Maternal autonomy and child nutrition

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Abstract

We create a measure of maternal autonomy that accounts for cultural and traditional environment, and examine the link between this and the nutritional status of her children. We deal with possible measurement error in the created index, and endogenous sample selection due to son preference in India. Using a sample of rural households, we find that one standard deviation increase in autonomy score (i) leads to a 10% reduction (representing 300,000 children) in the prevalence of stunting, and (ii) compensates for half of the estimated average decline in Height-for-Age Z-scores children experience at the end of 12 months.

Keywords: *Child Nutrition; Maternal Autonomy; Latent Factor Models; India, Measurement errors; Son preference.*

JEL Classification: C38, I14, I18

1. Introduction

In addition to playing a pivotal role in increasing childhood mortality, poor nutrition in childhood causes irreversible damage to cognitive development and future health (Dreze, (2004), Sumner, *et al.*, (2009); Saxena, (2018); Victora, *et al*., (2008)). Victora, *et al*., (2008) in a systematic review of the literature published in the Lancet (2008), document that child undernutrition is strongly associated with shorter adult height, less schooling, reduced economic productivity, lower adult body-mass index and mental illness. They conclude that damage suffered in early life leads to permanent impairment and might also affect future generations. Thus, the prevention of undernutrition would bring about important health, educational, and economic benefits to the individual as well as to society.

The data we use are drawn from the national survey, which is the third round of the National Family Health Survey (NFHS3, 2005-06) (IIPS and Macro International, 2007a).[1] The survey provides information on the three commonly used anthropometric indicators of nutritional status of children: Height for Age Z-score (HAZ score), Weight for Height Z-score (WHZ score) and Weight for Age Z-score (WAZ score).[2,3] The survey indicates that 48% of children under 5 years of age in India are chronically malnourished (i.e., stunted); 43% are underweight (i.e. WAZ<-2 SD); and 20% are acutely malnourished (i.e., wasted) (IIPS and Macro International, 2007a, 2007b). These figures are extremely high since statistically one would expect only about 2-3% of the population of children aged less than 5 to fall in the range below -2SD.

The focus of this paper is on the role of maternal autonomy in child nutrition. We face three econometric challenges. First challenge is how to define and measure ‘autonomy’. The term autonomy has often been confused with empowerment, though the latter is a process and the former the outcome (at least partly) of the process. Our concern in this paper is with the outcome. Many different definitions and measurements exist in the literature. One strand of the literature assumes that 'autonomy' is a directly observed outcome variable and measure it using an arithmetic average of binary answers to a set of questions that are elicited by surveys (Jensen and Oster, (2009)).[4,5] Another strand of the literature uses definable and easily measurable variables such as education and health (for example, see Imai, et al (2014)) as proxies for autonomy. Yet another strand of the literature, which is more related to what we do, assumes that the autonomy trait is essentially not observable and the answers to a set of questions (to be listed later), give you some proxy mis-measured information about autonomy, and uses principal component analysis to construct/extract a measure of 'autonomy' (Chakraborty and De (2011)).

We conducted small quantitative and qualitative field surveys in both urban and rural areas to gain insights into the concept of 'autonomy'.[6] Combining the survey results with literature from Sociology (see Section 2), we create an index of 'autonomy' based on the following: (i) autonomy *expresses* itself in a number of ways, such as, having decision-making power; mobility; and command and control over resources; (ii) the enabling factors in exercising autonomy are education, position in the household, closeness to kin, economic status of the woman and her household, access and availability of infrastructure, and norms and attitudes of the larger community; (iii) it is an unobserved trait and the answers given to the set of questions are *fallible measures* of autonomy. We use a latent factor model to create an index of autonomy accounting for traditional and cultural environment. Our approach allows us to separate the direct effects of maternal and family characteristics in our model from their indirect effects, which work through the impact of these factors on maternal autonomy. We also explore the effect of autonomy on child nutrition using popular proxy measures.

The second challenge is to account for possible measurement errors in the construction of various autonomy indexes. We explore the use of various measures of autonomy indexes as instruments for one another.

The third challenge is to deal with possible biases caused by endogenous sex composition of children in the sample (Yamaguchi, (1989)). Prevalence of 'son preference' in India can manifest itself in differences in the nutritional status (Barcellos et al. (2014) and Jayachandran and Kuziemko (2011)). If families sex-select the second and subsequent children by using prenatal sex-selection, even the nutritional status of the first-borns will be affected by the presence of subsequent children in the families.[7] In order to mitigate possible biases due to this endogenous selection, we restrict our analysis to first-borns and check for sensitivity of our results to different age composition of these children used in the analysis.[8,9]

Our main results indicate a significant beneficial effect of autonomy but only for rural children. 63% of our sample of women reside in an area classified as rural.[10] In the interest of space, we only provide results from our 'rural' sample. For the subset of first-born children aged less than 18 months, we find a significant positive effect only on long-term child nutrition (i.e., HAZ score) and a negative effect on the probability of the child being stunted. In terms of magnitudes, one SD increase in our autonomy score is estimated to reduce the number of first-born aged less than 18 months and classified as stunted (2.1m) by 0.3m children (30.5% to 27.3%) – a 10% reduction.[11] Our estimate implies that one SD increase in autonomy halves the observed average decline in the 6-12 month age group. These numbers indicate the importance of maternal autonomy on child nutrition. We did not find any differential effects of autonomy by sex of the child on child nutrition for our sample. The estimated effects of autonomy using other popular indexes produced estimated effects that were smaller than the ones from our measure. This is consistent with attenuation bias arising from measurement error.

The paper is organized as follows: next section discusses the relevant literature for India and the possible pathways. Discussion on data and sample selected are provided in Section 3. Section 4 discusses the methodology while Section 5 provides descriptive statistics. Section 6 presents the main results and addresses the issue of sample selection in the presence of son preference. Section 7 discusses the results from using different measures of autonomy. The final Section presents conclusions, including a tentative discussion of the gaps revealed by the findings regarding women's autonomy and child nutrition.

2. Overview of the literature and the possible pathways

One of the earliest studies by Dyson and Moore (1983) on kinship structures and women's autonomy, defined autonomy as the capacity to obtain information and make decisions about one's private concerns and those of one's intimates. In a similar vein, Saflios-Rothschild (1982) in the context of demographic change in the third world, defines autonomy as 'the ability to influence and control one's personal environment'. The essential elements of autonomy - namely the ability and capacity to make decisions in a way that can influence one's environment - is reflected in other definitions, such as that by Jejeebhoy (2000), according to whom, autonomy is the "extent to which women exert control over their own lives within the families in which they live at a given point of time." As stated by Agarwala and Lynch (2006), "These definitions assert a single construct that captures the multifaceted ability to gain control over the circumstances of one's life."[12]

In summary, autonomy has intrinsic relevance for a woman's own well-being. It determines to a large extent her ability to make effective choices, and to exercise control over her life. It also has instrumental value, in that the woman's autonomy contributes in large measure to enhancing quality of life for the family and for the community.

