Birth Order and Son Preference to Determine the Children of Shandong Province So Tall

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More children in Shandong Province are stunted than any other province in China. Data on more than 122,000 children show a dramatic increase in height advantage with birth order in Shandong relative to the average of other provinces. We suggest that the steep birth order gradient in Shandong is due to a preference for the eldest child, which influences parental fertility decisions and resource allocation to children. We show that within Shandong province, the gradient is steeper for regions and cultures with a high preference for the eldest child. As predicted, this gradient also varies with the sex of the sibling. By back-calculating, the steeper birth order gradient in Shandong Province explains more than half of the average height gap between Shandong Province and the rest of China.

Childhood stunting is a relatively significant problem worldwide, but hyperdevelopment has been less studied. Given that Shandong Province is not the wealthiest of all Chinese provinces and has a low per capita income and a large gap between rich and poor, this phenomenon of child overgrowth deserves some thought and is the focus of this paper. Using data from a survey of over 122,800 children in various provinces of China, we demonstrate that children born earlier in Shandong develop faster. The developmental advantage of children in Shandong Province is strongest among first-born children. In Shandong Province, weight-for-age, child hemoglobin and, importantly, a range of prenatal and postnatal health inputs also decline more than in other Chinese provinces as birth order changes. First, the same patterns hold when we control for maternal and neighborhood characteristics that are associated with total fertility and child outcomes. Second, the results are robust to using only between-sibling variation in child height when estimating these patterns (i.e., keeping family size and other family characteristics fixed). Finally, we consider two different samples in which mothers may have completed childbearing, and in both cases the birth order model is robust to flexible control for total fertility and birth order. Regarding the underlying mechanisms at work, we propose that Shandong's preference for firstborn children includes the desire to have at least one son and a healthy son that influences parents' fertility decisions and how they allocate resources among their children, leading to a steep birth order gradient in height. Eldest son preference can be traced to the paternal place and patrilineal kinship system of Confucian culture: aging parents usually live with their eldest son and bequeath property to the eldest son. In addition, Confucian culture emphasizes that post-death rituals can only be performed by male heirs. (Thus, "son preference" is shorthand for eldest son preference.) The data support several specific predictions of this hypothesis. Among boys, we believe that firstborn sons receive more health and nutritional inputs than their brothers. Consistent with the fact that sons born in high birth order are less likely to be the first son in the family, we observe a birth order gradient among boys. We also exploited the variation in the timing of birth of the eldest son in the family, provided that his older sibling was a girl: i.e., he was the eldest son in the family. Among girls, the gender composition of siblings affects resources in two ways, both to the detriment of later-born daughters. First, there is a "sibling competition effect": a girl born later (by definition) has more siblings. As a result, she is also more likely to
have an older brother and is likely to perform poorly when competing with her brother for family resources. The second mechanism is fertility cessation behavior, which in turn disadvantages late born daughters who lack brothers. When a daughter is born into a girl-only family, her parents are likely to continue having children in search of a son beyond the family size they initially expected. Thus, the birth of a late-born girl is equivalent to a negative shock to per capita income, and fewer resources are spent on her. These two mechanisms produce a birth order gradient among girls, and the net effect of having a brother on the resources allocated to girls is ambiguous. Empirically, we find that the net effect is positive, suggesting the importance of the birth stop mechanism. These two mechanisms affecting girls provide a third testable prediction among daughters without older brothers. While the absence of sibling competition increases prenatal and postnatal investment in these daughters relative to daughters with older brothers, the fertility cessation effect reduces their postnatal investment because after their birth, parents realize that they need to try again for a son. We show that relative to other Chinese provinces and prenatal investments, girls receive fewer postnatal resources if families in Shandong province do not already have sons. With the exception of son preference, it seems unlikely that the theory of a birth order gradient in Shandong province can explain several of the patterns we find in the data. Birth order differences in health inputs and height are a direct indication of the significant inequality among children in Shandong province. This inequality could also account for the average height advantage of children in Shandong province. At the most basic level, the decomposition by birth order and sex illustrates the genetic potential of children in Shandong province: unless there is systematic variation in genotype by birth order, all children in Shandong province have the genetic potential to be at least as tall as the observed average height of firstborns. Thus, the absence of a height advantage for first-born children in Shandong Province suggests that genetics cannot explain most of the height advantage in Shandong Province compared to other Chinese provinces. More directly, we suggest that the unequal distribution of parental resources among children influences the average height in Shandong Province. As with the pattern in Shandong Province and other Chinese provinces, our analysis within Shandong Province suggests that in those areas of Shandong Province where sons are less preferred, children have higher average heights and shallower birth order gradients. For these subgroups, we observe a more equal distribution of resources but, on average, no increase in inputs to children. Consistent with height production functions in the literature, these patterns suggest diminishing returns to height for inputs. The first question is how much of the gap is explained by the birth order gradient, and the second question is how much is specifically explained by the birth order gradient generated by firstborn preferences. As a starting point, we demonstrate a negative correlation between birth order gradients and height levels for countries in other Chinese provinces. In the first work, we multiply this estimated correlation by the difference in birth order gradients between Shandong Province and the rest of the Chinese provinces. When we compare the resulting estimates with the observed Shandong province-rest of China height gap (adjusted for GDP per capita), we find that the birth order gradient explains more than half of the height puzzle in Shandong province. We find that birth order gradients rooted in primogeniture preferences explain one-third of the height gap between Shandong Province and the rest of China. Although the link between gradient and level is not rigorously established, these two accounting exercises suggest that primiparity preference and the associated birth order gradient have a quantitatively important effect on average height in Shandong province. We also contribute to the literature on how cultural gender preferences and gender gaps in investment returns lead to
unequal distribution of resources among siblings. Our contribution is to show how gender preferences can explain an important part of child stunting in Shandong province by emphasizing birth order gradients. To our knowledge, we are the first paper to examine how cultural norms of son preference affect birth order effects and, more broadly, one of the few papers in economics to examine the causes of birth order effects. Finally, we contribute to the literature on the unintended consequences of son preference by demonstrating how dynamic fertility decisions can lead to inequalities in health outcomes between the sexes, between brothers, and even between sisters. The first chapter describes the data and presents descriptive statistics for the sample. Chapter 2 presents evidence for a birth order gradient in height disadvantage in Shandong Province; Chapter 3 presents evidence for primiparity as a root cause, and also tests alternative explanations for intra-household patterns. Chapter 4 concludes. All data analysis values are based on statistical logarithmic transformation (log10data/ln(data/log2data)).

