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Investigating the Determinants of Child Malnutrition in Cameroon: Evidence from the Second Cameroonian Household Consumption Survey

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Authors' contributions

This work was carried out in collaboration between both authors. Authors SF and FMB designed the study and prepared the final manuscript. In particular author FMB performed the statistical analysis, while author SF supervised the study and play major role in data interpretations and discussions. Both authors read and approved the final manuscript.

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ABSTRACT

Background/Objectives: This paper assesses the impact of household consumption spending on the nutritional status of children as measured by height-for-age, weight-for- age, and weight-for-height Z-scores, while controlling for other correlates.
Methods/Statistical Analysis: To address these objectives, use is made of a sample of children aged 0 to 36 months derived from the second Cameroonian household consumption survey. The method of analysis encompasses the ordinary least squares, two-stage least squares and the control function approach. The potential endogeneity of household consumption spending is addressed using four sets of instrumental variables: quantity of land, parental levels of educational, formal employment and dependence ratio.
Findings: The control function approach was effective in simultaneously purging the structural parameters of potential endogeneity of household consumption spending and unobserved heterogeneity. Reduced form estimates show that household land holding recorded a diminishing effect on household consumption spending, meanwhile parental levels of education and participation in formal labour markets correlate positively with household consumption spending.

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The main results show that household consumption spending is positively associated with short-term child nutritional status. In particular, male-headed households' seem to be more effective in achieving better child health than their female counterparts – a finding attributable to unobserved spousal inputs, especially as male household heads are generally married, whereas their female counterparts are typically single parents. Results also show that boys were more undernourished than girls and younger children were more undernourished than older ones. In addition, older household heads were more likely than their younger counterparts to achieve positive nutritional outcomes. This paper contributes to the empirical literature by suggesting instruments that correlate with child nutritional status mainly through household consumption spending.

Application/Improvements: If future human capital endowments are considered import in the development process, then it is important to focus on policies related to access to land, labour markets and adult literacy.

Keywords: Household consumption; child health/nutrition; control function modelling; Cameroon.

1. INTRODUCTION

Malnutrition is a very serious problem in developing countries [1,2]. According to [3], about a third of the children of less than 5 living in the developing world suffer from stunting. In Cameroon, malnutrition is endemic among children less than 5 years. Anthropometric estimates derived from the Demographic and Health survey and Multiple Indicators Cluster Survey DHS-MICS 2011 indicate that, 33% of the children were stunted, that is to say, they suffered from some measure of physical retardation in terms of growth, 6% suffered from acute malnutrition, and 15% were undernourished.

Many studies have found that inadequate nutrition during childhood affects the physical development of children in the long term [4,5], and the development of their cognitive abilities [6,7], as well as their ability to acquire education [8,9]. All these handicaps tend to affect their productivity as adults later in their working lives [10,11].

Child health and malnutrition should be directly related to household resources, in general and household consumption, in particular. It is apparent that income growth plays a key role in the fight against child malnutrition, which is one of the main Millennium Development Goals (MDGs) of the United Nations [12,13,14]. Higher incomes provide households with the wherewithal to spend more on food, potable water, hygiene, and preventive and curative medical care. They also enable them to have more diversified diets, and to make more effective arrangements for the care of their children. At the community level, higher incomes eventually give households easier access to quality medical services, to improved water and sanitation systems, and to greater access to information. Although these relationships are theoretically clear, their measurement is necessary and useful in the determination of the most significant factors affecting malnutrition for the effective design of strategies and policies aimed at addressing this phenomenon.

In the literature relative to the determinants of child health, studies in Cameroon that deal specifically with the impact of household income on child malnutrition are rare. To the best of our knowledge, the only study that includes household's asset as one of the determinants of child health or malnutrition using Cameroon data is [15]. Therefore, the brief review of literature on this theme is based on research studies carried out in other countries where empirical evidence generally supports the importance of income growth in the reduction of malnutrition [16,17,18].

According to [17], a sustained annual growth rate in per capita income of 2.5% over a 15-year period may lead to a decline of about 3 to 6% in chronic child malnutrition in Ethiopia. However, these authors argue that income growth alone cannot be sufficient to alleviate child malnutrition, for nutrition is also affected by several other factors.

In a similar way, [16] note that an impressive reduction in poverty and stunting among children has been achieved in Vietnam owing to the rapid economic growth witnessed by this country since 1986. These authors arrive at the conclusion that, even though the increase in the amount of household income was not very large, it had a positive impact on child nutrition during the 90s. They also noticed that stunting among children fell over time within each quintile even after making adjustments for changes in income, thus suggesting that factors other than income growth were also responsible for improvements in child nutrition.

A study by [19] used panel household survey data from 12 countries (including three African countries, namely Kenya, Mozambique, and South Africa) to estimate the magnitude of response of the weight-for-age indicator to an increase in income. Under a sustained annual growth rate scenario of 2.5% in per capita income, the average reduction in the proportion of underweight children would lie between 27% and 34%. These figures however conceal substantial variations between countries even in the case of African countries, because this reduction could be estimated at about 42% for Kenya and 14% for South Africa, if malnutrition were analysed in each individual country.

[20] assess the joint contribution of an increase in income and of interventions in favour of nutrition in the reduction of malnutrition in Tanzania. Using panel data gathered in the north western part of this country in addition to OLS and instrumental variables (IV) techniques, they estimated child nutritional status by including household income and community actions in favour of nutrition among other determinants of child malnutrition. Their results show that the best nutrition is associated with higher incomes, and that community nutritional actions have a substantial salutary impact on child nutrition. Their policy simulations clearly indicate that if malnutrition among children was to be reduced by half by 2015 as required by that MDG objective, income growth must has been supplemented with large-scale nutritional action programmes in Tanzania.

[21] use a unique dataset from Northern Ghana to explain the underlying causes of childhood malnutrition. They adopt an empirical framework to model inputs in the production of health and nutrition, as a function of child, household and community characteristics. Their findings suggest notably that child characteristics are important in explaining inputs and nutritional outcomes, and that maternal agency and health contribute to improved health status. Household resources in the form of consumption are positively associated with food intake and nutritional outcomes. The simulations show that income growth, improving maternal care and avoiding sudden price shocks have a positive but rather limited effect on the reduction of malnutrition. Effects are greater in children under two.