The nutritional status of a child is strongly related to characteristics of the mother, as many studies have shown. Mother's education is associated with child survival (Murthi, *et al.,* (1995); Cleland, (2010)) and the nutritional status of a child (Borooah, (2004); Frost, *et al.,* (2005)). Mother's health is also reflected in health outcomes for children. At birth, one third of Indian infants are underweight, and 20% are stunted because of poor intrauterine growth (Mamidi, *et al.,* (2011); Ramachandran and Gopalan, (2011). While the above studies have looked at readily definable and easily measureable variables, such as education and health, this paper treats 'autonomy' as an unobserved trait and only fallible measures of this trait are available to researchers.

3. Data and the sample

The data are from the third round of the National Family Health Survey (NFHS-3) for India, 2005. This is part of the Demographic and Health Survey (DHS). This survey collects extensive information on population, health, and nutrition, with an emphasis on women and young children. In addition, it gathers information concerning household decision making, as well as answers to some questions relating to the "autonomy" status of surveyed women. To supplement NFHS information, and to understand the situations and facts behind these figures, rapid field surveys and focus group discussions with women were also carried out. These were conducted in three villages in rural areas of the Allahabad district in Uttar Pradesh, and with groups of women in urban areas in Pune in the state of Maharashtra.[13]

The NFHS-3 interviewed over 230,000 women (aged 15-49) and men (aged 15-54) rom 29 Indian states, during the period December 2005 to August 2006 (IIPS, 2007a). As is common with the DHS, this survey also elicited responses to certain questions that may be interpreted as providing information on various aspects of autonomy. All children who were aged less than 60 months and living in the household at the time of the survey were weighed, and their heights were measured.

The sample selected for our analyses reported here, was based on the following criteria: (i) currently married women who are 'usual' residents and living in an area classified as rural; (ii) mothers who had at least one child born in the past 60 months, and who had at least one child living at the time of the interview; (iii) had non-missing values for the main variables of interest. We keep this index fixed over our different sample cuts when we investigate the effect of autonomy on nutrition. All analyses, including the construction of the autonomy index are carried out using rural households.

4. Modelling the main variables of interest

4.1 Nutritional status

The four outcome variables of interest are HAZ, WHZ, 'stunted', and 'wasted'. The variable stunted (wasted) is a binary indicator for HAZ (WHZ) less than -2 according to the WHO definition. All children in the family who were aged less than 60 months at the time of the interview, and who had valid measurements for these variables, form the main sample. We restrict our analysis to HAZ and 'stunted' as autonomy was never found to be a significant determinant of WHZ and 'wasted'.

All equations are specified as a linear regression model and estimated by OLS. All reported standard errors are bootstrapped and allows for clustering at the district level.

The equation for the measure of nutritional status *y* (HAZ and Stunted) for child *k* of mother i is specified as:

$$y_{ik} = x_{ik}^{'}\beta + z_i^{'}\gamma + \delta a_i + \varepsilon_{ik} \qquad i=1,..,n \quad \text{and} \quad k=1,..,K \qquad (1)$$

x_{ik} contains the child-specific characteristics such as age, birth order, sex, etc. z_i contains the mother, father and household characteristics, such as levels of education, religion, caste, wealth indexes, etc. a_i is the mother's autonomy trait which we assume to be *unobserved*.

The challenge here is to obtain a consistent estimator of equation (1) coefficients, where the parameter of interest is δ. Endogeneity of some of the covariates in equation (1) can occur if the proxy used for a_i does not capture fully the correlation between the covariates and the error term and thereby leaving some mother-level unobservable in the equation that is still correlated with the regressors. First we discuss how we proceed with the measurement and generation of a_i allowing for social and cultural environments to play a part, and then turn to the issue of how we deal with the endogenous sex-composition in the sample (see Introduction).

4.2 Defining and measuring maternal autonomy

The first methodological challenge of dealing with the construction of autonomy is the selection of appropriate indicators that capture the underlying unobserved trait. The second challenge is to find a way to combine the selected indicators into an index.

Based on the literature and the knowledge gained from our qualitative interviews, we choose the answers given to the following questions in the DHS surveys as indicative of woman's "*autonomy"* to think, speak, decide and act independently.[14]

The following responses were all coded as binary indicators.

Related to Physical Autonomy: Woman is allowed to go alone to (i) the to the market (m1), (ii) the health clinic (m2), and (iii) places outside the community (m3).

Related to Decision Making Autonomy: Woman decides alone on purchases for daily needs (m4); Woman decides alone or jointly with her husband on (i) her own health care (m5), (ii) large household purchases (m6), (iii) when they could visit family and friends (m7), and what to do with husband's money (m8).

Responses Related to Economic Autonomy: Woman has money of her own that she can decide how to spend (m9).

A measure of autonomy based on a simple average does not differentiate between women who have more autonomy from those who enjoy less autonomy. We let the data tell us about the importance of differential role of autonomy on different dimensions by using a latent factor model where the autonomy variable is treated as a random effect. Since all measurements (*j=1,.,9*) are binary we use a logit model for woman *i* (conditional on her autonomy trait a_i) as

$$\Pr ob(m_{ij} = 1 | \eta_i) = \Delta(\delta_j + \lambda_j a_i) \qquad (2)$$

with $a_i = \theta' s_i + u_i$ (3)

Δ is the logistic distribution function, and δ_j and λ_j are the intercepts and factor loadings respectively. The enabling factors of autonomy enter as a set of variables in *s* in equation (3). *u* is an error that is uncorrelated with *s* by construction.[15] All mother, father, and household characteristics that are in *z* (equation (1)) and, an additional variable that is the age difference between the husband and wife are included in (3). This is our identifying variable. The assumption here is that, the larger the age difference between the partners, the higher the autonomy of the wife *ceteris paribus* because the husband will be able to make decisions that do not constraint him to follow customs and traditions to some extent.

We impose the restriction that the first loading is 1 in (2) for identification, and assume the autonomy trait is centred at $\theta' s_i$ with variance is σ_a^2. The Model given by equations (2) and (3) are jointly estimated using maximum likelihood methods with the assumptions that a_i s are normally distributed (i.e $a_i \sim N(\theta' s_i, \sigma_a^2)$). We then use the estimated posterior conditional mean (Empirical Bayes) *E*(a_i |data) of the latent variable a_i to construct our index of autonomy for every woman in the sample.[16] We construct our index of autonomy distinguishing between rural and urban households.[17]

Two remarks are in order. First, it is assumed that the likelihood of a woman saying "yes" to one of the questions (called "measurements") is a sum of two variables: the latent 'autonomy' characteristic that has different effects on the measurements and an error orthogonal to the autonomy trait, which is assumed to be logistically distributed. This assumes that conditional on autonomy, the measurements are independently distributed. These important assumptions play a crucial role in most of the estimators used in the literature. If cultural norms play an important role in defining the autonomy a woman has, then equation (3) becomes crucial.[18]

Second, in the language of Item Response Theory (IRT), the intercepts δ_j are called item "difficulty" and factor loadings (i.e. slope coefficients) λ_j are called item "discrimination". Comparing two intercepts, the larger the intercept, larger the probability of saying yes to the question for the same autonomy measure. Hence the smaller intercept measurement is said to be a more "difficult" item. In terms of the factor loadings which are the slope coefficients, the probability of saying yes with the measurement that has a larger slope will be more sensitive to small changes in the autonomy trait compared to the one with the lower slope and hence said to be more discriminatory. Hence in our application, (i) a larger intercept implies that women are more autonomous in this dimension; (ii) the larger the slope, the better would be the measurement in distinguishing different autonomy traits. It is important to account for the differential role of autonomy on different dimensions.

