WOMEN’S EMPOWERMENT AND CHILD MALNUTRITION: THE CASE OF MOZAMBIQUE

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Abstract
Using data from the 2011 Demographic and Health Survey in Mozambique this paper checks whether women empowerment has an impact on the nutritional status of children. We evaluate the degree of empowerment of women via multidimensional approaches, making a distinction between five domains: decision making, use of violence by husband/partner, attitude of the woman towards this use of violence, available information, material resources. Each domain includes several questions reflecting different aspects of empowerment. For each domain of empowerment, three different methods of aggregation are used: correspondence analysis, the so-called Alkire and Foster methodology and the “fuzzy sets” approach. The impact of women empowerment on the nutritional status of children is analyzed via the MIMIC approach. No clear-cut conclusion concerning the possible impact of women's empowerment on the nutritional status of children could be drawn. But, ceteris paribus, the material wealth of the household, the educational level of the mother and her BMI are positively correlated with the nutritional status of children which is also higher when the child is female. Finally, there are important differences in the nutritional status of children between the various regions of Mozambique and this nutritional status is in most regions lower in rural areas.

JEL Classification: D13, I15, J16, O15, O55
Keywords: Alkire and Foster approach, correspondence analysis, demographic and health Survey, “fuzzy sets” approach, health, MIMIC approach, Mozambique, women empowerment

1. INTRODUCTION

One of the most robust features of economic development is that in countries with higher income, lifespans are longer, infant mortality lower and illness reduced throughout the life...
course (Deaton, 2013). Similar conclusions seem to hold within countries. As argued by Wilkinson (2000), death rates are two to three times higher among people at the bottom than at the top of the social hierarchy. Wilkinson adds that such differences may be larger in some countries than in others but they are found wherever data are available, and it does not matter whether people are ranked by education, income, occupation, or living area.

One of the main determinants of illness turns out to be malnutrition. Malnutrition, severe or otherwise, is estimated to be a contributing factor in over 50% of child deaths (Prudhon et al., 2006). Müller and Krawinkel (2005) also argue that malnutrition “is globally the most important risk factor for illness and death, with hundreds of millions of pregnant women and young children particularly affected.” Malnutrition can refer to a deficiency in macronutrients (protein, carbohydrates and fat) causing thus protein–energy malnutrition, but there exists also malnutrition in micronutrients (electrolytes, minerals and vitamins).

Among children, protein–energy malnutrition occurs when a child suffers of under-weight (weight falling below two standard deviations under the normal weight for age), stunting (height falling below two standard deviations under the normal height for age) and/or wasting (weight for height falling below two standard deviations under the normal weight for height). While wasting is a sign of recent weight loss, stunting is the consequence of chronic weight loss. These anthropometric measures are hence indicators of malnutrition.

Smith and Haddad (2000), in a cross-country analysis covering the 1970–1995 period, stressed four underlying determinants of child malnutrition: health environment, women’s education, women’s relative status (measured via the ratio of female to male life expectancy at birth) and per capita food availability.

While education may be considered as an element of women empowerment, the latter includes other aspects. Among these other features of women empowerment are the extent of a woman’s decision making within the household, the absence of violence experienced by the woman as well as her attitude towards this kind of violence, the amount of material resources that the household enjoys, and the extent of the information available to the woman.

The purpose of this paper is precisely to look at the link that may exist between these other components of women empowerment and the health status of children, measured via two anthropometric indicators, the height for age percentile, a variable referring to stunting and the weight for age percentile, a variable referring to wasting. Since the nutritional status of a child is not really observed and is in fact a latent variable, we use a MIMIC model (see Section 3 and Appendix B, for more details on this technique) where the two anthropometric indicators that have just been mentioned are considered as observed measures of the latent variable representing the nutritional status of the child.

The paper contributes in different ways to the literature that examined the link between women empowerment and children’s nutritional status. First, as mentioned previously, it takes into account several domains of women empowerment and looks at their specific relationship with the two anthropometric indicators of child malnutrition that we use. Second, for each of the five domains of women empowerment taken into account, we construct an aggregate variable derived from the answers to the specific questions asked for each domain, and implement several techniques of aggregation of variables (see Section 3 and Appendix B for more details on these techniques). Finally,
we examine the relationship between women empowerment and child malnutrition indicators in Mozambique, a country where this issue has not yet been examined. Moreover, Mozambique is a particularly interesting case study because child mortality fell from about 250 deaths per 1000 live births in the late 1980s to 71.3 deaths per 1000 live births in 2016, a drastic reduction in child mortality indeed. This decrease in mortality was certainly related to the end of the civil war that was fought from 1977 to 1992.

The paper is organised as follows. In Section 2, we review the literature examining the relationship between women empowerment and children’s health-related outcomes. We first mention studies where changes in women empowerment related to individual choices had been neutralised thanks to some natural experiment. But we also review studies where such a “neutralization” was not possible so that the link between women empowerment and children’s health status cannot be given a causal interpretation. In Section 3, we describe the data sources and explain succinctly, more details being given in Appendix B, the various techniques we used to aggregate the variables that were available for each domain of women empowerment. In Section 4, we describe the main aspects of the MIMIC model while Section 5 presents the results of our empirical investigation, based on the MIMIC model. Section 6 briefly concludes.

The main findings of our investigation are as follows. When looking at the whole sample, no clear-cut conclusion could be drawn concerning the possible impact of women’s empowerment on the nutritional status of children. However, when limiting the analysis to male-headed households, the extent of a woman’s decision making as well as a negative attitude towards her husband’s or partner’s violence, had often a positive impact on the (latent) nutritional status of her children. The material wealth of the household, the educational level of the mother and her BMI (body mass index) were, ceteris paribus, positively correlated with the nutritional status of children. The latter was also generally higher when the child was female. Finally, there were important differences in the nutritional status of children between the various regions of Mozambique and this nutritional status was in most regions lower in rural areas.

2. ON WOMEN EMPOWERMENT AND CHILDREN’S HEALTH-RELATED OUTCOMES

The relationship between women empowerment and family outcomes, such as child health, was discussed, quite at length, by Duflo (2012). Concerning the fact that the health of children is more correlated with the education of mothers than with that of fathers, Duflo (2012) stresses that such a difference raises two important issues. On the one hand a woman’s education is likely to be correlated with “unobserved dimensions of her ability, family or community background” so that if these factors have a direct impact on the health of children, the correlation between women’s education and children’s health is not a causal relationship. Moreover, as emphasised by Duflo (2012), when comparing the coefficients of husbands’ and wives’ education, one should not forget that there is probably a correlation between the education of wives and unobserved characteristics of their husbands. First more educated women “may be able to marry men who care more about their children” (Duflo, 2012). Second if a husband is “progressive enough to allow his wife to seek employment, then this same progressive attitude may make him treat his children better” (Duflo, 2012).
To investigate the relationship between women’s education, and more generally empowerment, and children’s health, researchers need therefore to exploit circumstances “where the distribution of power, education or earnings of women and men changed for reasons that had nothing to do with their individual choices” (Duflo, 2012).

Duflo (2003), for example, examined the effect of the expansion for the black population of the benefits and coverage of the South African social pension programme. She concluded that pensions received by women had a larger impact on the anthropometric indicators (weight for height and height for age) of girls but a small influence on those of boys. She also noted that such an impact was not observed for pensions received by men.

Breierova and Duflo (2004) took advantage of the fact that there was a massive expansion in the construction of schools in Indonesia in the 1970s and thus could analyse schooling differences between husbands and wives that depended only on their region and dates of birth. These authors then concluded that, given the average education level of households, there are fewer children, but not necessarily a lower infant mortality, when the women is more educated.

Chou et al. (2010) used a similar approach when they investigated the specific impact of father and mother education on the health of children in Taiwan, a country where compulsory junior secondary education was introduced progressively in different regions. They concluded that there indeed was a positive impact of fathers’ and mothers’ education on child survival, but no differential effect between the genders.

It is, however, not easy to disentangle the impact of exogenous changes on children’s health from that of individual choices, mainly because natural experiments that would allow such a distinction are not so common. In the absence of such natural experiments, one has to be careful in examining the role of women’s education and empowerment on the health of children and if such a link is observed, one can only talk about a correlation and not about a causal relationship.

Thomas (1990), for example, used data on family health and nutrition in Brazil to examine the distribution of assets and income within a household. He concluded that unearned income in the hands of the mother had a bigger effect on family health indicators than income attributed to the father. Thomas (1990) also examined whether there were differences between fathers and mothers in the amount of resources devoted to sons and daughters. He concluded that mothers devote more resources to improving the height and weight of their daughters while the contrary is true for fathers. But the impact of the income of mothers on both sons’ and daughters’ anthropometric outcomes is stronger than that of the income of fathers.

Thomas (1993) looked at the distribution of income and expenditures within Brazilian households. He concluded that, whether we refer to non-labour income (assumed to be exogenous) or to total income, “income in the hands of women is associated with a larger increase in the share of the household budget devoted to human capital (household services, health and education) and leisure (recreation and ceremonies) goods.”

Thomas et al. (1999) focus their attention on the value of resources that husbands and wives bring to the marriage. They assume that “relative asset positions at the time of marriage are an indicator of economic independence within marriage and are thus an important source of power.” They then examined the respective effect of a husband’s

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1 We thank an anonymous referee for stressing this point.
and a wife’s assets on the health of children. The authors used data from the Indonesian Family Life Survey that has information on the resources brought by husband and wife to the marriage as well as indicators of power within the household. Controlling for household income, the authors examine the effect of maternal and paternal assets at marriage on “whether children experience coughs, fevers, diarrhoea or other symptoms in the month prior to the interview.” They then concluded that “mothers who are more powerful allocate resources towards goods and services that they value differently from their husbands and that is reflected in their sons having fewer episodes of illness (of cough and fever) than their daughters.”

Lépine and Strobl (2013) looked at the impact of women’s bargaining power on child nutritional status using data from rural Senegal. They concluded that while standard ordinary least square (OLS) suggests that if a mother has more bargaining power, her children will have better nutritional status, their Instrumental Variables estimates indicate that the true impact is underestimated if the endogeneity of bargaining power is not taken into account.

In their study of women’s empowerment and childhood malnutrition in Timor-Leste, Scantlan and Previdelli (2013) could not conclude that the association between women’s empowerment and childhood malnutrition is causal. They found a positive relationship for two of the empowerment measures, attitudes towards violence and experiences of violence, but the strength of the association was quite small.

In a study, covering 19 countries, of the nutritional returns to parental education, Alderman and Headey (2014) concluded that maternal education yields larger returns than paternal education, although for both sexes positive returns generally only appear with secondary education.

Malapit and Quisumbing (2014) checked what dimensions of women’s empowerment in agriculture matter for nutrition-related practices and outcomes in Ghana. Using the Women’s Empowerment in Agriculture Index, they concluded that women’s empowerment is more strongly associated with infant and young child feeding practices and only weakly associated with child nutrition status.

Ziaei et al. (2014) investigated the association between women’s exposure to intimate partner violence and their children’s nutritional status, using data from the 2007 Bangladesh Demographic and Health Survey. They concluded that women were more likely to have a stunted child if they had lifetime experience of physical intimate partner violence.

Cunningham et al. (2015), using a survey of women’s empowerment and child nutritional status in South Asia, made a distinction between three domains of empowerment: control of resources and autonomy, workload and time, and social support. These authors concluded that women’s empowerment tends to be associated with child anthropometry.

Yimer and Tadesse (2015) believe that maternal and children’s dietary diversity depend on the circumstances of the household but also on the status of women. Their argument is that the extent to which women have access to and control over resources largely determines the kind of care they provide for their children and for the rest of the household. Using Ethiopian household survey data from 2013, they concluded that there is a positive correlation between women’s empowerment indicators and better dietary diversity for both children and women.

Malapit et al. (2015) analyse the 2012 Bangladesh Integrated Household Survey and provide empirical evidence on the relationship between empowerment gaps between men.
and women in the same household and children’s well-being. They estimated relative empowerment using the Women’s Empowerment in Agriculture Index (see Alkire et al., 2013). They concluded that increasing women’s decision making over credit and assets was associated with improvements in girls’ nutritional status, while increasing women’s life satisfaction and participation in groups was associated with improvements in boys’ nutritional status.

Zereyesus et al. (2017) examined the association between the Women’s Empowerment in Agriculture Index (see, Alkire et al., 2013) and children’s health status, measured via height-for-age and weight-for-height z-scores, in Northern Ghana. Using the MIMIC approach, they concluded that neither the composite empowerment score measuring women’s empowerment in agriculture nor its decomposed components were statistically significant in their association with the latent children’s health status. However, the associations between children’s health status and variables such as mother’s education, child’s age, and area of residence were statistically significant.

3. THE DATA SOURCES AND VARIABLES

Our database is the Demographic and Health Survey for Mozambique of the year 2011. Demographic and Health Surveys (DHS) are nationally representative household surveys. They provide data for a wide range of information in the domains of population, health and nutrition. A standard DHS Survey has a large sample size (between 5,000 and 30,000 households). Usually it is conducted about every five years. It covers a wide range of topics such as household and respondent characteristics, child health, domestic violence, education, family planning, infant, child and maternal mortality, nutrition, wealth and women empowerment.

The 2011 DHS in Mozambique (for more details on this survey, see, Moçambique, 2013) included several parts with questions specific to households, the individuals, the children. The analysis in the present paper used the file including information focusing mainly on the children. The sample in this file included more than 11,000 observations. However, taking into account the fact that for many variables used in our analysis, there were missing answers, we ended up with a sample size of 4,399. A footnote in Table 1 compares the means of the variables of the original sample and the one we ended up working with. When analysing Table 1, we will discuss differences between the two samples in the means of some socio-economic characteristics.

As no direct health measure was available, we used two anthropometric outcomes, the height for age percentile, a variable referring to stunting and the weight for age percentile, a variable referring to wasting. These two variables are rather measures of nutrition. However, as mentioned previously, malnutrition is the most important risk factor for illness and death, so that these two anthropometric indicators are, in a way, indirect measures of the health of children.