[22] examine the important socioeconomic determinants of malnutrition among under-five children in India. They use descriptive analyses and regression analyses to explore the determinants of child malnutrition from National Family Household Survey-III, 2005-06 data on around 38,000 children from all parts in India. Descriptive results of Z-Score (below -2 SD) indicate that 48.0%, 42.5% and 20.89% of the sample children under five were stunted, underweight and wasted respectively. Regression analyses (OLS and Ordered Probit models) show that the significant determinants of malnutrition are age and birth history of child, mother's education, mother's underweight, wealth of the households, household size and presence of toilet in the households.

[23] analyse the anthropometric determinants of children based on a sample of poor Colombian children living in small municipalities by focusing on the impact of household consumption and public infrastructures. Their study takes account of the endogeneity of household consumption by using two different sets of instruments: household assets and the average salary in the municipality. Their results notably show that household consumption is a highly significant determinant of child health. This result is confirmed by the two different sets of instruments. The authors find that the use of OLS estimation would lead to the conclusion that household consumption shows much less significance instrumental variables estimation. In terms of methodology, the studies examined the relationship between child health and its determinants using notably the standard OLS and instrumental variables (IV) techniques.

To contribute to the literature on correlates of child health/nutrition, the present study uses three different approaches simultaneously: the OLS method, IV techniques and the control function approach to analyse the links between child health/nutrition and its determinants. Contrary to the other methods, the control function approach has the advantage that it can simultaneously purge estimated parameters of endogeneity and unobserved heterogeneity biases.

This paper, therefore, aims at modelling some of the main determinants of child health/nutrition in Cameroon. In particular, it investigates the potential effects of household consumption spending on child health/nutrition status in Cameroon, while controlling for other correlates.

This paper is organized as follows: after the introduction, Section 2 presents the theoretical and methodological framework of the study. Section 3 describes the data used in the study. Section 4 presents and discusses the empirical results of the study, while Section 5 concludes the study and provides some policy recommendations.

2. MATERIALS AND METHODS

2.1 Theoretical Framework

Since the household head plays a key role in making decisions on problems linked to child health and nutrition outcomes, we adopt in this study a methodological framework in which the household utility function encompasses child health captured by the three standard anthropometric measures, namely: height-for-age, weight-for-age, and weight-for-height z-scores of children aged 0 to 36 months. In many studies, the anthropometric indicators of child health and nutrition tend to be positively associated with the chances of a child to survive, his later health status, his subsequent performance in school, and his eventual productivity as an adult worker [24].

Nowadays, the analysis of the supply and demand for reproductive health care is increasingly carried out using the theoretical framework of the household model based on « the new household economics ». This theoretical framework assumes that households also derive utility from home goods and services (i.e. which are also produced for the home and for which there is no market). This framework is well-known and discussed in detail in studies by [25,26,27], and it is applied in works by [28,29].

In a simple version of this model, it is assumed that the household maximizes a utility function which depends on leisure, market goods (goods bought and sold on the market), and home goods (goods produced at home) such as child health, subject to four main constraints, namely: the budget, time, distance, and health production function constraints. The health production function depends on the inputs bought on the market such as food (or nutritive elements) and health services, time and the main characteristics of working households, the environment, and the community in which the household resides such as the sewage system and sanitation, access and nearness of public services, as well as the child's endowments.

In our specific context, we glimpse at household utility through the utility function of the household head in terms of three representative commodities: (1) a health-neutral good, X, (that is, a good that yields utility to the household head but has no direct effect on reproductive health status of the household, e.g. a household durable asset etc.; (2) a health-related good, service or behaviour, Y, that yields utility to the household head and also affect child health and nutrition, e.g. food, smoking and drinking; and (3) health and nutritional status of the child, H, captured by anthropometric indicators. Such a utility function may take the implicit form:

$$U = U\left(X, Y, H\right) \tag{1}$$

where, X is the health-neutral good; Y is the health-related good, service or behaviour; and H is the health and nutritional status of the child.

The production function of health and nutritional status of the child can take the implicit form:

$$H = f\left(Y, Z, \mu\right) \tag{2}$$

where, Z is purchased market inputs such as medical care goods and services that affects child health directly, and μ is the component of child health due either to genetics (such as parents height) or environmental conditions and other unobserved variables. Notice that good Z enters the household utility function only through H, which captures the child's health and nutrition. The household through the head can be seen as maximising utility (Equation (1)) and health production (Equation (2)) subject to a budget constraint that resembles Equation (3).

$$I = XP_x + YP_y + ZP_z \tag{3}$$

where, I is exogenous income, P_x, P_y, P_z are, respectively, the prices of the health-neutral good such as hairstyle; the health-related consumer good such as alcohol; and the health enhancing investment good such as child or mother's immunization and household head's education or literacy status.

Equations (1)-(3) can be manipulated to yield reduced from reproductive health care demand functions related to the X, Y and Z goods. The equilibrium conditions of this model are: (a) that the marginal products of reproductive health inputs equal their respective average prices; and (b) that the marginal rates of substitution between each pair of items in the utility function should equal the price ratios between them.

2.2 Empirical Model Specification

We adopt a causal chain depicted by the link between child nutrition (N) and the parental per capita consumption expenditure (PCE). Following [30,31], our empirical specification may be given by the following equations:

$$N = w_1\delta_n + \eta PCE + \varepsilon_1 \tag{4}$$

$$PCE = w\delta pce + \varepsilon_2 \tag{5}$$

where, *N* and *PCE* respectively represent child nutrition (HAZ, WAZ, or WHZ) and the household head per capita consumption; w_1 is a vector of exogenous variables such as individual characteristics, and those of the household, the community, and the region of residence, participation in post-natal campaigns, etc; *w* is a vector of exogenous variables comprising the vector w_1, which belong to the equation of child nutrition (the outcome equation), and a vector of instrumental variables, w_2, which affect the per capita consumption of the household head (PCE), but has no influence on child nutrition, *N*; and finally δ and η are vectors of parameters to be estimated, while ε is the error term, respectively.

In tandem with the complementarity and substitution assumptions, the null hypothesis of no spillover is $H_0 : \eta = 0$ [32]. Since Household head per capita consumption has no biomedical impact on child nutrition, the alternative hypothesis $\eta > 0$ is assumed to work through an increase in the child health inputs in response to an increase in investment incentives, given that high income exposes the household head to better child care and health practices. The alternative hypothesis (substitution) $\eta < 0$ is supposed to work through public policy which is explicitly biased in favour of improving access to public health-care infrastructures and other health inputs to children in poor households.

