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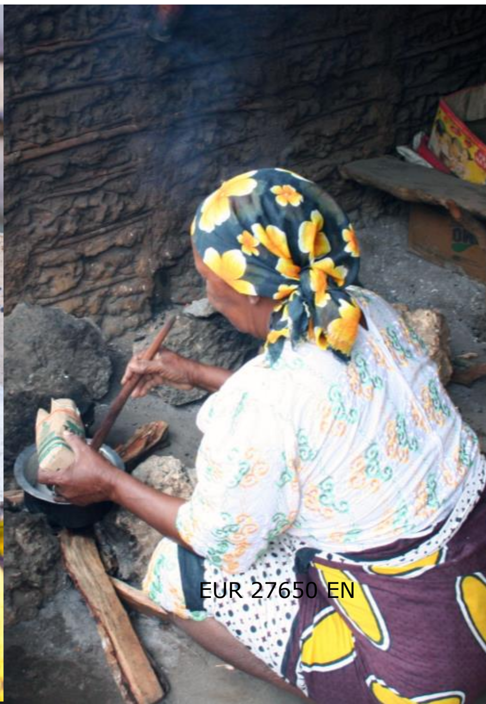

Joint Research Centre

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## Executive Summary

Food demand in Sub-Saharan Africa is rapidly changing. Given an expanding population, rising incomes and intensified urbanization, the demand for food will not only continue to rise, but will also change in its composition. In order to combat malnutrition, economists and policymakers need to understand better, first, the factors underlying the relation between income and food demand, and, second, how this relation is changing according to the income level and/or characteristics of the country under study. Such understanding will help to improve the design and implementation of nutrition policies as the continent further develops.

There are a number of studies that have estimated the relation between income growth and food demand in Africa, but the resulting estimates are highly heterogeneous. This report provides a systematic review of the existing literature on income elasticities of food demand in Africa. A meta-sample has been constructed including both attributes of the primary studies and external country-level factors thought to influence the income elasticities.

The sample includes elasticities for different categories of food (cereals, legumes and nuts, meat, fish and eggs, dairy products, fruits and vegetables, and beverages) as well as elasticities for calorie and nutrient consumption. A total of 2,101 elasticity estimates drawn from 66 studies and covering 54 African countries have been included in the sample.

Descriptive statistics indicate that food demand is more responsive to changes in income (in other words, income elasticities are higher) for beverages, meat, fish and eggs and dairy, compared to foods that tend to constitute basic diets (e.g. cereals, legumes and nuts, fruit and vegetables, and fats and oils, tubers). Correspondingly, certain nutrient elasticities (especially elasticities of demand for proteins) are found to be higher than calorie elasticities.

Based on this sample, meta-regression analyses were conducted for each of the food categories separately, as well as for food, calorie and nutrient demand as a whole. The role of methodological factors and country-level characteristics in explaining the different responses of food demand to income have been examined. There is no strong evidence of major methodological and data-related differences, although some tendencies can be identified: the use of panel data, the use of expenditures as a proxy for income and the use of single-equation models rather than demand systems all seem to result in lower elasticities.

Factors relating to a country's income and degree of urbanisation, time period of primary data, and geographical sub-region (e.g. Western Africa) are found to explain heterogeneity in the estimated elasticities. For calorie demand and food demand in general, we find that a higher level of income results in lower elasticities. For nutrient demand, we find instead that elasticities are higher in richer countries. This suggests that as countries grow richer, households tend to spend more on food with higher nutritional value. We also find that for most types of food, elasticities tend to be lower in urban areas or in countries with a larger share of urban population.

The considerable regional differences in food-income elasticities across African sub-regions suggest that the impact of agricultural and nutrition policies may be expected to differ by region. Further research could usefully explore in greater detail some of the patterns identified and, in doing so, contribute to the design of policies aimed at addressing malnutrition.