A common standard, and the one we follow, is to establish a child's height-for-age (HFA) z-score based on the World Health Organization (WHO) universally applicable growth standards for children aged 0 to 5 years. a score of 0 indicates that the child is two standard deviations above the median of the reference population, and a score of -2 represents the median of the sex- and age-specific reference population, which is the threshold for what we consider to be overgrowth. Our primary outcome of interest is the HFA z-score because it is the child health indicator most strongly associated with later life outcomes and is considered the best cumulative measure of child nutritional levels. the 2000-2003 National Family Health Survey is our source of data on children in Shandong Province; it uses sampling methods and surveys similar to those used in the internationally used Demographic and Health Survey (DHS) instruments. Our sample consisted of 122,543 children for whom anthropometric data were available. We also defined a subsample of likely completed births, including 13,230 mothers who indicated that they did not want more children or were sterilized or infertile. In addition, we used data on prenatal and postnatal health-related behaviors. Prenatal behaviors include the number of antenatal care visits, whether pregnant women receive tetanus shots and iron supplements, and delivery at a health facility; Shandong province typically outperforms other Chinese provinces in these areas (e.g., in 55% of cases, pregnant women in Shandong province take iron supplements, compared to 43% in other Chinese provinces). Data on health inputs for young children include whether they had a medical checkup within the first two months of life, whether they received iron supplements, and the total number of vaccinations received. Vaccination rates were higher in Shandong province, while postnatal checkups and iron supplementation for children were more common in other Chinese provinces. Table 1 also summarizes our control variables. Reflecting differences in the number of countries covered and total sample size, the other Chinese provinces had nearly three times as many primary sampling units as Shandong Province, which had a higher rate of maternal literacy.
II. Birth order and child outcomes

We first document the key fact that underlies our analysis: the birth order gradient in child height is steeper in Shandong province relative to other Chinese provinces. We then discuss endogeneity issues and provide relevant robustness checks. Finally, we document similar gradients
in parental inputs and other child health outcomes that may influence height. A. Basic findings on
child height - Figure 2 shows the mean child height-for-age (HFA) z-score in Shandong Province
and other Chinese provinces, separated by birth order. Shandong Province shows a deficit at birth
2, which widens at birth 3 and higher. In , we show the average height gap between Shandong
Province and the rest of China, pooling all children. Children in Shandong province are on
average 0.08 standard deviations shorter than children in other Chinese provinces, and this gap is
significant at the 1% level. As shown in the online appendix, this average gap remains significant
and increases to -0.16 standard deviations when controlling for purchasing power parity-adjusted
GDP per capita in the year of the child's birth; on average, Shandong province is richer than the
comparison group of other Chinese provinces. We estimate that I c is an indicator for children in
Shandong province; a1 is the gap in Shandong province for first-born children (omitting birth
order categories), and a2 and a3 capture the gap between second-born children and third and
higher birth order children; Ximc is a control vector that always includes the child age dummy
variable (months) to account for the nonlinear pattern of z-scores and age. We also expanded the
control set to check the robustness of our results, as described below. It is shown that the height
advantage for Shandongers starts at the 2nd birth order: the interaction between Shandongers and
2nd births is -0.14 and is highly significant. The dominance of Shandong people is still significant
and increasing, with a height z-score difference of -0.28 (sum of main effects and interaction terms)
for the third and higher births compared to children in other Chinese provinces. Endogeneity
issues - The ideal data to study differences in birth order gradients in Shandong Province and other
Chinese provinces would be to use families that have completed births and have height data for all
children. This would allow us to control for birth order while controlling for total family size, and
ensure that the estimates do not confound the effects of birth order and family size. In this case,
birth order would be orthogonal to family characteristics (so adding a fixed effect of motherhood
might improve precision but would not change the birth order coefficient). However, the nature of
the DHS sample means that a large proportion of households in our sample do not complete births.