We assume that evaluating the degree of empowerment of women requires taking a multidimensional approach to the measurement of these variables. The issue of choosing between a multidimensional measure of empowerment and a series of empowerment indicators is in fact similar to that concerning the choice between a multidimensional poverty measure and what Ravallion (2011) called a “dashboard” approach. As stressed by Ravallion in the context of poverty, two questions need to be asked. First can a single
Table 1. Mean and Standard Deviation of the variables in the survey (DHS of Mozambique, 2011) that have been used in the empirical analysis: whole sample, male-headed and female-headed households

| Variable                                      | Whole sample, means | Male-headed households, means | Female-headed households, means |
|-----------------------------------------------|---------------------|------------------------------|---------------------------------|
| z-value of Height/Age                         | -1.44               | -1.440                       | -1.435                          |
| z-value of Weight/Age                         | -0.94               | -0.947                       | -0.909                          |
| Education of mother                           | 0.119               | 0.114                        | 0.136                           |
| Residing in urban area                        | 0.280               | 0.280                        | 0.280                           |
| Age of mother                                 | 28.705              | 28.744                       | 28.565                          |
| Square of age of mother                       | 871.768             | 874.189                      | 862.883                         |
| B.M.I. of mother (centigrams per square meter)| 2238.521            | 2238.340                     | 2239.188                        |
| Female child                                  | 0.496               | 0.495                        | 0.500                           |
| Person who usually decides on respondent's health care | 0.219            | 0.184                        | 0.349                           |
| Person who usually decides on large household purchases | 0.123             | 0.100                        | 0.206                           |
| Person who usually decides on visits to family or relatives | 0.151            | 0.124                        | 0.251                           |
| Person usually deciding about what to do with money husband earns | 0.101            | 0.078                        | 0.186                           |
| Never humiliated by husband                   | 0.831               | 0.832                        | 0.827                           |
| Never been insulted by husband                | 0.710               | 0.710                        | 0.709                           |
| Never had forced unwanted sex                 | 0.932               | 0.936                        | 0.917                           |
| Never had forced other unwanted sexual acts   | 0.946               | 0.949                        | 0.936                           |
| Does not think beating justified if she goes out without the husband/®partner’s permission | 0.868            | 0.876                        | 0.839                           |
| Does not think beating justified if she neglects children | 0.916            | 0.921                        | 0.897                           |
| Does not think beating justified if she argues with husband | 0.844            | 0.846                        | 0.833                           |
| Does not think beating justified if she refuses having sex | 0.930            | 0.935                        | 0.912                           |
| Does not think beating justified if she burns food | 0.924            | 0.927                        | 0.914                           |
| Source of water on premises                   | 0.140               | 0.137                        | 0.149                           |
| Household has radio                           | 0.556               | 0.585                        | 0.448                           |
| Household has television                      | 0.195               | 0.184                        | 0.232                           |
| Household has refrigerator                    | 0.103               | 0.101                        | 0.108                           |
| Household has bicycle                          | 0.460               | 0.501                        | 0.309                           |
| Household has motorcycle/scooter               | 0.065               | 0.067                        | 0.058                           |
| Household has car/truck                       | 0.035               | 0.036                        | 0.032                           |
| Variable                                | Whole sample, means | Whole sample, standard deviations | Male-headed households, means | Male-headed households, standard deviations | Female-headed households, means | Female-headed households, standard deviations |
|-----------------------------------------|---------------------|-----------------------------------|------------------------------|---------------------------------------------|-------------------------------|---------------------------------------------|
| Main floor material                     | 0.0229              | 0.167                             | 0.031                        | 0.173                                       | 0.021                         | 0.144                                       |
| Main wall material                      | 0.214               | 0.410                             | 0.211                        | 0.408                                       | 0.224                         | 0.417                                       |
| Main roof material                      | 0.028               | 0.166                             | 0.029                        | 0.168                                       | 0.025                         | 0.158                                       |
| Type of cooking fuel                    | 0.027               | 0.163                             | 0.030                        | 0.172                                       | 0.016                         | 0.125                                       |
| Household has landline phone            | 0.094               | 0.064                             | 0.004                        | 0.061                                       | 0.005                         | 0.073                                       |
| Owns house alone or jointly             | 0.078               | 0.269                             | 0.069                        | 0.253                                       | 0.113                         | 0.316                                       |
| Owns land alone or jointly              | 0.079               | 0.269                             | 0.066                        | 0.248                                       | 0.125                         | 0.331                                       |
| Frequency reading newspaper/magazine    | 0.059               | 0.236                             | 0.059                        | 0.236                                       | 0.059                         | 0.236                                       |
| Frequency listening to radio            | 0.413               | 0.492                             | 0.439                        | 0.496                                       | 0.316                         | 0.465                                       |
| Frequency watching television           | 0.174               | 0.379                             | 0.176                        | 0.381                                       | 0.166                         | 0.372                                       |
| Regions                                 |                     |                                   |                              |                                             |                               |                                             |
| Niassa urban                            | 0.086               | 0.281                             | 0.101                        | 0.302                                       | 0.032                         | 0.176                                       |
| Niassa rural                            | 0.021               | 0.142                             | 0.017                        | 0.131                                       | 0.033                         | 0.178                                       |
| Cabo Delgado urban                      | 0.086               | 0.280                             | 0.080                        | 0.271                                       | 0.010                         | 0.312                                       |
| Cabo Delgado rural                      | 0.028               | 0.164                             | 0.028                        | 0.166                                       | 0.024                         | 0.154                                       |
| Nampula urban                           | 0.055               | 0.228                             | 0.061                        | 0.239                                       | 0.034                         | 0.181                                       |
| Nampula rural                           | 0.017               | 0.129                             | 0.017                        | 0.131                                       | 0.015                         | 0.121                                       |
| Zambezia urban                          | 0.118               | 0.322                             | 0.131                        | 0.337                                       | 0.069                         | 0.253                                       |
| Zambezia rural                          | 0.010               | 0.102                             | 0.012                        | 0.110                                       | 0.004                         | 0.065                                       |
| Tete urban                              | 0.095               | 0.293                             | 0.109                        | 0.312                                       | 0.044                         | 0.204                                       |
| Tete rural                              | 0.021               | 0.144                             | 0.023                        | 0.151                                       | 0.013                         | 0.112                                       |
| Manica urban                            | 0.074               | 0.262                             | 0.060                        | 0.237                                       | 0.128                         | 0.335                                       |
| Manica rural                            | 0.042               | 0.201                             | 0.043                        | 0.204                                       | 0.038                         | 0.192                                       |
| Sofala urban                            | 0.077               | 0.267                             | 0.079                        | 0.270                                       | 0.070                         | 0.255                                       |
| Sofala rural                            | 0.012               | 0.107                             | 0.009                        | 0.096                                       | 0.020                         | 0.141                                       |
| Inhambane urban                         | 0.058               | 0.233                             | 0.047                        | 0.213                                       | 0.096                         | 0.294                                       |
| Inhambane rural                         | 0.018               | 0.131                             | 0.011                        | 0.104                                       | 0.041                         | 0.199                                       |
| Gaza urban                              | 0.050               | 0.219                             | 0.031                        | 0.173                                       | 0.122                         | 0.327                                       |
| Gaza rural                              | 0.045               | 0.206                             | 0.045                        | 0.206                                       | 0.045                         | 0.206                                       |
| Maputo provincial urban                 | 0.020               | 0.140                             | 0.021                        | 0.144                                       | 0.016                         | 0.125                                       |
| Maputo provincial rural                 | 0.047               | 0.211                             | 0.048                        | 0.214                                       | 0.041                         | 0.199                                       |

Notes: Comparison between our whole sample and the original sample: There were no significant differences in the mean age of the mother (28.7 years in our sample, 28.4 in the original sample), in the mean BMI (2.239 in our sample, 2.250 in the original sample) and in the percentage of female children (0.496 in our sample, 0.495 in the original sample). There were somehow bigger differences in the educational level of the mother (in our sample 11.9% completed secondary or higher education but this percentage was 14.4% in the original sample). Similarly the percentage of individuals living in urban areas was 28% in our sample, 32.5% in the original sample. We would have in fact expected a lower percentage of educated mothers and of individuals living in urban areas not answering some of the questions, whereas the opposite seems to be true. We did not make any correction for these gaps but need obviously to be careful when drawing conclusions.

Size of samples: whole sample: 4,399; male-headed households: 3,457; female-headed households: 942.
index be a sufficient statistic, or are multiple indices required because each measures different things? Second, how should one “collapse” multiple dimensions into one, recognizing that some degree of aggregation will probably be called for, even in the ‘dashboard’ approach” (Ravallion, 2011).

We have somehow taken an intermediate approach because we made a distinction between several domains of women’s empowerment and aggregated the empowerment variables, separately for each domain. These domains are decision making, experienced violence, attitude of the woman towards this use of violence, material resources and available information. The aggregate variable “decision-making” was derived from questions relative to the person who usually decides on the health care of the respondent, on large household purchases, on visits to family or relatives and on what to do with the money husband earns. To derive the aggregate variable “experienced violence,” we looked at the answers of the woman to questions where she was asked whether she had ever been humiliated by her husband, been insulted by him, been forced to have unwanted sex or other unwanted sexual acts. As far as the aggregated variable “attitude of the woman towards this use of violence” is concerned, we derived it from questions on whether the woman thinks that beating is justified if she goes out without her husband’s/partner’s permission, neglects her children, argues with her husband, refuses having sex or burns food.

The aggregated variable “material resources” refers to assets available in the household and was derived from questions concerning the presence of a source of water on the premises, a radio, a television, a refrigerator, a bicycle, a motorcycle or scooter, a car or a truck, a land line telephone and from questions about the main material of the floor, the walls and the roof, the type of cooking fuel and about the ownership of a house and of land. Finally, the aggregated variable ‘available information’ was derived from answers to questions the woman was asked on the frequency at which she reads newspapers or magazines, listens to radio and watches television.

As far as the aggregation procedures are concerned, we can choose between two approaches. One possibility is to let the data determine the weights of the variables, when aggregating them in a given domain. This is what correspondence analysis, one of the aggregation method we adopted, does. Or we decide how to weight these variables, giving equal weights to all the variables within an empowerment domain or using another weighting procedure. This is what the so-called “fuzzy” approach does. The third aggregation technique we implemented is somehow a mixed one. On the one hand, we let the data decide which women will be classified as empowered, by defining a minimal number of variables for which the woman is a decision maker, such a threshold making the difference between the women who are empowered in the domain under scrutiny and those who are not. On the other hand, for the empowered women, we choose how to weight the variables, either by giving them the same weight or using another weighting procedure.

Another potentially serious issue is the fact that the answers to all the empowerment-related questions are self-reported, which might bias the measurement in certain ways. In a study of domestic violence and household decision making in East Africa, González-Brenes (2004) writes that although she does not rule out underreporting, there is no evidence of a major underestimation of spousal violence. She thus stresses that in Zambia, for example, there was no statistically significant difference in the percentage of married and widowed women reporting being victims of spousal violence at some point.
in the past. Separated and divorced women, however, reported rates of violence that were 9% higher than married and widowed women, a statistically significant difference. But González-Brenes (2004) argues that “it is reasonable to assume that the difference in prevalence reflects an increased likelihood for violent relationships to end up in divorce, rather than a sign of underreporting.” She nevertheless did not rule out the possibility that divorced women feel more comfortable speaking about violence perpetrated by their former husbands than women currently residing with their spouse.

Note also that some of the questions we included in the empowerment domains may not necessarily measure empowerment. For example, a question like "person who usually decides what to do with money husband earns" is about the management of money, and hence not necessarily reflect the empowerment of women. These are issues commonly faced when trying to rely on surveys where most of the answers are provided by the respondents rather than by the person in charge of the survey.²

To aggregate the variables included in each domain, we used three different techniques: correspondence analysis, the Alkire and Foster (2011) approach to multidimensional poverty measurement and the “fuzzy approach” to poverty measurement.

Correspondence analysis (CA) was originally introduced by Benzécri and Benzécri (1980). It is quite similar to principal components analysis (PCA) but while PCA assumes that the variables are quantitative, CA has been designed to deal with categorical variables. Moreover, while PCA is a statistical procedure revealing the internal structure of the data in a way that best explains the variance in the data, the goal of CA is to find scores for both the row and column categories on a small number of dimensions (axes) that will account for the greatest proportion of the \( \chi^2 \) measuring the association between the row and column categories. A clear presentation of CA is given in Volle (1985) as well as in Asselin (2009). While CA requires as input a table with only two dimensions, multiple correspondence analysis (MCA) is the extension of CA to the case where a table has more than two dimensions. More details on correspondence analysis are given in Appendix B, Section B-1.

The Alkire and Foster (2011) way of measuring multidimensional poverty has become extremely popular in recent years. This approach may, however, be also relevant for other domains of investigation. Let us assume, for example, that we have several questions aiming at checking whether, say, the woman is the person making decisions within the household. For such an illustration, Alkire and Foster (2011) would assume that for each question, several answers could be given (e.g. complete decision making, partial decision making, no decision making at all) and they therefore would define what they called a “double cutoff.” The first threshold indicates which answers on a given question could be considered as indicating decision making, while the second cut-off specifies the number of questions on decision making to which the woman would have to show decision making to be considered as a “decision making” person. Alkire and Foster then defined three indicators that in our case would be measures of the extent of decision making. The exact definition of these indices and more details on the Alkire and Foster approach are given in Appendix B, section B-2. Note that we have limited ourselves to dichotomous questions so that we need only to define the second cut-off.

² We thank an anonymous referee for drawing our attention to these two issues.