Equation (4) is the structural equation of interest, that is, the production technology of child nutrition whose parameters will be estimated. It is possible for an inverse causality to exist in Equation (4), because household head per capita consumption is assumed to supplement some relevant inputs which are omitted in the child health production function. In this situation, ordinary least squares (OLS) estimation generally yields biased and inconsistent estimates. Getting rid of the potential problem of endogeneity calls for using instrumental variables which do not belong to the outcome equation, but which are correlated with the endogenous explanatory variable (i.e. household per capita consumption), conditional upon the other co-variables.

Equation (5) is the linear projection of the potential endogenous variable (PCE) on all the exogenous variables (w), i.e. a reduced form of the probability model of the household per capita consumption.

To take account of potential endogeneity and the nonlinear interactions of unobservable (latent) variables with the regressors of child nutrition, and to explain the behaviour of complementarity/ substitution between the per capita consumption of the household and the other health inputs, Equation (4) may be augmented to become the control equation (Equation (6)) as follows [33,29]:

$$N = \alpha_0 + w_1\delta + \eta PCE + \alpha_1\hat{\varepsilon}_2 + \gamma\hat{\varepsilon}_2 * FCE + \mu \tag{6}$$

where, $\hat{\varepsilon}_2$ is the residual estimated from *PCE*, and derived from the reduced-form model of household per capita consumption, Equation 5; and ($\hat{\varepsilon}_2$ **PCE*) is the interaction of the estimated residual of household per capita consumption with the observed value of household per capita consumption, while μ is a composite error term composed of ε_1 and the unpredicted part of ε_2, under the assumption that $E(\mu) = 0;$ lastly, δ, η, α, and γ are parameters to be estimated.

Exclusion restrictions are imposed on Equation (6), for the vector of instruments w_2, representing the household per capita consumption variable PCE, is omitted from the equation. The terms $\hat{\varepsilon}_2$

and ($\hat{\varepsilon}_2$ *PCE*) in Equation (6) are the control function variables because they control for the effects of unobservable factors which, in one way or another, would contaminate the structural parameter estimates. The reduced form of the household capita consumption residual $\hat{\varepsilon}_2$, serves as a control for the unobservable variables which are correlated with PCE. In particular, if an unobservable variable is linear in $\hat{\varepsilon}_2$, only the constant term will be affected by this unobservable variable, and the estimates derived from Equation (6) using the instrumental variables (VI) method are consistent, even without the inclusion of the interaction term.

In addition, [34] notes that the estimates derived from Equation (6) using the method of instrumental variables (VI) are unbiased and coherent only when the expected value of the interaction term between household per capita consumption and its residual ($\hat{\varepsilon}_2$ *PCE) is nil, or when the expectation of the interaction term between household per capita consumption and its estimated residual is linear. However, if the correlation is nonlinear, then the use of the control function approach is required and the inclusion of the interaction term, ($\hat{\varepsilon}_2$ *PCE*) in Equation (6) purifies the coefficient estimates of the effects of unobservable variables (see [35,31,29]).

3. DATA PRESENTATION, MEASURES OF CHILD HEALTH AND DESCRIPTION OF VARIABLES

3.1 Data Presentation

The data used in this study are derived from the Cameroonian household survey - ECAM II, conducted by the National Institute of Statistics (NIS) from September to December 2001. The ECAM II survey is representative at the national level; it contains a sample of about 12000 households and 4516 children aged from 0 up to 36 months, and it was carried out with a view to construct a poverty profile for Cameroon at the national level and at the levels of the 10 provinces of the country. The sampling basis of this survey was the 2nd General Census of the Population and the Habitat (GCPH) of April 1987 which was updated to take account of its age. Two types of sampling were carried out according to area of residence.

In the main cities of Yaoundé and Douala (respectively, the political and economic capitals of the country), a two-stage sampling frame was adopted. On the other hand, in the semi-urban and rural strata of the provinces, a three-stage sampling frame was adopted following the sequence city – primary sampling unit - household, with equal probability at each level. Such sampling frames make it possible to carry out an analysis both at the national and provincial levels and at the rural and urban levels.

The ECAMII questionnaire was organized around 15 sections, of which several can be used to analyze both the demand for reproductive health care services and the nutritional status of children in Cameroon. Considering the objective of this study and the links existing between the different sections of the questionnaire, the files containing the data on individual and household characteristics were used to carry out the present study. Data on individual characteristics notably involve the anthropometric attributes of children aged 0 to 36 months, the demographic attributes and the education of household members. On the other hand, the information gathered by the survey at the household level include, among other things, access to basic infrastructures, access to social services, land ownership, and household expenditures [36].

3.2 Child Health/Nutritional Status

The nutritional status of young children is measured with the help of anthropometric indicators [25,37,9] which are considered as objective indicators of the health status [38]. Our measures of child malnutrition are therefore based on the following three anthropometric indicators, namely: height-for-age, weight-for-age, and weight-for height. Each index is expressed in terms the number of standard deviation (SD) units relative to the median of the National Center for Health Statistics (NCHS)/the Centers for Disease Control and Prevention (CDC)/the World Health Organization (WHO) international population of reference, and they provide somewhat different information on child nutritional status [39,40,41,42,43].

The height-for-age indicator is a chronic malnutrition index, for it measures long-term malnutrition effects and varies only very little depending on the season and the data gathering period. Too small a height for a given age is a manifestation of stunting.

As for weight-for-height indicator, it provides a measure of body mass in relation to height. A low value for the weight-for-height index is usually associated with acute malnutrition or wasting. This indicator is considered as a good reflection of the actual nutritional situation (when the survey is in progress), following a recent and severe process of weight loss, which is often linked to an acute privation of food (i.e. starvation) and/or severe illness. It is therefore affected by the period during which data is being gathered. This index makes it possible to estimate the emaciation generally associated with a recent or progressive weight loss.

The weight-for-age indicator reflects both the height-for-age and weight-for-height indicators. It is therefore a combined index: too small a weight for a given age is a sign of being underweight among children. Although commonly used in monitoring growth among children less than 5, its interpretation is more difficult because it does not make a distinction between acute and chronic malnutrition.

3.3 Description of the Variables

The outcome variables of interest in this paper are: height-for-age z-score (HAZ), weight-for-age z-score (WAZ), and weight-for-height z-score (WHZ). These variables are used as the dependent variable in estimating the child health/nutrition production function. The right-hand-side variables in the regression estimates include real per capita household consumption expenditure, parental age in years, completed grades of schooling, distance in meters to the nearest private primary school, father present in the household during survey, the dependency ratio, sex of child (male), child's age in months, and time in minutes to the nearest health center.

Table 1 reports sample mean and standard deviation of all variables used in the regression specifications.

