fathers' exposures to famine in early childhood on their children's illiteracy rate (rural sample from 2000 census)

Dependent variable: Child aged 13–20 being illiterate (dummy)						
	All		Boys		Girls	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Famine× Cohort 1959–1961	0.013**	0.011***	0.007*	0.006*	0.019**	0.017*
	(0.005)	(0.004)	(0.004)	(0.003)	(0.009)	(0.009)
Cohort 1959–1961	-0.119	-0.097	-0.107	-0.095	-0.135	-0.108
	(0.078)	(0.076)	(0.070)	(0.061)	(0.144)	(0.153)
Famine	0.001		-0.002		0.005	
	(0.005)		(0.004)		(0.007)	
Boy dummy	-0.213*	-0.205				
	(0.119)	(0.121)				
Age	-0.392	-0.228	-2.402	-2.273	2.805	3.032
	(4.328)	(4.460)	(5.014)	(4.954)	(9.003)	(9.275)
Age square	0.036	0.024	0.157	0.148	-0.162	-0.178
	(0.289)	(0.298)	(0.330)	(0.326)	(0.594)	(0.611)
Age cubic	-0.001	-0.001	-0.003	-0.003	0.003	0.004
	(0.006)	(0.007)	(0.007)	(0.007)	(0.013)	(0.013)
Household head education	-0.833***	-0.802***	-0.574***	-0.551***	-1.096***	-1.053***
	(0.243)	(0.240)	(0.165)	(0.165)	(0.343)	(0.333)
Number of children	0.363***	0.391***	0.383***	0.448***	0.365**	0.373**
	(0.117)	(0.135)	(0.116)	(0.138)	(0.136)	(0.154)
Birth order	-0.028	-0.030	-0.064	-0.064	-0.002	-0.004
	(0.052)	(0.052)	(0.071)	(0.070)	(0.063)	(0.063)
Province dummies	No	Yes	No	Yes	No	Yes
Observations	145110	145110	75721	75721	69389	69389
Adjusted R^2	0.068	0.071	0.043	0.045	0.101	0.105
AIC	996045.3	995562.7	497751.9	497569.5	491803.8	491464.3

Source: Sampling of 2000 Population Census (1%).

Notes: From the 1% sample of the China Population Census 2000. Ethnicity fixed effects (55 race dummies) are controlled in all regressions. Due to space limit, they are not reported. The dummy variable "Cohort 1959–1961" indicates children whose fathers were born during 1959–1961. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Table A.2 Intergenerational impact (rural father to children) of famine on word test scores: China Family Panel Studies 2010 sample)

Dependent variable: Word test scores (the higher the better)									
	Famine measure at the provincial level						Famine measure at the county level		
	All		Boys		Girls		All	Boys	Girls
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Famine×Cohort 1959–1961	-0.073**	-0.084**	-0.025	-0.039	-0.107**	-0.098*	-4.559	-1.039	-9.142*
	(0.034)	(0.036)	(0.050)	(0.060)	(0.044)	(0.052)	(4.683)	(6.097)	(5.279)
Cohort 1959–1961	-0.231	-0.175	-1.434	-1.260	0.671	0.456	-0.069	-1.653	1.903
	(0.936)	(0.982)	(1.296)	(1.445)	(1.132)	(1.207)	(1.457)	(1.993)	(1.635)
Famine	0.025		0.056*		-0.035*		-0.587	-0.066	-1.926
	(0.024)		(0.031)		(0.019)		(1.534)	(1.973)	(2.254)
Boy dummy	-1.536**	-1.300*					-1.555**		
	(0.598)	(0.651)					(0.611)		
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province dummies	No	Yes	No	Yes	No	Yes	No	No	No
Observations	968	968	547	547	421	421	968	547	421
Adjusted R^2	0.214	0.225	0.200	0.197	0.317	0.318	0.214	0.194	0.314
AIC	6347.2	6310.4	3650.0	3624.7	2662.2	2631.3	6349.4	3652.6	2663.5

Source: China Family Panel Studies (2010).