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The theory of “Fuzzy Sets” was developed by Zadeh (1965) on the basis of the idea that certain classes of objects may not be defined by very precise criteria of membership. In other words, there are cases where one is unable to determine which elements belong to a given set and which ones do not. Zadeh himself (1965) characterised a fuzzy set (class) as “a class with a continuum of grades of membership.” To the best of our knowledge, Cerioli and Zani (1990) were the first to apply the concept of fuzzy sets in economics and they used it to measure poverty. Additional illustrations of the application of the concept of multidimensional fuzzy poverty were then proposed by Cheli et al. (1994) and Cheli and Lemmi (1995). An interesting approach to multidimensional poverty measurement, related to the concept of fuzziness, was proposed by Rippin (2012, 2013, 2017). More details on the application of the theory of fuzzy sets to the aggregation of variables in a given domain of investigation (e.g. decision making), with special emphasis on the suggestions made by Rippin, are given in Appendix B, Section B-3.

Finally, note that when applying the Alkire and Foster as well as the fuzzy sets approaches, we examined also the case where not all the questions within a given domain had the same weight. We followed ideas suggested by Cerioli and Zani (1990) that may be summarised as follows. Assume we focus our attention on two aspects of a woman’s decision making: the management of the family budget and the responsibility for the health of children (like bringing one’s child to a physician). Assume that in the first case women generally are not allowed to manage the family budget while in the second case women generally are allowed to decide whether they should bring their child to the physician. Cerioli and Zani (1990) then argued that if a woman, in a given household, is not allowed to decide whether to bring her child to the physician as well as not allowed to manage the family budget, a greater weight will be given to the fact that she is not allowed to bring her child to the physician, because most women are allowed to do so. More details on such a weighting procedure are given in Appendix B, Section B-4.

4. THE MODEL

A theoretical framework attempting to analyse the determinants of health has to assume that health is an unobservable variable observed through a set of indicators. Factor analysis, MIMIC (multiple indicators and multiple causes) and structural equation models all apply this kind of reasoning. Principal components (PC) is not really a latent variable model. It is a method deriving linear combinations of the observed indicators in a way that best explains the variance in the data. But this method does not provide the reader with an underlying explanatory model. In factor analysis, on the contrary, there is a theoretical framework where the observed values (in our case measures of health) are assumed to be linear functions of unobserved latent variables called factors. Such a model, however, does not attempt to explain the latent variables. As stressed by Krishnakumar (2008) in the context of development, “it is not enough to be able to measure how much is achieved but it is also essential to be able to say how things can be improved.”

This is the main advantage of the MIMIC model that was introduced by Jöreskog and Goldberger (1975). Such a model takes into account the fact that the observed variables

3 For a thorough review of the fuzzy set approach to multidimensional poverty measurement, see, Lemmi and Betti (2006).

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are manifestations of a latent concept but it also introduces exogenous variables that affect the latent factor(s). One could go one step further and use what is called a structural equation model (SEM), one that includes not only several latent endogenous variables but also various exogenous determinants. To be satisfactory, such a model not only requires the presence in the database of many variables but it also compels the researcher to be able to make a distinction between endogenous and exogenous variables and to clearly define causality links. This is a very difficult task and in any case the database used in the present research did not really allow us implementing a SEM.

As mentioned previously, we assume that the nutritional status of the children is a latent variable. In our database (DHS), the only observed nutritional status-related variables are anthropometric outcomes, the height for age percentile, a variable referring to stunting, and the weight for age percentile, a variable referring to wasting. We link the nutritional status of the children to the following set of exogenous variables. The first one refers to each domain of women’s empowerment (decision making, experienced violence, attitude of the woman towards this use of violence, available information and material resources). Additional exogenous variables are the educational level of the mother, her age and its square, her body mass index (BMI), the gender of the child and the area of residence (region, and whether it is an urban or rural area). The MIMIC model allows for taking into account eventual measurement errors in the indicator variables.

The MIMIC model includes two types of equations, measurement and structural equations, that are expressed as

\[ y = \Lambda f + \epsilon \]  
\[ f = Bx + \zeta \]

where \( y, f \) and \( x \) refer, respectively, to the observed anthropometric indicators for the children variables, the latent nutritional status of the children variable and the determinants of this nutritional status. \( f \) is, therefore, a vector while \( \Lambda \) and \( B \) are matrices. More details on the MIMIC model are given in Appendix B, Section B-5, as well as in Jöreskog (1973), Jöreskog and Goldberger (1975), Krishnakumar (2008) and Ballon (2012).

5. EMPIRICAL RESULTS

Appendix A gives the list of variables introduced. We first made a distinction between the five domains of empowerment previously mentioned. Since for each domain, the number of variables was quite high, there was a need to find a procedure to aggregate the variables available for these domains. As stressed in Section 3, we implemented three different methods of aggregation of the variables, separately for each domain: correspondence analysis, the Alkire and Foster (2011) approach to multidimensional poverty measurement and the so-called “fuzzy sets” approach. Some of the results we present were derived by assuming that in each domain \( D \), each variable had the same weight \( 1/N_D \) where \( N_D \) refers to the number of variables in domain \( D \). But we also present result where the variables in a given domain have different weights, the weighting
procedure being that originally proposed by Cerioli and Zani (1990) and described in section 3 and in Appendix B, section B-4.

Let us first look at Table 1, which gives the means of the different variables. Let us first analyse the results concerning the whole sample, that is, both male- and female-headed households. We observe that only 11.9% of the women had a secondary or higher educational level and that 28% of the individuals lived in urban areas. Mothers were on average 28.7 years old and had a BMI\(^2\) of 22.4. The means of the z-values of the anthropometric indicators were, respectively, −1.44 and −0.94, indicating that the children in the sample were 1.44 standard deviations below the population mean of height by age and 0.94 standard deviations below the population mean of weight by age.

We also see that only 22% of the women are the usual decision makers concerning health care, the percentages of decision makers among women being even lower for visits to family or relatives (15.1%), for making large household purchases (12.3%) or for deciding what to do with the money the husband earns (10.1%). Table 1 also shows that 71% of the women affirm that their husband never insulted them. Table 1 also indicates that 83.1% of the women stated that their husband/partner never humiliated them, 93.2% that he never forced them in unwanted sex and 94.66% that he never forced in other unwanted sexual acts.

In another set of questions, women were asked in which circumstances beating by their husband/partner was justified. According to Table 1, 84.4% of the women do not think that beating is justified if they argue with their husband/partner. Table 1 also shows that a great majority of women does not believe that beating is justified if they go out without their husband/partner permission (86.8%), if they neglect children (91.6%) or if they burn food (92.4%).

As far as material resources are concerned, 14% of the individuals have water available on the premises, 10.3% have a refrigerator. Only for 2.3% of the individuals is the floor material made of wood plank, parquet or polished wood or tiles; for 2.8% of them the roof material is made of calamine, cement fibre, ceramic tiles or cement and for only 2.7% of the individuals the type of cooking fuel is electricity or natural gas. We also observe that 21.4% of the individuals live in places where the wall material is made of bricks or cement blocks and less than 8% of the individuals own alone or jointly a house (7.8%) or land (7.9%). Table 1 also shows that 46% of the individuals have a bicycle, 6.5% a motorcycle/scooter and 3.5% a car. While 41.3% of the individuals listen to radio, only 17.4% watch television and 5.9% read newspapers or magazines.

When looking separately at male- and female-headed households, we observe in Table 1 some difference between these two cases. Among female-headed households, there is a higher proportion of women making decisions concerning health care, large purchases, visits to relatives or use of the money earned by the husband, but these percentages are always smaller than 40%. It is also interesting to note that the percentage of households with a radio is smaller among female-headed households but the percentage

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4 A similar idea appeared already in Desai and Shah (1988).
5 The Body Mass Index (BMI) is the ratio of the body mass, expressed in kilograms, over the square of the body height, expressed in meters. The normal range of the BMI is from 18.5 to 25 kg/m\(^2\). There is underweight if the BMI is under 18.5 kg/m\(^2\). The range of overweight is from 25 to 30 while there is obesity if the BMI is over 30.
having a television is higher among female-headed households. Finally, bicycles and motorcycles are less frequent among female-headed households.

In Table 2, we present, for the whole sample, results concerning the five aggregated domains of women empowerment. We first present results derived from the Alkire and Foster (2011) approach and then those obtained when adopting the “fuzzy sets” approach. In each case, we use two weighting procedures: one giving the same weight to each question belonging to a given domain of women empowerment; the other based on the Cerioli and Zani (1990) weighting procedure that is summarised in Appendix B-4.

For the Alkire and Foster approach (see, Appendix B-2), we computed the headcount ratio $H$, the indicator $A$ and the index $M$. Assume that a certain number of questions are asked about the power of women to make decisions and that each possible answer is a dichotomous variable $d_i$, equal to 1 if the woman is a decision maker. Given some threshold $h$, a woman will be considered as “overall decision maker” if the (eventually weighted) average, over all questions, of the values of $d_i$ is higher than the threshold $h$. The headcount ratio $H$ will then be equal to the proportion of women defined as “overall decision makers.” Consider now only those women defined as “overall decision makers” and call $A$ the (eventually weighted) proportion of questions to which these women answered positively (were “decision makers” on the question). Finally, call $M$, the product of $H$ and $A$. $M$ is therefore equal to the ratio of the (eventually weighted) number of questions to which women defined as “overall decision makers” answered positively (were decision maker for this question) over the maximum number of questions to which all the women, whether “decision makers” or not, could have answered positively (could have been considered as decision makers on a question). In our empirical analysis, we took a threshold of 51% of the questions for each of the five domains of empowerment.

Table 2 then shows that 6.3% of the women are decision makers when an equal weight is given to each variable in this domain, but this percentage rises to 8.9% when adopting

| Variable                          | Decision making | Experienced violence | Attitude towards beating | Material wealth | Information |
|-----------------------------------|-----------------|----------------------|--------------------------|----------------|-------------|
| Headcount $H$ in AF Approach (threshold: 51%) |                 |                      |                          |                |             |
| equal weights in a given domain   | 0.063           | 0.844                | 0.930                    | 0.015          | 0.135       |
| Cerioli and Zani weighting procedure, for each domain | 0.089           | 0.710                | 0.910                    | 0.011          | 0.059       |
| Indicator $A$ in AF Approach (threshold: 51%) |                 |                      |                          |                |             |
| equal weights in a given domain   | 0.866           | 0.940                | 0.947                    | 0.625          | 0.736       |
| Cerioli and Zani procedure        | 0.766           | 0.975                | 0.947                    | 0.597          | 0.828       |
| Indicator $M$ in AF Approach (threshold: 51%) |                 |                      |                          |                |             |
| equal weights in a given domain   | 0.055           | 0.793                | 0.881                    | 0.009          | 0.099       |
| Cerioli and Zani procedure        | 0.068           | 0.692                | 0.862                    | 0.007          | 0.049       |
| Fuzzy Set Approach Mean (equal weights) |                 |                      |                          |                |             |
| $\beta = 0$                       | 0.148           | 0.855                | 0.896                    | 0.144          | 0.215       |
| $\beta = 0.5$                     | 0.108           | 0.815                | 0.871                    | 0.070          | 0.153       |
| $\beta = 1$                       | 0.084           | 0.784                | 0.852                    | 0.037          | 0.134       |
| $\beta = 1.5$                     | 0.068           | 0.760                | 0.836                    | 0.021          | 0.089       |
| Fuzzy Set Approach Mean (unequal weights) |                 |                      |                          |                |             |
| $\beta = 0$                       | 0.142           | 0.788                | 0.884                    | 0.079          | 0.153       |
| $\beta = 0.5$                     | 0.103           | 0.746                | 0.857                    | 0.034          | 0.102       |
| $\beta = 1$                       | 0.079           | 0.719                | 0.857                    | 0.017          | 0.075       |
| $\beta = 1.5$                     | 0.065           | 0.701                | 0.822                    | 0.010          | 0.060       |
the Cerioli and Zani weighting procedure. We also observe that 84.4% of the women did not experience violence and 93% believe that such violence is not justified, when an equal weight is given to the variables within each of these two domains, the percentages being lower (71% and 91%, respectively) with unequal weights. Given the much longer list of questions for material wealth we should not be surprised to observe that the head-count ratio \( H \) is very low (1.5% with equal weights and 1.1% with unequal weights). Finally, for the empowerment domain related to information, \( H \) is equal to 13.5% with equal weights but only to 5.9% with unequal weights.

Remembering that the indicator \( A \) gives, among the women considered as empowered in a given domain (e.g. those classified as decision makers), the percentage of the questions to which their answer indicates empowerment, we observe in Table 2 that \( A \) is high (above 85%), assuming equal weights, for decision making, absence of experience violence and non justification of beating. These percentages are quite similar with unequal weights, except for decision making where the percentage drops to 76.6%. But even for material wealth and information \( A \) is at least equal to 60%, whether we use equal or unequal weights.

Remembering that the index \( M \) is equal to the product of \( H \) and \( A \), we are not surprised to observe that \( M \) is high (equal to at least 0.69) for absence of violence and non justification of beating, whatever the weighting procedure, but low for decision making and information and extremely low for material wealth.

In Table 2, we present also results derived from the “fuzzy sets” procedure to aggregate variables. These results are given separately for the case where an equal weight is given to all the variables in a given domain and when unequal weights, derived from the Cerioli and Zani procedure, are used. Moreover, in each case, we give the results for different values of the parameter \( \beta \), which, as shown in Appendix B-3, gives information on the function linking the fuzzy estimation of the existence of empowerment in a given domain and the percentage of questions in this domain to which the woman indicated that she is empowered (for more details, see Appendix B-3).

As expected, the higher the value of the parameter \( \beta \), the lower the extent of empowerment in a given domain, the reason being that when \( \beta = 0 \), we have the perfect substitution case (e.g. for the domain of decision making, if a woman shows decision making in answering only one question, she is already defined as decision maker for the whole domain, whereas the higher \( \beta \), the higher the number of questions for which she will have to show decision making, to be considered as decision maker in the domain).

As expected, the extent of empowerment is much higher for the domains “absence of experienced violence” and “non justification of beating,” whatever the weighting procedure. For decision making, the results are very similar, for a given value of \( \beta \), whether we use equal or unequal weights, and the percentages are quite low (below 10% for \( \beta \) higher than or equal to 1). For material wealth, the percentages are also low (generally below 10%, especially when adopting unequal weights). Finally, for information, the percentages are higher than 10% when \( \beta \) is not higher than 1, but again lower when using unequal weights.