We report 'reliability' measure which is the proportion of the total variance in that particular measurement that is attributed to the "unobserved autonomy" trait, i.e., a measurement with a larger "reliability" measure is able to explain larger proportion of the variability in the observed pattern of women's answers to that question relative to another measurement with a smaller reliability measure.

5. Descriptive statistics of the variables

The anthropometric information was collected on surviving children who were under 5 years old at the time of the interview. Sample selection criteria used is provided in Section 3. Descriptive statistics for the main variables of interest are given in Table 1 and the full list of summary statistics of all the variables in online Appendix Table A1.

Autonomy measurements: A score created by summing all the means of the autonomy-related measures is only 4.24. That is, on average, rural women only have autonomy in four dimensions. The frequency distribution of the score is provided in Table 2. About 8% of women do not have any autonomy at all according to our chosen measurements. Only a very small proportion of women (2.2%) are recorded saying that they have full autonomy.

***Variables in the autonomy equation (3) alone – s*:** Our identifying assumption is that age gap between the partners only acts on the autonomy trait and not on nutritional status conditional on autonomy. As discussed earlier we expect this variable to have a positive effect on autonomy. The summary statistics for this is provided in Panel [2] of Table 1. In nearly 50% of the families, the husband is three to five years older than the wife.

Nutritional status variables: Panel [3] in Table 1 provides summary statistics for the nutritional status variables. 48% of children are stunted according to the WHO definition. This is very large compared to the predicted proportion of children who would be classified as stunted according to the WHO distribution. The HAZ scores, the smoothed HAZ score by age in months, and the probability of being stunted by age, are provided in Figures 1 to 3 respectively. Three points are noteworthy here. First, the distribution of HAZ is shifted to the left relative to the WHO distributions. Second, HAZ scores deteriorate with age but stabilises after the child reaches approximately 2 years of age. Third, the proportion of children classified as stunted also rapidly increases with age.

6. Results

6.1 Autonomy index

In the interest of space, we do not discuss the estimates of equations (2) and (3) but provide them in online Appendix Tables A2 and A3. Brief highlights are provided here.

The estimation of the model requires a normalization and the factor loading related to whether the woman is allowed to go to the market alone is normalized to 1.[19] In terms of the discriminatory power of the measurements (higher factor loadings), the decision-making measurements have high discriminatory power relative to the reference case (i.e., they have a factor loading that is larger than 1). Another way to say this is that a small change in the autonomy trait will have a larger increase in the probability of saying "yes" to these questions relative to other measurements. This is not surprising given that just over half the women in the sample answered 'yes' to these questions (see Table 1).

The "reliability" measure (equation (4)) is reported at the bottom of Table 3. This is calculated as the proportion of variance explained by the autonomy index in the total variation of the measures (m1-m9) individually (see equation (4)). The latent autonomy trait is able to explain more than 60% of the variations in the observed measures related to whether the woman has a role in the decisions concerning large household purchases, and on visiting family and friends; the latent autonomy trait also explains over 40% of the variations in the woman's participation in decisions regarding her own health care. Unequal factor loadings estimated in this model reiterate the importance of allowing for different dimensions of autonomy to play different roles; thus, they illustrate why an index derived by simply averaging the measures would be problematic.[20] We will return to this issue later in Section 7.

6.2 Nutritional status

We estimate a series of linear regressions explaining child nutritional status measured as (i) the Height for Age Z (HAZ) score; (ii) Stunted: an indicator for whether the child is "stunted" according to the WHO (2006) definition where the HAZ score is less than -2.

If a child has died in the past because of severe malnutrition, then the sample of surviving children for whom we have a valid measurement of nutritional status is an endogenously selected sample. 6% of the mothers in the sample had experienced a child death (Table 1). In the absence of plausible instruments to account for this selection, we include in all our regressions an indicator variable that accounts for whether the mother has experienced child death in the past. The effect of this variable is never significant in any of the regressions except in the simplest of the specification where no covariates were included in the nutrition equation.

As discussed in the Introduction, son-preference is likely to lead to differential care and feeding practices, and hence to differential nutritional outcomes. That is, nutritional outcomes would depend significantly not only upon the sex of the child, but also upon the sex composition of existing children, and how this compares with parents' desired number of boys and girls.

There are two ways in which son preference may cause our sample to be endogenously selected. First, son preference may lead to sex-selective abortion, which may lead to a lower proportion of girls at birth. Second, son preference is likely to have an impact on birth intervals and fertility choices. Parents may use a stopping rule for their fertility choice that depends on the number of girls and boys they already have (Barcellos et. al. 2014). Additionally, the birth-intervals between children also might depend on the sex of the previous child if the mother tries to conceive faster in the hope of having a boy after a girl (Jayachandran and Kuziemko, 2011). Both these practices would imply that the number and sex of children in the sample are not randomly determined but depend upon various other observed and unobserved factors - thereby causing estimators to be inconsistent.[21]

The data on child nutrition were collected for children born within the last five years at the time of the interview. As Panel [1] of Table 3 shows, 64% of mothers had only one child born during this time interval and 96% of mothers only contribute one or two observations to the sample.

We first address the issue of possible sex selection through abortion of female foetuses. As shown in Panel [2] of Table 3, among all children, except for the first-borns, the sex imbalance is exacerbated. We cannot reject the null of equality of proportion of boys and girls among the first-born children - implying that parents generally do not sex-select their first child. Based on this evidence, we choose to only use the first-borns for further investigations.

The other issue (i.e., son preference affecting birth spacing, stopping rules, and care and feeding practices) is more complicated. If the first-born is a girl child, the family may try to conceive sooner in the hope of having a boy. This would reduce the amount of time that the child can receive undivided care and attention (and, especially, breast milk) (Jayachandran and Kuziemko, 2011). Therefore, nutritional status of the first-born may depend upon the parents' attitude (i.e., their son preference) as well as upon the birth interval, and the sex of the second child. In order to address this problem, we restrict our sample to those first-borns who are less than a certain age threshold, i.e., who are young enough that they are not very likely to be affected by the birth (and hence sex) of the second child. We have elected to restrict our sample in this way rather than choosing those eldest children without a younger sibling because the choice of the “only child” as a sample group will lead to endogenous selection if mother conceives sooner after a girl (Barcellos et al. (2014)).

Panel [3] of Table 3 describes how many first-born children were observed with a second-born by the birth-year of the first-born. We find that 34.2% of first-borns have a second sibling in the sample. The older the first-born, the higher the chances of observing a second child in the sample. Since this pattern is dictated by the birth intervals, selecting a sample of first-borns without a sibling, will not deal with the problem of endogeneity caused by son preference as discussed earlier. This can be illustrated with an example. If a woman has a girl for a first child, then she may have the second child quickly in hope of having a boy. On the other hand, if the first child is a boy, the woman may delay the second pregnancy to allow the boy to receive full care and attention. Thus, if we use this criterion, i.e., first-borns without a sibling, boys may have a higher probability of inclusion into the sample.