Notes: At the provincial level, famine is measured as the difference of the highest mortality during 1959–1961 and the average mortality during 1956–1958. At the county level, it is calculate d as (cohort size 1956–1958 – cohort size 1959–1961)/cohort size 1956–1958. Ethnicity fixed effects are controlled in all regressions. Due to space limit, they are not reported. Cohort 1959–1961 (dummy) indicates children whose fathers were born during 1959–1961. Other controls same as those in Table 4.2 are included but not reported here. Robust standard errors clustered at the province level (columns 1–6) or county level (columns 7–9) are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Table A.3 Intergenerational impact of famine on short-term memory scores for the children of rural famine survivors: Baseline results based on the China Family Panel Studies 2012

Dependent variable: Short-term memory test scores (the higher the better)						
	All		Boys		Girls	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Children of rural fathers						
Famine×Father born in 1959–1961	0.004	0.009**	0.021**	0.024**	-0.008	-0.003
	(0.005)	(0.004)	(0.008)	(0.009)	(0.007)	(0.007)
Father born in 1959–1961	-0.013	-0.087	-0.289	-0.279	0.161	0.009
	(0.115)	(0.099)	(0.231)	(0.251)	(0.209)	(0.186)
Famine	-0.005		-0.015*		0.002	
	(0.009)		(0.008)		(0.012)	
Boy dummy	-0.291*	-0.215**				
	(0.144)	(0.086)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	1,083	1,083	528	528	555	555
Adjusted R^2	0.017	0.097	0.031	0.071	0.011	0.129
AIC	4228.6	4108.4	2042.4	1990.4	2188.6	2088.6
Panel B: Children of Rural Mothers						
Famine×	0.001	0.003	-0.005	0.000	0.003	0.005
Mother born in 1959–1961	(0.007)	(0.008)	(0.011)	(0.010)	(0.014)	(0.016)
Mother born in 1959–1961	0.036	-0.016	0.271	0.196	-0.154	-0.197
	(0.146)	(0.145)	(0.249)	(0.256)	(0.201)	(0.213)
Famine	0.001		-0.000		0.004	
	(0.007)		(0.006)		(0.010)	
Boy dummy	-0.190	-0.085				
	(0.189)	(0.175)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	1,022	1,022	497	497	525	525
Adjusted R^2	0.038	0.079	0.034	0.052	0.031	0.083
AIC	3956.8	3883.3	1911.5	1872.9	2058.2	2002.7

Source: China Family Panel Studies (2012).

Notes: Ethnicity fixed effects and same control variables as those in Table 4.2 are included. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Table A.4 Intergenerational impact (rural mothers to children) of famine on math and word test scores: China Family Panel Studies 2010 sample

Variable	All (1)	All (2)	Boys (3)	Boys (4)	Girls (5)	Girls (6)
Panel A: Math test scores (the higher the better)						
Famine× Cohort 1959–1961	0.011	0.007	0.006	0.003	-0.014	-0.010
	(0.023)	(0.020)	(0.035)	(0.032)	(0.027)	(0.035)
Cohort 1959–1961	0.283	0.320	1.347**	1.438**	-0.311	-0.412
	(0.438)	(0.509)	(0.603)	(0.645)	(0.687)	(0.877)
Famine	-0.001		-0.002		0.003	
	(0.023)		(0.030)		(0.019)	
Boy dummy	-0.515	-0.584				
	(0.476)	(0.494)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	939	939	519	519	420	420
Adjusted R^2	0.203	0.235	0.184	0.216	0.304	0.322
AIC	5666.0	5599.3	3130.5	3078.6	2507.9	2465.6
Panel B: Word test scores (the higher the better)						
Famine× Cohort 1959–1961	0.034	0.019	0.048	0.033	-0.019	-0.020
	(0.034)	(0.035)	(0.043)	(0.048)	(0.043)	(0.046)
Cohort 1959–1961	-0.363	-0.034	-0.662	0.023	0.939	0.848
	(0.834)	(0.802)	(1.129)	(1.252)	(0.975)	(0.898)
Famine	0.006		0.029		-0.024	
	(0.016)		(0.024)		(0.019)	
Boy dummy	-2.037**	-1.891**				
	(0.748)	(0.835)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	939	939	519	519	420	420
Adjusted R^2	0.187	0.205	0.175	0.193	0.270	0.278
AIC	6084.5	6036.8	3361.7	3319.2	2697.9	2664.0

Source: China Family Panel Studies (2010).

