Gbakou, Monnet Benoit Patrick; Sousa-Poza, Alfonso

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Monnet Benoit Patrick Gbakou & Alfonso Sousa-Poza

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# Engel Curves, Spatial Variation in Prices and Demand for Commodities in Côte d'Ivoire

Monnet Benoit Patrick Gbakou[a] and Alfonso Sousa-Poza[b]

**Abstract**
This paper aims to estimate the price and income elasticities of the demand for essential commodities in Cote d'Ivoire. Using data from the 2002 Cote d'Ivoire Living Standard Survey and a theoretical framework developed by Crawford et al. (2003), we analyse price effects on the demand for groups of commodities by exploiting a relationship between unit values and commodity quantities and deriving Engel curves. Our findings reveal that the own-price elasticity of meat and dairy products is considerably stronger for rich households (those in the 90th percentile of total expenditure) than for poor households (those in the 10th percentile of total expenditure). Although all the modelled groups of commodities are normal goods, the paper shows that starch is more of a necessity for poor households than for rich ones, whereas meat and dairy products are more of a luxury good for poor households than for rich households.

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**JEL classification**: D11, D12
**Keywords:** Consumer demand, Unit values, Developing country

[a] Food Security Center, University of Hohenheim (Germany) and University of Cocody-Abidjan (Côte d'Ivoire). Corresponding author: monnet.gbakou@uni-hohenheim.de
[b] Chair for Household and Consumer Economics, University of Hohenheim (Germany)

## 1. Introduction

This paper aims to estimate the price and income elasticities of the demand for essential commodities in Cote d'Ivoire. The price elasticities of food demand in Côte d'Ivoire were first calculated from the 1979 Household Budget Survey by Deaton (1987a, 1987b), who jointly models the price reactions and choice of unit values under an assumption of a constant structure for relative prices. Such an assumption is useful when defining the relationship between the vector of prices for a group of goods (e.g., the prices of different types or qualities of meat), a homogeneous price level for the group (e.g., a constant Laspeyres price index for meat), and a vector representing the fixed within-group relative price structure (e.g., the relative prices of different types and qualities of meat). Deaton's original model, however, suffers from a reliance on the loglinear demand specification, meaning that its demand functions do not add up to total expenditures. Deaton's (1990) later work therefore extends the model to take into account the zero consumption that may occur when households do not consume all modelled commodities during the survey period. In this amended version, however, the specification of unit value equations intended to model the quality effect (relationship between unit value and total budget) in the sense of Prais-Houtakker (1955) is incompatible with the Almost Ideal Demand System chosen for the model. Nevertheless, despite this drawback, many researchers (e.g., Ayadi et al., 2003) use Deaton's approach to estimate price elasticities in developing countries.

To address this methodological weakness, we instead employ a relationship between unit value and quantity under an assumption of weak separability of preferences (Crawford et al, 2003). This separability assumption allows the partitioning of goods into a number of separate groups in which a change in the price of a good in one group similarly affects the demand for all commodities in another group. The functional form of the demand functions is the widely used loglinear approximation of the Almost Ideal Demand System (LA/AIDS; Deaton and Muellbauer, 1980). The LA/AIDS model has several desirable properties. For instance, it is simple to estimate and can be used to test the restrictions of homogeneity and symmetry using linear restrictions on fixed parameters. The LA/AIDS specification with a loglinear approximation of the log price index allows avoidance of the nonlinearity assumption that would defeat the within-cluster estimation adopted in the estimation strategy. Although the double loglinear specification of the unit value functions is an arbitrary choice, it is compatible with the specification of the demand functions. In contrast to Deaton's (1990) model, however, the double loglinear specification of the unit value functions does not allow for zero consumption of groups of commodities.

Applying the model to a cross-section from the 2002 Côte d'Ivoire Living Standard Survey (CILSS), we distinguish four groups of commodities: starch, fat and oil, vegetables and fruit, and meat and dairy. By distinguishing four groups of goods, we are able to keep 2,512 households with no missing values residing in 158 clusters. Our findings indicate that these groups of commodities are normal goods, that starch is a necessity, but that meat and dairy is a luxury good. At the sample means, own-price elasticities are negative and less than 1, suggesting that the groups of commodities are price inelastic, except for meat and dairy which is price elastic. Finally, because rich and poor households allocate their budgets in different ways, we show that in Côte d'Ivoire, the price and income elasticities of demand differ according to household social status.

It is also worth noting that over the past decade, Côte d'Ivoire has experienced relatively high inflation rates: between 2000 and 2002, the consumer price index increased by 9%, and between 2000 and 2005, it rose 16% (IMF, 2008)[1]. This inflation rate in the 2000s can be primarily explained by excess demand, although the civil crisis that erupted on September 19, 2002, and the partitioning of the country into South and North did little to reduce the inflation rate. We therefore preface our analysis by examining how Ivorian households allocated their budgets among available commodities in the pre-civil war context, in which the inflation rate was relatively high.

The rest of the paper is organized as follows. Section 2 examines consumption and the prices of commodities in Côte d'Ivoire before the civil war. Section 3 outlines the model developed by Crawford et al. (2003), and section 4 delineates the econometric specifications and pertinent identification issues. Section 5 then describes the important features of the data and variables used in the analysis, whose results are reported in section 6. Section 7 concludes the paper.

## 2. Consumption and the price of commodities in Cote d'Ivoire before the beginning of the civil war

During the 1990s, Côte d'Ivoire was one of sub-Saharan Africa's most stable nations and an economic heavyweight among West Africa's French-speaking countries. From national independence in August 1960 until today, the nation's economic performance has been based primarily on agriculture: Côte d'Ivoire is the world's largest producer and exporter of cacao beans and is among the top five producers of coffee. This performance took shape through sustained economic growth, with the GNP per capita reaching US$ 700 in 1998 as compared to an average of US$ 400 in surrounding countries. This situation, however, did not encourage the

1 The index of average consumer prices was 109.5 in 2002 versus116.3 in 2005 (index 2000 = 100)

production of certain food crops – for example, potato – and the country performed poorly in the production of commodities like rice, meat and dairy. Many of these products therefore had to be imported and excess demand gave rise to high prices.