We therefore explore if and how we can select a sample of children based on their birth order and age in order to reduce the endogeneity problem caused by son preference. Compared to a selection based on the age of the child, a calendar-year based criterion is likely to suffer less from endogenous selection bias. Below we describe some descriptive statistics of sample selected when different age, birth-order and date-of-birth criteria are applied.

The age distribution of the first-borns is provided in Panel [4]. Around 60% of the children in the sample are aged 24 months or more, and approximately 30% are under 18 months old. In terms of the age distribution of last-borns given in Panel [5], approximately 31% are aged less than 15 months. This is the sample used in Barcellos, et al. (2014) drawn from first round of the same survey we use (third round). If the families did not sex-select using pre-natal diagnostic tools but perhaps used birth-spacing to achieve the desired target for the number of boys, choosing a sample of last-borns who are aged less than 15 months, would mitigate the endogenous selection somewhat. About 18% of children who are first-borns are also the last one to be observed in the sample (Panel [6]). These figures reflect the fact that the birth intervals are short.

We next look at the age distribution among our first-borns who were born after 2003 (Panel [7]). The age of children born in the same month may also vary at the time of the interview due to the interviews taking place sometime between 2005 and 2006. Among this group of children, about 65% are aged less than 17 months. We therefore take our main preferred sample as those first-borns who are aged less than 18 months.

We next summarize the estimates of the effects of our autonomy variable on nutritional status by different cuts of the sample used in the estimations in Table 4. As discussed earlier, we only report the results for the long-term nutritional status indicators given by the HAZ score and an indicator "stunted"' for whether the child is below -2 SD of the HAZ distribution according to the WHO.[22] An additional interaction term between the autonomy variable and a girl child was included in the model to assess whether female children benefit more than male children when the mother is more "autonomous", ceteris paribus. However, the interaction term was insignificant in all the regressions using either the first-borns or the last-borns.

The most important finding is that maternal autonomy has a significant positive impact on HAZ, and a negative impact upon stunting irrespective of the sample used. We defer discussions on the magnitudes of these estimates until later in this section and summarise the main results here.

(i) The effect of maternal autonomy is positive on the HAZ score. A one SD increase of the autonomy index is estimated to increase HAZ score by around 0.04-0.05 for children aged 0-59 months, regardless of whether the sample contains all children or just the first or the last-borns only (Panels [1] and [5]).

(ii) In terms of the first-born sample, the estimated effect of autonomy is much larger than the estimates obtained using the full sample of children aged 0-59 months. A one SD increase in autonomy is estimated to be associated with an increase of about 0.11 to 0.16 in the HAZ score, depending on how we cut the sample. The magnitude is not sensitive to whether we select children aged less than 15 months or 18 months. The lowest estimate of 0.11 was obtained when the sample is extended by including children born during 2004. That is, extending the sample to situations in which more children might be present in the family reduces the effect of autonomy on long-term nutritional status.

(iii) As discussed earlier, prevalence of son preference in India can lead to families engaging in pre-natal sex selection, and/or endogenously choosing birth-spacing to obtain the desired sex composition of the family's children. Generally, the estimated effects of autonomy are lower when the sample of last-borns is used compared to the estimates from the sample of first-borns. This is not surprising because the nutritional status of last-born children may be affected by the presence of older children and the sex composition of children in the family.

(iv) The estimated effect of autonomy for the sample of children aged 0-59 months is about a quarter of the estimates obtained for the sample of only the first-borns who are less than 18 months old.

The beneficial effect of autonomy on the probability of stunting wanes when older children are included, regardless of their birth orders. A one SD increase in autonomy is estimated to decrease the probability of stunting by 0.035 among younger children, but only by about 0.015 when older children are included, regardless of their birth-order. For our first-born sample aged less than 18 months, a one SD increase in autonomy is associated with approximately 0.032 point reduction in the probability of stunting. The discussion of this magnitude is deferred until the next subsection.

We therefore conclude that there is a positive association between the long-term nutritional status of the first-born and maternal autonomy. The investigations we have carried out suggest a positive association even for children aged 18-60 months.

It is well known that the first two years of life are considered to be the most important "window of opportunity" to make a long-term impact upon children's nutritional status (UNICEF, 2013), and their lifelong health and well-being. Thus, the finding that more autonomous mothers are able to contribute to better health for their children specifically during this key window of time is very crucial for policy purposes.

The full sets of results for this model are presented in online Appendix Table A4. As seen in the figures earlier, relative to the HAZ scores of children younger than 6 month of age, the HAZ scores of older children become worse as they grow older; the probability of being stunted increases as well. These findings are reiterated in our estimates. A 6-11-month-old child is estimated to have a HAZ score of about 0.3 SD lower than that of a child aged less than 6 months, *ceteris paribus*. This even deteriorates for a child who is between 12 and 17 months old.

Biologically girls are born with relatively good survival chances and this is what we also find. Relative to boys, girls have a better nutritional status at the beginning of their life, *ceteris paribus*.

Interpretation of the magnitude of impact of autonomy

We next turn to the interpretation of the estimated effect of autonomy on the HAZ score, and the probability of stunting as reported in Table 5. As we saw earlier in the figures, as children age, their HAZ scores deteriorate. The average HAZ score and the proportion who are classified as stunted, for the sample of first-borns aged less than 18 months are -1.15 (SD 1.72) and 0.31, respectively. Hence, one SD higher autonomy index is associated with an increase in the HAZ score of 0.09 (0.161/1.72) giving a new HAZ score of -1.06 and the new probability of stunting of 0.28. In terms of the WHO distribution of HAZ scores, this is equivalent to a shift of a child from the 13th to the 15th percentile position. Interestingly, the effect of a change in 1 SD of our autonomy index both in our HAZ and stunted regressions is about half the age effect for 6-11-month-old children and about 15% for 12-17 month old children, relative to those aged less than 6 months. An estimated 22 million children aged less than 18 months live in rural India (Census of India, 2011). Using the sample proportion (30%), an estimated 6.6 million children are first-borns in this age group; among them, approximately 2.1 million children (30.5%) would be classified as stunted. A one SD increase in autonomy would be expected to lead to 300,000 fewer cases of stunting among first-*born children aged less than 18 months* (as evidenced by a decline from 30.5% of this population to 27.3%). As this group of children age from the birth-to-5-month age group to 6-11 month age category, this level of increase in maternal autonomy would effectively halve the average deterioration in HAZ scores experienced.

7. Other measures of autonomy

In this section, we discuss the differences between using our preferred measure of autonomy and those that are routinely used in the literature. We assess the sensitivity of our results in two ways: (i) bivariate plots to assess whether the ranking of the mothers change;[23] (ii) whether there is a role for maternal autonomy in child nutrition. We use the sample of first-borns who are aged less than 18 months. We have labelled various models as Model 2-5 keeping our preferred specification as Model 1.