Notes: Ethnicity fixed effects are controlled in all the regressions. Due to space limit, they are not reported. Cohort 1959–1961 (dummy) indicates children whose mother was born during 1959–1961. Other controls same as those in Table 4.2 are included but not reported here. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Table A.5 Intergenerational impact of famine on math scores: Adding the age difference between parents

Variable	All (1)	All (2)	Boys (3)	Boys (4)	Girls (5)	Girls (6)
Panel A: Children of rural fathers						
Famine× Cohort 1959–1961	-0.056*	-0.073**	-0.004	-0.022	-0.107**	-0.119**
	(0.031)	(0.034)	(0.037)	(0.043)	(0.041)	(0.045)
Cohort 1959–1961	0.237	0.470	-1.146	-0.914	1.603	1.893
	(0.770)	(0.799)	(0.828)	(0.916)	(1.025)	(1.107)
Famine	0.009		0.021		-0.020	
	(0.025)		(0.031)		(0.021)	
Boy dummy	-1.098**	-1.165**				
	(0.527)	(0.530)				
Age difference between parents	0.035	-0.003	0.073	0.007	-0.002	0.016
	(0.068)	(0.063)	(0.107)	(0.099)	(0.101)	(0.098)
Province dummies	No	Yes	No	Yes	No	Yes
Observations	957	957	542	542	415	415
Adjusted R^2	0.212	0.233	0.223	0.251	0.252	0.263
AIC	5806.5	5759.6	3324.6	3281.1	2469.2	2432.9
Panel B: Children of rural mothers						
Famine× Cohort 1959–1961	0.014	0.007	0.014	0.002	-0.020	-0.017
	(0.026)	(0.022)	(0.037)	(0.033)	(0.028)	(0.036)
Cohort 1959–1961	0.254	0.331	1.224*	1.442**	-0.150	-0.222
	(0.468)	(0.514)	(0.629)	(0.648)	(0.705)	(0.873)
Famine	-0.003		-0.005		0.000	
	(0.023)		(0.028)		(0.018)	
Boy dummy	-0.456	-0.536				
	(0.489)	(0.504)				
Age difference between parents	0.027	-0.013	0.077	0.021	-0.030	-0.039
	(0.050)	(0.051)	(0.060)	(0.069)	(0.078)	(0.073)
Province dummies	No	Yes	No	Yes	No	Yes
Observations	923	923	511	511	412	412
Adjusted R^2	0.200	0.232	0.188	0.219	0.298	0.311
AIC	5561.4	5501.9	3086.9	3035.6	2452.6	2413.4

Source: China Family Panel Studies (2010).

Notes: Ethnicity fixed effects are controlled in all the regressions. Due to space limit, they are not reported. Cohort 1959–1961 (dummy) indicates children whose father/mother was born during 1959–1961. Other controls same as those in Table 4.2 are included but not reported here. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Table A.6 Intergenerational impact of famine on math scores for the children of rural mothers: China Family Panel Studies 2010 sample

Dependent variable: Math test scores (the higher the better)						
	All		One child		More than one child	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Boy dummy×Famine×	0.029	0.028	0.151	0.016	0.022	0.021
Mother born in 1959–1961	(0.025)	(0.024)	(0.112)	(0.092)	(0.027)	(0.026)
Famine× Mother born in	0.008	-0.002	-0.160	-0.139	0.033	0.021
1959–1961	(0.026)	(0.026)	(0.116)	(0.095)	(0.024)	(0.025)
Mother born in 1959–1961	-0.325	-0.115	0.910	3.269***	-0.690**	-0.477
	(0.307)	(0.352)	(1.604)	(1.075)	(0.308)	(0.388)
Famine	-0.008		-0.003		-0.009	
	(0.012)		(0.028)		(0.016)	
Boy dummy	-0.589**	-0.512*	-1.728	-1.716	-0.591*	-0.566*
	(0.276)	(0.288)	(1.147)	(0.997)	(0.308)	(0.316)
Province dummies	No	Yes	No	Yes	No	Yes
Observations	939	939	148	148	791	791
Adjusted R^2	0.581	0.585	0.239	0.441	0.584	0.589
AIC	5056.2	5022.7	843.8	769.6	4280.4	4245.7

Source: China Family Panel Studies (2010).
Notes: Ethnicity fixed effects and same control variables as those in Table 4.2 are included. Due to space limit, they are not reported. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

Table A.7 Intergenerational impact of famine on math scores for the children of rural mothers: Different families