Imports of rice,[2] for instance, reached 474,000 tons in 1998 compared to 300,000 tons in 1995 and increased to around 800,000 tons in 2010 (Food and Agricultural Organization, FAO, website). Before the devaluation of the national currency in January 1994, meat (both frozen pieces and offal) was imported primarily from the European Union, which subsidized the price by 70%. After devaluation of the national currency in 1994, however, the European Union eliminated these subsidies on meat prices, and meat imports from Europe collapsed. Since then, even though increased imports of meat from the Sahelian African countries (Burkina-Faso, Mali and Niger) have partially compensated for the drop, the meat supply remains insufficient to match demand: the 7,343 tons of imported beef in 1999 reduced to 6,066 tons in 2000 and dwindled to 163 tons in 2002. Likewise, in 1998 the country needed to import 100,000 tons of fish to meet demand (UEMOA[3], 2002). The market prices of dairy and dairy products (DDPs) have also remained high because the country has a weak production capacity for these products. In 1999, the demand was about 173,000 tons of DDP, but national production was only 24,000 tons (Hassainya et al, 2006). This gap between level of demand and amount of supply is undoubtedly the main source of the high DDP prices. Nevertheless, the excess demand for commodities like meat and dairy is not the only contributor to the increase in commodity prices: taxes and transport costs are relatively high, and importers must deal daily with unethical practices by customs and police on the national roads.

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[2] Importation from Asia (Thailand, India, China, Pakistan and Vietnam) accounted for 90% of the total imports of rice, a commodity that is much appreciated by Ivorian households.

[3] UEMOA stands for Union Economique et Monétaire de l’Afrique de l’Ouest (West African Economic and Monetary Union, WAEMU).

Côte d'Ivoire is self-sufficient, however, in millet, sorghum and fonio, and there may even sometimes be an oversupply of such food crops as yam, cassava, plantain and maize. In fact, in the 1999/2002 period, the amounts of maize, cassava and yam produced were 550,000 tons, 1,700,000 tons, and 3,000,000 tons, respectively (UEMOA, 2002). These production levels made these commodities available and affordable for poor households. In addition, although the international price of wheat changed substantially between 1995 and 2002, the price of bread did not rise too much because the flour used by bakers comes from the sole national manufacturer of flour (Grands Moulins d'Abidjan, GMA), which effectively sets the prices. The coup of September 19, 2002, however, plunged the country into turmoil, and its division into two parts caused massive population displacement, increased poverty, and a marked reduction in the availability of many household commodities.

## 3. A brief description of the model

The aim is to jointly model demand functions and unit value functions. In doing so, we accept Crawford et al.'s (2003) proposition that including the relationship between unit value and quantity allows for more attractive specification of the demand functions, particularly the use of an Almost Ideal Demand (AID) approach. Indeed, the model of quality in the sense of Prais-Houthaker (1955) is only compatible with a loglinear specification of demand functions, a specification that is undesirable because its demand functions do not add up to total expenditures.

Setting up the relationship between unit value and quantity first requires an assumption of weak separability of preferences when grouping the commodities into several groups. Then, using the homogeneity assumption, we can show that for each commodity group G, the following relationship can be defined between $V_G/\pi_G$ and $Q_G$:

$$V_G = \pi_G h_G(V_G Q_G/\pi_G) \qquad (1)$$

where for each group G, $V_G$ is the unit value, $Q_G$ is the quantity, $\pi_G$ is a homogenous price level (e.g., the Paasche price index) and $h_G(.)$ is a function that has no restriction on its functional form. Construction of $\pi_G$ is based on an assumption of the constant structure of relative prices within each group G.

By defining function $\varphi$ for the budget shares (demand functions) as $w_G = \varphi(X,\pi)$ and deriving a double natural log specification of equation (1), we obtain

$$\ln V_G = \ln\pi_G + \ln h_G\left(\frac{X}{\pi_G}\varphi(X,\pi)\right). \qquad (2)$$

where X is total expenditure (or income) and $\pi$ is the vector of the price of commodity groups. In equation (2), however, the unit value still depends on X, which is undesirable because once the budget share function $\varphi$ (.) is specified, too many cross-equation restrictions prevent an unrestricted dependence of the unit value on X and $\pi$. The trick to solving this problem is to specify the budget share relationship $\varphi$ (.) and use an independent specification of equation (1) to retrieve a desirable relationship between unit value $V_G$ and quantity $Q_G$ (given that the form of $h_G(.)$ is unrestricted). The special cases where $V_G = \pi_G \psi_G(Q_G)$ are not impossible at all, particularly a specification

$$\ln V_G = a_G + b_G \ln Q_G + \ln\pi_G \qquad (3)$$

occurs if one assume the following functional form for $h_G(.)$:

$$h_G(V_G Q_G/\pi_G) = A_G (V_G Q_G/\pi_G)^{B_G}$$

where $b_G = A_G / (1 - A_G)$ and $a_G = (1 + b_G)\ln B_G$.

Equation (3) thus defines the functional form of the relationship between unit value and quantity that is subsequently used for each group G.

## 4. Econometric specification and estimation

Before performing our econometric estimations, we must choose a functional form for the demand functions $\varphi_G(.)$. One obvious choice is the approximate Almost Ideal Demand (AID) model with a loglinear approximation of the log index price (or LA/AID), given the following estimation strategy below. Under the assumption of fixed prices for all households located within a cluster c, for a household h, the demand function of group G is

$$w_G^h = \alpha_{0G} + \mathbf{Z}^h \boldsymbol{\alpha}_G + \sum_H \gamma_{GH} \ln \pi_H^c + \beta_G \ln \breve{x}^h + u_G^h \qquad (4)$$

where $\breve{x}^h$ is deflated total expenditure, $\ln \breve{x}^h \equiv \ln X^h - \ln p^c \equiv \ln X^h - \sum_H \lambda_H \ln \pi_H^c$, and $p^c$ is a cluster price index. Equation (4) can be then be rewritten as

$$w_G^h = \alpha_{0G} + \mathbf{Z}^h \boldsymbol{\alpha}_G + \sum_H \delta_{GH} \ln \pi_H^c + \beta_G \ln X^h + u_G^h \qquad (5)$$

where $\delta_{GH} = \gamma_{GH} - \beta_G \lambda_H$. The vector $\mathbf{Z}^h$ reflects the influence of socio-demographic characteristics and further conditioning variables, and $u_G^h$ is the error term.

From equation (3), the unit value equation for a household h is

$$\ln V_G^h = a_{0G} + \mathbf{Z}^h \mathbf{a}_G + \ln \pi_G^c + b_G \ln Q_G^h + v_G^h \qquad (6)$$

where $v_G^h$ is the error term.

Estimating equations (5) and (6), however, leads to identification issues because, since the households are grouped by cluster, the observations are not independent; that is, common factors affect the demand for commodities within the cluster. Nevertheless, for the sake of simplicity and following Crawford et al. (2003), we assume that these observations are independent, which allows the unobserved-cluster price effect to be the only relevant cluster effect[4]. The corresponding estimation strategy consists of three stages. First, we estimate equations (5) and (6) using a within-cluster two-stage least squares method that takes into account certain endogenous variables in $\mathbf{Z}^{h}$. In this method, the cluster means are calculated and subtracted from all variables and the 2SLS estimator is then used to estimate the resulting equations.