Model 2 – Principal Component Analysis (PCA)

The autonomy index a_i is very often estimated as the first principal component from the set of measurements (Chakraborty and De (2011)). This is a data dimension reduction technique and the first component is a linear combination of the observed data (measurements) and this explains the largest variation in the observed measurements. The use of this measure does not allow socioeconomic variables to play a role in woman's autonomy.

Model 3 – Average of the Measurements

Another popular method used is an index defined as the average of a set of measurements (Jensen and Oster (2009)). This is equivalent to using OLS to estimate the mother-level 'fixed effects' a_i in the specification,

$$m_{ij} = a_i + \varepsilon_{ij} \quad (4)$$

j=1,..,9 are the measurements and i is the mother.

Importantly, this specification (a linear probability model) assumes, unlike ours, that the effect of autonomy a_i is the same on all measurements. This is a crucial shortcoming as discussed earlier as we expect the autonomy to play different roles in different dimensions.

Model 4 - Restricted versions of Model 1

We consider two different restricted versions of our preferred model. First, the most restricted version is the random effects logit model with the restriction that all factor loadings and intercepts are the same across the various measurements without accounting for equation (3) (Model 4a). Second, we relax the equality of intercepts and factor loadings without accounting for equation (3) (Model 4b). These restrictions can then be tested using likelihood ratio tests.

The autonomy index is then created using the Empirical Bayes method as before (see footnote 16).

Model 5 – Measurements included directly in the nutrition equation

All individual measurements are directly used in the ‘nutrition’ equation (1).[24]

The bivariate plots in Figures 4a-4d provide a visual assessment of the correlation between our measure of autonomy and other measures of autonomy. The PCA factor is highly correlated to the index created using the simple average of the measurements. The important point to note from these plots is that there are some women who are assessed to have an autonomy index below the mean of 0 according to our measure (vertical axis) are given an index value which is above the mean according to other measures (and vice versa). In summary, unsurprisingly the autonomy indexes calculated using the latent factor model with different factor loadings provide better correlated measures.

The estimated effects of autonomy from using different measures are presented in Table 7. The highest effect of autonomy is estimated for our measure. When the measurements are entered separately in place of one summary index, the effects are not significant.

The main question to ask is whether the OLS estimator of the nutrition equation parameters is consistent? In order to achieve this, we have constructed the index in a specific way and also restricted the sample to the first-borns who are aged less than 18 months. This paper has argued that unlike other measures, our autonomy index is able to better capture the mother level unobservable that is correlated with the covariates in the nutrition equation when the sample is restricted to the first-borns who are aged less than 18 months.

8. Discussion and Conclusion

Maternal autonomy is a latent trait which is based on cultural and traditional norms that are difficult to shift in the short run. The difficulty of measuring such a trait has for long hampered our understanding of its role in shaping other indicators. We suggest the use of latent factor modelling to construct an index of autonomy allowing for socioeconomic factors to play a part. This contrasts with the use of other measures in the literature such as those constructed using adding up of binary responses, averaging binary responses, or using principal component analysis. These alternative measures which do not control for custom and traditional environments, produced estimated effects that are lower than what we find with our latent factor modelling measure.

The paper has argued that by restricting the sample to first-born children aged less than 18 months and using our autonomy index, we are able to better capture the mother level unobservable in the nutrition equation.

Analysis of NFHS data helps us to understand that greater autonomy leads to better child nutrition. However, due to the limitations of the survey, understanding of how and why greater autonomy leads to better child nutrition remains limited. We are still left with questions: what decisions do sufficiently autonomous mothers make that improve the nutritional outcomes of their children? Are these decisions related to feeding, hygiene, preventive health care, treatment of illnesses, or are they just environmental factors? To gain insights and answers, we conducted small quantitative and qualitative field surveys in both urban and rural areas in the Maharashtra and Uttar Pradesh states in India. The findings of the field survey revealed unexpected pathways. The most important impacts of greater maternal autonomy are delayed marriage and pregnancies, fewer children, and appropriate birth spacing. Women with young children desired delayed pregnancies, fewer children, and larger gaps between births. Many women mentioned that they "longed" to take care of their children and breastfeed them until they reached 3 years of age. However, interviews revealed that a number of prevailing beliefs hampered what young mothers wanted to do: others in the family, including the husband, mother in law and even the woman's mother, would convince the woman to have children immediately in succession after marriage. There was a common belief, especially among poor families, that women should get married at an early age in order to circumvent the prospect that, as she grows older, she might fall in love with a man and run away with him. Once she gets married, she should fulfil her marital responsibility of producing children in quick succession. This was important for many reasons, including to prove man's sexual potency. Producing children in quick succession ensures that women can fulfil their reproductive responsibilities "at one go". This reduces the age gap between children and ensures that childcare is a continuous phenomenon which lasts a relatively shorter period. It also ensures that children grow up with one another and can keep each other company. In light of these commonly-held beliefs, young mothers who wanted to delay their first pregnancy wait longer between pregnancies and have fewer children, nonetheless faced pressure from others in the family, including the husband, mother in law and even the woman's own mother, to have children immediately and in quick succession after marriage. Greater autonomy among women would enable women to override these long-standing cultural perceptions, and to adopt fertility practices which are much more conducive to better child nutrition, with long-term health and economic benefits for the next generation.

The findings from the field study offer significant help in understanding how maternal autonomy can play a role on children's health and nutrition.

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HAZ scores – Children aged 0-59 months