The optimal proxy for expected family size is a survey question about the mother's expected
fertility, but it is not asked before childbirth, making it potentially endogenous to women's fertility
outcomes. In addition, actual and desired fertility rates often differ in countries with limited access
to contraception. Thus, our regressions do not control for total family size, raising a problem of
omitted variable bias; birth order variables in inter-family comparisons may proxy for
high-fertility families. Children with higher birth order are more likely to come from larger
families, and family size may be associated with child height; family size may affect child height
through its effect on available resources per child, coupled with the fact that larger families tend to
be poorer. One response was to include family fixed effects; although we did not observe family
size directly, the final total family size was fixed when making comparisons between siblings. One
caveat is that the DHS survey only provides height data for children age 5 and younger, which
raises the possibility of endogenous selection on the sample of interest; for example, samples in
regressions with family fixed effects will typically have shorter birth intervals than the full sample,
and birth intervals may differ between Shandong Province and other Chinese provinces. First, as
we describe below, we perform a series of robustness checks using the DHS data. Second, in the
third section, we perform a parallel within-Shandong province analysis using the IHDS data for
the children of women who completed childbirth. Finally, we consider comparison groups for
countries other than other Chinese provinces; if the nature of differential selection is specific to the
comparison between Shandong Province and other Chinese provinces, then we should not observe a steeper birth order gradient when we use other comparison groups. In rural areas, a PSU is a village, whereas in urban areas it is a community. fixed effects in PSUs control for many aspects of economic and health status, as well as for unobserved environmental conditions. For example, fertility outcomes are highly correlated within PSUs. We also control for maternal literacy, which is also highly correlated with observed fertility. Our other two controls relate to the age of the mother and child. Within families, birth order was correlated with maternal age. The public health literature identifies a nonlinear relationship between maternal age and child health. To ensure that birth order effects are not surrogate for maternal age, we included a quadratic representation of maternal age in our controls. Finally, child age is correlated with birth order within the family; among siblings, children with higher birth order are, by definition, younger. Therefore, we used child age dummies as covariates. Importantly, for each of these covariates, we include the interaction with the Shandong Province dummy. The showed that adding these control variables reduced the magnitude of the \( \text{IC} \times 3\text{rd+Child} \) coefficient, but not its significance, and did not significantly change the \( \text{IC} \times 2\text{ndChild} \) coefficient. Next, we categorized women who did not want more children or had been sterilized as likely to have completed childbearing. We then reproduced and analyzed the children belonging to this subsample of families whose mothers may have completed childbearing (our sample size was approximately 40% of the original sample). We use the observed number of children in these families as their total family size, and include controls for family size dummies for interactions with Shandong province in our regressions. show that our results on the birth order gradient hold, although they are less precise estimates. Finally, in a similar spirit to controlling for actual household size is controlling for desired household size. Considering the caveats mentioned earlier, the online appendix of shows that our results are robust to controlling for desired fertility. In the ones that do, we report regressions that include mother fixed effects. By using only within-family comparisons for identification, we fully control for differences in family size. Birth order and child age are strongly correlated within a family, so we continue to control for \( \text{IC} \times \text{ChildAge} \). Requiring at least 2 children from a family in the sample reduces the sample size to 83,228 children. The effective sample size is even smaller: birth order coefficients were identified from 42,524 children (13,550 in Shandong Province and 28,974 in the rest of China) who had one or more siblings in the sample with a different birth order than theirs (i.e., not simply multiple births) and at least one sibling of birth order 1 or 2 (thus, not all siblings belong to our 3rd+ child category). The birth order gradient in Shandong Province remains statistically significant, with results similar to those of and but larger in magnitude. Consistent with the better results found for lower children in many cases, we observe negative birth order gradients in other Chinese provinces (negative and significant coefficients for the 2nd and 3rd+ children). The key finding is that the birth order gradient in child height is twice as high in Shandong Province as in the rest of China. The specification of mother's fixed effects is an important robustness check and in fact includes a final fixed effect of total family size, which does not vary within families. The drawback is that the birth order gradient is identified in less than half of the sample. A specific problem is that siblings with shorter-than-average birth intervals identify the mother's fixed effects estimates, so that selection based on birth intervals may differ between Shandong Province and other Chinese provinces. Reassuringly, the mean birth interval for this subsample was quite high and similar between Shandong Province and the rest of China (26 months vs. 29 months). Furthermore, because the fixed-effects specification for mothers includes
dummies for the age of the child (in months), we in fact control for birth intervals between siblings in the sample. As a further robustness check, we also directly controlled for a child's interaction with his or her sibling's birth interval with Shandong Province. In the specification with family controls (Online Appendix, ), the birth order gradient is very similar to our main results. In the presence of maternal fixed effects, the birth order gradient in Shandong province remains statistically significantly steeper for children with birth order 3 and higher; the interaction coefficient becomes smaller for birth order 2, but remains marginally significant. Next, we use other geographic comparison groups to check whether what we interpret as an unusually steep birth order gradient in Shandong province is in fact an unusually shallow gradients in the other provinces of China. In columns 1-3 of the online appendix, we define the comparison group for Shandong province economically: the comparison group includes 25 countries surveyed (2004-2010) whose GDP per capita in the survey year was within 50% of (either above or below) Shandong's GDP per capita in 2005-2006. The birth order gradient out of Shandong Province is significantly stronger than this alternative comparison group. In columns 4-6, we define the comparison group in terms of genetic similarity. Recent genomic studies using genetic distances between modern ethnic groups to reconstruct prehistoric migration patterns have found evidence of Indo-European migration and genetic similarity between Shandong Province, Europe, Central Asia and West Asia. We used 16 European, Central Asian, and West Asian countries with DHS surveys as a comparison group and again found a significantly stronger birth order gradient in Shandong Province than in the comparison group. Finally, we compared Shandong Province with its two South Asian neighbors. Developmental delay is often cited as a problem, but our hypothesis that son preference is the underlying cause Columns 7-9 show that the birth order gradient is indeed steeper in Shandong province. (In Section 3, we will show that within Shandong Province, the birth order gradient is steeper in Shandong Province than in Muslims.)