Next, having obtained the vector of coefficients $\hat{\boldsymbol{\alpha}}_{G}$ and the coefficient $\hat{\beta}_{G}$ in equation (5), we must estimate $\hat{\gamma}_{GH}$ and give a value to $\lambda_{H}$[5]. To do so, we exploit only the between-cluster information because the fixed nature of the within-cluster price effects has already been used in the first stage. The derivation of the estimated vector $\hat{\gamma}_{G}$ (price effects in the budget equation for group G), which assumes the homoscedasticity of the variance of $\left(\overline{u}_{G}^{c}, \overline{\mathbf{v}}^{c}\right)$ and imposes $\lambda = \overline{\mathbf{w}}$ (the vector of average budget shares), must also take into account the measurement errors on the unit values. At this stage, we also impose the standard homogeneity restrictions required by demand theory (which also implies an adding-up restriction), yielding the following relationship

$$\hat{\gamma}_{G} = \left[\sum_{c=1}^{C} n_{c} \zeta^{c} \zeta^{c'} - \hat{\boldsymbol{\Omega}}_{v}\right]^{-1} \left[\sum_{c=1}^{C} n_{c}\left(\eta_{G}^{c} \zeta^{c} + \beta_{G} \zeta^{c} \zeta^{c'} \lambda\right) - \hat{\boldsymbol{\Omega}}_{vu_{G}} - \hat{\Omega}_{v} \lambda\right] \quad (10)$$

where $n_c$ is the size of cluster c,

$$\eta_{G}^{c} \equiv \overline{w}_{G}^{c} - \overline{\mathbf{Z}}^{c} \hat{\boldsymbol{\alpha}}_{G} - \hat{\beta}_{G} \overline{\ln X}^{c}$$

4 Even if we suppose another cluster effect only in equation (4), nothing would change in the subsequent estimations provided that this cluster effect is independent of $\pi$.

5 The need to give a value to $\lambda_H$ derives from the fact that we are using an LA/AID specification.

$\zeta^c \equiv \left(\zeta_1^c, \cdots, \zeta_m^c\right)'$, when we have m groups of commodities

$$\zeta_G^c \equiv \overline{\ln V_G}^c - \overline{\mathbf{Z}}\hat{\mathbf{a}}_G - \hat{b}_G \overline{\ln Q_G}^c$$

$\hat{V}\begin{pmatrix} \overline{u}_G^c \\ \overline{\mathbf{v}}^c \end{pmatrix} = \hat{\mathbf{\Omega}} = \dfrac{1}{n_c}\begin{bmatrix} \hat{\mathbf{\Omega}}_{u_G} & \hat{\mathbf{\Omega}}_{u_G\mathbf{v}} \\ \hat{\mathbf{\Omega}}_{\mathbf{v}u_G} & \hat{\mathbf{\Omega}}_{\mathbf{v}} \end{bmatrix}$, where each term of $\hat{\mathbf{\Omega}}$ has been obtained from the first stage residuals.

The variance of the price coefficients (without the imposition of symmetry) is obtained by a bootstrap procedure in which the number of resamples equals the number of observations but the size of the clusters remains fixed[6].

Lastly, we impose the symmetry restrictions $\gamma_{GH} = \gamma_{HG}$ using the minimum distance approach, except that, in line with the efficiency arguments of Kodde et al. (1990, theorem 5), we minimise only over $\gamma$ rather than over $\gamma$ and $\beta$.

## 5. Data

The data, taken from the Côte d'Ivoire Living Standard Survey (CILSS), were collected between January and December 2002 by the National Statistics Office (NSO) of Côte d'Ivoire. These cross-sectional data, which are the most recent available, provide information on 10,800 households distributed among 540 clusters[7] of households located in the same area or village. Because 20 households in each cluster were interviewed at around the same time, the assumption of fixed prices within clusters is reasonable[8].

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6 When we did not keep the size of the clusters fixed, the bootstrapping procedure collapsed.

7 The CILSS 2008 data have not yet been released by the national authorities, and the CILSS 1998 data do not include quantities of commodities.

8 This approach allows the NSO to minimise the cost of data collection, which was impossible in past practice. For instance, rural households in the 1979 Household Budget Survey of Côte d'Ivoire were visited four times and some urban households more than once. Deaton (1987a, 1987b) then assumed that the same cluster at a different time could be treated as if it were distinct. The 2002 CILSS, in contrast, was designed to capture more household characteristics, thereby enabling the

In the regressions, our final sub-sample includes 2,512 households for which information is available on all variables. Of these households, which are distributed among 158 clusters of between 6 and 20 households, 72% have a married household head (HoH). It is impossible, however, to ascertain whether the union is a traditional African marriage, a religious marriage or a civil marriage[9]. Although less than 6% of total (male) HoHs are polygamous[10], some were not living in the same dwelling as their female partners, a situation that also holds true for some women in a relationship with a polygamous man. Because it is difficult to classify these individuals as single or married, we do not limit the study to married couples only. In other words, we do not expect our results to be significantly affected by the inclusion of heterogeneous households. In the equations, however, we control for polygamy using one dummy for ethnic group and one for the HoH religion[11], and for household heterogeneity using a dummy for married HoH.

Although some households undoubtedly live in rural areas, we do not separate the sub-sample of rural households (42) from that of urban households (116) because the former's small size makes it difficult to identify the coefficients when the within-cluster 2SLS estimator is applied to rural clusters only. It is thus impossible to obtain relevant results in, for instance, the over-identification and endogeneity tests. Moreover, even if the final sub-sample included more rural clusters, separating the rural household sub-sample from the urban household sub-sample might still not be desirable because such separation could cause a sample selection bias[12]. For the same

use of instruments for some endogenous variables, an econometric procedure that Deaton could not achieve because such household information was lacking.

9 Civil marriage is the only form that is recognized by the national authorities and gives rights to married or divorced individuals.

10 Only men can have more than one female partner.

11 Including a dummy for polygamy would be inappropriate since only 6% of households have this marital status.

12 See Vijverberg's (1993, 1995) study of the selectivity bias of location using CILSS data from 1985, 1986, and 1987.

reason, we include no dummy for household location (i.e., rural vs. urban) in the equations for the complete final sub-sample because any attempt to do so using the within-cluster 2SLS estimator yields insufficient variation. Rather, we include the HoH's social status (farmer) as an approximation of location, since in Côte d'Ivoire, farmers live primarily in rural areas.

The CILSS 2002 data set contains information on 99 different commodities, including expenditures and the quantity of each commodity during the prior seven days or the previous month. Here, we consider only monthly data because they allow retention of more households in our final sub-sample. No information is available, however, on "in-kind" quantities, which reduces the importance of consumption of own production. In other words, we expect that the amounts purchased on the market represent a good approximation of the amounts consumed. We do not address zero purchase of groups of commodities because the model does not allow it[13].