Let us now look at the results of the estimation of the MIMIC model that appear in Tables 3–11, depending on the approach adopted to aggregate the variables for each empowerment domain.”>
All these tables include dummy variables for the region and type of residence (urban vs. rural). We also included dummy variables\(^6\) for the clusters used by those who designed the survey but we do not show their coefficients in the tables.

In Table 3, which covers the whole sample, we present the results of the MIMIC model when no aggregation takes place and where we have included all the variables assumed to measure one aspect of empowerment, no matter what domain of empowerment they belong to. We observe that the latent nutrition variable is higher among mothers who have a higher level of education and a higher BMI. The latent variable reflecting the level of nutrition is also higher if the child is female. Only three of the many variables assumed to measure an aspect of empowerment are significant. We thus see that, ceteris paribus, the latent nutritional status is higher when the woman is the one who decides what to do with the money the husband earns and when she listens to radio. However, this latent nutritional status is lower when the woman is the one who makes the decision concerning health care, a somehow surprising result. Note also that not in all regions is the latent nutritional status lower in rural than in urban areas.

In Table 4, we present, for the whole sample, the results of the MIMIC model when the aggregation of the empowerment variables was implemented, separately for each empowerment domain, via correspondence analysis (see, Appendix B-1 for more details on this multivariate analysis). In the first two columns of Table 4, we ignore possible interactions. It then appears that the coefficients of two empowerment domains are positive: the attitude towards beating by the husband/partner and material wealth. In other words, there is, ceteris paribus, a positive correlation between the variable indicating that the woman considers that a husband/partner should not beat his wife and the latent variable reflecting the nutritional status of her children. Such a positive correlation is also observed, ceteris paribus, for the empowerment variable measuring the wealth of the household to which the woman belongs. Education and the body mass index of the mother have also, other things constant, a positive correlation with the nutritional status of the children. The other variables whose coefficients are significant are regional variables, each sub-region (urban and rural areas of a region) being compared with the city of Maputo. It also appears that in most rural areas, the latent variable measuring the nutritional status of children is lower, ceteris paribus, than in urban areas.

In columns 3 and 4 of Table 4, we added interactions between four aggregated empowerment variables (decision making, experienced violence, attitude towards beating and information) and wealth. It then appears that, as in the case without interactions, the aggregated variable “attitude towards beating” has a significant coefficient. As far as the interactions are concerned, only that between decision making and wealth has a significant coefficient, indicating that decision making and wealth are, ceteris paribus, positively correlated. The impact of the other variables was quite similar to that observed in columns 1 and 2.

\(^6\) See Abadie et al. (2017) for a thorough discussion of when one should adjust standard errors for clustering and of when one can simply use fixed effects.
Table 3. MIMIC approach when none of the explanatory variables is aggregated, with dummies for clusters, with the coefficients of the dummies not displayed in the table (whole sample: number of observations: 4,399)

| Variable                                           | Coefficient | P > z |
|----------------------------------------------------|-------------|-------|
| **Structural equation**                            |             |       |
| Decides on health care                             | -12.85      | 0.003 |
| Decides on large household purchases               | -2.87       | 0.596 |
| Decides on visits to relatives                     | -1.11       | 0.817 |
| Decides on what to do with money husband earns     | 15.98       | 0.005 |
| Not humiliated by husband                          | -0.56       | 0.902 |
| Not insulted by husband                            | 2.87        | 0.455 |
| Not forced into unwanted sex                       | 2.59        | 0.761 |
| Not forced into other unwanted sexual acts          | -3.10       | 0.741 |
| Beating not justified if goes out without permission| 6.44        | 0.220 |
| Beating not justified if neglects children          | 7.14        | 0.304 |
| Beating not justified if argues with husband        | -4.78       | 0.346 |
| Beating not justified if refuses having sex         | -0.17       | 0.981 |
| Beating not justified if burns food                 | 6.69        | 0.335 |
| Source of water on premises                        | 4.28        | 0.429 |
| Household has radio                                | 2.43        | 0.459 |
| Household has television                           | 7.39        | 0.231 |
| Household has refrigerator                         | 11.01       | 0.143 |
| Household has bicycle                              | -0.50       | 0.881 |
| Household has motorcycle/scooter                    | 9.39        | 0.141 |
| Household has car/truck                            | 9.18        | 0.347 |
| Main floor material                                | 6.04        | 0.533 |
| Main wall material                                 | 3.31        | 0.506 |
| Main roof material                                 | -3.93       | 0.705 |
| Type of cooking fuel                               | 3.56        | 0.755 |
| Household has landline telephone                   | -10.14      | 0.667 |
| Owns house alone or jointly                        | -11.36      | 0.181 |
| Owns land alone or jointly                         | 12.22       | 0.145 |
| Highest educational level                          | 15.15       | 0.008 |
| Frequency reading newspaper/magazine               | 0.09        | 0.989 |
| Frequency listening to radio                       | 7.35        | 0.030 |
| Frequency watching television                      | -7.42       | 0.182 |
| Current age of mother                              | -2.16       | 0.178 |
| Square of current age of mother                    | 0.03        | 0.223 |
| Mother’s BMI                                       | 0.06        | 0.000 |
| Sex of child is female                             | 8.65        | 0.004 |
| **Regions**                                        |             |       |
| Niassa urban                                       | -25.80      | 0.049 |
| Niassa rural                                       | -28.66      | 0.010 |
| Cabo Delgado urban                                 | -18.52      | 0.165 |
| Cabo Delgado rural                                 | -33.94      | 0.002 |
| Nampula urban                                      | -33.76      | 0.007 |
| Nampula rural                                      | -44.43      | 0.000 |
| Zambezia urban                                     | -25.03      | 0.079 |
| Zambezia rural                                     | -31.41      | 0.003 |
| Tete urban                                         | -42.90      | 0.008 |
| Tete rural                                         | -34.76      | 0.001 |
| Manica urban                                       | -25.37      | 0.051 |
| Manica rural                                       | -26.14      | 0.013 |
| Sofala urban                                       | -12.38      | 0.249 |
| Sofala rural                                       | -11.18      | 0.318 |
| Inhambane urban                                    | 14.30       | 0.364 |
| Inhambane rural                                    | 4.36        | 0.679 |
| Gaza urban                                         | 25.05       | 0.070 |
| Gaza rural                                         | 17.60       | 0.103 |
| Maputo provincial urban                            | 1.27        | 0.897 |
| Maputo provincial rural                            | 13.73       | 0.289 |
| **Measurement equations**                          |             |       |
| **height/age**                                     |             |       |

(Continues)
Finally, in columns 5 and 6 of Table 4 we added a dummy variable equal to 1 when the husband is the head of the household. The coefficient of this variable was not significant and the impact of the other variables was similar to that observed in Columns 3 and 4.

In Table 5, we estimated separate regressions for the case where the man or the woman is the head of the household. In columns 1 and 2, which refer to the case where the husband is the head of the household, we observe that the coefficients of decision making and of the variable “attitude towards beating” are significant and the interaction between wealth and decision making is also significant. The impact of the other variables is similar to that observed when no distinction was made according to the sex of the head of the household.

The results concerning the case where the woman is the head of the household (see columns 3 and 4 of Table 5) are quite interesting but one should remember that the number of observations is quite small (317), in particular given the high number of explanatory variables we use. It appears that the only aggregated empowerment variable which at the limit has a significant coefficient is “information.” The interaction between information and wealth is also significant and positive. On the contrary, the coefficient of the educational variable is not significant. This seems to indicate that once the woman is the head of the household, there is no additional impact of her level of education on the nutritional status of the children. But whether she has access to information has a positive effect on the nutritional status of her children.

Note also that in Table 5, the coefficients of the interaction terms are never significant in the case of female-headed households. Among male-headed households, the interaction term between material wealth and decision making is significant, though not at the 5% level. Since in the case of male-headed households, the coefficient of decision making is significant but not that of material wealth, this positive interaction seems to indicate that the extent of decision making increases with material wealth.

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7 We introduced this variable because Mozambique has actually a relatively high number of female-headed households (36% in 2011 according to the National Statistical Institute). For more details, see Morgado and Salvucci (2016). We thank a referee for suggesting to take the sex of the head of the household into account.

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In order not to include too many regressions in the following tables we decided not to include interaction terms in the following tables. Table 6 presents the results of the MIMIC model when the aggregation of the empowerment variables is done, separately.
for each of the five domains of empowerment, via the Alkire and Foster approach (see, Appendix B-2 for more details on this methodology). The results in Table 6 are based on the whole sample. A distinction was made between the case where, for a given domain of empowerment, all the empowerment variables have an equal weight, and that where, again for a given domain of empowerment, the Cerioli and Zani (1990) weighting structure has been adopted (see, Appendix B-4 for more details on this weighting procedure). When equal weights are used, only one domain of empowerment is positively correlated, ceteris paribus, with the nutritional status of children: the (negative) attitude of the women towards beating. When the weights suggested by Cerioli and Zani are used, none of the five empowerment domains has a significant positive coefficient. As in Table 4, we observe a positive and significant coefficient of the education of the mother and her body mass index and here again we observe that, ceteris paribus, the nutritional status of the children is generally (but not always) lower in rural than in urban areas. One additional very interesting result, that is observed, whatever weighting structure we adopt, is the positive correlation, ceteris paribus, between the fact that the child is female and the (latent) nutritional status of the child.

In Table 7, we present results based only on male-headed households, using again as aggregation procedure the Alkire and Foster approach. The results are very similar to those presented in Table 6 for the whole sample. The only difference is that now the empowerment variable “attitude towards beating,” whose coefficient in Table 6 was significant only when equal weights were given to all variables within an empowerment domain, is now also significant when the Cerioli and Zani aggregation procedure is adopted.

Finally, in Tables 8‒11, we present the results of the MIMIC model when the aggregation of the variables measuring empowerment, separately for each domain of empowerment, is based on the so-called fuzzy sets approach. We adopted the suggestions of Rippin (2013) concerning the fuzzy identification function (for more details, see Appendix B-3). In other words, a distinction is made between the cases where the variables, within a given empowerment domain, are assumed to be substitutes (in which case the parameter $\beta$ is smaller than 1), complements (parameter $\beta$ greater than 1) or neither substitutes or complements (parameter $\beta$ equal to 1). Tables 8 and 9 presents first the results for the whole sample and for the following values of $\beta$: 0, 1, 0.5 and 1.50. We present the results for both weighting structures. It appears that in all cases, the coefficient of the wealth variable is positive and significant, indicating a positive correlation, ceteris paribus between the wealth of the household and the (latent) nutritional status of the children. The other empowerment (aggregated) variables do not have a significant coefficient, at least at the 5% level of significance. There is one case ($\beta$ equal to 0 and with equal weights) where the empowerment variable referring to the negative attitude of the women towards beating is positive and significant at the 10% level. As in the other tables previously analysed, the coefficient of education and of the body mass index of the mother is positive and significant. Note also that, as was the case when adopting the Alkire and Foster approach, the coefficient of the sex of the child is significant, indicating that, ceteris paribus, there is a positive correlation between the nutritional status of the child and the fact that it is a girl. This is true, whatever value of $\beta$ is selected. Finally, here again we observe that in many, but not all, regions, the (latent) nutritional status of the children is generally (but not always) lower, ceteris paribus, in rural than in urban areas.
In Tables 10 and 11, we present results based on the case of male-headed households. The results are very similar to those observed in Tables 8 and 9. Nevertheless we may note that the coefficient of the empowerment variable “attitude towards beating” is more often significant in the case of male-headed households. The impact of the empowerment variable is stronger in male-headed households than in female-headed households.

Inhambane urban −47.6 0.082
Inhambane rural −11.6 0.063 26.6 0.348
Gaza urban 32.4 0.026 17.1 0.062
Gaza rural 20.0 0.086 21.5 0.247
Maputo provincial urban 4.59 0.749 10.7 0.712
Maputo provincial rural −8.68 0.744 25.5 0.654

Measurement equations

Height
Latent variable 1 (constrained) 1 (constrained)
Constant −293 0.000 −201 0.079

Weight
Latent variable 0.981 0.000 0.747 0.000
Constant −242 0.000 −136 0.127
χ² of likelihood ratio test vs saturated 105.4 0.000

*The basis of comparison is the city of Maputo.

Source: Authors’ estimations.

In Tables 10 and 11, we present results based on the case of male-headed households. The results are very similar to those observed in Tables 8 and 9. Nevertheless we may note that the coefficient of the empowerment variable “attitude towards beating” is more often significant in the case of male-headed households. The impact of the empowerment variable is stronger in male-headed households than in female-headed households.