B. Other Health Outcomes We focus on the continuous HFA z-score, but of policy relevance is the stunting rate (a measure of overall child malnutrition).

It is shown that the steep gradient in birth order in Shandong province is also true for stunting: the advantage relative to peers in other Chinese provinces is 5 percentage points for second births and 6 percentage points for third births (statistically significant at the 1% level). Thus, in Shandong province, high birth order penalizes stunting two to three times more than in other Chinese provinces. If the birth order gradient in height reflects inequality in the distribution of resources among children, then we would also predict the birth order gradient for other health outcomes. To investigate this possible mechanism, we first consider other health outcomes that may also be influenced by parental resource allocation. and showed that there were different degrees of birth order gradients in weight for age and hemoglobin in Shandong Province. Infant mortality was studied. This is a negative health outcome, so we would predict a positive interaction term with birth order in Shandong province. The point estimate is indeed positive, although not statistically significant. The study of infant mortality serves a different purpose: it addresses the question of how mortality selection might underlie the strong birth order gradient in Shandong province. If mortality selection were to explain the height pattern, we would need Shandong province to have a negative and different birth order gradient in infant mortality; the high survival rate of weaker children born later produces a negative birth order gradient in the height of survivors. However, we observe the opposite pattern. C. Health inputs Next, we examine birth order gradients in prenatal and postnatal child investments in. Information on prenatal inputs
is based on retrospective information on inputs in utero and at delivery; prenatal outcomes (and some postnatal outcomes) are available only for the youngest child in the household. We estimate equation (1) in the form of covariates including PSU fixed effects and controls for maternal literacy, maternal and child age, and their interaction with the Shandong Province dummy. In 1 to, we investigate whether there is a steep gradient for each prenatal input. On average, women in Shandong province were more likely to receive prenatal care, take iron supplements, and receive tetanus shots during pregnancy, but less likely to deliver in a medical facility. However, for all outcomes other than tetanus shots, we observed a stronger decline in birth order in Shandong Province than in other Chinese provinces. The magnitude of the gradient was large, with children born later in Shandong Province receiving fewer inputs than children in other Chinese provinces for two of the three inputs (prenatal visits and iron supplements) where the Shandong average exceeded the average for the rest of China.
The prevalence of postpartum checkups is much lower in Shandong Province than in other Chinese provinces (reflecting the social norm of confinement at home for 40 days postpartum in Shandong Province), and iron consumption among children is also lower. However, children in Shandong province are more likely to receive vaccinations. There was no different birth order gradient in postnatal screening and iron consumption between Shandong Province and other Chinese provinces. We summarize our findings and show that the steeper birth order gradient applies to a composite input indicator: the average pooled input received by a child. This indicator is the average of seven indicator variables. For three input variables that were originally multi-valued (total prenatal visits, total tetanus injections, and total vaccines), we constructed dummy variables that equaled 1 if the original measure exceeded the sample median. In summary, to the extent that child health inputs affect child height, this birth order gradient of inputs is consistent with the behavioral basis of the birth order gradient of height.
III. Culture and height deficits

The birth order gradient in height of children in Shandong Province is steeper than in other Shandong provinces and several other comparison groups, including Shandong Province. An important difference between Shandong Province and the comparators is the Confucian cultural composition of the population: about four-fifths of Shandong Province's population is Shandong Province religious. In this section, we provide two types of evidence that eldest child preference—which derives from the tenets of Shandong Province religion—is an important mechanism for the steepness of height gradients among children in Shandong Province. First, we exploit regional and Confucian cultural differences within Shandong province, where the birth gradient in height is shallower when son preference is lower. Second, we identify multiple subgroups within Shandong Province characterized by lower-than-average son preference and examine whether these subgroups have lower birth order gradients relative to other areas of Shandong Province. To construct our sample, we use the second wave to identify mothers who had completed childbearing before the first wave: nonpregnant women who did not give birth after the first wave. Among children born to these mothers, we examine the height-for-age of children under 5 years of age in the first wave. To examine whether the birth order gradient is attenuated in regions and social groups out of low son preference, we estimate a model similar to equation (1) with one difference: the indicator for Shandong province is replaced by an indicator for the low son preference subgroup. In regressions using the sample, we also control for family size dummies parallel to birth order, i.e., including the interaction of family size fixed effects with son preference proxies. Matrilineality—which is associated with kinship practices that give less preference to boys and less preference to firstborn sons—is more common in these states. The birth order gradient in height is shown to be significantly lower in matrilineal lines. Comparisons of
subsample means provide suggestive evidence that differences in gradients affect average child height: matrilineal states have higher average child heights than the rest of Shandong Province. The same relationship between weight and age was shown to be true. In , we estimate this relationship with the sample we used. We observe the same pattern - the birth order gradient in child height is significantly shallower in the matrilineal states.