Using the commodities included in the data (see table A6), we construct four commodity groups: (i) starch, (ii) fat and oil, (iii) vegetables and fruit, and (iv) meat and dairy. This choice is based on the need to retain more households in the final sub-sample rather than on including a greater number of groups or listed commodities. Our final commodity groups thus differ from Deaton's (1987) five-part division into meat, fresh fish, other fish, starches and cereals, whose inclusion of fresh fish versus other fish raises the problem of zero purchase. Likewise, Deaton used different sub-samples when estimating the equations of interest – for instance, the regressions for meat and those for fresh fish were based on different household sub-samples – which also imposes a sample selectivity bias on the estimates. Admittedly, Deaton's (1990) subsequent model, which took into account zero purchase, is more sophisticated;

[13] Zero purchase does not reflect zero consumption; it simply means that a household did not purchase any product from that commodity group during the previous month.

however, as previously mentioned, the specification of the unit value equation is incompatible with the AID specification of demand functions. We thus exclude households with zero purchase from the groups modelled.

In addition, like Crawford et al. (2003), we see no particular reason to suppose a connection between the availability (quantity) of the goods modelled and the structure of preferences. Hence, preferences for modelled goods do not need to be separated from those for non-modelled goods. We therefore condition the budget share equations on the expenditure for non-modelled foods (see table A6 for the composition), whose components are chosen based on the low availability of data on their quantities. We also assume the non-separability of preferences between leisure and modelled groups by including a dummy for the HoH's participation in the labour market[14] (see Browning and Meghir, 1991 on this point). We impose homogeneity in respect to the price of the conditioned goods by expressing the expenditure for non-modelled food relative to that for housing (that is, water, electricity, and rent). We also pay attention to the problem of zero conditioned expenditure by including a dummy in the equations[15] whose value is 1 if spending on non-modelled food is zero and 0 otherwise. Doing so retains households with zero conditioned expenditure in the final sample (see Crawford et al., 2003).

In vector $\mathbf{Z}^h$, we also include certain socio-demographic variables; specifically, age of the HoH, a dummy if the household occupies his own house, and the number of rooms per household member. We instrument the HoH's labour market participation using variables related to sex and education and also include two

[14] We measure the household's labour market status based on the participation of the HoH not the partner because some HoH males have more than one wife.

[15] As Crawford et al. (2003) point out, "Under weak separability assumption, the conditioning variables should play no role in the demand equations. The compatibility between this conditional approach and the unit value model….is ensured by the fact the conditional cost function is amenable to Hicks aggregation."

variables for the presence of children in the household (the proportion of pre-schoolers and the proportion of young children). The quantity of a group of commodities and the total expenditure are instrumented by a variable related to total income.

< INSERT TABLE 1a AND TABLE 1b >

Table 1a presents the relevant descriptive statistics for budget shares, quantities and unit values, while table 1b lists the budget shares as percentiles of total expenditure (see table A1 for a complete list of descriptive statistics). As the tables show, poor households (those in the 10th percentile of total expenditure) spend a large portion of their budget on starches (46%), whereas rich households (those in the 90th percentile of total expenditure) spend 62% of their budget on meat and dairy products. The 10th percentile of monthly total expenditure is FCFA59191.2 (€90.2) and the 90th percentile of monthly total expenditure is FCFA 498,117 (€759.3).

## 6. Results

### 6.1 Tests for endogeneity and over-identification in the within-cluster 2SLS estimations

The exclusion restrictions imposed are listed at the bottom of table A2. The statistic for the joint test of over-identification restrictions (Sargan test) is distributed chi-squared with 5 degrees of freedom in the budget share equations and distributed chi-squared with 4 degrees of freedom in the unit value equations. The test values range from 0.01 to 3, except in the unit value equation for vegetables and fruit, the test has a value of 36.6. Overall, therefore, the model is not at odds with the excluded variables, and the instruments are uncorrelated with the error terms.

The statistic for the joint test of endogeneity (Durbin-Wu-Hausman test) is distributed chi-squared with two degrees of freedom in the unit value equations and distributed chi-squared with three degrees of freedom in the budget share equations. In the unit value equations, the outcomes of the endogeneity test of HoH's participation and ln(quantity) fall between 30 and 46.7. The exception occurs once again in the equation of unit value for vegetables and fruits, which has a test of 0.1. In the budget share equations, the outcomes of the endogeneity test of HoH's participation, ln(total expenditure) and ln(other food) range between 10.3 and 19.1. On the basis of these results, it seems generally valid to treat HoH's participation, ln(quantity), ln(total expenditure), and ln(other food) as endogenous variables.

### 6.2 Separability test

The separability test of preference between the modelled commodity groups and the non-modelled foods is merely a test of significance of the variable ln(other food) in the budget share equations. The t-statistic in absolute values fall between 2.15 and 2.98, except in the budget share equation of fat and oil where the ratio equals 1.03 (see table A3). As a result, preferences should not be separate in the partition modelled groups and non-modelled food. This non-separability of preference also holds true between the modelled groups and leisure since the coefficient of HoH's participation is significant in all budget share equations.

### 6.3 Budget share equations

The findings from the first stage of the estimation strategy using the within-cluster 2SLS estimator are given in table A3. As the table shows, in the budget share equations, total spending negatively affects the demand for starch, positively impacts the demand for meat and dairy, but has no impact on the demand for fat and oil or vegetables and fruit. This finding confirms the existence in the Ivorian data of two Engel curves. Our results also demonstrate that when the HoH is a farmer (i.e., the household is located in a rural area), his household allocates a smaller part of its budget to starch and to fat and oil but spends more money on meat and dairy. Obviously, this last result is only valid if purchases at the market broadly reflect household consumption, especially that of rural households. That is, because we could not take into account the consumption of own-production, which may be important for rural households, the budget shares allocated to starch and to fat and oil may not accurately reflect the demand or consumption of either commodity group. Indeed, certain commodities in the starch and fat and oil groups can be easily produced by farmers and should be added to the purchases at market.

In addition, based on the negative and statistically significant coefficient of the Muslim dummy in the starch equation, being Muslim negatively affects the demand for starches. The HoH's ethnic group, in contrast, has no effect on the demand of food: the coefficients of the ethnic group dummies are statistically no different from zero. This finding means that we cannot discriminate consumption decisions (or consumption behaviour) in Côte d'Ivoire on the basis of ethnicity. Nevertheless, we should also remember that these variables are included to control for polygamy. That is, given that being Muslim[16] negatively affects the demand for starches, then the HoH's having several partners may also reduce their consumption. In fact, the results show that the coefficient of marital status is statistically significant (and positive) only in the equation for budget share of starch, indicating that marriage increases starch consumption. For other groups of commodities, the HoH's marital status has no effect, which raises the question of whether the sub-sample of households in which the HoHs are married should be separated from those in which they are not.

[16] According to Islamic law, a Muslim man may marry up to four wives.