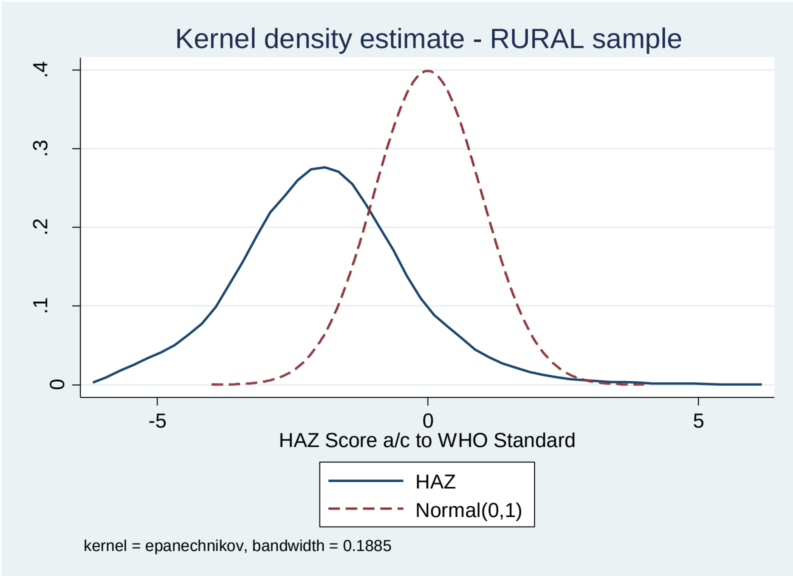

Figure 1

Smoothed Plots of HAZ by Age – all children

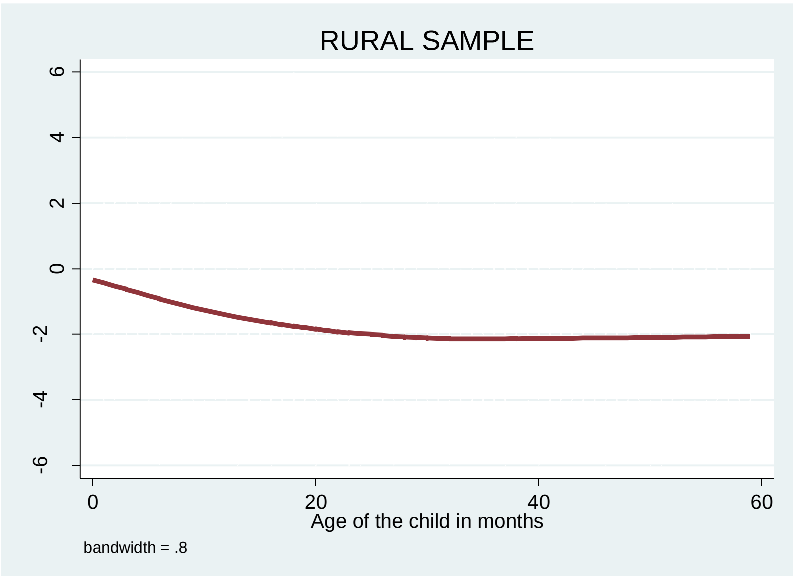

Figure 2

Proportion of children who are classified as 'stunted' by Age

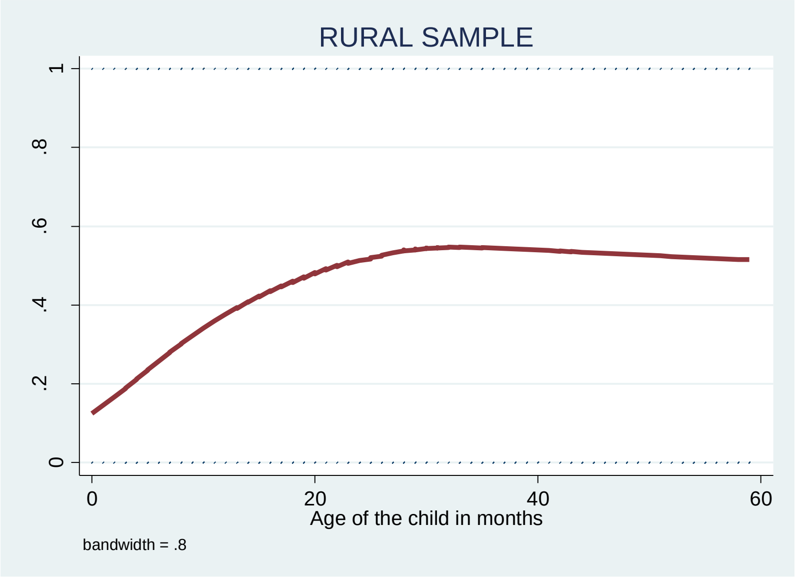

Figure 3

Notes to Figures 1-3: All figures are based on authors' calculations from the sample used for the estimation of the model.

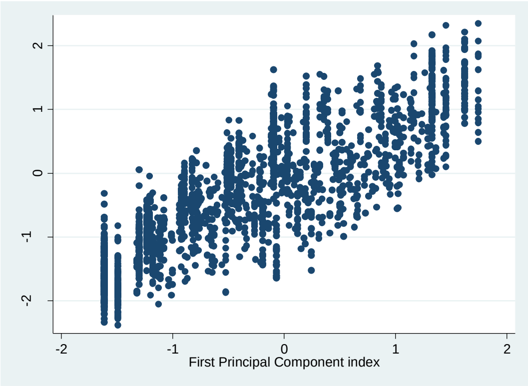

Figure 4a

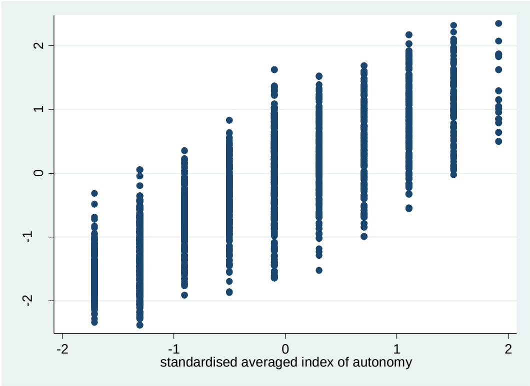

Figure 4b

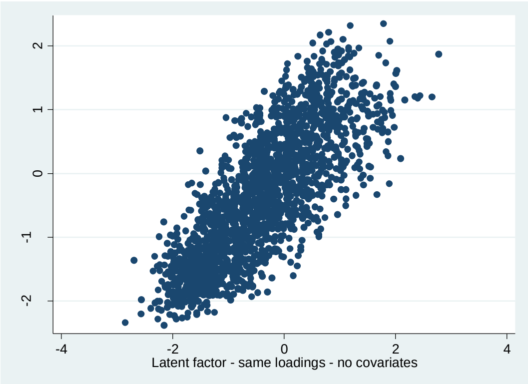

Figure 4c

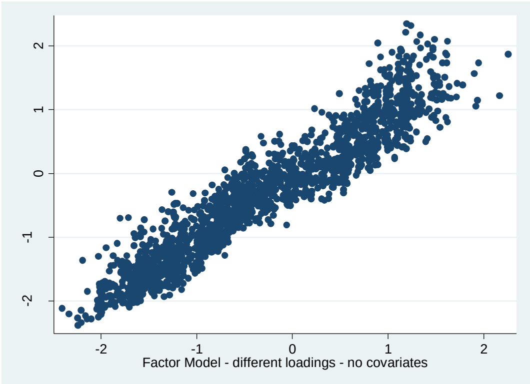

Figure 4d

Notes: Our measure of autonomy is plotted against:

i. Figure 4a: the first principal component – Model 2;

ii. Figure 4b: based on a simple average of the measures – Model 3;

iii. Figure 4c: measure created using a latent factor model without any covariates and with the same loadings – Model 4a;

iv. Figure 4d: measure created using a latent factor model without any covariates but with different loadings – Model 4b.

Table 1– Descriptive Statistics (mean (S.D))

Panel 1: measurements used in the construction of the autonomy index	
Woman is allowed to go to the:	
market alone (m1)	0.48
health facility alone (m2)	0.45
places outside the community alone (m3)	0.36
Woman has the final say alone on purchases for daily needs (m4)	0.29
Woman has the final say together on: own health care (m5)	0.61
large household purchases (m6)	0.50
visiting family and friends (m7)	0.58
what to do with husband's money (m8)	0.62
Woman has money for her own use (m9)	0.36
Average Score (Std Dev)	4.24 (2.48)
Mean of the Average Scores	0.47
Median of the Average Scores	0.44
Panel 2: variables only in the autonomy eq (3) - *s*	
Partner's age-woman's age (binary indicators)	
Base: Age difference between the woman and her partner < 3 years	0.12
Age difference between the woman and her partner 3-5 years	0.47
Age difference between the woman and her partner 6-10 years	0.30
Age difference between the woman and her partner > 10 years	0.11
Panel 4: variables only in the nutrition equation – *z*	
Child covariates	
Girl	0.48
Age in months	30.2 (17.0)
Part of a multiple birth	0.01
Birth Order 1	0.27
2	0.26
3	0.18
4	0.11
5 or more	0.18
Preceding birth interval	
< 18 months	0.08
18-24 months	0.15
25-36 months	0.51
>36 months	0.27