Next, we examine heterogeneity by child sex ratio, calculated for each province-urban unit (which is the best administrative level we can match census sex ratio data to). By definition, the sex ratio is the increase in the proportion of males. In 4th to mid, we find that, as predicted, areas with low sex ratios have a shallow birth order gradient. We continue to see a negative correlation between the birth order gradient and the average height of children: the mean of the subsample shows that the average height of children in areas with low sex ratios is higher. Finally, we examined differences in Confucianism: Confucian culture places less emphasis on the need for a son to perform Confucian cultural rituals than does Shandong religion, and Confucian inheritance rules are less unfavorable to females. In turn, Confucian culture has a weaker preference for sons; for example, Confucian culture has a smaller sex ratio than Shandong province and a smaller gender gap in child mortality. Using our, we find that the birth order gradient for HFA and WFA is much smaller for people from Confucian culture Shandong province relative to Shandong province. However, using the data, we did not observe differences in height gradients between Shandong Province religion and Confucian culture. This may be because our covariates do not fully control for unobserved socioeconomic characteristics by Confucian culture; it may also be why the subsample means show relatively lower HFA and WFA z-cores for Confucian culture children. Consistent with the fact that Confucian culture families are poorer on average, the online appendix shows that Confucian culture families have lower child inputs. Importantly, these resources are more evenly distributed by birth order among Confucian-culture families. B.
Preference for the eldest child and birth order gradient We now use the DHS sample to test a series of predictions if the child height gradient stems from parental preference for the eldest child. Prediction 1: Compared to their counterparts in other Shandong provinces, both boys and girls in Shandong province will come out with a steeper birth order gradient. Among boys, this is simple: by definition, the eldest child has the lowest birth order in the family and will be favored over his siblings. Importantly, this gradient does not exist if parents come out with a general son preference, i.e., they favor sons over daughters but not particularly the eldest son. First, with more siblings, a girl born later is more likely to have an older brother and compete with him for resources. Consider a family that expects to have two children and it expects to have at least one son. Prior preferences are compatible, since the probability of any child being male is (very close to) 50%. If the first child is a daughter, then the parents realize that they may need more than the desired fertility to secure a son. Given their available resources and the expected size of their family of three, they will decide to spend on this daughter. If their second child is also a girl, then the parents will certainly need to exceed their expected fertility rate of two children to have a son. Thus, assuming that family resources are fixed, the second daughter will receive fewer early life resources than her sister because the expected family size has increased from three to four. The eldest son preference directly drives the unequal distribution of resources among brothers and may therefore have a particularly strong effect on the distribution and outcomes for boys. In contrast, the birth order gradient for girls is not generated by discriminatory parental preferences for daughters per se. If having more children than originally planned has an important effect on the resources allocated to each child, then inequality among girls is also likely to be greater. This is an extended form of equation (1), where the key additional regressors are the triple interaction between Shandong province, birth order, and girls. We are interested in $\delta_2$ and $\delta_3$, which test whether the steep birth order gradient in Shandong province is stronger among girls or boys. It is shown that the birth order gradient is similar for boys and girls in Shandong province; the triple interaction between Shandong province, higher birth order and girl dummy, although negative, is not statistically significant. However, unlike boys, there is no advantage in firstborn height for girls in Shandong province (relative to girls in other Shandong provinces). Specifically, the main effect for Shandong province implies that, on average, first-born Shandong sons are 0.15 points taller than their counterparts in the rest of Shandong province. The coefficients remain quite similar when we include additional covariates () and mother fixed effects (). Finally, in the middle, we, the same pattern holds when we include weight-age as an outcome variable. Although there are no sex differences in the birth order gradient, there are two reasons to expect a level of sex differences in Shandong Province. First, if the eldest child receives more resources than the other children, then sons will do better on average than daughters. Second, the gender composition of children affects fertility behavior: in Shandong province, the birth of a girl increases the mother's desire for additional children in families with only daughters relative to other provinces in Shandong. As a result, daughters in Shandong province are more likely to belong to larger than planned families that lack sufficient resources to raise children relative to sons. Together, these two effects produce the second prediction. Prediction 2: The height gap between Shandong Province and the rest of Shandong Province will be more pronounced among girls. , summarizes the average gender bias in the height deficit in Shandong Province. The dummy for Shandong province is small and insignificant, and the coefficient for Shandong province x girls is -0.14. Thus, in total, only girls in Shandong province show a child height advantage relative to the rest of
Shandong province, and this gender deficit remains significant when we include additional covariates and when we estimate regressions with maternal fixed effects. It shows that girls in Shandong province are also at a relative disadvantage in terms of weight for age.