### 6.4 Unit value equations

In the estimates of unit value equations (whose results are summarised in table A3), the first stage of the estimation strategy uses a within-cluster 2SLS estimator that eliminates price effects. We identify a significant relationship between unit value and quantity in two cases: the vegetables and fruit equation (-) and the meat and dairy equation (+). The former result, however, is called into question by the rejections in the over-identification and endogeneity tests on the unit value equation for vegetables and fruit. We thus conclude that there is only strong evidence of a relationship between unit value and quantity (conditional on the included explanatory variables) in the equation for meat and dairy. Nevertheless, the existence of this relationship between unit value and quantity of meat confirms that in this case the chosen approach is appropriate. We have a range of coefficients of the included explanatory variables which are statistically different from zero in the equations of unit value. For instance, when the HoH participates in the labour market or is older, the family pays less for a kilogram of starches.

### 6.5 Price elasticities

Before estimating the budget and price elasticities, we first estimate the unrestricted coefficients of price (i.e., we do not impose symmetry) using equation (10) and then estimate the symmetry-restricted coefficients of price using a distance minimum estimator (see, e.g., Browning and Meghir, 1991). These estimations, reported in table A4, reveal one interesting outcome of imposing symmetry: it improves the significance of the price coefficients. Here, however, because the chi-square test of validity of symmetry is 378.8 (see table A4) – that is, over $\chi^2(6) = 12.59$ – symmetry is rejected. Such rejection has become quite standard in the literature. For instance, Blundell and Robin (2000) and Browning and Meghir (1991), using the 1974–1993 British Family Expenditures Surveys (FES), find that symmetry is less easily accepted for married couples. Likewise, Browning and Chiappori (1998), using 1974–1992 Canadian Family Expenditure (FAMEX) data, reject it for two-person couples. Subsequently, Crawford et al. (2003) reject symmetry in the Czech family budget data from 1991/1992, attributing it primarily to the fact that household decisions cannot be incorporated into an overly restrictive unitary framework. In other words, because a household consists of several members, it would be more appropriate to analyse household behaviour as the result of several individual rational decisions (Chiappori, 1988, 1992; Browning and Chiappori, 1998; Bargain et al., 2010). In Côte d'Ivoire, household structure may be even more complex; for example, it may include elementary couples like those formed by the HoH's adult children who live in the same dwelling with the household targeted. We therefore recognise that such peculiarities should be taken into account when analysing the behaviour of African households; however, given the difficulty of integrating them all into a general framework, we leave that challenging task to future investigations.

Our estimates of Marshallian elasticities are based on the symmetry-restricted coefficients of prices and $\hat{\beta}_G$ obtained from the first stage of the estimation strategy using the within-cluster 2SLS estimator. As proven in Crawford et al. (2003), price elasticities can be computed at the sample means based on the following:

$$e_G = (\gamma_{GH} - \beta_G \overline{w}_H)/\overline{w}_G - 1_{[G=H]}$$

In addition, given the earlier finding that poor households and rich households do not behave in the same way (see the descriptive statistics), we compute the price elasticities for three representative households that correspond to the 10th percentile of total expenditure ("the poor household"), the 50th percentile of total expenditure ("the median household") and the 90th percentile of total expenditure ("the rich household").

As table A5 shows, the uncompensated own-price elasticities are all negative, less than 1 and statistically different from zero at the mean point, indicating that the modelled groups of commodities are all price inelastic. For instance, all things being equal, a 10-percent increase in the price of starch causes a 4-percent decrease in the budget share of starch at the mean point and a 5-percent decrease for the poor household. For the rich household, in contrast, an increase in the price of starch has no effect on the demand for starch: the own-price elasticity is not statistically different from zero. A more interesting result is that the own-price elasticity for the meat and dairy demand is higher for the rich household (-1.05) than for the poor household (-0.71), suggesting that meat and dairy is price elastic for the former, which has a very large demand, but price inelastic for the latter, whose demand is much lower (see the descriptive statistics). The cross-price elasticities also show that starch and fat and oil, starch and vegetables and fruit, and fat and oil and vegetables and fruit are substitutes for both rich and poor households, whereas meat and dairy and starch, meat and dairy and fat and oil, and meat and dairy and vegetables and fruit are complementary goods[17].

### 6.6 Budget elasticities

Budget (or income) elasticities reflect the responsiveness of the budget shares of the commodity groups to changes in total expenditure. The Marshallian elasticities

[17] Although it would have been interesting to compare our results with those of Deaton (1987a, 1987b), this is impossible for several reasons: First, as discussed above, his methodological approach differs from ours. Second, the commodity groups and their components differ between the two studies; for instance, in rural areas, the own-price elasticities of the five groups defined by Deaton (1987a, 1987b) are meat (-0.353), fresh fish (-2.131), other fish (-1.059), starches (-0.393), cereals (-1.647), generally higher than those we obtain in 2002. Lastly, we use a more recent data set, and household preferences and tastes may have changed.

for income, estimated and computed at the mean sample following the formula $e_G = 1 + \beta_G / \overline{w}_G$, are given in table A5. As the table shows, the total expenditure elasticities are all positive and significantly different from zero, indicating that all the commodity groups are normal goods. The test for an elasticity different from 1, however, shows that starch is a necessity, whereas meat and dairy is a luxury. In addition, the sensitivity of the demand for meat and dairy to a change in total expenditure is stronger for the poor household than for the rich household. For instance, all things being equal, in the case of starch, a 10-percent increase in income causes a 12-percent increase in budget share at the mean point for the rich household but a 22-percent increase in budget share for the poor household,.

**7. Conclusions**

Deaton (1987a, 1987b) estimates the price elasticities of commodities for Côte d'Ivoire using a structural model; however, this model suffers from its reliance on a loglinear specification of demand functions, which is inconsistent with demand theory. In addition, in Deaton's model, the specification of unit value equations (model of quality effect in the sense of Prais-Houtakker, 1955) is not compatible with a different specification of demand functions and is therefore very restrictive. In this paper, we instead use the model of unit value developed by Crawford et al. (2003), which is compatible with a large range of possible specifications of demand functions. In this model, the unit value function is a double logarithmic function that establishes a relationship between unit value and the quantity of a good, and the specification of the demand functions is based on the AID specification with a loglinear approximation of price index (LA/AID).

Specifically, using data from the 2002 Côte d'Ivoire Living Standard Survey (CILSS 2002), we model four groups of commodities – starch, fat and oil, vegetables and fruit, and meat and dairy – and draw the following primary conclusions:

(i) There is a statistically significant relationship between the unit value and quantity of meat and dairy, even if the effects of other factors are controlled for. This result provides evidence for the appropriateness of Crawford et al.'s (2003) approach.

(ii) Starch, fat and oil, and vegetables and fruit are price inelastic, whereas meat and dairy is price elastic for the "rich household" that represents those in the 90th percentile of total expenditure but price inelastic for the "poor household" that represents those in the 10th percentile of total expenditure.