Table 1– Descriptive Statistics (mean (S.D)) Continued

Panel 5: nutrition equation dependent variables	
HAZ – Height for Age Z scores	-1.86 (1.66)
Binary Indicators	
Stunted (HAZ<-2)	0.48
Wasted (WHZ<-2)	0.19
Stunted but not wasted	0.39
Not stunted but wasted	0.11
Neither stunted nor wasted	0.41
Stunted and wasted	0.09
Number of mothers	17,749
Number of Children	23,878
Proportion of Mothers with one child in the sample	0.59
Mother has experienced at least one Child death	0.06

Notes: (i) Sample is the women who had children who were less than 5 years old at the survey time and thus contributed to the 'nutrition' analyses. See text for further details; (ii) The nutritional status variable definitions are based on the World Health Organisation standards; (iii) All variables are binary except when a SD is indicated in parenthesis.

Table 2
Frequency distribution of the sum of the measurements (m1-m9) used in the construction of the autonomy index

Sum	# of women	%	Cumulative %
0	1,454	8.2	8.2
1	1,729	9.7	17.9
2	1,589	9.0	26.9
3	1,976	11.1	38.0
4	2,800	15.8	53.8
5	2,355	13.3	67.1
6	1,784	10.1	77.1
7	2,103	11.9	89.0
8	1,564	8.8	97.8
9	395	2.2	100.0

Notes: (i) See Table 1 for the definitions of the measurements; (ii) Number of women in the rural sample=17,749; (iii) Sample average of the score is 4.2.

Table 3 – Sample Characteristics

	PANEL [1]: Number of Mothers Contributing							
Number of children	1	2	3	4				Total (#)
% of mothers	63.9	32.1	3.9	0.12				15,669
	PANEL [2]: Distribution of Birth Order							
	1	2	3	4	5	6	7 or more	Total
Girls (col %)	49.4	48.2	46.5	48.4	47.8	49.4	46.7	48.2
Boys (col %)	50.6	51.9	53.5	51.6	52.2	50.7	53.3	51.8
Total (number)	6,434	6,312	4,219	2,682	1,758	1,078	1,395	23,878
Total %	26.9	26.4	17.7	11.2	7.4	4.5	5.8	100
	PANEL [3]: % of FIRST-BORNS with SECOND-BORN in the sample by Year of Birth of First-Born							
	2001	2002	2003	2004	2005	Overall		Total (#)
%	70.4	62.6	43.5	14.6	0.9	34.2		2,199
	PANEL [4]: Age in Months of FIRST-BORNS at the time of the interview							
	0-15	16-17	18-23	24+				Total(#)
%	26.4	3.8	10.2	59.7				6,434
	PANEL [5]: Age in Months of LAST-BORNS at the time of the interview							
	0-15	16-17	18-23	24+				Total (#)
%	31.0	4.4	11.6	53.0				16,026
	PANEL [6]: Age in Months of FIRST-BORNS who is also the LAST-BORN at the time of the interview							
	0-15	16-17	18-23	24+				Total (#)
%	40.2	5.4	14.0	40.4				4,202
	PANEL [7]: Age in Months of FIRST-BORNS with birth-year>2003 at the time of the interview							
	0-15	16-17	18-23	24+				Total (#)
%	57.2	8.1	22.2	12.5				2,964

Table 4 – HAZ & ‘Stunted’ regressions - Coefficient Estimate (std error)

VARIABLES	HAZ	‘STUNTING’	HAZ	‘STUNTING’
	[1]	[2]	[3]	[4]
PANEL [1]	ALL BIRTH-ORDER AGE 0-59 months		FIRST-BORNS AGE 0-59 months	
Autonomy	0.038**	-0.015**	0.046*	-0.012
	(0.015)	(0.004)	(0.025)	(0.008)
Constant	-0.953***	0.254***	-1.469***	0.446***
	(0.086)	(0.026)	(0.173)	(0.052)
R-squared	0.170	0.129	0.181	0.142
Number of Children	23,788	23,788	6,413	6,413
PANEL [2]	FIRST-BORNS AGE<15 months		FIRST-BORNS AGE<18 months	
Autonomy	0.146**	-0.029*	0.161***	-0.032**
	(0.061)	(0.015)	(0.051)	(0.014)
Constant	-1.218***	0.325***	-1.441***	0.382***
	(0.377)	(0.098)	(0.364)	(0.088)
R-squared	0.139	0.133	0.176	0.157
Number of Children	1,571	1,571	1,931	1,931
PANEL [3]	FIRST-BORNS Birth Year >2003		FIRST-BORNS Birth Year >2004	
Autonomy	0.108***	-0.035***	0.162***	-0.033**
	(0.041)	(0.011)	(0.055)	(0.015)
Constant	-1.248***	0.376***	-1.109***	0.299***
	(0.265)	(0.077)	(0.393)	(0.093)
R-squared	0.195	0.169	0.151	0.133
Number of Children	2,956	2,956	1,640	1,640
PANEL [4]	LAST-BORNS AGE<15 months		LAST- BORNS AGE<18 months	
Autonomy	0.097***	-0.028***	0.093***	-0.029***
	(0.034)	(0.009)	(0.033)	(0.008)
Constant	-0.543**	0.143***	-0.741***	0.210***
	(0.208)	(0.051)	(0.184)	(0.049)
R-squared	0.122	0.098	0.150	0.126
Number of Children	4,594	4,594	5,668	5,668
PANEL [5]	LAST-BORNS AGE 0-59 months		LAST- BORNS Birth Year >2004	
Autonomy	0.053***	-0.020***	0.110***	-0.031***
	(0.016)	(0.005)	(0.033)	(0.009)
Constant	-0.882***	0.224***	-0.500***	0.169**
	(0.101)	(0.029)	(0.208)	(0.053)
R-squared	0.180	0.138	0.129	0.105
Number of Children	15,963	15,963	4,785	4,785

Notes: (i)The regressions contain the variables listed in Appendix Table A2; (ii) age dummies (0-5 (base), 6-11, 12-17, 18-23, 24+) as well as birth order dummies were included where appropriate; (iii) Bootstrapped standard errors (allows for clustering at the district level with 500 replications) in parentheses.

Table 5 – Estimates of Equation (1): First-born rural children aged<18 months

	HAZ	'Stunted' [binary]
Maternal Autonomy –z score	0.161***	-0.032**
	(0.051)	(0.014)
<u>Child Characteristics</u>		
Age in months – binary – (base <6 months) 6-11	-0.318***	0.058**
	(0.100)	(0.025)
12-17	-1.032***	0.237***
	(0.099)	(0.027)
Girl	0.178**	-0.039**
	(0.071)	(0.019)
Part of multiple birth	-2.392***	0.630***
	(0.442)	(0.162)
R-squared	0.176	0.157
Sample average of the dependent variable (SD)	-1.15	0.31
	(1.72)	
Number of Children	17.749	11,187

Notes: (i) ***, **, * p-value<0.01, 0.05 and 0.10 respectively. (ii) All the estimates are in online Appendix Table A2; (iii) Bootstrapped standard errors (allows for clustering at the district level with 500 replications) in parentheses.