Table 1. Description of the variable used and descriptive statistics

Variables	Definitions of variables	Observations	Mean	Standard deviation
Haz	Height for Age Z-Score of the 0-36 months old	4510	-1.056	5.455
Waz	Weight for Age Z-Score of the 0-36 months old	4168	-0.288	3.398
Whz	Weight for Height Z-Score of the 0-36 months old	4185	1.374	5.144
logtotale~c1	Log of total expenditure per Capita (adults)	4516	12.051	0.643
m_childsex	Gender of child: male_child=1 and 0, otherwise	4516	0.512	0.499
child_age	Child age in months	4394	15.776	9.939
childage2	Child age squared	4402	347.111	342.251
ageg2	person is between 5 -9 years	4516	1.605	1.410
ageg3	person is between 10 -14 years	4516	1.281	1.342
ageg7	person is between 25 - 59 years	4516	0.253	0.556
logdistpriv3	Log of distance in meters to the nearest private primary school	4516	8.802	2.904
logtimehea~c	Log of time in minutes to the nearest health center	4516	3.025	1.023
Fpresent	Father present in the household during the survey	4516	0.934	0.2471
Logland	Log of land in hectares	4494	2.141	0.624
logland2	Log of land squared	4494	4.974	2.972
edulevel1	Persons with primary level of Education	4516	0.376	0.484
edulevel2	Persons with secondary first and second cycle level of education	4516	0.265	0.441
edulevel3	Persons with tertiary level of education	4516	0.0476	0.2130
Formalsector	Formal sector	4516	0.219	0.414
dependency~o	household size minus adults over adults	4506	1.5667	0.957

Source: Computed by authors using ECAM II data set

4. RESULTS AND DISCUSSION

4.1 Estimates of Child Nutrition under Alternative Assumptions: Full Sample

Table 2 presents the structural-form estimates of the child nutrition production function for the whole sample according to different assumptions. In effect, column (1) contains the gross OLS structural parameter estimates of equation 4, while column (2) represents first-stage OLS estimates, or the reduced form of the consumption equation (regression of the log of consumption expenditure per head on the instruments and the others co-variables). Column (3) contains the structural parameter estimates derived from 2-stage least squares (2SLS)/instrumental variables (IV) estimation to correct for potential endogeneity. Columns (4) and (5) respectively represent the control function estimates, captured by the nonlinear interaction term.

Column (2) of Table 2 presents the OLS structural parameter estimates of the short-run child nutrition production function (WAZ).

These estimates indicate that if the log of consumption expenditure is assumed to be exogenous, it would seem to increase child nutrition very significantly by 0.32 standard scores, while controlling for other correlates. This indicates that child nutrition is highly correlated with household consumption expenditures. A similar result was obtained by [23], using data from Colombia.

However, OLS estimation most probably suffers from the omitted-variables bias due to the unobservable characteristics of the community. In addition, the OLS estimates might also be biased, since they ignore the endogeneity and measurement errors inherent in the household expenditure variable.

Households typically make decisions about the health of their children concurrently with decisions about the best way to earn income from employment, and these decisions may be associated with one another. For instance, parents whose children suffer from chronic illness may have to buy expensive drugs or medical services, and some household members may have to work more hours to pay for these drugs or medical services. If such is the case, OLS estimation would tend to underestimate the impact of household income on child health (nutrition), because the unobserved negative health shocks would be positively correlated with household income.

On the other hand, some household members, such as the mother, may reduce their hours of work during the illness of the child to spend more time taking care of him /her. In this case, OLS estimation would overestimate the impact of household income on the health of the child.

Another issue linked to both household income and expenditure is their strong likelihood of being measured with error, because it is difficult for households to provide this type of information accurately. Therefore, as in [16], this paper uses household expenditure rather than income because expenditure survey data are more likely to represent actual household expenditure more accurately [44]. However, it should be noted that even these expenditure data may have substantial measurement errors, many of these errors being random. This would result in an underestimation of the real impact of household expenditure on child health or nutrition.

In principle, instrumental variables method can eliminate the bias caused by either endogeneity or by errors of measurement. The problem is to find plausible instrumental variables, i.e. variables correlated with household consumption expenditure, but uncorrelated with the unobserved determinants of child health (nutrition) and measurement errors.

The literature on demand systems typically uses income to instrument consumption. If preferences are separable between consumption and leisure, total consumption and not income is relevant to decide on the good shares. However, there exist several reasons for which household income cannot be a valid instrument. In effect, households with a child in bad health can increase the supply of labour to save money with a view to meet future medical care expenses. Consequently, income would be negatively linked to the error term even after having conditioning on total consumption.

In addition, families with children in poor health may receive transfers which might also produce a negative correlation between the error term and household income. These discussions therefore prevent us from using household income as an instrument. Consequently, we explored alternative identification strategies and kept 6 identifier instruments of household consumption expenditure, namely: the log of land (logland), the log of land squared (logland2), the educational levels of parents (edulevel1, edulevel2, edulevel3), the formal sector (formalsector), and the dependence ratio (dependencyratio) (Column 3).

According to the 2SLS estimates in Column 3 of Table 2, the consumption expenditure of the household increases the observed nutritional status by 2.298 standard scores. This shows that after correcting for endogeneity, the coefficient of the log of consumption expenditure significantly increases by about thrice compared with the estimates derived from OLS (Column 2). This is proof that the magnitude of the consumption expenditure effect on child nutrition depends on the method of estimation. Thus, to avoid false policy implications, it is of crucial importance to use adequate estimation methods which internalize potential econometric problems.

The reduced form of the determinants of the log of consumption expenditure in Column 3 of Table 2 offers proof that land ownership in acres is significantly positive in explaining household consumption expenditure, and records decreasing returns to scale as borne out by the negative and statistically significant sign of the « land squared » variable. The educational levels of the household heads and their membership to the formal sector are individually and jointly significantly in the explanation of the household consumption expenditure.

On the other hand, the dependence ratio is negatively significant in the explanation of household consumption expenditure. This could represent evidence of the prevalence of child labour.

The F-statistic of 129.65 (p-value = 0.000) for the excluded variables indicates that the six identification variables are jointly significant. The Sargan Chi-sq test statistic of 18.390 (p = 0.0053) does not cast any doubt on the validity and the strength of the 6 instrumental variables. Moreover, by tolerating the relative bias of 2SLS up to 5%, the test statistic of 129.65 [exceeds the Stock-Yogo weak ID test critical value of 19.28, thus confirming that our instruments are not weak (Column 3). The tests appearing at the bottom of Table 2 also show that household consumption expenditure is indeed exogenous with a Durbin-Wu-Hausman Chi-square statistic of 47.70 (p-value = 0.000), which indicates that the OLS estimates are not reliable for making inferences. This result is confirmed by the significance of the predicted residual of the potential endogenous variable, i.e. the log of household consumption expenditure (Column 5 of Table 2).