(iii) Although all the modelled groups of commodities are normal goods, starch is more of a necessity for poor households than for rich ones, whereas meat and dairy is more of a luxury good for poor households than for rich households.

These findings have important implications for tax or subsidy policies in Côte d'Ivoire. They indicate, for example, the necessity of supporting poor families in their consumption of meat and dairy, which suggests that national authorities should develop innovative aid programs to offset the European subsidies eliminated in 1994. Likewise, a policy of tax reduction or a subsidy on the price of meat-and-diary should be a priority.

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Table 1a: Descriptive statistics of budget shares, quantity and unit value

| | Budget Shares | | ln(Quantity) | | ln(Unit value) | |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev | Mean | Std. Dev | Mean | Std. Dev |
| Starch | 0.413 | 0.148 | 4.126 | 0.888 | 5.711 | 0.859 |
| Fat and Oil | 0.076 | 0.046 | 2.016 | 1.129 | 6.033 | 1.114 |
| Veg and Fruit | 0.152 | 0.082 | 4.661 | 1.004 | 4.081 | 1.421 |
| Meat and Dairy | 0.359 | 0.151 | 3.375 | 1.418 | 6.280 | 1.403 |
| Number of observations | | | 2512 | | | |

Table 1b: Budget shares from the percentiles of total expenditure

| **Percentiles of total expenditure** | **Budget Shares** | | | |
|---|---|---|---|---|
| | Starch | Fat and Oil | Veg and Fruit | Meat and Dairy |
| 10th | 0.458 | 0.106 | 0.343 | 0.093 |
| Median | 0.517 | 0.065 | 0.176 | 0.242 |
| 90th | 0.188 | 0.076 | 0.114 | 0.622 |

Notes:
10th percentile of total expenditure = CFAF 59,191.22
Median of total expenditure = CFAF 145,650
90th percentile of total expenditure = CFAF 498,117.14
Household total expenditure is measured in the Ivorian currency unit, the Communauté Financière Africaine franc (CFAF). In 2010, CFAF 656 was equal to €1.

## Appendix

Table A1: Descriptive statistics

| Variables | Mean | Std Deviation |
|---|---|---|
| **Included variables** | | |
| Participation of HoH | 0.781 | 0.414 |
| Age of HoH (in years) | 42.793 | 12.984 |
| Married HoH | 0.720 | 0.449 |
| Self-employed HoH | 0.218 | 0.413 |
| Farmer HoH | 0.176 | 0.381 |
| Number of rooms per MoH | 0.674 | 0.783 |
| Muslim HoH | 0.327 | 0.469 |
| Christian HoH | 0.533 | 0.499 |
| Akan HoH | 0.381 | 0.486 |
| Krou HoH | 0.151 | 0.358 |
| Mande-North HoH | 0.121 | 0.326 |
| African HoH | 0.238 | 0.426 |
| Owner-occupier household | 0.338 | 0.473 |
| ln(other food) | -3.777 | 1.279 |
| No other food | 0.003 | 0.060 |
| ln(total expenditure) | 11.978 | 0.840 |
| **Excluded variables** | | |
| No education | 0.332 | 0.471 |
| Male HoH | 0.818 | 0.385 |
| Children 0-6 | 0.153 | 0.168 |
| Children 7-16 | 0.207 | 0.199 |
| ln(total Income) | 11.379 | 1.404 |
| Total number of clusters | 158 | |
| Number of observations | 2512 | |

Notes:
The minimum and maximum size of the clusters is 6 and 20 households, respectively.
Expenditures are measured in CFA francs per month

Table A2: Over-identification and endogeneity tests

| Equations | Sargan Test | | | Durbin-Wu-Hausman Test | | |
|---|---|---|---|---|---|---|
| | Statistic | Degrees of freedom | P value (%) | Statistic | Degrees of freedom | P value (%) |
| ln(unit value Starch) | 0.384 | 4 | 94.35 | 46.701 | 2 | 0.000 |
| ln(unit value Fat and Oil) | 3.183 | 4 | 36.43 | 46.495 | 2 | 0.000 |
| ln(unit value Veg and Fruit) | 36.657 | 4 | 0.00 | 0.125 | 2 | 93.94 |
| ln(unit value Meat and Dairy) | 1.803 | 4 | 61.43 | 30.005 | 2 | 0.000 |
| Budget Share Starch | 0.680 | 5 | 87.79 | 19.095 | 3 | 0.000 |
| Budget Share Fat and Oil | 0.015 | 5 | 99.95 | 11.834 | 3 | 0.797 |
| Budget Share Veg and Fruit | 0.032 | 5 | 99.85 | 10.336 | 3 | 1.592 |
| Budget Share Meat and Dairy | 0.858 | 5 | 83.56 | 12.957 | 3 | 0.473 |

Notes:
The Sargan test statistic is distributed chi-square with 4 degrees of freedom in the equations of unit value and 5 degrees of freedom in the equations of budget share.
The Durbin-Wu-Hausman test statistic is distributed chi-square with 2 degrees of freedom in the equations of unit value and 3 degrees of freedom in the equations of budget share.
Endogenous variables in the equations of unit value: HoH participation, ln(quantity of group)
Endogenous variables in the equations of budget share: HoH participation, ln(total expenditure), ln(other food)
Excluded instruments in the equations of unit value: (no education of HoH minus the cluster mean of no education of HoH), (male HoH minus the cluster mean of male HoH), (children 0-6 minus the cluster mean of children 0-6), (children 7-16 minus the cluster mean of children 7-16), and the cluster mean of ln(total income).
Excluded instruments in the equations of budget share: (no education of HoH minus the cluster mean of no education of HoH), (male HoH minus the cluster mean of male HoH), (children 0-6 minus the cluster mean of children 0-6), (children 7-16 minus the mean of children 7-16), the cluster mean of ln(total income) and the cluster mean of ln(other food)