# 1. Introduction

Ensuring food security in Sub-Saharan Africa (SSA) remains a huge challenge, and will continue to be so in the coming decades. FAO, IFAD and WFP (2015) estimate that over 200 million people in Africa are hungry. The share of undernourished people in SSA has declined (from 27.6% in 1990-1992 to 20.7% in 2010-2012), but at a considerably slower pace than in the rest of the developing world. Moreover, given that by 2050 the population of SSA is expected to double (UNPD, 2015), feeding the poor will remain an enormous challenge. Not only will the demand for food continue to rise, but also the composition of food demand will change with rising incomes and growing urbanization contributing to changing diets (Popkin, 1994). With more than half of the African population projected to live in cities by 2050 and average growth of GDP in SSA continuing at a rate of 4 to 5 percent in the coming years (World Bank, 2015), the composition of African food demand may be expected to alter substantially in the future.

Beyond these general trends, studies note that there are significant differences in dietary patterns and food supply structures across regions (Fabiosa, 2011). These differences influence the relationship between income and food demand and thus the impact of alternative policy mechanisms in different areas. An examination of the drivers of food demand, and how they are changing over time especially in the face of growing national incomes, is needed to reveal the impact of growth and policy interventions on malnutrition. For example, a large responsiveness of food demand to rising incomes suggests that income-oriented policy interventions can be an effective tool to combat undernutrition, while a low responsiveness indicates that income growth will affect food demand only to a limited extent and that other types of policy interventions will be needed. Also, for projecting future patterns of food demand, it is important to know how demand will respond to rising incomes and which segments of the population will be most threatened by hunger. Overall, a better understanding of food demand is needed to inform policies aimed at improving food security across Africa.

## 1.1 Food demand and income

Generally, the income elasticity of food demand (i.e. the percentage change in food consumption in response to a 1% change in income) is positive but smaller than 1, i.e. spending on food increases less than proportionally with total expenditures. For poor people, food makes up an important share of household spending. However, as people get richer, they tend to allocate proportionally more of that additional income to non-food items, reducing the share they spend on food. As a result, even though total spending on food increases, the share of total income devoted to food declines, also known as Engel's Law. This also explains why, as people become richer and their daily calorie demand is fulfilled, they start spending more on the taste, quality and diversity of their food instead of the amount of food (Jensen and Miller, 2011), i.e. the "trading up" of food consumption. As a result, the composition of people's food basket is changing Understanding the relationship between income and the demand for food is critical for the design of policies aimed at addressing under-nutrition and improving food security in developing countries. Studies which have looked at the relationship at global level have found evidence of "trading up" (whereby consumption patterns shift as income levels increase towards high value protein rich meat and dairy products, more convenience foods and specific product characteristics) and "convergence" (whereby the consumption patterns in low to middle income countries converge, over time, towards the consumption patterns in high income countries). However, studies also note that there are significant differences in dietary patterns and food supply structures both across regions and within regions such as Africa (Fabiosa, 2011). These differences influence the relationship between income and food demand and thus the impact of alternative policy mechanisms in different areas.

By and large, the existing literature on income and food demand has focused on the relationship between income and calorie consumption (i.e. calorie-income elasticities), while relatively few have considered the nutrient composition (e.g. fats, proteins, carbohydrates) of calorie consumption (see Salois et al., 2012). Studies have shown that the relationship between income and calorie consumption is not linear and that the increase in the demand for calories as a result of income growth becomes smaller as income levels become higher (i.e. the income elasticity of demand is less elastic for higher income countries or groups of the population with higher income). This is thought to result from the reaching of a saturation point in calorie consumption (e.g. Skoufias et al., 2011, Salois et al., 2012) and the preference for higher quality foods with increased income, without changing their nutrient composition (e.g. Jensen and Miller, 2011, Skoufias et al., 2011).

## 1.2 Aims and objectives

A large number of studies have estimated the relation between food demand and income for specific categories of food, time periods and countries. Yet, the resulting elasticity estimates vary widely across studies. In this report we examine the relation between income and food, calorie and nutrient consumption through a systematic review of the existing literature, specifically focusing on Africa. Through a meta-analysis approach, we aim to explain this large heterogeneity in income elasticities across the African continent in terms of country attributes, the specific food or nutrient categories considered, or the methodological characteristics of the data and estimation techniques. Meta-analysis provides an objective approach to review empirical literature through the use of statistical techniques (Stanley and Jarrell, 2005)[1]. As such, our main objectives are to identify the factors underlying differences in the estimated food income elasticities within and between developing countries in Africa.