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Table 6. MIMIC model with the Alkire and Foster approach with dummies for clusters, with dummies for clusters and the coefficients of the dummies not displayed in the table (whole sample: number of observations: 4399)

| Structural equation | Coefficient | $P > z$ | Coefficient | $P > z$ |
|---------------------|-------------|--------|-------------|--------|
| Empowerment          |             |        |             |        |
| Decision making      | -4.98       | 0.393  | 0.21        | 0.966  |
| Experienced violence | -1.53       | 0.701  | 1.30        | 0.690  |
| Attitude towards beating | 10.46     | 0.065  | 6.02        | 0.237  |
| Information          | 4.49        | 0.337  | 3.69        | 0.571  |
| Material wealth      | 15.26       | 0.224  | 7.47        | 0.592  |
| Education of mother  | 18.38       | 0.000  | 19.39       | 0.000  |
| Age of mother        | -1.91       | 0.208  | -1.80       | 0.235  |
| Square of age of mother | 0.03      | 0.242  | 0.03        | 0.272  |
| BMI of mother        | 0.06        | 0.000  | 0.06        | 0.000  |
| Female child         | 7.83        | 0.007  | 7.87        | 0.006  |

| Regions*             | Coefficient | $P > z$ | Coefficient | $P > z$ |
|----------------------|-------------|--------|-------------|--------|
| Niassa urban         | -28.10      | 0.017  | -28.87      | 0.014  |
| Niassa rural         | -31.22      | 0.001  | -32.56      | 0.001  |
| Cabo Delgado urban   | -27.44      | 0.022  | -28.54      | 0.017  |
| Cabo Delgado rural   | -43.99      | 0.000  | -46.23      | 0.000  |
| Nampula urban        | -35.09      | 0.002  | -35.74      | 0.001  |
| Nampula rural        | -48.58      | 0.000  | -49.54      | 0.000  |
| Zambezia urban       | -28.01      | 0.028  | -29.20      | 0.021  |
| Zambezia rural       | -35.42      | 0.000  | -37.57      | 0.000  |
| Tete urban           | -45.66      | 0.003  | -45.99      | 0.003  |
| Tete rural           | -36.63      | 0.000  | -38.04      | 0.000  |
| Manica urban         | -29.46      | 0.012  | -30.40      | 0.009  |
| Manica rural         | -34.14      | 0.000  | -34.93      | 0.000  |
| Sofala urban         | -18.32      | 0.051  | -18.90      | 0.044  |
| Sofala rural         | -17.81      | 0.058  | -18.79      | 0.044  |
| Inhambane urban      | 11.99       | 0.408  | 10.79       | 0.454  |
| Inhambane rural      | -2.47       | 0.786  | -4.04       | 0.651  |
| Gaza urban           | 17.97       | 0.150  | 16.88       | 0.174  |
| Gaza rural           | 11.06       | 0.234  | 9.32        | 0.310  |
| Maputo provincial urban | 1.49      | 0.872  | 0.31        | 0.973  |
| Maputo provincial rural | 9.14      | 0.442  | 7.78        | 0.511  |

| Measurement equations |          |        |            |        |
|-----------------------|----------|--------|------------|--------|
| Height/age            |          |        |            |        |
| Latent variable       | 1 (constrained) | 1 (constrained) |
| Constant              | -234     | 0.000  | -233       | 0.000  |
| weight/age            |          |        |            |        |
| Latent variable       | 1.19     | 0.000  | 1.19       | 0.000  |
| Constant              | -201     | 0.000  | -201       | 0.000  |
| $\chi^2$ of likelihood ratio test vs saturated | 202.3    | 0.000  | 199.6      | 0.000  |

*The basis of comparison is the city of Maputo.

Source: Authors’ estimations.

Variable wealth is similar to that observed in the whole sample. The other results are similar in Tables 8 and 9.

Note also that in all the tables, as expected, the variables measuring the nutritional status of the children are positively correlated, with the latent variable assumed to represent the nutritional status of the children.8

8 Note that one of the two coefficients is constrained to be equal to 1, as explained by Jöreskog and Goldberger (1975).
We noted previously that the aggregated variable “material wealth” has a significant (and positive) impact on the nutrition of children only when the aggregation method adopted is the “fuzzy approach.” In Appendix C, we give the correlation coefficients between material wealth and the other aggregated variables. All the correlations are very low, except for information which is positively correlated with material wealth, whether among male- or female-headed households. This explains why we never observe that

**Table 7. Male-headed households: MIMIC model with the Alkire and Foster approach with dummies for clusters and the coefficients of the dummies not displayed in the table, (number of observations: 3457)**

| Dependent variable: latent child nutrition | Separate aggregation for each domain (equal weights to all the variables within a domain) | Separate aggregation for each domain (weighting structure proposed by Cerioli and Zani (1990) within a domain) |
|------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| **Structural equation Empowerment**      |                                                                                 |                                                                                 |
| Decision making                         | -5.73 0.500 5.02 0.468                                                        |                                                                                 |
| Experienced violence                    | 0.19 0.968 3.52 0.370                                                          |                                                                                 |
| Attitude towards beating                | 16.90 0.014 11.96 0.057                                                        |                                                                                 |
| Information                             | 1.68 0.759 1.34 0.864                                                          |                                                                                 |
| Material wealth                         | 11.44 0.427 7.14 0.654                                                         |                                                                                 |
| Education of mother                     | 20.45 0.001 21.45 0.001                                                         |                                                                                 |
| Age of mother                           | -1.18 0.508 -0.99 0.582                                                         |                                                                                 |
| Square of age of mother                 | 0.02 0.493 0.02 0.562                                                          |                                                                                 |
| BMI of mother                           | 0.06 0.000 0.06 0.000                                                          |                                                                                 |
| Female child                            | 7.02 0.037 7.27 0.033                                                          |                                                                                 |
| **Regions**                             |                                                                                 |                                                                                 |
| Niassa urban                            | -28.43 0.028 -28.57 0.029                                                      |                                                                                 |
| Niassa rural                            | -31.82 0.002 -32.22 0.002                                                      |                                                                                 |
| Cabo Delgado urban                      | -27.50 0.063 -28.00 0.061                                                      |                                                                                 |
| Cabo Delgado rural                      | -41.75 0.000 -43.40 0.000                                                      |                                                                                 |
| Nampula urban                           | -34.57 0.008 -33.99 0.009                                                      |                                                                                 |
| Nampula rural                           | -46.27 0.000 -46.00 0.000                                                      |                                                                                 |
| Zambezia urban                          | -30.23 0.042 -30.65 0.041                                                      |                                                                                 |
| Zambezia rural                          | -39.15 0.000 -40.42 0.000                                                      |                                                                                 |
| Tete urban                              | -44.76 0.008 -45.42 0.008                                                      |                                                                                 |
| Tete rural                              | -34.17 0.001 -34.43 0.000                                                      |                                                                                 |
| Manica urban                            | -28.86 0.030 -28.97 0.031                                                      |                                                                                 |
| Manica rural                            | -30.71 0.004 -29.74 0.006                                                      |                                                                                 |
| Sofala urban                            | -9.73 0.378 -8.84 0.429                                                        |                                                                                 |
| Sofala rural                            | -25.94 0.011 -25.73 0.012                                                      |                                                                                 |
| Inhambane urban                         | -1.20 0.949 -0.61 0.974                                                        |                                                                                 |
| Inhambane rural                         | -10.50 0.348 -10.14 0.364                                                      |                                                                                 |
| Gaza urban                              | 29.25 0.095 30.19 0.088                                                        |                                                                                 |
| Gaza rural                              | 20.85 0.094 20.86 0.095                                                        |                                                                                 |
| Maputo provincial urban                 | 2.77 0.797 1.63 0.882                                                          |                                                                                 |
| Maputo provincial rural                 | 13.05 0.342 12.55 0.366                                                        |                                                                                 |
| **Measurement equations Height/age**    |                                                                                 |                                                                                 |
| Latent variable                         | 1 (constrained) 1 (constrained)                                                |                                                                                 |
| Constant                                | -255 0.000 -257 0.000                                                          |                                                                                 |
| **Measurement equations Weigth/age**    |                                                                                 |                                                                                 |
| Latent variable                         | 1.16 0.000 1.14 0.000                                                          |                                                                                 |
| Constant                                | -224 0.000 -224 0.000                                                          |                                                                                 |
| \( \chi^2 \) of likelihood ratio test vs saturated | 91.2 0.000 88.7 0.000 |                                                                                 |

*The basis of comparison is the city of Maputo.

Source: Authors’ estimations.

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Table 8. MIMIC with “fuzzy approach,” assuming the parameter $\beta$ is equal to 0 or 1, with dummies for clusters and the coefficients of the dummies not displayed in the table (whole sample with 4399 observations)

| Variables | Structural equation | Decision making | Experienced violence | Attitude towards beating | Information | Material wealth | Education of mother | Age of mother | Square of age of mother | BMI of mother | Female child | Regions |
|-----------|---------------------|-----------------|---------------------|-------------------------|-------------|----------------|--------------------|---------------|------------------------|---------------|-------------|---------|
|           | Coefficient         | $P > z$         | Coefficient         | $P > z$                 | Coefficient | $P > z$       | Coefficient         | $P > z$       | Coefficient            | Coefficient   | Coefficient | Coefficient |
| Decision  | -6.66               | 0.289           | -8.08               | 0.191                   | -3.32       | 0.656         | -5.87              | 0.435         |                        |               |             | Niassa urban -25.93 0.034 -26.78 0.028 -27.33 0.023 -26.77 0.029 Niassa rural -28.07 0.004 -29.37 0.003 -30.09 0.002 -28.20 0.004 Cabo Delgado urban -21.86 0.000 -21.59 0.002 -25.99 0.003 -23.37 0.006 Cabo Delgado rural -38.88 0.000 -37.54 0.000 -43.54 0.000 -40.15 0.000 Nampula urban -31.84 0.000 -32.10 0.000 -33.45 0.000 -31.62 0.000 Nampula rural -44.57 0.000 -44.97 0.000 -47.18 0.000 -45.05 0.000 Zambezia urban -36.44 0.000 -30.17 0.000 -34.10 0.000 -30.64 0.000 Cabo Delgado rural -45.31 0.000 -46.69 0.000 -44.39 0.000 -45.50 0.000 Tete urban -34.54 0.000 -35.26 0.000 -35.43 0.000 -33.88 0.000 Manica urban -27.50 0.000 -27.44 0.003 -28.64 0.007 -27.09 0.026 Manica rural -29.76 0.000 -29.65 0.001 -32.02 0.000 -29.74 0.001 Sofala urban -14.84 0.132 -14.54 0.140 -16.82 0.082 -14.27 0.150 Sofala rural -11.44 0.252 -12.06 0.224 -15.16 0.119 -11.69 0.241 Inhambane urban 4.13 0.668 4.78 0.620 -0.06 0.995 4.13 0.697 Inhambane rural 2.21 0.082 23.26 0.007 20.08 0.117 23.02 0.079 Gaza urban 22.71 0.001 23.26 0.000 20.08 0.117 23.02 0.079 Gaza rural 17.15 0.004 18.03 0.009 13.42 0.163 17.29 0.081 Maputo provincial urban 2.04 0.831 2.36 0.805 1.40 0.882 2.16 0.822 Maputo provincial rural 14.06 0.258 14.26 0.250 11.21 0.358 13.76 0.270

Measurement equations
| Height/age | Constant | 0.000 | -244.5 | 0.000 | -231.1 | 0.000 | -234.2 | 0.000 |
| Weightage | Latent variable | 1 (constrained) | 1 (constrained) | 1 (constrained) | 1 (constrained) |
|           | Latent variable | 1.1 | 0.000 | 1.1 | 0.000 | 1.2 | 0.000 | 1.1 | 0.000 |
|           | Constant | -203.9 | 0.000 | -209.0 | 0.000 | -195.5 | 0.000 | -196.7 | 0.000 |
| $\chi^2$ of likelihood ratio test vs saturated | 211.5 | 0.000 | 208.9 | 0.000 | 207.7 | 0.000 | 211.7 | 0.000 |

Note: The basis of comparison is the city of Maputo. 
Source: Authors’ estimations.

the coefficients of the two aggregated variables, information and material wealth, are significant in the same regression. In Table 5 (aggregation via correspondence analysis), the coefficient of information is significant (though not at the 5% level) among female-headed households, but then the coefficient of material wealth is not significant. In Table 7 (aggregation via the Alkire and Foster approach) none of these two variables has a significant coefficient. Finally, in Tables 10 and 11, as we saw previously, the coefficient of material wealth is always significant but then that of information is not.

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6. CONCLUDING COMMENTS

Using data from the 2011 Demographic and Health Survey in Mozambique, this paper attempted to check whether women empowerment was, ceteris paribus, positively correlated with the nutritional status of children. Five domains of women empowerment were

Table 9. MIMIC with “fuzzy approach,” with equal weights to all variables within a domain, assuming the parameter $\beta$ is equal to 0.5 or 1.5 (with dummies for clusters and the coefficients of the dummies not displayed in the table; whole sample with 4,399 observations)

| Structural equation | Coefficient $P > z$ | Coefficient $P > z$ | Coefficient $P > z$ | Coefficient $P > z$ |
|---------------------|---------------------|---------------------|---------------------|---------------------|
| Decision making     | -5.03 0.474         | -7.32 0.297         | -1.95 0.800         | -4.37 0.577         |
| Experienced violence| 2.18 0.606          | 2.58 0.646          | 1.92 0.598          | 2.10 0.644          |
| Attitude towards beating | 7.30 0.199       | 9.57 0.119          | 4.7 0.376           | 5.94 0.248          |
| Information         | 4.86 0.582          | 7.16 0.368          | 3.26 0.722          | 4.41 0.626          |
| Material wealth     | 83.75 0.003         | 81.24 0.000         | 97.09 0.038         | 132.00 0.001        |
| Education of mother | 15.19 0.006         | 14.22 0.009         | 17.51 0.001         | 15.25 0.005         |
| Age of mother       | -2 0.07            | -2.17 0.173         | -1.97 0.200         | -2.12 0.178         |
| Square of age of mother | 0.03 0.230        | 0.03 0.213          | 0.03 0.240          | 0.03 0.219          |
| RMI of mother       | 0.06 0.000          | 0.06 0.000          | 0.06 0.000          | 0.06 0.000          |
| Female child        | 8.37 0.005          | 8.53 0.000          | 8.09 0.006          | 8.48 0.005          |
| Regions             |                     |                     |                     |                     |
| Niassa urban        | -26.61 0.029        | -26.50 0.031        | -27.86 0.020        | -27.20 0.026        |
| Niassa rural        | -28.92 0.005        | -28.16 0.004        | -30.95 0.001        | -28.79 0.003        |
| Cabo Delgado urban  | -24.10 0.052        | -22.03 0.079        | -27.21 0.026        | -24.75 0.047        |
| Cabo Delgado rural  | -41.55 0.000        | -38.45 0.000        | -44.77 0.000        | -41.77 0.000        |
| Nampula urban       | -32.56 0.004        | -31.33 0.007        | -34.09 0.002        | -32.26 0.005        |
| Nampula rural       | -45.91 0.000        | -44.43 0.000        | -47.97 0.000        | -45.95 0.000        |
| Zambezia urban      | -23.88 0.071        | -22.22 0.097        | -26.55 0.040        | -23.36 0.079        |
| Zambezia rural      | -32.28 0.001        | -29.70 0.002        | -35.35 0.000        | -31.94 0.001        |
| Tete urban          | -44.51 0.005        | -46.07 0.004        | -44.60 0.004        | -45.10 0.004        |
| Tete rural          | -34.75 0.000        | -34.04 0.000        | -36.07 0.000        | -34.23 0.000        |
| Manica urban        | -28.04 0.020        | -26.96 0.027        | -29.12 0.014        | -27.49 0.023        |
| Manica rural        | -30.91 0.001        | -29.26 0.002        | -32.80 0.000        | -30.50 0.001        |
| Sofala urban        | -15.74 0.108        | -13.87 0.163        | -17.60 0.066        | -15.03 0.126        |
| Sofala rural        | -13.20 0.182        | -11.02 0.271        | -16.57 0.084        | -12.93 0.191        |
| Inhambane urban     | 15.56 0.301         | 17.25 0.258         | 13.36 0.364         | 16.31 0.281         |
| Inhambane rural     | 1.97 0.835          | 4.94 0.610          | -1.47 0.872         | 2.25 0.813          |
| Gaza urban          | 21.44 0.098         | 23.69 0.072         | 19.04 0.133         | 22.04 0.091         |
| Gaza rural          | 15.33 0.117         | 18.34 0.066         | 11.99 0.205         | 15.89 0.105         |
| Maputo provincial urban | 1.69 0.859     | 2.31 0.810          | 1.16 0.901          | 2.02 0.833          |
| Maputo provincial rural | 12.66 0.305   | 14.50 0.246         | 10.11 0.402         | 12.79 0.302         |