The effect of problems caused by the endogeneity and nonlinearity of unobservable variables on household consumption expenditure is captured by comparing the OLS coefficients estimates (Column 2) with the control function estimates (Columns 4 and 5 of Table 2). When the control function approach is used without the interaction term (which implies the use of 2SLS estimation and the inclusion of the residual of the log of total household expenditure (residlogto~h) to take potential endogeneity into account), the coefficient of the log of total household expenditure as compared with the one obtained OLS estimation (Column 2), almost triples in size to 0.972 standard scores (Column 5), but slightly decreases when it is estimated using 2SLS (Column 4).

Moreover, taking account of the possibility of nonlinear interactions between household consumption expenditure and unobservable variables slightly reduces the coefficient estimate of household consumption expenditure, which amounts to 0.963 standard scores and still remains triple the size of the OLS coefficient estimate. Since the interaction term is statistically significant at the 10% level, the 2SLS coefficient estimate of the log of total household expenditure in the pooled sample is biased downwards.

The absolute value of the coefficient of the residual, for the log of consumption expenditure without restrictions on nonlinear interactions, is equal to 0.789 with a t-statistic of 4.01 (see Column 4). In addition, by imposing restrictions on nonlinear interactions between the log of consumption expenditure and unobservable variables (see Column 5), the absolute value of the coefficient increases to 2.644 and becomes less statistically significant with a Student t-ratio of 2.71. Since the interaction term is statistical significance at the 10% level, it follows that the log of consumption expenditure is endogenous relative to child nutrition, but evidence for heterogeneity of child nutrition response to household consumption expenditure is not very strong.

Table 2. Estimation of the child nutrition production function under different assumptions – Dependent variable is weight-for-age z-score (WAZ)

Variables	OLS	IV		Control function approach	
	WAZ	logtotale~c1	WAZ	WAZ	
	(1)	(2)	(3)	With interaction(4)	Without interaction (5)
logtotale~c1	0.319***	-	0.911***	0.963***	0.972***
	(4.37)		(5.31)	(5.42)	(5.47)
m_childsex	-0.300***	0.054***	-0.332***	-0.322***	- -0.328***
	(-3.54)	(3.27)	(-3.86)	(-3.79)	(-3.86)
Child_age	-0.249***	0.001	-0.250***	--0.250***	- 0.249***
	(-15.19)	(0.35)	(-15.09)	(-15.22)	(-15.18)
childage2	0.005***	-0.000025	0.005***	0.005***	0.005***
	(11.58)	(-0.27)	(11.52)	(11.60)	(11.57)
Ageg2	0.1008***	-0.055***	0.144***	0.157***	0.153***
	(2.89)	(-7.87)	(3.91)	(4.21)	(4.12)
Ageg3	-0.162***	-0.037***	-0.138***	-0.135***	-0.138***
	(-4.61)	(-5.47)	(-3.81)	(-3.78)	(-3.87)
Ageg7	0.378***	-0.042***	0.447***	0.452***	0.450***
	(4.98)	(-2.81)	(5.68)	(5.80)	(5.77)
Logdistpriv3	-0.090***	-0.014***	-0.067***	-.0061***	-0.063***
	(-5.59)	(-4.42)	(-3.86)	(-3.52)	(-3.59)
Logtimehea~c	-0.276***	-0.065***	-0.207***	-0.187***	-.0190***
	(-6.18)	(-7.33)	(-4.26)	(-3.77)	(-3.85)
Fpresent	-0.004	0.052	-0.0409***	-0.038	-0.045
	(-0.02)	(1.58)	(-0.24)	(-0.23)	(-0.27)
Identification variables that affect logtotale~c1 but not WAZ					
Logland		0.307***			
		(7.86)			
Logland2		-0.059***			
		(-7.33)			
edulevel1		0.064***			
		(3.09)			
edulevel2		0.300***			
		(12.24)			
edulevel3		0.658***			
		(14.62)			
formalsector		0.305***			
		(13.61)			

dependency~o		-0.058*** (-6.18)			
Control function variables (account for WAZ effects of unobservables in the error term of the projected endogenous variable)					
residual of spending				-2.644*** (-2.71)	-0.789*** (-4.01)
residual times spending				0.151* (1.94)	
_cons	-0.734 (-0.75)	11.981*** (159.88)	-8.342*** (-3.75)	-9.150*** (-3.96)	-9.176*** (-3.97)
Number of obs.	4025	4018	4018	4018	4018
F-Stat	56.06	121.62	55.98	52.53	48.50
[df]	[10, 4014]	[10, 4001]	[10, 4007]	[11, 4006]	[12, 4005]
Adj R-squared	0.1204	0.3272	0.1062	0.1237	0.1269
Partial R-squared (on excluded instruments)		0.1849			
Test of Joint Significance of Identifying Variables/Cragg-Donald F-Statistic for weak identification test					
F-stat		129.65			
[df; p-value]		[7,4001; 0.000]			
5% Relative Bias		19.86			
Underidentification tests (Anderson canon. corr. LR statistic)					
Chi-sq [df; p-value]		821.38 [7; 0.000]			
Sargan statistic (overidentification test of all instruments)					
Chi-sq [df; p-value]			18.390[6; 0.0053]		
Durbin–Wu–Hausman Chi2 test for exogeneity of the potential endogenous variables [df; p-value]			47.70 [7; 0.000]		

Source: Computed by authors using ECAMII survey data and STATA 9.1.

*Notes: (·) implies t-ratios. ***, ** and * indicate 1%, 5% and 10% levels of significance, respectively*

Thus, control function modelling has a great advantage over other modelling approaches owing to the fact that it is able to purge the structural parameters of most potential econometric problems such as the endogeneity and heterogeneity of unobservable variables with the endogenous variable. Heterogeneity may come from the nonlinear interaction of the log of consumption expenditure with the unobserved or omitted determinants of child nutrition, the genetic characteristics of parents, and their environment.

Given that all the empirical specifications in this study yield a positive and highly significant effect of the log of consumption expenditure on the Z score weight-for-age, (and Z score height-for-age, Z score weight-for-height; see Tables 3 and 4 in appendix), there is no reason to believe that consumption expenditure affects the height and weight of the child directly.