The report draws on recent review studies, including other meta-analyses of food demand (e.g. Bouis and Haddad, 1992, Salois et al., 2012, Ogundari and Abdulai, 2013, Zhou and Yu, 2014)[2]. Table 1 provides a summary of the main features of previous review studies of calorie-income elasticities. Yet, we extend the work in a number of ways.

First, our main interest is to uncover the explanations behind the different food income elasticities found in the literature. While Ogundari and Abdulai (2013) did a detailed meta-analysis of calorie-income elasticities, they focused only on the methodological explanations for the heterogeneity in estimated elasticities. Instead, Zhou and Yu (2014) and Salois et al. (2012) focused specifically on income to explain different elasticity estimates. Salois et al. (2012) investigated the nature of the relationship between income and calorie and nutrient consumption using both parametric and non-parametric methods that can accommodate nonlinearities and make fewer (or no) assumptions about the functional form of the relationship. Zhou and Yu (2014) discussed in detail how the calorie-income relation differs between the 'poor stage' and the 'affluent stage'. In addition to the income level, in this report, we also explore how other country-specific factors (such as urbanization and geography) may explain the heterogeneity in food-income elasticities across countries, while still controlling in detail for methodological aspects of the studies.

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[1]This approach to conducting a literature review has been more commonly applied in psychology and the medical sciences, but has recently also gained popularity in environmental economics (e.g. Nelson and Kennedy, 2009), labour economics (e.g. Ashenfelter et al., 1999, Longhi et al., 2005, Nijkamp and Poot, 2005, Weichselbaumer and Winter-Ebmer, 2005), international economics (e.g. Rose and Stanley, 2005, de Groot et al., 2005, Disdier and Head, 2008) and urban and regional economics (e.g. Beaudry and Schiffauerova, 2009, Melo et al. 2009, de Groot et al., 2009, Melo et al., 2013).

[2]Meta-analyses of price elasticities of food demand have been carried out by Andreyeva et al. (2010) and Green et al. (2013) but are not further discussed here.

**Table 1. Previous review studies of calorie-income elasticities**

| Study | Bouis and Haddad (1992) [1] | Salois et al. (2012)[1] | Ogundari and Abdulai (2013) | Zhou and Yu (2014) |
|---|---|---|---|---|
| No. primary studies | 26 | 15[2] | 40 | 90 |
| No. elasticity estimates | Not reported | 171[3] | 99 | 387 |
| Range | [0.01,1.18][2] | <0-0.59 (based on study-level data) | [0.004,0.97] | [-0.23,0.99] (approximately) |
| Average | Not reported | Not reported | 0.31 | 0.35 |
| Time period | Not reported | 1990-1992;2003-2005 | Not reported | Not reported |
| Spatial coverage | Developing countries | Developing and developed countries | Developing and developed countries | Developing and developed countries |

[1] These studies do not conduct a meta-analysis but provide an overview of the empirical literature.
[2] This value is inferred from the list of primary studies reported on Table 1 of the review study.
[3] Based on the information that the study uses "A cross-sectional sample of 171 developing and developed countries…"

Second, we consider a very comprehensive list of potential methodological sources of variation in calorie-income elasticities, including a number of factors which were not controlled for in the studies conducted by Ogundari and Abdulai (2013) and Zhou and Yu (2014): modelling approach (e.g. linear vs. nonlinear), type of food demand model (e.g. single-equation vs. demand system), potential mis-specification of the demand model (e.g. omitted variable bias, measurement error in calorie consumption), and adjustment of demand responses to changes in income over time (i.e. short-, medium-, and long-run income elasticities). They also did not test for publication bias. The review by Bouis and Haddad (1992) centers on issues relating to the measurement of the calorie and income variables used in the estimation of elasticities, the level of (dis)aggregation of food data, the different estimation techniques used in the estimation of calorie-income elasticities, and the country to which the estimates refer to. They argue that a large part of the divergence in calorie-income elasticities results from the choice of measurement of the calorie and income variables and from food aggregation. We therefore also control for these factors.

Third, most review studies have focused on the relation between income and calorie consumption. This report will provide evidence for income elasticities associated with different types of food and nutrients, besides calories, in order to improve our understanding of the relationship between income and nutrition. Salois et al. (2012) also considered different nutrient-income elasticities (including carbohydrates, proteins and fats), but their analysis is based on a much smaller sample and failed to control for a number of methodological study attributes which may influence results.