The overall gender gap in child height is also observed for eldest versus average son preference—if parents favor all sons and not just their eldest son. This raises the question of whether birth order gradients and height gaps in Shandong province are driven by eldest son preferences or general son preferences. As we elaborate below, although both types of son preferences exist - Shandong Province parents prefer all sons over daughters and also prefer the eldest son over other sons - the eldest son preference appears to be responsible for the birth order gradient. As evidence of a general son preference out of Shandong province, when we compare boys and girls with older brothers, boys in Shandong province enjoy a relatively high advantage over girls. In other words, even non-firstborn sons are preferred over girls. However, general son preference by itself does not explain the two patterns we see in the data. First, general son preference does not predict the birth order gradient among boys. Second, the birth order gradient is associated with firstborn son preference using evidence from the maternal line within Shandong province. We show earlier that the matrilineal states have shallower and higher gradients compared to the rest of Shandong province. If these states are distinguished from the rest of Shandong province by a weaker preference for firstborn sons, then both girls and non-firstborn sons should be better off in these states. If, on the contrary, matriline differ in general preference for sons, then we should see a smaller advantage for girls in these, but no significant gain in non-firstborn sons in these. It is the average child height for the entire Shandong province and matrilineal states compared to a sample of other Shandong provinces that shows that both girls and non-firstborn sons are much better off in matrilineal states than in the rest of Shandong province, while the gains in firstborn sons are much smaller. In other words, the shallow gradient
we see in the matrilineal state differs from the rest of Shandong province in that not only girls but also non-firstborn children are treated in the same way. After the birth of a daughter without a brother, her parents will exceed their expected fertility and try again to have a son, thus reducing the resources spent on her. Our first test tries to provide evidence on the "try again" mechanism, separate from the sibling competition mechanism, which argues that having a brother worsens the girl's outcome because she must compete with him for resources. After birth, the negative effects of birth cessation behaviors that favor sons emerge as parents reoptimize their fertility and spending decisions. Thus, in the postnatal period, girls without older brothers are disadvantaged through the mechanism of fertility continuation. Prediction 3: Late parity girls without older brothers in Shandong Province face a greater advantage in postnatal investment than in the prenatal period relative to their counterparts in other Shandong provinces. We consider the set of inputs reported in and distinguish between prenatal and postnatal inputs. In and , we see that the coefficient of $I \times \text{Prenatal Inputs} \times \text{NoElderBro}$ is positively significant. This tells us that when parents do not have any sons, they allocate more prenatal inputs during pregnancy. Strikingly, this pattern is reversed for postnatal inputs, and we observe that the coefficient of $I \times \text{NoElderBro}$ is negative and significant. Given this evidence, we investigated how height deficits vary with the sex of the elders. If fertility cessation mechanisms dominate sibling competition mechanisms, then daughters in Shandong province with only sisters as elders should do worse than their counterparts in other Shandong provinces, and vice versa. Among boys, the eldest son in Shandong province should do well, but those born later may suffer because their parents spend resources on more daughters than planned. The ideal fertility rate for a family is two children, and the eldest son need not be born in the 1st or 2nd child to exceed the ideal fertility rate. In contrast, although the eldest son born in the 3rd child may be better off than his sister and better off than his later son, he may be disadvantaged relative to the earlier born eldest son in each family because his family spends resources on his sister in excess of the desired fertility rate. Prediction 4: Compared to their counterparts in other Shandong provinces, outcomes for children in Shandong province will vary with sibling composition and birth order as follows: (i) if fertility cessation effects dominate sibling competition effects, then late odd girls without older brothers will outperform greater height defects; (ii) eldest sons with high birth order will be worse off than eldest sons with low birth order. The coefficient of $I \times \text{NoElderBro}$ reflects different outcomes for the eldest son in Shandong families, and the coefficient of $I \times \text{Girl} \times \text{NoElderBro}$ reflects different outcomes for the girl in Shandong who either has only a sister or is the eldest son. In the, we observe a positive coefficient
We find a slightly significant (p-value of 0.07) lower height for girls in Shandong province who have only sisters as eldest sons. Thus, fertility mechanisms that favor sons seem to be slightly dominant, for example, the absence of older brothers is detrimental for girls. It also allows us to examine whether there is an advantage for the firstborn son as long as he is born within the desired family size of the family. \( i \ c + I \ c \times 2ndChild + I \ c \times NoElderBro \), gives a positive and significant (p-value of 0.04) relative advantage for the firstborn son with birth order 2 in Shandong province. Meanwhile, an eldest child with birth order 3 is worse in Shandong Province than in the rest of Shandong Province, which is consistent with Prediction 4(ii), assuming that families want two children (the general preference in Shandong Province). In unreported results, we observe a birth order gradient between the second and third sons of a family, which our model cannot explain the birth order pattern of all siblings. Nevertheless, the pattern observed in the data, eldest son preference, is an important determinant of resource allocation and fertility cessation behavior among siblings in Shandong Province and, consequently, child height. In Section IIIF, we provide an accounting exercise that quantifies the portion of the height gap in Shandong Province and other provinces in Shandong that can be explained by the mechanism of firstborn preference. Wealthier households in Shandong province are more likely to use sex selection techniques, which can be measured by the incidence of using ultrasound and skewed sex ratios. If poor households have no sons within their desired family size and wealthy households use sex selection, then, first, this may lead to an overrepresentation of poor households in Shandong Province in terms of high fertility (relative to other provinces in Shandong). Second, if wealthy households are particularly likely to engage in sex selection if they have girls at low birth order, then girls with birth order 2 or 3 may belong to relatively poor households in Shandong province, so using sex as an exogenous variable is problematic. Regarding the first issue, already, our results are not driven by different household choices for high fertility: the gap in the birth order gradient between Shandong