Table 6 –Nutritional Status: HAZ scores –sample of first born aged less than 18 months

Coefficient estimate (std error)

		Variables				
Model		Autonomy		Intercept		R sq
1	Factor Model with Covariates	0.161***	(0.051)	-1.441***	(0.364)	0.176
2	First Principal Component	0.113**	(0.043)	-1.541***	(0.342)	0.174
3	Simple Average	0.105**	(0.043)	-1.563***	(0.340)	0.174
4A	Factor Model with Same Factor Loading and No Adjustment for Covariates	0.093**	(0.039)	-1.586***	(0.336)	0.174
4B	Factor Model with Different Factor Loading and No adjustment for Covariates	0.119***	(0.041)	-1.567***	(0.338)	0.175
5	All measurements entered separately					
	m1: Woman is allowed to go to the market alone	0.183	(0.130)	-1.685***	(0.346)	0.178
	m2: Woman is allowed to go to the health facility alone	-0.200	(0.139)			
	m3: Woman is allowed to go to places outside the community alone	0.103	(0.114)			
	m4: Woman has the final say alone on purchases for daily needs	0.065	(0.108)			
	m5: Woman has the final say together on own health care	0.037	(0.088)			
	m6: Woman has the final say together large household purchases	0.061	(0.100)			
	m7: Woman has the final say together visiting family and friends	0.207**	(0.094)			

Table 6 - continued

	Autonomy		Intercept		R sq
	Coeff. Estimates	Std. Errors	Coeff. Estimates	Std. Errors	
m8: Woman has the final say together on what to do with husband's money	-0.025	(0.084)			
m9: Woman has money for her own use	-0.107	(0.088)			

Notes: (i) Bootstrapped standard errors (allows for clustering at the district level with 500 replications) in parentheses; (ii) *** p<0.01, ** p<0.05, * p<0.1; (iii) The dependent variable used is the Height-for-Age Z-scores (HAZ) defined according to the World Health Organisation (iv) Model 1 is our preferred one – see Table 5 Panel [2]; (v)All autonomy measures have been standardised to have 0 mean and unit variance.

End notes

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[1] The questions we use to construct our measure of autonomy, are routinely collected in Demographic Health Surveys and the NFHS is part of this survey series.

[2] The Z scores are the number of standard deviations above or below a set of standard deviation-derived growth reference curves by the Centre for Disease Control obtained from a reference population from the U. S. National Centre for Health Statistics, as recommended by the WHO (2006). The recommendations are based on evidence that differences in “unconstrained growth” across children of different ethnic and racial background, socioeconomic status and feeding, are so minor for children under 5 years of age that it is appropriate to use a common reference.

[3] Children who are less than two standard deviations below the median are classified as: stunted (HAZ score less than -2), wasted (WHZ score less than -2) and/or underweight (WAZ score less than -2). Each index provides different information about the growth of a child. The HAZ score provides information about long-term nutritional status; it does not vary according to recent dietary intake. The WHZ score is an indicator of current nutritional status; a low WHZ score can indicate recent inadequate food intake, or a recent episode of illness. The WAZ score, which reflects body mass relative to chronological age, is a composite indicator.

[4] Some but not all of the questions that are used by Jensen and Oster (2009) are similar to the ones we use in this study although the surveys are different.

[5] This is similar to the literature which assumes test scores measure unobserved ability (see for example, Heckman et al. (2006)).

[6] The details of the field survey can be obtained from the authors.

[7] The data we use is part of the Demographic Health Survey series. The series collects nutritional information on children born with 3 to 5 years of the survey and this is the sample that is routinely used by researchers.

[8] For example, Hu and Schlosser (2015) present some indirect evidence of possible pre-natal sex selection in India.

[9] Barcellos et al (2014) use the first round (1992) of the same data source to look at the effect of child sex on parental investments. This round was used to avoid the issues related to sex selective abortions. Since it is assumed that there is no prenatal sex selection in the early '90s, their concern was regarding families possibly following a male-biased stopping rule. They address this by selecting a sample of last children aged less than 15 months at the time of the interview, assuming that the family has not had time to react to the sex composition of the existing children. For comparison with this set of results, we also provide estimates based on the sample of last-borns.

[10] Since we did not find significant effects of autonomy on nutritional status of urban children, we focus on the results for the rural households. The urban household results are available from the authors.

[11] The autonomy index is normalised to have 0 mean and variance of 1.

[12] For other definitions, see for example Caldwell (1986) who defines opportunities for women to receive an education and work outside the home to proxy autonomy, while Mason (1986) uses control over household and societal resources to the same purpose.

[13] Further details of the surveys are available from the authors.

[14] See Arulampalam, et al (2015) for a discussion on the choice of measurements used for constructing this index. In that paper, we experimented with many more measurements and found the additional measures did not significantly add to the estimation of the

autonomy index. The ranking of mothers in terms of their estimated autonomy status did not change with the addition of other measures.

[15] This is equivalent to Mundlak's (1978) correction used in correlated random effects models.

[16]This is the Bayesian shrinkage estimator, see Goldstein (2003), which can be used for estimating unobserved individual specific heterogeneity(Train, 2009: Chapter 11). Simply put, this estimator is $E\left(a \mid m_1,\dots,m_9\right)=\int a\, f(a \mid m_1,\dots,m_9)da=\frac{\int a\, f(m_1,\dots,m_9 \mid a)\, f(a)da}{f(m_1,\dots,m_9)}$.

[17] We also allow for clustering at the district level, but do not explicitly show this to keep the discussion and notation simple.

[18] In contrast to our approach, Autonomy is treated as an observable variable in Jensen and Oster (2009). The authors' definition of 'autonomy' is the average of answers given to six questions/measurements with some overlap with the measures we have used although the conversions into binary indicators differ somewhat from ours. All answers are equally weighted in the construction of the index. Also see the replication study by Iversen and Palmer-Jones (2014) and the response by Jensen and Oster (2014). We also explore the effect of using this average measure.

[19] We chose to normalise on this factor loading since we expect autonomy to have a non-zero effect on this measurement.

[20] Detailed discussion about the other methods of capturing "autonomy", the ranking of mothers under different methods and the estimated effects of autonomy on nutritional status for our preferred specification, can be obtained from the authors.

[21] The survey collected information on what the ideal number of boys and girls the woman would like to have. We created a binary indicator for women who stated that they preferred a higher number of boys than girls. We do not report results with this variable

included because of the possibility of this variable being highly correlated to the number of children already in the family and their sex composition.

[22] The results for the other nutritional status measures (WHZ, 'wasted') and also all results for the urban samples are available on request from the authors. These are not reported due to the insignificant effect of autonomy on child nutrition.

[23] Note bivariate correlation between the ranks would not be informative since many mothers will have the same score under some of the measures. For example, the index created using an average of our binary measurements is discrete.

[24] Dancer and Rammohan (2009) and Imai, et al. (2014) are examples that take this approach.