Dependent variable: Math test scores (the higher the better)						
	All		Boys		Girls	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Family type×Famine×	-0.008	-0.023	0.027	-0.036	-0.126	-0.095
Mother born in 1959–1961	(0.055)	(0.065)	(0.072)	(0.094)	(0.071)	(0.077)
Famine×Mother born in	-0.006	0.001	-0.026	-0.004	0.037	0.040
1959–1961	(0.037)	(0.040)	(0.047)	(0.053)	(0.029)	(0.033)
Mother born in 1959–1961	-0.296	-0.486	0.876	0.556	-1.345*	-1.371
	(0.667)	(0.804)	(0.787)	(1.023)	(0.784)	(0.911)
Famine	-0.013		-0.018		-0.012	
	(0.026)		(0.033)		(0.020)	
Boy dummy	-0.754	-0.775				
	(0.576)	(0.469)				
Province dummies	No	Yes	No	Yes	No	Yes
Observations	939	939	519	519	420	420
Adjusted R^2	0.215	0.245	0.204	0.232	0.301	0.318
AIC	5630.4	5569.4	3100.9	3052.5	2495.1	2452.7

Source: China Family Panel Studies (2010).
Notes: Family type equals 1 if the family has both sons and daughters, and equals 0 otherwise. Its level term and same control variables as those in Table 4.2 are included. Due to space limit, they are not reported. Robust standard errors clustered at the province level are in parentheses. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

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REFERENCES

Alderman, H., J. Hoddinott, and B. Kinsey. 2006. "Long Term Consequences of Early Childhood Malnutrition." *Oxford Economic Papers* 58 (3): 450–474.

Almond, D., and J. Currie. 2011. "Killing Me Softly: The Fetal Origins Hypothesis." *Journal of Economic Perspectives* 25 (3): 153–172.

Almond, D., L. Edlund, L. Hongbin, H. Li, and J. Zhang. 2010. "Long-Term Effects of Early-Life Development: Evidence from the 1959–1961 China Famine." In *The Economic Consequences of Demographic Change in East Asia,* National Bureau of Economic Research—East Asia Seminar of Economics, vol. 19, edited by T. Ito and A. Rose, 321–345. Chicago: University of Chicago Press.

Almond, D., and B. Mazumder. 2011. "Health Capital and the Prenatal Environment: The Effect of Ramadan Observance during Pregnancy." *American Economic Journal: Applied Economics* 3 (4): 56–85.

Ampaabeng, S., and C. M. Tan. 2013. "The Long-Term Effects of Childhood Malnutrition on Cognitive Development: The Case of Famine in Ghana." *Journal of Health Economics* 32 (6): 1013–1027.

An, L., and Q. Li. 2013. *Intergenerational Health Consequences of the Great Famine on Children in Rural China.* Working paper. Jacksonville: University of North Florida.

Ashton, B., H. Kenneth, A. Piazza, and R. Zeitz. 1984. "Famine in China, 1958–61." *Population and Development Review* 10 (4): 613–645.

Badcock, C. 2009. *The Imprinted Brain: How Genes Set the Balance of the Mind Between Autism and Psychosis.* 1st ed. London: Jessica Kingsley.

Barker, D. J. P. 1992. "The Fetal Origins of Diseases of Old Age." *European Journal of Clinical Nutrition* 46: S3–S9.

Belsky, J., L. Steinberg, and P. Draper. 1991. "Childhood Experience, Interpersonal Development, and Reproductive Strategy: An Evolutionary Theory of Socialization." *Child Development* 62: 647–670.

Black, S. E., and P. J. Devereux. 2011. "Recent Developments in Intergenerational Mobility." In *Handbook of Labor Economics,* edited by D. Card and O. Ashenfelter, 1487–1541. Amsterdam: Elsevier.

Black, S. E., P. J. Devereux, and K. G. Salvanes. 2005. "Why the Apple Doesn't Fall Far: Understanding Intergenerational Transmission of Human Capital." *American Economic Review* 95 (1): 437–449.

Bleker O. P., T. J. Roseboom, A. C. J. Ravelli, G. A. van Montfans, C. Osmond, and D. J. P. Barker. 2005. "Cardiovascular Disease in Survivors of the Dutch Famine." In *The Impact of Maternal Nutrition on the Offspring,* Nestlé Nutrition Workshop Series: Pediatric Program, vol. 55, edited by G. Hornstra, R. Uauy, and X. Yang, 183–195. Basel, Switzerland: Karger.

Bohlken, M. M., R. M. Brouwer, R. C. Mandl, N. E. van Haren, R. G. Brans, G. C. van Baal, E. J. de Geus, D. I. Boomsma, R. S. Kahn, and H. E. Hulshoff Pol. 2013. "Genes Contributing to Subcortical Volumes and Intellectual Ability Implicate the Thalamus." *Human Brain Mapping.* DOI: 10.1002/hbm.22356.