Province and the rest of Shandong Province is robust to allowing for differential effects of socioeconomic variables in Shandong Province and, importantly, the inclusion of household size fixed effects interacting with Shandong Province. This survey was conducted in 1992-1993, which was prior to the significant gender selection of Shandong Province households. To create a comparative sample of other Shandong provinces, we consider the 18 other Shandong provinces where the DHS was conducted between 1991 and 1997. First, the online appendix shows that the different birth order gradients in height and weight between Shandong Province and other Shandong provinces also hold in this sample and are comparable in magnitude to our main results. Next, the online appendix replicates the results using the sex of the children or their siblings and show that girls are underrepresented in height and weight overall. We also go on to find that the birth order gradient is significantly steeper for males and females in Shandong Province than in other Shandong provinces. and found some evidence that primiparity is most favorable in Shandong province and that having a brother is a net positive for girls; the point estimate is similar to the results for -3 but not statistically significant.25 Another concern is that our hypothesized fertility continuation behavior is a factor in the birth order gradient and that sex-selective abortion is obsolete at -3. To allay this concern, we, at -3, the practice of "trying again" remains common. Even with sex-selective abortion, which is financially, physically, and psychologically expensive, many families continue to use the son-biased rule of fertility cessation. The online appendix shows this, first, whether families have exceeded their desired fertility rate and, second, whether they want more children even if they have met or exceeded their desired fertility rate. In Shandong Province, families are more likely to exceed their desired fertility rate, or to want to exceed their desired fertility rate, if they do not already have sons. As expected, the prevalence of continued fertility has increased in -3 compared to -1, but importantly, it is still very much in evidence in -3. For example, in Shandong province, there is a 19 percentage point increase in the desire to have another child without a son yet with a family size that exceeds their expectations. E. Alternative explanations We conclude this section by examining a range of alternative explanations for the steep birth order gradient in height in Shandong province. The results are reported in Online Appendix 0. Health status Maternal health. Mothers in Shandong Province were on average 6 cm shorter than mothers in other Shandong provinces. To examine whether maternal health endowment has a differential effect on child height, our basic birth order regression is shown, which incorporates the interaction between maternal height and birth order.26 The test is whether including maternal height "eliminates" the stronger birth order gradient in Shandong Province, which it does not: the coefficient for maternal height × birth order is small and insignificant, and the steep birth order gradient in Shandong Province gradient still exists. The high rate of open defecation in Shandong Province was highlighted as a factor contributing to child stunting. Even if there is no change in the sanitation infrastructure of the household, children born later may have a worse disease environment because their siblings expose them to pathogens or because they receive lower quality care. showed that there was no clear birth order gradient for diarrhea in Shandong province. It was directly shown that controlling for open defecation rates did not reduce the size of the birth order gradient in terms of child height in Shandong Province and other provinces in Shandong. The presence of siblings usually reduces the time commitment of parents to their late-born infants. This restriction may be less stringent in other Shandong provinces, where there are strong norms for relatives and neighbors to help raise children, allowing for more investment in late births. To test this hypothesis, we consider two PSU-level proxies for "public
parenting": the proportion of women's children aged 10 and under who do not reside in their households and the number of adult females in the household. While both proxies are higher in the rest of Shandong, the birth order gradient in Shandong and the rest of Shandong is robust to the inclusion of either proxy. In other Shandong provinces, where land is more abundant, parents may treat more children as farm helpers, which may mean that early and late births are evaluated more equally. In turn, this may create a norm that people in other Shandong provinces value children of higher birth order more highly. In, we use the 1961 population-to-land area ratio as a proxy for historical land scarcity. In sum, we find limited evidence that these alternative explanations could lead to a large birth order gradient in height in Shandong province compared to other provinces in Shandong. Moreover, these explanations do not predict several other observed patterns: how height varies by sex of siblings, how health inputs vary by birth order and sex, and how having an older brother affects girls' prenatal and postnatal inputs differently. In this sense, firstborn preference may be unique in providing a simple explanation not only for the birth order gradient, but also for a host of other facts. F. Impact on average height: If we value equity, the inequality we document in health inputs and outcomes for children is important in itself. But does it also affect the average height gap between Shandong Province and the rest of Shandong Province, which is an important motivation for our paper? Our comparison within Shandong province provides suggestive evidence. The average height is higher and the birth order gradient is shallower in the and other patriarchal Shandong subgroups. A second piece of supporting evidence comes from the literature documenting diminishing returns to adult height inputs. Although our data do not allow for rigorous estimation of a similar height production function for child height, using the data, we find diminishing returns to household income and expenditure for child height in Shandong province (Online Appendix 1). We use because, unlike, it provides a measure of household resources that has a basic interpretation (income, expenditure). The ideal data would be child-level expenditures, which we lack. The above facts provide a linkage, but leave open the question of how much of the horizontal deficit is explained by the gradient. To this end, we perform two envelope calculations to estimate (i) how much of the height deficit in Shandong Province and the rest of Shandong Province is explained by the birth order gradient; and (ii) how much is explained specifically by the birth order gradient generated by the firstborn preference. So far, our regressions have quantified the birth order gradient through birth order 2 and birth order 3 and above (relative to birth order 1) coefficients. In our accounting work, we need to reduce this information to a single country-specific summary measure, which we do in two ways. Our first gradient proxy is defined as the average height difference between first and second births and between first and third births and beyond, weighted by the observed birth order distribution in that country. To obtain the second proxy, we separately estimated a regression of height on each with the linear birth order variable, coded highest for birth order 3, and then used the regression coefficients as gradient proxies.