Measurement equations

Height/age

| Latent variable | Coefficient $P > z$ | Coefficient $P > z$ | Coefficient $P > z$ | Coefficient $P > z$ |
|-----------------|---------------------|---------------------|---------------------|---------------------|
| Constant        | -233.4 0.000        | -238.4 0.000        | -229.9 0.000        | -231.7 0.000        |

Weight/age

| Latent variable | Coefficient $P > z$ | Coefficient $P > z$ | Coefficient $P > z$ | Coefficient $P > z$ |
|-----------------|---------------------|---------------------|---------------------|---------------------|
| Constant        | -197.6 0.000        | -201.2 0.000        | -195.0 0.000        | -194.5 0.000        |

Note: The basis of comparison is the city of Maputo.

Source: Authors’ estimations.
Table 10. Male-headed households, MIMIC with “fuzzy approach,” assuming the parameter $\beta$ is equal to 0 or 1 (with dummies for clusters and the coefficients of the dummies not displayed in the table; number of observations: 3102)

| Variables                          | Different weights for aggregated variables ($\beta = 0$) | Equal weights for aggregated variables ($\beta = 0$) | Different weights for aggregated variables ($\beta = 1$) | Equal weights for aggregated variables ($\beta = 1$) |
|------------------------------------|---------------------------------------------------------|-----------------------------------------------------|--------------------------------------------------------|-----------------------------------------------------|
|                                    | Coefficient    $P > z$                                  | Coefficient    $P > z$                                  | Coefficient    $P > z$                                  | Coefficient    $P > z$                                  |
| Decision making                    | -2.39          0.786                                   | -4.35          0.611                                   | -1.65          0.883                                   | -5.33          0.637                                   |
| Experienced violence               | 6.07           0.311                                   | 5.30           0.508                                   | 5.05           0.280                                   | 5.40           0.368                                   |
| Attitude towards beating           | 16.34          0.042                                   | 19.66          0.021                                   | 8.95           0.146                                   | 11.99          0.074                                   |
| Information                        | -0.03          0.997                                   | 3.17           0.688                                   | -1.89          0.859                                   | -1.62          0.874                                   |
| Material wealth                    | 61.44          0.009                                   | 49.15          0.009                                   | 86.57          0.050                                   | 107.81         0.003                                   |
| Education of mother                | 16.36          0.016                                   | 16.52          0.012                                   | 18.33          0.006                                   | 16.13          0.016                                   |
| Age of mother                      | -1.11          0.555                                   | -1.22          0.513                                   | -1.08          0.561                                   | -1.21          0.523                                   |
| Square of age of mother            | 0.02           0.556                                   | 0.02           0.515                                   | 0.02           0.563                                   | 0.02           0.531                                   |
| BMI of mother                      | 8.73           0.000                                   | 8.51           0.016                                   | 8.51           0.015                                   | 8.80           0.014                                   |
| Female child                       |                                                           |                                                           |                                                           |                                                           |
| Regions                            |                                                           |                                                           |                                                           |                                                           |
| Niassa urban                       | -26.27         0.054                                   | -26.70         0.048                                   | -27.83         0.038                                   | -27.35         0.045                                   |
| Niassa rural                       | -25.50         0.022                                   | -26.20         0.017                                   | -28.20         0.010                                   | -26.09         0.019                                   |
| Cabo Delgado urban                 | -21.82         0.161                                   | -21.23         0.169                                   | -25.66         0.094                                   | -22.28         0.155                                   |
| Cabo Delgado rural                 | -38.39         0.001                                   | -36.54         0.002                                   | -42.68         0.000                                   | -39.32         0.001                                   |
| Nampula urban                      | -30.49         0.024                                   | -30.80         0.021                                   | -32.38         0.015                                   | -30.86         0.022                                   |
| Nampula rural                      | -41.96         0.000                                   | -42.07         0.000                                   | -44.60         0.000                                   | -42.54         0.000                                   |
| Zambezia urban                     | -24.38         0.121                                   | -24.85         0.110                                   | -27.50         0.075                                   | -24.32         0.123                                   |
| Zambezia rural                     | -28.09         0.010                                   | -27.38         0.011                                   | -31.65         0.003                                   | -28.15         0.010                                   |
| Tete urban                         | -44.92         0.013                                   | -45.37         0.010                                   | -43.90         0.012                                   | -44.41         0.012                                   |
| Tete rural                         | -34.39         0.001                                   | -34.57         0.001                                   | -35.94         0.001                                   | -34.20         0.001                                   |
| Manica urban                       | -26.83         0.053                                   | -26.58         0.053                                   | -27.95         0.041                                   | -26.59         0.056                                   |
| Manica rural                       | -23.50         0.041                                   | -24.06         0.034                                   | -25.15         0.026                                   | -23.52         0.042                                   |
| Sofala urban                       | -4.56          0.698                                   | -4.77          0.683                                   | -7.10          0.537                                   | -4.60          0.697                                   |
| Sofala rural                       | -12.26         0.301                                   | -12.80         0.273                                   | -16.18         0.161                                   | -12.92         0.274                                   |
| Inhambane urb.                     | 2.58           0.896                                   | 2.87           0.883                                   | 1.37           0.943                                   | 0.36           0.841                                   |
| Inhambane rural                    | -5.68          0.759                                   | -2.71          0.820                                   | -7.77          0.504                                   | -4.24          0.723                                   |
| Gaza urb.                          | 35.12          0.057                                   | 35.45          0.053                                   | 32.66          0.072                                   | 35.48          0.055                                   |
| Gaza rural                         | 28.33          0.035                                   | 29.28          0.028                                   | 24.06          0.064                                   | 28.23          0.035                                   |
| Maputo provincial urb.             | 2.73           0.808                                   | 3.04           0.785                                   | 2.79           0.802                                   | 3.26           0.773                                   |
| Maputo provincial rural            | 17.20          0.234                                   | 17.32          0.226                                   | 15.21          0.284                                   | 17.31          0.231                                   |

| Latent variable                    | 1 (constrained)                                      | 1 (constrained)                                      | 1 (constrained)                                      | 1 (constrained)                                      |
| Constant                           | -265.8        0.000                                   | -269.4        0.000                                   | -253.9        0.000                                   | -257.7        0.000                                   |

| Latent variable                    | 1.1           0.000                                   | 1.1           0.000                                   | 1.1           0.000                                   | 1.1           0.000                                   |
| Constant                           | -228.9        0.000                                   | -233.7        0.000                                   | -217.9        0.000                                   | -219.4        0.000                                   |
| $\chi^2$ of likelihood ratio test vs saturated | 172.4         0.000                                   | 169.3         0.000                                   | 169.7         0.000                                   | 172.1         0.000                                   |

*The basis of comparison is the city of Maputo.

Source: Authors’ estimations

distinguished: decision making, experienced violence, attitude of the woman towards this use of violence, available information and material resources. Each of these five domains included several questions reflecting different aspects of empowerment. While
we first included in the analysis the answers to all the questions related to women empowerment in all the five domains, in a second stage, we aggregated, separately for each domain, the answers given to the different questions.

We implemented, for each domain of empowerment, three different methods of aggregation: correspondence analysis, the so-called AF (Alkire and Foster, 2011) methodology and the “fuzzy sets” approach. For the AF and “fuzzy sets” aggregation procedure, the variables, in a given empowerment domain, were given two different sets of weights:

| Variables | Coefficient | $P > \hat{z}$ | Coefficient | $P > \hat{z}$ | Coefficient | $P > \hat{z}$ | Coefficient | $P > \hat{z}$ |
|-----------|-------------|---------------|-------------|---------------|-------------|---------------|-------------|---------------|
| Structural equation |                     |               |             |               |             |               |             |               |
| Decision making | -2.08 | 0.839 | -5.33 | 0.601 | -1.31 | 0.912 | -4.80 | 0.689 |
| Experienced violence | 5.41 | 0.292 | 5.53 | 0.414 | 4.91 | 0.265 | 5.21 | 0.342 |
| Attitude towards beating | 11.75 | 0.087 | 15.10 | 0.042 | 7.15 | 0.207 | 9.82 | 0.114 |
| Information | -1.88 | 0.857 | 0.27 | 0.977 | -1.57 | 0.884 | -2.65 | 0.802 |
| Material wealth | 80.74 | 0.017 | 81.42 | 0.003 | 85.19 | 0.126 | 128.70 | 0.006 |
| Education of mother | 17.13 | 0.012 | 15.80 | 0.018 | 19.38 | 0.004 | 16.88 | 0.012 |
| Age of mother | -1.10 | 0.557 | -1.22 | 0.517 | -1.05 | 0.568 | -1.18 | 0.530 |
| Square of age of mother | 0.02 | 0.000 | 0.06 | 0.000 | 0.06 | 0.000 | 0.06 | 0.000 |
| BMI of mother | 8.68 | 0.014 | 8.75 | 0.014 | 8.35 | 0.016 | 8.74 | 0.014 |
| Female child | -27.08 | 0.046 | -26.89 | 0.049 | -28.38 | 0.033 | -27.82 | 0.041 |
| Niassa urban | -26.81 | 0.015 | -25.62 | 0.021 | -29.15 | 0.007 | -26.92 | 0.015 |
| Niassa rural | -23.76 | 0.125 | -21.13 | 0.175 | -27.00 | 0.076 | -23.64 | 0.128 |
| Cabo Delgado urban | -40.85 | 0.001 | -37.50 | 0.002 | -43.80 | 0.000 | -40.99 | 0.001 |
| Cabo Delgado rural | -31.39 | 0.019 | -30.32 | 0.025 | -33.04 | 0.012 | -31.62 | 0.019 |
| Niassa rural | -43.36 | 0.000 | -41.74 | 0.000 | -45.35 | 0.000 | -43.51 | 0.000 |
| Niassa rural | -25.77 | 0.099 | -23.77 | 0.132 | -28.78 | 0.059 | -25.40 | 0.105 |
| Niassa rural | -29.93 | 0.006 | -27.12 | 0.013 | -32.79 | 0.002 | -29.46 | 0.006 |
| Tete urban | -43.61 | 0.013 | -44.85 | 0.011 | -44.38 | 0.010 | -44.15 | 0.012 |
| Tete rural | -35.06 | 0.001 | -33.94 | 0.001 | -36.63 | 0.000 | -34.77 | 0.001 |
| Manica urban | -24.19 | 0.034 | -23.27 | 0.044 | -25.91 | 0.021 | -24.13 | 0.036 |
| Manica rural | -5.74 | 0.062 | -4.10 | 0.728 | -8.04 | 0.480 | -5.43 | 0.624 |
| Sofala urban | -14.19 | 0.026 | -12.09 | 0.307 | -17.54 | 0.123 | -14.20 | 0.225 |
| Sofala rural | 2.18 | 0.911 | 3.90 | 0.843 | 0.58 | 0.976 | 3.52 | 0.858 |
| Inhambane urban | -5.89 | 0.618 | -2.84 | 0.813 | -8.98 | 0.432 | -5.75 | 0.626 |
| Inhambane rural | 33.98 | 0.064 | 36.06 | 0.052 | 31.63 | 0.078 | 34.54 | 0.061 |
| Gaza urban | 26.22 | 0.048 | 29.52 | 0.028 | 22.51 | 0.079 | 26.61 | 0.045 |
| Gaza rural | 2.80 | 0.083 | 3.18 | 0.778 | 2.08 | 0.807 | 3.30 | 0.769 |
| Maputo provincial urban | 16.26 | 0.257 | 17.75 | 0.220 | 14.40 | 0.305 | 16.65 | 0.247 |
| Maputo provincial rural | 172.3 | 0.000 | 171.8 | 0.000 | 166.7 | 0.000 | 171.0 | 0.000 |

*The basis of comparison is the city of Maputo.

Source: Authors’ estimation

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first each variable had an equal weight; then we used the Cerioli and Zani (1990) weighting procedure.

To analyse the impact of women empowerment on the nutritional status of children, we used the MIMIC approach. We thus made a distinction between a structural equation, whose dependent variable is a latent variable assumed to represent the nutritional status of children, and two measurement equations, where the two observed nutritional variables, height and weight by age, are related to the latent nutritional status of the children.