Table A3: Estimates for Engel curves and unit value equations

| Variables | Engel Curves | | | | | | | | Unit Value Equations | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Starch | | Fat and Oil | | Veg and Fruit | | Meat and Dairy | | Starch | | Fat and Oil | | Veg and Fruit | | Meat and Dairy | |
| | Coef | Std-err | Coef | Std-err | Coef | Std-err | Coef | Std-err | Coef | Std-err | Coef | Std-err | Coef | Std-err | Coef | Std-err |
| **Household characteristics** | | | | | | | | | | | | | | | | |
| Participation of HoH | **24.668** | 0.106 | **7.703** | 0.030 | **-10.254** | 0.047 | **-22.117** | 0.100 | **-75.523** | 0.366 | 41.934 | 0.385 | 4.956 | 0.288 | 16.212 | 0.537 |
| Age of HoH | 0.117 | 0.001 | **0.055** | 0.021 | -0.061 | 0.000 | -0.111 | 0.001 | **-0.7598** | 0.004 | 0.060 | 0.004 | **0.818** | 0.002 | **0.893** | 0.004 |
| Married HoH | **0.537** | 0.012 | -0.173 | 0.003 | -0.226 | 0.005 | -0.137 | 0.011 | 4.139 | 0.052 | -3.663 | 0.065 | **19.904** | 0.044 | -4.824 | 0.106 |
| Self-employed HoH | **-4.549** | 0.026 | **-2.413** | 0.007 | **2.582** | 0.012 | 4.381 | 0.025 | **24.770** | 0.094 | -11.905 | 0.102 | 2.593 | 0.074 | 10.378 | 0.151 |
| Farmer HoH | **-10.047** | 0.041 | **-2.968** | 0.011 | 2.405 | 0.018 | **10.610** | 0.038 | -19.542 | 0.134 | **-30.028** | 0.105 | **-26.975** | 0.115 | 0.001 | 0.230 |
| Number of rooms per MoH | **-1.733** | 0.005 | -0.086 | 0.001 | **0.627** | 0.002 | **1.191** | 0.005 | **8.370** | 0.035 | 1.108 | 3.029 | **-4.666** | 0.020 | -2.747 | 0.040 |
| Muslim HoH | **-0.124** | 0.018 | -0.644 | 0.005 | 1.115 | 0.008 | -0.347 | 0.017 | 10.516 | 0.078 | -10.984 | 0.095 | 8.260 | 0.087 | 29..670 | 0.155 |
| Christian HoH | 0.803 | 0.013 | 0.257 | 0.004 | 0.010 | 0.006 | -1.071 | 0.012 | 6.770 | 0.057 | -4.366 | 0.071 | 9.141 | 0.049 | 5.764 | 0.095 |
| Akan HoH | -1.700 | 0.016 | -0.841 | 0.005 | 0.336 | 0.007 | 2.205 | 0.015 | -0.919 | 0.069 | -12.911 | 0.082 | -1.897 | 0.079 | -11.576 | 0.127 |
| Krou HoH | -0.156 | 0.020 | -0.450 | 0.005 | 0.430 | 0.009 | 0.176 | 0.018 | 4.665 | 0.079 | -10.909 | 0.095 | -4.004 | 0.091 | **-29.810** | 0.151 |
| Mande-North HoH | -0.720 | 0.018 | 0.962 | 0.005 | -0.065 | 0.008 | -0.178 | 0.017 | -3.570 | 0.080 | 5.519 | 0.095 | 6.509 | 0.070 | -2.686 | 0.136 |
| African HoH | -2.299 | 0.020 | -0.106 | 0.006 | 0.988 | 0.009 | 1.417 | 0.019 | 2.002 | 0.075 | -0.282 | 0.088 | **-13.207** | 0.061 | 11.778 | 0.155 |
| Owner-occupier household | 3.358 | 0.018 | 0.868 | 0.005 | -1.301 | 0.008 | -2.925 | 0.017 | -12.684 | 0.073 | 2.542 | 0.076 | 8.382 | 0.053 | 2.719 | 0.108 |
| **Conditioning expenditure** | | | | | | | | | | | | | | | | |
| ln(other food) | **-9.475** | 0.032 | -0.920 | 0.009 | **3.038** | 0.014 | **7.358** | 0.030 | | | | | | | | |
| No other food | **42.979** | 0.155 | 4.670 | 0.044 | **-18.477** | 0.069 | **-29.171** | 0.146 | | | | | | | | |
| ln(Quantity) | | | | | | | | | 19.722 | 0.160 | 10.565 | 0.191 | **-94.828** | 0.151 | **22.787** | 0.100 |
| ln(total expenditure) | **-9.494** | 0.045 | -2.221 | 0.013 | 0.869 | 0.020 | **10.846** | 0.042 | | | | | | | | |

Notes:
HoH = head of household; MoH = member of household.
All coefficients are multiplied by 100. Bold entries correspond to a 5% or 1% significance level.

Table A4: Estimates of coefficients of price $\gamma$

| | Unrestricted Coefficients of Prices | | | | Symmetry Restricted Coefficients of Prices | | | |
|---|---|---|---|---|---|---|---|---|
| | Starch | Fat and Oil | Veg and Fruit | Meat and Dairy | Starch | Fat and Oil | Veg and Fruit | Meat and Dairy |
| Starch | **9.261** (0.022) | -0.742 (0.019) | **7.754** (0.016) | **-2.752** (0.013) | **18.812** (0.014) | | | |
| Fat and Oil | 0.379 (0.006) | 0.850 (0.005) | **2.273** (0.004) | **-0.347** (0.003) | **2.540** (0.004) | **2.024** (0.004) | | |
| Veg and Fruit | -0.417 (0.008) | 0.050 (0.007) | **3.408** (0.006) | 0.117 (0.005) | 0.859 (0.007) | **1.010** (0.003) | **3.160** (0.005) | |
| Meat and Dairy | -1.585 (0.018) | 0.293 (0.015) | **-5.944** (0.013) | 1.616 (0.011) | **-6.348** (0.010) | **-2.090** (0.003) | **-2.063** (0.004) | **3.658** (0.010) |

Notes:
All coefficients are multiplied by 100. Bold entries correspond to a 5% or 1% significance level.
Standard errors in brackets.
Wald test of symmetry restrictions $\chi^2(6)$ = 378.84 (critical value at a 5% significance level is 12.59)

Table A5: Marshallian elasticities for demand for good

| | Marshallian Elasticities to the Mean Point | | | | | Marshallian Elasticities to the 10th Percentile of Total Expenditure | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Starch | Fat and Oil | Veg and Fruit | Meat and Dairy | Total Budget | Starch | Fat and Oil | Veg and Fruit | Meat and Dairy | Total Budget |
| Starch | **-0.449** (0.057) | **0.079** (0.013) | **0.056** (0.024) | -0.071 (0.046) | **0.770** (0.108) | **-0.495** (0.055) | **0.077** (0.014) | **0.090** (0.037) | **-0.119** (0.024) | **0.793** (0.098) |
| Fat and Oil | **0.451** (0.088) | **-0.714** (0.053) | **0.176** (0.047) | **-0.169** (0.070) | 0.710 (0.165) | **0.334** (0.068) | **-0.788** (0.039) | **0.166** (0.050) | **-0.177** (0.029) | 0.791 (0.119) |
| Veg and Fruit | 0.033 (0.071) | **0.062** (0.022) | **-0.800** (0.039) | **-0.156** (0.055) | 1.057 (0.131) | 0.013 (0.033) | **0.027** (0.011) | **-0.916** (0.025) | **-0.062** (0.014 | 1.025 (0.058) |
| Meat and Dairy | **-0.302** (0.056) | **-0.081** (0.012) | **-0.103** (0.022) | **-1.006** (0.050) | **1.302** (0.117) | **-1.222** (0.236) | **-0.350** (0.057) | **-0.624** (0.163) | **-0.713** (0.113) | **2.171** (0.454) |

Notes:
Standard errors in brackets.
Bold entries correspond to rejection of the Ho: e = 0; for expenditure elasticities, rejection of the Ho: e = 1.