A meticulous examination of the different structural equation specifications made in this study, reveals that there is no evidence suggesting the existence of a bias against young girls. On the other hand, the effect of household consumption expenditure puts boys at a disadvantage, since they have lower weight-for-age Z-scores (WAZ), which are highly significant because boys are more likely to be undernourished than girls. Moreover, in all these structural equation specifications, the behaviour of child age coefficients displays an inverted U-shaped form, which indicates that younger children have a higher probability of being undernourished than older ones. Likewise, the behaviour of coefficients linked to the age of household heads in all the specifications follow an inverted U-shaped profile, indicating that older household heads are more likely to have well-fed children than younger ones. It may therefore be concluded that younger household heads lack experience when it comes to achieving positive nutritional results.

All the preceding results are obtained by considering our sample as a homogeneous group. Yet, an empirical disaggregation of this sample according to gender of the household head is useful for targeting public health interventions.

4.2 Control Function Estimation of the Child Nutrition Production Functions (WAZ, HAZ, and WHZ)

Tables 5, 6, and 7 respectively present the structural parameter estimates of the WAZ, HAZ, and WHZ nutrition production functions generated by the control function at the national level and according to gender of the household head, by assuming that the existence of linear interactions between total household expenditure and the unobserved variables.

An examination of the structural parameter estimates of the WAZ in Table 5 shows that, for the sub-sample of male household heads, the impact of total household expenditure on the child's weight (given his weight) is positive and significant. This impact is one and a half times higher than the one produced by the sample with pooled data (Column 1). On the other hand, the sample of female household heads reveals a negative and insignificant relationship between household consumption expenditure and the WAZ estimate (Column 3). Similar but insignificant results are obtained for the structural parameter estimates of the WHZ (see Table 7 in Appendix).

By contrast, the structural parameter estimates of the HAZ (Table 6 in Appendix) indicate that, for the sub-sample of male household heads, the impact of total household consumption expenditure on the height of the child (given his age) is positive but insignificant. In addition, the female household heads sub-sample also reveals a positive but insignificant relationship between household consumption expenditure and the HAZ. Were these results significant, they would be consistent with the complementarity hypothesis.

In general, the above empirical results suggest that male household heads are more instrumental than their female counterparts in seeking useful health practices. This result seems to contradict the one often found in the literature; but it is quite plausible because female household heads generally have lower incomes, and they tend to be confronted with many problems which they alone can manage, notably, when they are household heads and/or single parents.

On the other hand, male household heads generally earn higher incomes than their female counterparts. Moreover, they are usually assisted by their spouses when confronted with family problems, and they seek the quality information on nutrition and health which may help improve the child's anthropometrics. The positive effect of household consumption expenditure on child health obtained for the sub-sample of male

Table 5. Estimation of child-health production function (WAZ) using control function approach by gender

Variables	All (1)	Male (2)	Female (3)
logtotale~c1	0.963***	1.0831***	-0.102
	(5.42)	(5.62)	(-0.19)
m_childsex	-0.322***	-0.376***	-0.027
	(-3.79)	(-4.06)	(-0.13)
Child_age	-0.250***	-0.257***	-0.227***
	(-15.22)	(-14.35)	(-5.49)
Child_age2x10^{-2}	0.157***	0.006***	0.004***
	(4.22)	(11.03)	(3.94)
age2x10-3	0.157***	0.203***	- 0.167*
	(4.22)	(4.97)	(-1.64)
Age3x10-3	-0.135***	-0.132***	-0.241**
	(-3.78)	(-3.45)	(-2.11)
ageg7 x10-3	0.452***	0.402***	0.831***
	(5.80)	(4.84)	(3.40)
logdistpriv3	-0.061***	-0.073***	0.047
	(-3.52)	(-3.84)	(0.88)
logtimehea~c	-0.187***	-0.164***	-0.353***
	(-3.77)	(-3.02)	(-2.73)
fpresent |	-0.038	0.015	-0.327
	(-0.23)	(0.09)	(-0.53)
Control Function Variables (Account for WAZ effects of unobservables in the error term)			
residual of spending	-2.644***	-1.816*	-7.10***
	(-2.71)	(-1.71)	(-2.67)
residual times spending	0.151	0.079	0.588**
	(1.94)	(0.94)	(2.75)
_cons	-9.150***	-10.595***	3.045
	(-3.96)	(-4.22)	(0.44)
Number of obs	4018	3370	648
F-Stat [df]	45.76 (12, 4005)	43.53 (12, 3357)	7.90 [12, 635]
R-squared	0.1269	0.1346	0.1299
Adj R-squared	0.1243	0.1315	0.1134

Source: Computed by authors using ECAMII survey data and STATA 9.1.
*Notes: (·) implies robust t-ratios. ***, ** and * indicate 1%, 5% and 10% levels of significance respectively*

household heads may be considered as including the unobservable contribution of their spouses, since this effect is likely to be the result of household members working in synergy. Furthermore, male household heads are usually assisted by their spouses when they are looking for child health care technologies.

5. CONCLUSION

The purpose of this study was to carry out an empirical estimation of the potential effects of household income/consumption expenditure on the nutritional status of children in Cameroon, and to examine gender disparities in the effects of consumption expenditure. Three different econometric estimation approaches were used in the study - ordinary least squares (OLS), instrumental variables (IV) techniques, and the control function approach. The data used were derived from the Cameroonian household consumption survey (ECAM II) conducted in 2001 by the National Institute of Statistics (NIS) over the national territory.

The results of the study show that the control function approach is the appropriate estimation strategy, for it purged the structural parameters of potential econometric problems such as the endogeneity and unobserved heterogeneity. Household consumption expenditure is positively and significantly associated with child nutritional status. This result has important policy implications one of the most important being that, since inadequate nutrition in childhood affects the physical and psychological development of children, and their ability to acquire education, the lack of household resources will manifest itself in the deterioration of the health status of children and will probably hinder long-term welfare and human capital accumulation in societies in which they live. Consequently, policies ensuring adequate resource availability to households should figure high on the decision-makers agenda.

Moreover, the parameters estimated with the instrumental variables (IV) method or those derived from the control function approach, which assumes the presence of nonlinear interactions with the residual of consumption expenditure, are the appropriate estimation strategies for the whole sample.

Furthermore, a meticulous examination of the different specifications of the structural equations reveals that there exists no evidence suggesting the existence of a bias against young girls. By contrast, the effect of household consumption expenditure puts boys at a disadvantage, since they had lower weight-for-age Z-scores (WAZ), which are highly significant because boys are more likely to be undernourished than girls. Older household heads were more likely to have well-fed children than younger ones. This result indicated that older household heads were more experienced in achieving positive nutritional outcomes.