Brandt, L., A. Siow, and C. Vogel. 2008. *Large Shocks and Small Changes in the Marriage Market for Famine Born Cohorts in China.* 2010 Meeting Papers, no. 264. St. Louis: Society for Economic Dynamics.

Brown, A. S., J. van Os, C. Driessens, H. W. Hoek, and E. S. Susser. 2000. "Further Evidence of the Relation between Prenatal Famine and Major Affective Disorder." *American Journal of Psychiatry* 157: 190–195.

Cai, Y. 2000. "Between State and Peasant: Local Cadres and Statistical Reporting in Rural China." *China Quarterly* 163: 783–805.

Chen, C., and S. Chen. 2004. *The Fertility Culture of Minorities [Shaoshu Minzu Shengyu Wenhua].* Beijing: China Population Press.

Chen, Y., and L. Zhou. 2007. "The Long-Term Health and Economic Consequences of the 1959–1961 Famine in China." *Journal of Health Economics* 26: 659–681.

China Family Panel Studies. 2013. 2010 and 2012 Baseline Data. Beijing: Institute of Social Science Survey. http://www.isss.edu.cn/cfps/EN/Data/.

Clark, G. 2014. *The Son Also Rises: Surnames and the History of Social Mobility.* Princeton, NJ, US: Princeton University Press.

Comings, D. E., D. Muhleman, J. P. Johnson, and J. P. MacMurray. 2002. "Parent–Daughter Transmission of the Androgen Receptor Gene as an Explanation of the Effect of Father Absence on Age of Menarche." *Child Development* 73: 1046–1051.

Fung, W., and W. Ha. 2010. "Intergenerational Effects of the 1959–61 China Famine." In *Risk, Shocks, and Human Development: On the Brink,* edited by R. Fuentes and P. Seck, 222–254. Basingstoke: Palgrave Macmillan.

Huang, C., M. Phillips, Y. Zhang, Q. Shi, Z. Song, Z. Ding, S. Pang, and R. Martorell. 2012. "Malnutrition in Early Life and Adult Mental Health: Evidence from a Natural Experiment." *Social Science and Medicine* 97: 259–266.

Hulshoff Pol, H. E., H. W. Hoek, E. Susser, A. S. Brown, A. Dingemans, H. G. Schnack, N. E. van Haren, L. M. Pereira Ramos, C. C. Gispen-de Wied, and R. S. Kahn. 2000. "Prenatal Exposure to Famine and Brain Morphology in Schizophrenia." *American Journal of Psychiatry* 157: 1170–1172.

Jirtle, R. L., and M. K. Skinner. 2007. "Environmental Epigenomics and Disease Susceptibility." *Nature Reviews: Genetics* 8: 253–262.

Jorm, A. F., H. Christensen, B. Rodgers, P. A. Jacomb, and S. Easteal. 2004. "Association of Adverse Childhood Experiences, Age of Menarche, and Adult Reproductive Behavior: Does the Androgen Receptor Gene Play a Role?" *American Journal of Medical Genetics Part B* 125: 105–111.

Kim, S., and B. M. Fleisher. 2010. *The China Great Leap Forward Famine: The Lasting Impact of Mothers' Fetal Malnutrition on Their Offspring.* Working Paper. Columbus, OH, US: Ohio State University.

Kung, J. K., and J. Y. Lin. 2003. "The Causes of China's Great Leap Famine, 1959–1961." *Economic Development and Cultural Change* 52 (1): 51–73.

Kung, K. S., and S. Chen. 2010. "The Tragedy of the Nomenklatura: Career Incentives and Political Radicalism during China's Great Leap Famine." *American Political Science Review* 105: 27–45.

Li, H., and L. Zhou. 2005. "Political Turnover and Economic Performance: The Incentive Role of Personnel Control in China." *Journal of Public Economics* 89: 1743–1762.

Li, W., and D. T. Yang. 2005. "The Great Leap Forward: Anatomy of a Central Planning Disaster." *Journal of Political Economy* 113: 840–877.

Lin, J. Y., and D. T. Yang. 2000. "Food Availability, Entitlements, and the Chinese Famine of 1959–1961." *Economic Journal* 110: 136–158.

Luo, Z., R. Mu, and X. Zhang. 2006. "Famine and Overweight in China." *Review of Agricultural Economics* 28 (3): 296–304.

Meng, X. 2012. "Impact of Economic Reform on Labor Market Outcomes in China." *Journal of Economic Perspective* 26 (4): 75–101.