Table A5 continued

| | Marshallian Elasticities to the Median (50th Percentile) of Total Expenditure | | | | | Marshallian Elasticities to the 90th Percentile of Total Expenditure | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Starch | Fat and Oil | Veg and Fruit | Meat and Dairy | Total Budget | Starch | Fat and Oil | Veg and Fruit | Meat and Dairy | Total Budget |
| Starch | **-0.541** (0.053) | **0.061** (0.010) | **0.049** (0.020) | **-0.078** (0.029) | **0.816** | 0.097 (0.088) | **0.174** (0.029) | **0.103** (0.046) | -0.023 (0.158) | **0.494** (0.239) |
| Fat and Oil | **0.570** (0.121) | **-0.665** (0.063) | **0.217** (0.059) | **-0.240** (0.065) | 0.656 | **0.389** (0.065) | **-0.711** (0.054) | **0.166** (0.045) | -0.093 (0.110) | 0.708 (0.167) |
| Veg and Fruit | 0.023 (0.071) | **0.054** (0.019) | **-0.829** (0.035) | **-0.129** (0.037) | 1.049 | 0.061 (0.070) | **0.083** (0.030) | **-0.731** (0.049) | **-0.228** (0.115) | 1.076 (0.175) |
| Meat and Dairy | **-0.495** (0.099) | **-0.115** (0.016) | **-0.164** (0.035) | **-0.957** (0.058) | **1.449** | **-0.135** (0.021) | **-0.047** (0.007) | **-0.053** (0.010) | **-1.050** (0.045) | **1.174** (0.067) |

Notes:
Standard errors in brackets.
Bold entries correspond to rejection of the Ho: e = 0; for expenditure elasticities, rejection of the Ho: e = 1.

Table A6: Components of the commodity groups

| **Modelled commodity groups** | |
|---|---|
| Starch | Local rice, imported rice (denicacha), rice deluxe, ear of corn, grain of corn, corn flour, millet grain, millet flour, sorghum grain, sorghum flour, grain fonio, wheat, green bean, dry beans, yam, fresh cassava, attieke, cassava flour, placali (cassava paste), other forms of cassava (tapioca, gari, …), taro, sweet potato, , plantain, carrot, bread, paste food, wheat flour, (imported) potato |
| Fat and Oil | Shelled peanut, peanut paste, pistachio, palm nuts, traditional palm oil, shea butter, butter margarine, refined oil, |
| Veg and Fruit | Fresh tomato, local eggplant, purple eggplant, fresh okra, dry okra and okra powder, onion, pimento, cabbage, pumpkin, cucumber, pepper, various salads, cassava leaf, potato leaf, kloila leaf, dah leaf, other fresh leaves, pineapple, banana, orange, mandarin, grapefruit, lemon, avocado, mango, papaya, cane sugar |
| Meat and Dairy | Beef, mutton, pork, poultry, offal , fresh fish, smoked fish, snail, bush meat, egg, fresh milk, condensed milk and milk powder, yogurt, cheese |
| **Non-modelled food** | |
| Other food | Traditional alcoholic beverages, traditional soft drinks (bissap, etc.), other drinks, cookies and pastries, crustaceans, bouillon cubes, tomato paste, salt, sugar, café, chocolate, tea, modern alcoholic beverages (beer, wine, liquor, etc.), modern soft drinks (cola, etc.), canned sardines, canned meat, canned fruit, imported fruit (apple, grapes, etc.), takeaway meals, meals out |

Notes:
Housing expenditure includes expenditures on water, electricity and rent

Table A7: Definition of variables

| Variables | Definition |
|---|---|
| Participation of HoH | =1 if HoH has worked one hour or more during the last seven days, or HoH has claimed that he/she simply has a job even if he/she did not work the last seven days; 0 if HoH is pensioner, housewife, ill, or a student. |
| Age of HoH | =Age of the head in years |
| Married HoH | =1 if HoH is married; 0 otherwise |
| Self-employed HoH | =1 if HoH is self-employed in the main job (but is not a farmer or sharecropper) even if he/she has some employees; 0 otherwise |
| Farmer HoH | =1 if HoH is a farmer in the main job or a sharecropper; 0 otherwise |
| Number of rooms per MoH | =Total number of rooms of the dwelling divided by household size |
| Muslim HoH | = 1 if HoH is a Muslim; 0 otherwise |
| Christian HoH | = 1 if HoH is a Christian; 0 otherwise |
| Akan HoH | =1 if HoH's ethnic group is Akan ((southern, eastern, and central ethnic groups); 0 otherwise |
| Krou HoH | =1 if HoH's ethnic group is Krou (south-western ethnic group); 0 otherwise |
| Mande-North HoH | =1 if HoH's ethnic group is Mande-North (North-Western ethnic group); 0 otherwise |
| African HoH | =1 if HoH is an non-Ivorian African (Burkina Faso, Malian, etc.); 0 otherwise |
| Voltaic or Mande-South HoH | =1 if ethnic group is Voltaic (north-central and north-eastern ethnic group) or Mande-South (western ethnic group), 0 otherwise |
| Owner-occupier household | = 1 if household occupied his own dwelling; 0 otherwise |
| ln(other food) | = Natural logarithm of expenditure of non-modelled food |
| No other food | = 1 if no expenditure on non-modelled food ; 0 otherwise |
| No education | =1 if HoH never attended school or only attended pre-school education |
| Male HoH | =1 if HoH is a man ; 0 otherwise |
| Children 0-6 | = Total number of children between 0-6 years old divided by household size |
| Children 7-16 | = Total number of children between 7-16 years old divided by household size |
| ln (quantity) | = Natural logarithm of total quantity of commodity group |
| ln(total income) | = Natural logarithm of monthly income |
| ln(total expenditure) | = natural logarithm of monthly total expenditure |

Notes:
We created one dummy for Voltaic and Mande-South ethnic groups because the number of households in each group was less than 10% of our final sub-sample. Côte d'Ivoire has more than 60 ethnic groups; however, a standard classification contains the five main ethnic groups used here. We also separate other Africans from Ivorian citizens and place them in an ethnic group called "African".

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FORSCHUNGSZENTRUM FZID

Universität Hohenheim
Forschungszentrum
Innovation und Dienstleistung
Fruwirthstr. 12
D-70593 Stuttgart
Phone +49 (0)711 / 459-22476
Fax +49 (0)711 / 459-23360
Internet www.fzid.uni-hohenheim.de