Generally speaking, our empirical results indicate that male household heads are more instrumental than their female counterparts in the search for useful health practices. This finding seems to be the opposite of the one usually found in the literature; but it is quite plausible because female household heads generally have lower incomes, and they tend to confront many problems, especially as they are typically single parents.

The impact of consumption spending on child nutritional status captured in the male head sub-sample is more spectacular than those derived from the whole sample. This finding suggested that the incomes of male household heads play a more decisive role in financing child health than those of female household heads. The positive effect of household consumption expenditure on child nutritional status obtained from the sub-sample of male heads could be considered as including the contribution of the incomes of their spouses, given that this effect is likely to be the result of joint financing when child health care has to be taken care of.

These findings indicate the importance of using sub-samples when the objective is to carry out an empirical analysis of the impact of household consumption spending on child nutritional status, and to gain more insight in terms of magnitude of parameter estimates and the verification of potential econometric problems of endogeneity and unobserved heterogeneity.

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COMPETING INTERESTS

Authors have declared that no competing interest exists.

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APPENDIX

Table 3. Estimation of the child nutrition production function under different assumptions – dependent variable is height-for-age z-score (HAZ)

Methods	**OLS**	**IV**		**Control function approach**	
Variables	**HAZ**	**logtotale~c1**	**HAZ**	**HAZ**	
	(1)	**(2)**	**(3)**	**With interaction(4)**	**Without interaction (5)**
Logtotale~c1	-0.071	-	0.207	0.579**	0.207
	(-0.69)		(0.81)	(2.17)	(0.81)
M_childsex	-0.156	0.0451***	-0.168	-0.366***	- 0.167***
	(-1.28)	(2.79)	(-1.36)	(-3.21)	(-3.86)
Child_age	-0.697***	8.14e-06	-0.698***	--0.251***	- 0.698***
	(-29.68)	(0.00)	(-29.62)	(-12.58)	(-28,65)
Childage2	0.011***	0.00001	0.011***	0.005***	0.011***
	(17.06)	(-0.27)	(17.04)	(7.73)	(17.05)
Ageg2	-0.004	-0.060***	0.017	0.158***	0.017***
	(-0.10)	(-8.76)	(0.32)	(3.31)	(0.33)
Ageg3	-0.024	-0.033***	-0.014	-0.100**	-0.014
	(-0.48)	(-4.88)	(-0.28)	(-2.26)	(-0.28)
Ageg7	0.010	-0.042***	0.047	0.410***	0.047
	(0.10)	(-2.81)	(0.41)	(4.32)	(0.41)
Logdistpriv3	0.029	-0.019***	0.040*	-.0067***	0.040*
	(0.19)	(-6.20)	(1.64)	(-3.26)	(1.64)
Logtimehea~c	-0.206***	-0.080***	-0.170**	-0.221***	-.0.170**
	(-3.21)	(-8.56)	(-2.41)	(-3.66)	(-2.42)
Fpresent	-0.068	0.054*	-0.087	-0.152***	-0.087
	(-0.28)	(1.66)	(-0.35)	(-0.65)	(-0.35)
Identification variables that affect logtotale~c1 but not HAZ					
Logland		0.271***			
		(7.14)			
Logland2		-0.050***			
		(-6.42)			
edulevel1		0.037*			
		(1.87)			
edulevel2		0.237***			
		(10.07)			
edulevel3		0.637***			
		(14.65)			
formalsector		0.304***			
		(13.79)			
dependency~o		-0.063***			
		(-6.79)			
Control function variables (account for HAZ effects of unobservables in the error term of the projected endogenous variable)					
residual of spending				-2.417	-0.333
				(-1.61)	(-1.19)
residual times spending				0.158	
				(1.28)	
_cons	7.133***	12.136***	3.532	-4.417***	3.533
	(5.09)	(167.56)	(1.07)	(-1.30)	(1.07)
Number of obs.	4046	4046	4357	2355	4357
F-Stat	69.73	129.95	284.47	27.32	259.16
[df]	[6, 4039]	[16, 4340]	[10, 4346]	[12, 2342]	[11, 4345]
Adj R-squared	0.0925			0.1183	0.3946
Partial R-squared (on excluded instruments)		0.1702			
Test of Joint Significance of Identifying Variables/Cragg-Donald F-Statistic for weak identification test					
F-stat		127.14			
[df; p-value]		[7, 4340; 0.000]			
5% Relative Bias		19.86			
Underidentification tests (Anderson canon. corr. LR statistic)					
Chi-sq [df; p-value]		812.72[7; 0.000]			

Sargan statistic (overidentification test of all instruments)	
Chi-sq [df; p-value]	7.802 [6; 0.2530]
Durbin–Wu–Hausman Chi2 test for exogeneity of the potential endogenous variables [df; p-value]	8.50 [7; 0.2908]

Source: Computed by authors using ECAMII survey data and STATA 9.1.
*Notes: (·) implies t-ratios. ***, ** and * indicate 1%, 5% and 10% levels of significance, respectively*

Table 4. Estimation of the child nutrition production function under different assumptions – dependent variable is weight -for-height z-score (WHZ)