Meng, X., and N. Qian. 2009. *The Long Term Consequences of Famine on Survivors: Evidence from a Unique Natural Experiment Using China's Great Famine.* NBER Working Paper 14917. Cambridge, MA, US: National Bureau of Economic Research.

Meng, X., N. Qian, and P. Yared. 2011. "The Institutional Causes of Famine in China, 1959–61." NBER Working Paper 16361. Cambridge, MA, US: National Bureau of Economic Research.

Mu, R., and X. Zhang. 2011. "Why Does the Great Chinese Famine Affect the Male and Female Survivors Differently? Mortality Selection versus Son Preference." *Economics and Human Biology* 9: 92–105.

Mustanski, B. S., R. J. Viken, J. Kaprio, L. Pulkkinen, and J. R. Rose. 2004. "Genetic and Environmental Influences on Pubertal Development: Longitudinal Data from Finnish Twins at Ages 11 and 14." *Developmental Psychology* 40 (6): 1188–1198.

Neelsen, S., and T. Stratmann. 2011. “Effects of Prenatal and Early Life Malnutrition: Evidence from the Greek Famine.” *Journal of Health Economics* 30 (3): 479–488.

Neugebauer R., H. W. Hoek, and E. Susser. 1999. “Prenatal Exposure to Wartime Famine and Development of Antisocial Personality Disorder in Adulthood.” *Journal of the American Medical Association* 281 (5): 455–462.

Pembrey, M. E., L. O. Bygren, G. Kaati, S. Edvinsson, K. Northstone, M. Sjostrom, et al. 2006. “Sex-Specific, Male-Line Transgenerational Responses in Humans.” *European Journal of Human Genetics* 14: 159–166.

Ravallion, M. 1997. “Famines and Economics.” *Journal of Economic Literature* 35 (3): 1205–1242.

Ravelli, A. C. J., J. H. van de Meulen, and R. P. J. Michels. 1998. “Glucose Tolerance in Adults after Prenatal Exposure to Famine.” *Lancet* 351: 173–177.

Ravelli, A. C. J., J. H. van de Meulen, C. Osmond, D. J. Barker, and O. P. Bleker. 1999. “Obesity at the Age of 50 in Men and Women Exposed to Famine Prenatally.” *American Journal of Clinical Nutrition* 70: 811–816.

Riskin, C. 1990. “Feeding China: The Experience since 1949.” In *The Political Economy of Hunger,* vol. 3., edited by J. Dreze and A. Sen. Oxford: Oxford University Press.

Roseboom, T. J., J. H. P. Meulen, A. C. J. Ravelli, C. Osmond, D. J. P. Barker, and O. P. Bleker. 2001. “Effects of Prenatal Exposure to the Dutch Famine on Adult Disease in Later Life: An Overview.” *Twins Research* 4 (5): 293–298.

Skuse, D. H. 2005. “X-Linked Genes and Mental Functioning.” *Human Molecular Genetics* 14 (Review Issue 1): R27–R32.

Song, S. 2010. “Mortality Consequences of the 1959–1961 Great Leap Forward Famine in China: Debilitation, Selection, and Mortality Crossovers.” *Social Science Medicine* 71 (3): 551–8.

Stein, Z., M. Susser, G. Saenger, and F. Marolla. 1972. “Nutrition and Mental Performance.” *Science* 179 (4062): 708–713.

Stock, James H, Jonathan H Wright, and Motohiro Yogo, 2002. "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments," *Journal of Business & Economic Statistics*, 20(4): 518-29.

Trivers, R. L., and R. E. Willard. 1973. “Natural Selection and the Ability to Vary the Sex Ratio of Offspring.” *Science* 179 (4068): 90–92.

Turner, G. 1996. “Intelligence and the X Chromosome.” *Lancet* 347 (9018): 1814–1815.

U.S. National Library of Medicine. 2014. *Genetics Home Reference Handbook*. “X-Linked dominant (affected father)” and “X-Linked dominant (affected mother)” figures. Rockville, MD: Lister Hill National Center for Biomedical Communications. http://ghr.nlm.nih.gov/handbook/illustrations/xlinkdominantfather; http://ghr.nlm.nih.gov/handbook/illustrations/xlinkdominantmother.

Wei, S., H. Fang, and B. Gong. 2014. *Sex Ratios and Savings Rates: Some Experimental Evidence.* Paper presented at the annual meetings of Allied Social Science Associations January 3-5, 2014, Philadelphia.

Yao, S. 1999. “A Note on the Causal Factors of China’s Famine in 1959–1961.” *Journal of Political Economy* 107 (6): 1365–1369.

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