The empirical analysis presented in this paper does not lead to clear-cut conclusions concerning the possible correlation, ceteris paribus, between women’s empowerment and the nutritional status of children. When aggregating the empowerment variables, within a domain of empowerment, via correspondence analysis, the results of the MIMIC procedure indicated that, ceteris paribus, the higher the wealth of the household and the more women did not justify beating by their husband/partner, the higher the (latent) nutritional status of the children. When we adopted the AF aggregation procedure, as well as the fuzzy sets approach, no matter which value was given to the parameter $\beta$, only the material wealth of the household was positively and significantly correlated with the nutritional status of children.

Looking only at male-headed households gave a slightly different picture of the impact of the empowerment variables. The coefficient of experienced violence was never significant in this case either. However, the coefficients of the decision making variable and that of the variable representing the woman’s attitude towards violence were more often significant.

We also observed that the (latent) nutritional status of the children was always higher, the higher the educational level of the mother and her BMI, no matter which aggregation procedure was selected. This impact of the mother’s education confirms the results obtained by Makoka (2013) for Malawi, Tanzania and Zimbabwe. He found that, after controlling for other factors, maternal education reduces the odds of the three measures of child nutrition, stunting, wasting, and underweight. Makoka (2013), however, stressed that there was generally a threshold beyond which female education had an impact on child nutrition. Offering free primary education may hence not be sufficient to address child malnutrition, but offering nutritional education programmes for women with low levels of education might certainly help them achieve better nutritional outcomes for their children.

Several studies have also shown a significant association between the nutritional statuses of mothers and that of their offsprings (see, for example, Rahman et al., 1993; Islam et al., 1994; Santos et al., 2009; Kulasekaran, 2012; Lata Tigga and Sen, 2016). As emphasised by Lata Tigga and Sen (2016) it is possible that, “during infancy, the relationship between mother and child malnutrition is affected by the biological consequences of maternal malnutrition during lactation.” Interventions aiming at improving the nutritional status of mothers may well help preventing childhood malnutrition.

Improving the educational level of mothers and their nutritional status are hence important policy recommendations of the present study. Whether this implies that the educational level of the mother and her nutritional status should in fact be considered as...
empowerment variables\textsuperscript{9} depends evidently on how empowerment is defined.\textsuperscript{10} Bennett (2002), following somehow Narayan (2002), described empowerment as “the enhancement of assets and capabilities of diverse individuals and groups to engage, influence and hold accountable the institutions which affect them.” If we adopt this definition, we certainly can consider the education of the mother and her BMI as empowerment variables.

Some other findings of our study are worth mentioning again. Thus, the latent nutritional status was also higher when the child was female, although this result was not observed, when we aggregated the empowerment variables via correspondence analysis. Finally, for most but not all regions, we observed that the nutritional status of children was lower in rural areas. There were also important differences in the nutritional status of children between the various regions of Mozambique. This last effect is likely to be associated with differences in the extent and quality of health facilities, the impact of which seems to neutralise the role of most empowerment variables, whether aggregated or not.

Finally, it will be interesting, in future work, to compare the results obtained in this study, with those derived from other Demographic and Health Surveys in Mozambique, to see if there are changes over time in the observed patterns.

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\textsuperscript{10} See Malhotra et al. (2002) for a review of various approaches to the notion of empowerment.
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APPENDIX A. LIST OF VARIABLES USED FOR WOMEN’S EMPOWERMENT

Decision Making

“Person who usually decides on respondent’s health care”: equal to 1 if wife is the one deciding.

“Person who usually decides on large household purchases”: equal to 1 if wife is the one deciding.

“Person who usually decides on visits to family or relatives”: equal to 1 if wife is the one deciding.

“Person who usually decides what to do with money husband earns”: equal to 1 if wife is the one deciding.

Actual Use of Violence by Husband

“Ever been humiliated by husband/partner”: equal to 1 if wife has not been humiliated.

“Ever been insulted or made to feel bad by husband/partner”: equal to 1 if wife has not been insulted.

“Ever been forced into other unwanted sex by husband/partner”: equal to 1 if wife has not been forced.

“Ever been forced into other unwanted sexual acts by husband/partner”: equal to 1 if wife has not been forced.
**Attitude Towards Use of Violence**

“The wife thinks that beating is justified if she goes out without telling husband”: equal to 1 if wife does not think so.

“The wife thinks that beating is justified if she neglects the children”: equal to 1 if wife does not think so.

“The wife thinks that beating is justified if she argues with husband”: equal to 1 if wife does not think so.

“The wife thinks that beating is justified if she refuses to have sex with husband”: equal to 1 if wife does not think so.

“The wife thinks that beating is justified if she burns the food”: equal to 1 if wife does not think so.

**Resources of Household**

“Time to get to water source”: equal to 1 if on premises.

“Household has: radio”: equal to 1 if there is a radio.

“Household has: television”: equal to 1 if there is a television.

“Household has: refrigerator”: equal to 1 if there is a refrigerator.

“Household has: bicycle”: equal to 1 if there is a bicycle.

“Household has: motorcycle/scooter”: equal to 1 if there is a motorcycle/scooter.

“Household has: car/truck”: equal to 1 if there is a car/truck.

“Main floor material”: equal to 1 when wood plank, parquet or polished wood, tiles.

“Main wall material”: equal to 1 when bricks or cement blocks.

“Main roof material”: equal to 1 when made of calamine, cement fibre, ceramic tiles, or cement.

“Type of cooking fuel”: equal to 1 when electricity or natural gas.

“Household has: telephone (landline)”: equal to 1 if there is a landline telephone.

“Owns a house alone or jointly”: equal to 1 if the wife owns a house alone or jointly.

“Owns land alone or jointly”: equal to 1 if the wife owns land alone or jointly.

**Information**

“Frequency of reading newspaper or magazine”: equal to 1 if at least once a week.

“Frequency of listening to radio”: equal to 1 if at least once a week.

“Frequency of watching television”: equal to 1 if at least once a week.

**Other Characteristics of Household**

“Highest educational level of the wife”: equal to 1 if she has a secondary or higher educational level.

“Age”: current age of the mother.

“Square of Age”: square of current age of the mother.

“bmi”: body mass index of the mother.

“female”: equal to 1 if the child is female.

**Regional Variables**

The following areas have been distinguished: Niassa Urban; Niassa Rural; Cabo Delgado Urban; Cabo Delgado Rural; Nampula Urban; Nampula Rural; Zambezia Urban; Zambezia Rural; Tete Urban; Tete Rural; Manica Urban; Manica Rural; Sofala Urban;
Sofala Rural; Inhambane Urban; Inhambane Rural; Gaza Urban; Gaza Rural; Maputo province Urban; Maputo province Rural. The basis of comparison was the capital city of Maputo.

Health Variables of Children

“Height/age”: z-value of height/age of the child (number of standard deviations from the mean this variable is).

“Weight/age”: z-value of weight/age of the child (number of standard deviations from the mean this variable is).

APPENDIX B. METHODOLOGICAL NOTES

B-1 ON CORRESPONDENCE ANALYSIS

The main features of correspondence analysis may be summarised as follows. Assume that there are \( K \) primary indicators that are categorical ordinal and that the indicator \( I^k \) for category \( k \) has \( J_k \) categories. To each primary indicator \( I^k \), we therefore associate a set of \( J_k \) binary variables that can only take the value 0 or 1.

Call \( J = \sum_{k=1}^{K} J^k \) the total number of categories and \( X(M,J) \) the matrix corresponding to the \( M \) observations on the total number \( J \) of categories. Call \( N_j \) the absolute frequency of category \( j \) so that \( N_j \) is equal to the sum of column \( j \) of the matrix \( X \). Similarly call \( N_i \) the absolute frequency of observation \( i \) so that \( N_i \) is equal to the sum of line \( i \) of the matrix \( X \). Finally let \( N_= \) refer to the sum of all the \((M \times J)\) elements of the matrix \( X \). Let \( f_j, f_i \) and \( f_{ij} \) be, respectively, equal to the relative frequencies \( \left( N_j/N_\right), \left( N_i/N_\right) \) and \( \left( N_{ij}/N_\right) \). Call also \( f_j \) the ratio \( \left( f_{ij}/f^i\right) \) and \( \{ f^i \} \) the set of all \( f_{ij} \)'s for a given observation \( i \) (\( j = 1 \) to \( J \)). This set will be called the profile of observation \( i \). The \( \chi^2 \)-metric-related distance \( d^2(f^i_{j},f^i_{j'}) \) between two profiles \( i \) and \( i' \) is then defined as

\[
    d^2(f^i_{j},f^i_{j'}) = \sum_{j=1}^{J} \left( 1/f_j \right)(f^i_{j} - f^i_{j'})^2
\]

Note that the only difference with the Euclidean metric lies in the term \( (1/f_j) \) which indicates that categories which have a low frequency will receive a higher weight in the computation of distance. As a consequence CA will be overweighting the smaller categories.

Call now \( X^i \) the point in a space of \( J \) dimensions whose coordinates are \( f^i_{j} = \left( f_{ij}/f^i \right) \). To \( X^i \) we associate the mass \( f^i \). Call \( C(M) \) the cloud of the points \( X^i \) with their mass \( f^i \). The gravity center \( H \) of this cloud is then defined as

\[
    H = \sum_{i} f^i X^i.
\]

We can now project a point \( X^i \) on two axes determining a plane. These axes will be called factorial axes and their definition will be given below. Call \( Z_1^i \) and \( Z_2^i \) the
projections of $X^i$ on the first and second axis and call $F_1 (i)$ the abscissa of $Z_1^i$ and $F_2 (i)$ the ordinate of $Z_2^i$. More generally, assuming more than two axes, the projection of $X^i$ on the axis $\alpha$ will be called $F_\alpha (i)$.

We can similarly define a point $X_j$ in a space of $M$ dimensions whose coordinates are $f_j^i = (f_{ij}/f_j)$. To $X_j$, we associate the mass $f_j$. Call $C (J)$ the cloud of the points $X_j$ with their mass $f_j$. The gravity center $E$ of this cloud is then defined as

$$E = \sum_j f_j X_j$$

(B3)

Here also we can now project a point $X_j$ on the two axes previously mentioned. Call $L_1^j$ and $L_2^j$, the projections of $X_j$ on the first and second axis and call $G_1 (j)$ the abscissa of $L_1^j$ and $G_2 (j)$ the ordinate of $L_2^j$. And again, more generally, when we assume more than two dimensions, the projection of $X_j$ on axis $\alpha$ will be labelled $G_\alpha (j)$.

It can be shown (see, Volle, 1985, p. 39) that

$$F_\alpha (i) = \frac{1}{\sqrt{\lambda_\alpha}} \sum_j \left( \frac{f_{ij}}{f_i} \right) G_\alpha (j)$$

(B4)

and that

$$G_\alpha (j) = \frac{1}{\sqrt{\lambda_\alpha}} \sum_i \left( \frac{f_{ij}}{f_j} \right) F_\alpha (i)$$

(B5)

where $\alpha$ refers to one of the axes\(^\dagger\) while $\lambda_\alpha$ is the inertia of axis $\alpha$. The inertia $\lambda_\alpha$ of factorial axis $\alpha$ is defined as

$$\lambda_\alpha = \sum_j \left( \frac{N_j}{N} \right) \left( w_j^\alpha \right)^2$$

(B6)

where $w_j^\alpha$ is the score of category $j$ on factorial axis $\alpha$. This score $w_j^\alpha$ is itself defined as

$$w_j^\alpha = \left( \frac{1}{\sqrt{\lambda_\alpha}} \right) \left( \frac{1}{N_j} \right) \sum_{i=1}^{N_j} F_\alpha (i)$$

(B7)

This duality relationship (between expressions (B-5) and (B-6)) implies thus that the score of a population unit on factor $\alpha$ is equal to the average of the standardised factorial weights of the $J$ categories to which it belongs. Conversely, the weight of a given category

\(^\dagger\) The number of factorial axes is determined by the rank of the data matrix $X(M, J)$. As is well known, the rank of a matrix is equal to the maximum number of linearly independent rows (columns), so that $\text{rank}(X) \leq \text{Min}(M, J)$.
on this same factor $\alpha$ is is equal to the average of the standardised scores of the population units belonging to the corresponding category.

How do we compute $F_\alpha (i)$ and $G_\alpha (j)$?

Call $Z$ the matrix defined as

$$Z = X / N..$$  \hfill (B8)

Call $r$ the vector of the row totals of $Z$, (i.e. $r = Z 1$ where 1 is a vector whose elements are all equal to 1) and $c$ the vector of the columns totals (i.e. $c = Z^T 1$ where $Z^T$ is the transpose of matrix $Z$ and 1 again a vector whose elements are all equal to 1). Call now $D_c$ the matrix derived from the diagonalisation of $c$ and $D_r$ the matrix obtained from the diagonalisation of $r$.

The factor scores are then obtained from the following generalised singular value decomposition\(^{12}\):

$$(Z - rc^T) = A = P \Delta Q^T$$  \hfill (B9)

With

$$(P^T D^{-1}_r P) = (Q^T D^{-1}_c Q) = I$$  \hfill (B10)

where $I$ is the identity matrix.

$\Delta$ is a diagonal matrix whose elements are the singular values of $(Z - rc^T)$, these singular values being the square roots of the eigenvalues of the matrix $(A^T A)$.

The matrix $P$ contains the left generalised singular vectors of $(Z - rc^T)$, while the matrix $Q$ contains the right generalised singular vectors of $(Z - rc^T)$.

The columns of $Q$ are the eigenvectors $v_h$ of the matrix $(A^T A)$ while the columns of $P$ are the vectors

$$u_h = \left( \frac{1}{\lambda_h} \right) A v_h$$  \hfill (B11)

It can then be shown (see, Abdi and Béra 2014) that the row factors scores are obtained as

$$F = D_r^{-1} P \Delta$$  \hfill (B12)

and the column factors as

$$G = D_c^{-1} Q \Delta$$  \hfill (B13)

It should be stressed that the variance of the factor scores on a given axis is equal to the eigenvalue (inertia) associated with this axis.