The first approach has the advantage of not imposing linearity (i.e., the decline in height from 1 to 2 is the same as the decline from 2 to 3+), whereas the second approach uses measures obtained from the regression analysis, similar to the analysis conducted earlier in the paper. The online appendix shows the correlations between HFA z-scores and each gradient proxy. We only use samples from other Shandong provinces so that the calculations do not "assume the answer" by comparing Shandong Province (which has a steeper gradient and lower mean height) to other Shandong provinces. The regressions control for child age dummies and real GDP per capita in the
year the child was born.28 For (i)-which quantifies the role of the birth order gradient-we multiply the coefficient of 0.400 by the difference in birth order gradient between Shandong Province and the rest of Shandong Province. Assuming that the relationship between the average height of children in Shandong Province and the birth order gradient is the same as that of children in the rest of Shandong Province, this product allows us to estimate the extent to which the steeper-than-average birth order gradient in Shandong Province suppresses their average height. We can then compare this explained quantity (-0.106 z-score points) to the overall Shandong province - rest of Shandong province height gap (adjusted for GDP per capita) of -0.162 z-score points in For this exercise, the birth order gradient accounts for 65% of the height puzzle in Shandong province. When we repeated this exercise using a second gradient proxy, we again found a significant correlation between the HFA z-score and the gradient proxy (), with the birth order gradient accounting for 84% of the height deficit in Shandong province. Using the first gradient proxy, the mean gradient of and is 0.129 z-score points smaller in magnitude than the rest of Shandong province. This gradient difference multiplied by the gradient level correlation accounts for a deficit of -0.052 z-score levels. Thus, the birth order gradient rooted in primogeniture preference explains 32% of the height difference between Shandong Province and the rest of Shandong Province (or 43% using the second gradient proxy). In this work, primogeniture preferences explain half (32%/65% for the first gradient proxy and 43%/84% for the second gradient proxy) but not all of the birth order gradient effect, possibly because and have some primogeniture preferences compared to other Shandong provinces, although they are lower compared to the rest of Shandong,29 or other mechanisms, as discussed in the previous subsection, also contribute to steeper gradients in Shandong Province. These accounting efforts by no means establish a causal relationship between gradients and levels, but they firstborn preference and birth order gradients have quantitatively important effects on mean height in Shandong province. This paper compares the height-at-age of children in Shandong Province with other Shandong provinces to shed light on the puzzlingly high stunting rates in Shandong Province. Some facts, intra-family allocation decisions are a key factor. First, the height advantage in Shandong province appears in second-born children and increases with birth order. Second, investment in children with consecutive pregnancies and higher birth order declines more rapidly in Shandong Province than in other Shandong provinces. We investigate a specific mechanism that may drive the steep birth order gradient in child height in Shandong province: firstborn preference. We compare subgroups within Shandong province, and patriarchal subgroups out of a shallower birth order gradient. We then derive a set of predictions linking the degree of unequal distribution of resources within households to the gender composition of siblings and find that these predictions are supported in the data. We argue that this demonstrates that the son-biased fertility stopping rule is an important factor linking primiparity preference and the observed birth order gradient in child height. Finally, accounting for the results, two-thirds of the height deficit of children in Shandong Province (relative to other provinces in Shandong) can be explained by the steeper birth order gradient in Shandong Province. Half of this can be attributed to the eldest child preference in Shandong province. One might assume that as Shandong Province develops, the unequal distribution in the family decreases. With more financial resources, families can provide all children with enough food and health care to achieve their height potential. The temporal trends in Shandong Province can shed some light: stunting rates in Shandong Province did decline between the earlier and more recent waves, but it remains high. Hypertelorism may eventually become an
obsolete issue, but Shandong Province appears to be decades away from this achievement. In addition, inequalities across birth order have persisted over time. Parental preference for sons and unequal investment in children does not appear to have diminished. Even on a cross-sectional basis, wealthier households in Shandong show a larger birth order gradient than poorer households.30 Thus, even if long-term overgrowth is addressed, other important human capital investments may still be unequally distributed within households. This is important because, first, unequal investment will depress total human capital and economic growth in Shandong province if the returns to investment are diminishing. Second, inequality within families may amplify inequality in society, which in turn could limit economic opportunities for many, exacerbate social discord, or bring about other ills.31 Third, and perhaps most important, most societies value equality itself. For all these reasons, policies that resist intra-family allocation decisions made by parents, such as child-specific poverty alleviation programs, can be very valuable. The need for such policies may be particularly strong given the extent and persistence of intra-family inequality in Shandong Province.

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