Variables	**WHZ**	**logtotale~c1**	**WHZ**	**WHZ**	
	(1)	**(4)**	**(5)**	**With interaction(4)**	**Without interaction (5)**
logtotale~c1	0.434***	-	0.820**	0.878***	0.891**
	(3.34)		(2.69)	(2.78)	(2.84)
M_childsex	-0.319**	0.052***	-0.340***	-0.331**	- 0.339**
	(-2.12)	(3.20)	(-2.24)	(-2.19)	(-2.24)
Child_age	0.295***	0.0008	0.295***	0.295***	0.296***
	(10.10)	(0.26)	(10.08)	(-12.58)	(10.11)
childage2x10^{-2}	-0.004***	-0.000015	-0.004***	-0.004***	-0.004***
	(-5.59)	(-0.16)	(-5.58)	(-5.58)	(5.60)
Ageg2	0.141	-0.055***	0.169**	0.182***	0.178**
	(0.27)	(-7.91)	(2.59)	(2.75)	(2.68)
Ageg3x10^{-3}	-0.150**	-0.037***	-0.134**	- 0.128**	-0.133**
	(-2.39)	(-5.40)	(-2.10)	(-2.01)	(-2.09)
Ageg7	0.635***	-0.042***	0.681***	0.688***	0.686***
	(4.70)	(-2.82)	(4.41)	(4.95)	(4.93)
Logdistpriv3	- 0.095***	-0.014***	-0.080**	-. 0.074**	-0.076**
	(3.33)	(-4.49)	(2.69)	(-2.28)	(-2.44)
Logtimehea~c	-0.241***	-0.066***	-0.197**	-0.177**	-.0.182**
	(-3.03)	(-7.66)	(-2.29)	(-2.01)	(-2.07)
Fpresent	0.286	0.051	0.262	0.267	0.256
	(0.95)	(1.56)	(0.86)	(0.88)	(0.85)
Identification variables that affect logtotale~c1 but not WHZ					
Logland		0.308***			
		(7.89)			
Logland2		-0.059***			
		(-7.33)			
edulevel1		0.064			
		(3.09)			
edulevel2		0.296***			
		(12.13)			
edulevel3		0.658***			
		(14.66)			
formalsector		0.301***			
		(13.41)			
dependency~o		-0.059***			
		(-6.21)			
Control function variables (account for WHZ effects of unobservables in the error term of the projected endogenous variable)					
residual of spending				-3.207*	-0.551
				(-1.85)	(-1.19)
residual times spending				0.216	
				(1.56)	
_cons	-6.206***	11.986***	-11.1689**	-12.065***	-12.111***
	(-3.58)	(160.12)	(-2.83)	(-2.93)	(-2.95)
Number of obs.	4041	4034	4034	4034	4034
F-Stat	44.91	121.39	44.35	37.81	41.01
[df]	[10, 4030)	[16, 4017]	[10, 4023]	[12, 4021]	[11, 4022]
Adj R-squared	0.0980	0.3232	0.0961	0.0987	0.0984
Partial R-squared (on excluded instruments)		0.1834			

Test of Joint Significance of Identifying Variables/Cragg-Donald F-Statistic for weak identification test		
F-stat	128.86	
[df; p-value]	[7, 4017]	
5% Relative Bias	19.86	
Underidentification tests (Anderson canon. corr. LR statistic)		
Chi-sq [df; p-value]	817.185	
	[7, 0.000]	
Sargan statistic (overidentification test of all instruments)		
Chi-sq [df; p-value]		8.792
		[6, 0.1856]
Durbin–Wu–Hausman Chi2 test for exogeneity of the potential endogenous variables [df; p-value]		

Source: Computed by authors using ECAMII survey data and STATA 9.1.
*Notes: (·) implies robust t-ratios. ***, ** and * indicate 1%, 5% and 10% levels of significance, respectively*

Table 6. Estimation of child-health production function (HAZ) using control function approach by gender (assuming both linear and non-linear interactions)

Variables	All (1)	Male (2)	Female (3)
logtotale~c1	0.210	0.206	0.067
	(0.83)	(0.74)	(0.09)
m_childsex	-0.127	-0.376***	-0.391***
	(-0.94)	(-4.06)	(-13.53)
Child_age	-0.687***	-0.687***	0.749***
	(-29.62)	(-26.46)	(-5.49)
Child_age2x10^{-2}	0.011***	0.011***	0.013***
	(17.03)	(14.99)	(8.37)
age2x10-3	0.0177	-0.018	0.268**
	(0.32)	(-0.30)	(1.93)
Age3x10-3	-0.015	-0.006	-0.115
	(-0.30)	(-0.11)	(-0.74)
ageg7 x10-3	0.046	0.091	-0.268
	(0.41)	(0.74)	(-0.81)
logdistpriv3	0.040*	0.054**	-0.120
	(1.64)	(2.01)	(-1.62)
logtimehea~c	-0.170**	-0.190**	0.036
	(-2.42)	(-2.44)	(0.21)
fpresent |	-0.089	-0.191	1.090
	(-0.36)	(-0.72)	(1.38)
Control Function Variables (Account for HAZ effects of unobservables in the error term)			
residual of spending	-0.006	0.247	-4.609
	(0.00)	(0.17)	(-1.26)
residual times spending	-0.27	-0.049	0.362
	(-0.26)	(-0.43)	(1.24)
_cons	3.508	3.552	4.864
	(1.06)	(0.98)	(0.51)
Number of obs	4367	3661	696
F-Stat [df]	237.52	195.43	45.63
	(12, 4344)	(12, 3648)	[12, 683]
R-squared	0.3962	0.3913	0.4449
Adj R-squared	0.3945	0.3893	0.4449

Source: Computed by authors using ECAMII survey data and STATA 9.1.
*Notes: (·) implies robust t-ratios. ***, ** and * indicate 1%, 5% and 10% levels of significance, respectively*

Table 7. Estimation of child-health production function (WHZ) using control function approach by gender

Variables	All (1)	Male (2)	Female (3)
logtotale~c1	0.887**	0.958***	-0.310
	(2.78)	(2.78)	(-0.33)
m_childsex	-0.331**	-0.415**	0.157
	(-2.19)	(-2.21)	(0.43)
Child_age	0.295***	0.281***	0.336***
	(10.08)	(8.77)	(4.75)
Child_age2x10^{-2}	-0.004***	-0.004***	-0.006**
	(-5.58)	(-4.64)	(-3.09)
age2x10-3	0.0182***	0.288***	-0.600***
	(2.72)	(3.94)	(-3.43)
Age3x10-3	-0.128**	-0.140**	-0.173
	(-2.01)	(-2.05)	(-0.89)
ageg7 x10-3	0.688***	0.599***	1.145***
	(4.95)	(4.02)	(2.73)
logdistpriv3	-0.100***	0.054**	0.153*
	(-2.96)	(2.01)	(1.65)
logtimehea~c	-0.157	-0.190**	-0.545**
	(-1.62)	(-2.44)	(-2.46)
Fpresent |	0.267	0.438	-0.954
	(0.88)	(1.36)	(-0.91)
Control Function Variables (Account for WHZ effects of unobservables in the error term)			
residual of spending	-3.207*	-2.857	-1.804
	(-1.85)	(-1.50)	(-0.40)
residual times spending	0.216	0.183	0.220
	(1.56)	(1.20)	(0.60)
_cons	-12.06***	-13.006***	3.123
	(-2.93)	(-2.89)	(0.26)
Number of obs	4034	3381	653
F-Stat [df]	37.81	32.54	9.13
	(12, 4021)	(12, 3368)	[12, 640]
R-squared	0.1014	0.1039	0.1461
Adj R-squared	0.0987	4.7883	4.5594

Source: Computed by authors using ECAMII survey data and STATA 9.1.
*Notes: (·) implies robust t-ratios. ***, ** and * indicate 1%, 5% and 10% levels of significance, respectively*

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