\(^{12}\) For more details on the concept of singular value decomposition, see, Poole (2003).
B-2 THE ALKIRE AND FOSTER (2011) APPROACH

We present below the main features of their approach when applied to the aggregation of answers to questions on decision making, assuming only binary variables are available. Suppose that the domain of decision making includes $J$ questions and that a binary variable $p_{ij}$ takes a value of 1 when individual makes decisions in the subdomain covered by the question, and of 0 otherwise. The implementation of Alkire and Foster’s (2011) approach to the measurement of the extent of decision making implies first selecting a threshold $h$, so that an individual will be considered as a “decision maker” if the percentage of binary variables $p_{ij}$ equal to 1 is higher than $h$. If $d_i$ is a binary variable equal to 1 if individual $i$ is a “decision maker,” (to 0 otherwise), we will define $d_i$ as

$$d_i = 1 \text{ if } \sum_{j=1}^{I} w_j p_{ij} > h, = 0 \text{ otherwise}$$

where $w_j$ is the weight given to question $j$. If an equal weight is given to all the variables, then obviously

$$w_j = \left( \frac{1}{J} \right).$$

We can then we define the “decision making headcount” $H$ as

$$H = \left( \frac{1}{n} \right) \sum_{i=1}^{n} d_i$$

where $n$ refers to the number of individuals.

Note that when $h = 1$, we have the “intersection approach” which implies that an individual will be considered as “decision maker” only if all the binary variables $p_{ij}$ are equal to 1.

The other extreme case, corresponds to a “union approach,” in so far as an individual will be considered as “decision maker” as soon as one binary variable $p_{ij}$ is equal to 1.

Consider now only the individuals defined as “decision makers.” We then define an indicator $A$ as

$$A = \left( \frac{1}{nH} \right) \left[ \sum_{\text{with } d_i=1}^{I} \sum_{j=1}^{J} w_j p_{ij} \right]$$

$A$ is therefore equal to the weighted proportion of variables $p_{ij}$ equal to 1 among the individuals defined as “decision makers.”

Finally, we define an indicator $M$ as

$$M = AH = \left( \frac{1}{n} \right) \left[ \sum_{\text{with } d_i=1}^{I} \sum_{j=1}^{J} w_j p_{ij} \right]$$
$M$ is therefore equal to the ratio of the weighted number of binary variables $p_{ij}$ equal to 1 among the individuals defined as “decision makers” over the maximum ($nJ$) number of variables $p_{ij}$ that could have been equal to 1 among all the individuals, whether “decision makers” or not.

At the individual level, we will define the rate of “decision making” $\mu_{AF}(i)$ of individual $i$ as being identical to $d_i$ which was defined in (B-14). We can then estimate a logit regression where $\mu_{AF}(i) = d_i$ is the dependent variable, the explanatory variables being those relevant for the domain of investigation (e.g. decision making).

### B-3 AGGREGATING VARIABLES VIA THE “FUZZY SET” APPROACH

Let there be a set $Y$ and let $y$ be any element of $Y$. A fuzzy subset $A$ of $Y$ is characterised by a membership function $\mu_A(y)$ which will link any point of $Y$ with a real number in the interval $[0,1]$, the value of $\mu_A(y)$ denoting the degree of membership of the element $y$ to the set $A$.

If $A$ were a set in the sense in which this term is usually understood, the membership function which would be associated to this set would take only the values 0 and 1. One would then write that

$$\mu_A(y) = 1 \text{ if } y \text{ belongs to the subset } A$$

and

$$\mu_A(y) = 0 \text{ if } y \text{ does not belong to the set } A.$$  \hspace{1cm} (B18)

But if $A$ is a fuzzy subset, we will say that $= \mu_A(y)0$ if the element $y$ does not belong to $A$ and that $= \mu_A(y)1$ if $y$ completely belongs to $A$. But if $0 < \mu_A(y) < 1$, $y$ belongs only partially to $A$ and the closer to 1 the value of $\mu_A(y)$, the greater the degree of membership of $y$ to $A$.

These simple ideas may be easily applied to the issue of aggregating variables belonging to the same domain of investigation, these domains referring respectively in our empirical analysis to decision making; use of violence by husband; attitude towards use of violence; resources of the household; information. This fuzziness is easy to understand, because each domain includes several questions and, generally, the individual gives a positive answer to some questions, a negative one to some others. If, for example, this is the case of the domain referring to decision making, it is then likely that the individual has only partly the power to make decisions. In what follows we focus on the suggestions made by Rippin.

### Defining an Identification Function

Following Sen (1976) and Alkire and Foster (2011), Rippin starts by defining a poverty identification function $\psi_i$, but she assumed that this function was fuzzy. More precisely, rather than using the discrete identification function proposed by Alkire and Foster (where $\psi_i = 1$, if the proportion $c_i$ of poverty components for which individual $i$ is to be considered as poor is higher than some threshold $h$, while $\psi_i = 0$ otherwise), Rippin (2013, 2017) recommends adopting a “fuzzy” identification function, that requires taking into account the relationship between the various components of poverty (see, Silber and Yalonetzky, 2013, p. 12). Call $\beta$ a parameter measuring the extent of inequality aversion. This parameter, therefore, describes the relationship between the poverty attributes. Rippin (2013) defines then the fuzzy identification function $\psi_i$ as
In the case where not all the questions in a given domain have the same weight, the counting function \( c_i \) will be defined as

\[
\psi_i = (c_i)\beta
\]  

(B19)

where \( /\psi_i/ \) refers to the number of questions in the domain, \( w_j \) to the weight of question \( j \), and \( \Pi \) a function taking the value of 1 if the binary variable \( x_j \) for question \( j \) takes the value of 1.

Such an approach can naturally be applied when attempting to aggregate variables in a given domain. Suppose, for example, that the answer to each question about decision making is given by a binary variable \( p_{ij} \) taking this time the value of 1 if the individual is a decision maker in the subdomain covered by the question, of 0 otherwise. Call \( c_i \) the weighted proportion of questions in a given domain for which the binary variable \( p_{ij} \) is equal to 1. The fuzzy identification function \( /\psi_i/ \) assumes then different degrees decision making. This function \( /\psi_i/ \) is considered to be fuzzy because unless \( c_i = 1 \) or \( c_i = 0 \), each individual will be identified as having some degree of decision making (Silber and Yalonetzky, 2013, p. 13). In other words, individuals are identified as having different degrees of decision making, depending on i) the number of questions for which the binary variable took the value of 1 and on ii) the type of relationship that is assumed to exist between the various components of decision making. The shape of the identification function \( /\psi_i/ \) depends on the value of \( \beta \) value. If \( 0 < \beta < 1 \), the identification function has a concave shape, while if \( \beta > 1 \), it has a convex shape. The choice of a specific form will depend on whether it is assumed that the components of decision making are assumed to be complements or substitutes. Given that for each question \( j \), \( p_{ij} \) is assumed to be equal to 1 if for the subdomain examined by question \( j \), the individual is a decision maker, then if the variables \( j \) in a given domain are considered as substitutes, we will have the case of a concave function. In such case, the increase in decision making is marginally decreasing in \( c_i \). This implies that the higher the number of questions to which the binary variable takes the value of 1, the more he/she is identified as making decisions, but this increase in identification becomes smaller and smaller as \( c_i \) increases. If the components of decision making are perfect substitutes, we have the “union case,” so that as soon as for an individual there is one binary variable taking the value of 1, he/she is considered as making decisions.

If the components of decision making are imperfect complements, we have the more general case approximated by a convex identification function. Then the higher the number of questions to which the binary variable takes the value of 1, the more he/she is identified as making decisions. And this increase in decision making rises with \( c_i \). In the specific case where these components of decision making are perfect complements, as
long as for an individual not all the binary variables are equal to 1, his/her decision making will be equal to 0. This is the intersection case mentioned by Silber and Yalonetzky (2013).

The assumption of a particular relationship among the components of decision making is not certainly a simple task. It is often hard enough to determine such degree on a pair-wise basis, let alone among combinations of \( K \) variables taken 3, 4, up to \( K \) at a time. We will therefore assume different degrees of complementarity (\( \beta = 1.25, 1.50 \)) and substitutability (\( \beta = 0, 0.25, 0.50 \)) among the components of decision making. We will also consider the case where \( \beta = 1 \), in which case the function describing \( c_i \) is a straight line.

**Defining a Function Determining the “Breadth” of, Say, Decision Making**

As in the multidimensional poverty measurement literature, the individual decision making function identifies those who make decisions, though in a fuzzy way, but it needs also to take into account the intensity of decision making (Silber and Yalonetzky, 2013). However, with ordinal binary variables, the multidimensional decision making “depth”\(^{13}\) cannot be estimated, because one cannot define a gap between the degree of decision making of an individual and some decision making threshold. Following Silber and Yalonetzky (2013), we will therefore assume that the “breadth of decision making” is measured via the number of questions for which the binary variable takes the value of 1. The individual multidimensional decision making function will then be defined as the product of the identification function defined previously and a function that captures the breadth of multidimensional decision making. Let \( g \left( c_i \right) \) be the function measuring the multidimensional decision making breadth. This function depends on the number of questions for which the binary variable took the value of 1. The degree of multidimensional decision making will then be expressed as \( DM_i \) with

\[
DM_i (c_i) = \psi_i (c_i) g (c_i)
\]

(R21)

Rippin (2012) assumed that \( \psi_i (c_i) = c_i^{\beta} \) and that \( g (c_i) = c_i \) so that for Rippin the degree of multidimensional individual decision making \( DM_i \) is expressed as

\[
DM_i = (c_i)^{1+\beta}
\]

(R22)

Then, for Rippin, the extent of decision making \( DM \) in the whole population will be written as

\[
DM = \left( \frac{1}{n} \right) \sum_{i=1}^{n} DM_i = \left( \frac{1}{n} \right) \sum_{i=1}^{n} (c_i)^{1+\beta}
\]

(R23)

where \( n \) refers to the number of individuals.

\(^{13}\) The “depth” of poverty measures how far the poor are, on average, from the poverty line.
It is important to stress, that the measure proposed by Rippin (2012) takes into account the degree of inequality, between the individuals (households) classified as decision makers, in the number of questions to which the binary variable takes the value of 1.

B-4 WHICH WEIGHTS $w_j$ TO SELECT?

We will apply the weighting scheme originally proposed by Cerioli and Zani (1990). Call $\bar{p}_j$ the percentage of individuals in the population for which $p_{ij} = 1$. In other words,

$$\bar{p}_j = \left( \frac{1}{n} \right) \sum_{j=1}^{n} p_{ij}. \quad (B24)$$

Cerioli and Zani (1990) then suggested defining the weight $w_j$ of question $j$ as

$$w_j = \frac{\left( \frac{1}{\ln \bar{p}_j} \right)}{\sum_{j=1}^{J} \left( \frac{1}{\ln \bar{p}_j} \right)} \quad \quad (B25)$$

The idea is that if for a given question $a$ in a subdomain (e.g. decision making), for most people $p_{ia} = 1$ (that is, most people make decisions in the area covered by the question) so that $\bar{p}_a$ is relatively high, then the weight $w_a$ for this question will be relatively low. On the contrary, if for another question $b$, in this same subdomain, for most people $p_{ib} = 0$ and as a consequence $\bar{p}_b$ will be relatively high, the weight of this other question, $w_b$, will be low. Take as illustration the following two aspects of a woman’s decision making: the management of the family budget and the responsibility for the health of children (like bringing one’s child to a physician). Assume that in the first case (question $a$) $\bar{p}_a$ is high (women generally are allowed to manage the family budget) while in the second case (question $b$) $\bar{p}_b$ is low (women generally are not allowed to decide whether they should bring their child to the physician). Expression (B-25) then shows that if a woman, in a given household, is allowed to decide whether to bring her child to the physician as well as allowed to manage the family budget, a greater weight will be given to the fact that she is allowed to bring her child to the physician, because most women are not allowed to do so$^{14}$.

B-5 THE MIMIC MODEL

Let us now summarise the main features of the MIMIC model. We follow here Krishnakumar and Nagar (2008) and use their notations. In the multidimensional version of this model the measurement and structural equations are expressed as

$$y = \Lambda f + \varepsilon \quad \quad (B26)$$

$^{14}$ Note that Desai and Shah (1988) came up with a similar idea, although they used weights different from those given in expression (B-25).
\[ f = Bx + \xi \]  

where \( y, f \) and \( x \) refer, respectively, to the observed health variables, the latent health variable and the determinants of health. \( f \) is therefore a vector, \( \Lambda \) and \( B \) are matrices and \( V(\xi) = \Psi, V(\xi) = \sigma^2 I \).

It can then be shown that \( f \) is estimated as

\[ \hat{f} = (I - \Lambda\Omega^{-1}\Lambda)^{-1} \left( Bx + \Lambda\Psi^{-1}y \right) \]  

(B28)

Since \( \Omega = (\Psi + \Lambda\Lambda') \) (see, Krishnakumar and Nagar, 2008) we conclude that

\[ \hat{f} = (I + \Lambda'\Psi^{-1}\Lambda)^{-1} Bx + (I + \Lambda'\Psi^{-1}\Lambda)^{-1} \Psi^{-1}y \]  

(B29)

So it turns out that the MIMIC latent factor estimator is a sum of two terms. The first one relates to the determinants \( x \) of health while the second one is related to the observed health variables \( y \).

**APPENDIX C**

Correlation between the aggregated variable measuring material wealth on the one hand and the aggregated variables measuring decision making, experienced violence, attitude towards beating and information on the other hand.

|                      | Decision Making | Experienced Violence | Attitude towards beating | Information |
|----------------------|-----------------|---------------------|-------------------------|-------------|
| Whole sample         | -0.023          | 0.082               | -0.104                  | 0.461       |
| Male-headed households| 0.001           | 0.100               | -0.113                  | 0.497       |
| Female-headed households | -0.106         | 0.018               | -0.060                  | 0.330       |