Finally, our analysis is different from previous meta-analyses in that it provides specific evidence for Africa. With the exception of Bouis and Haddad (1992), none of these studies have looked specifically at Africa or exclusively at developing countries. Although the previous meta-analyses of calorie-income elasticities conducted by Ogundari and Abdulai (2013) and Zhou and Yu (2014) considered studies from around the world, their meta-samples were highly dominated by developing countries in Asia (e.g. China, India, Indonesia, Philippines, Vietnam), South America (e.g. Brazil, Mexico), and only a limited number of African countries (e.g. Kenya, Nigeria, Rwanda, Tanzania, Uganda).

Summarizing the above, this study improves on the previous review studies in the following ways:

1. **Selection of primary studies**, by including estimates obtained from international organisations engaged in international food policy in Africa.
2. **Specification of food demand**, by distinguishing between different types of food. This will improve the comparability of income elasticities between studies and improve the ability of policy makers to understand the response in an individual's demand for certain types of food (and nutrients) as a result of changes in income.
3. **Specification of meta-regression**, by including new meta-regressors, not considered in the previous meta-analyses, to capture heterogeneity across income elasticities due to:
   - Type of food
   - Nature of data (e.g. disaggregate household or individual data vs. aggregate data)
   - Modelling approach (e.g. linear vs. nonlinear)
   - Type of food demand model (e.g. single-equation vs. demand system vs. almost ideal demand system)
   - Potential misspecification of primary study food demand model (e.g. omitted variable bias)
   - Adjustment of food demand to changes in income over time (i.e. differences between short-, medium-, and long-run income elasticities)
   - Income level of countries in the meta-regression
   - Differences in food supply across regions of Africa
4. **Sensitivity analysis**, by considering issues arising from potential model misspecification and publication bias.

The following chapter (Chapter 2) provides a brief discussion of the methods used in both constructing the meta-sample (e.g. the search terms used to find studies, the internal and external variables included in the meta sample) and in the meta-regression analysis (e.g. specification of the equation, types of sensitivity analyses conducted). Chapter 3 provides summary descriptive statistics and reports the distribution of elasticities for several of the variables known to influence food demand patterns. Chapter 4 reports the results from the regression analyses, first for all foods and then by food type, nutrients, and calories. Chapter 5 shows the robustness of the results, exploring the sensitivity of findings to sample size, and the type and quality of the associated publication. Chapter 6 discusses the key results and concludes.

# 2. Research Methods

The first part of this report consists of a systematic review of the relevant empirical literature and included the construction of a meta-sample of income elasticities of food demand. The second part consists of a meta-regression analysis and included also sensitivity tests. The successful estimation of the meta-regressions (part two) is strongly dependent on the quality of the meta-sample (part one). This chapter provides further details on the approach adopted at both stages of the report.

## 2.1 Development of the meta-sample

### *2.1.1 Search terms and selection strategy*

The search was carried out using a combination of terms including "nutrition and income elasticity", "food and income elasticity", "calorie-income elasticity" and the combination of "income elasticity" and "demand elasticity" with a list of keywords such as "developing countries", "Africa", "food", "calorie", "nutrition", type of food (e.g. "eggs", "dairy", "milk", "cereal", "fruit", "vegetable", "fish", "meat"). Given the focus on developing countries in Africa, we also specified the search terms in Portuguese, French and Spanish, besides English although, in the event, none were located.[3]

An initial filtering of relevant sources was carried out across the online databases listed in Table 2. These included both published peer-reviewed literature (e.g. journal articles) and 'grey' literature (e.g. working papers, reports, dissertations) in the economics, medical and nutrition discipline areas. In addition, we also considered the references of primary studies included in previous review studies of food demand (e.g. Salois et al., 2012, Green et al., 2013, Ogundari and Abdulai, 2013, Zhou and Yu, 2014) as well as the references to studies of the calorie-income elasticity for developing countries listed in the literature review conducted by Bouis and Haddad (1992). The main source of studies for African studies was found to be *African Journals OnLine (AJOL)*.

**Table 2. Online databases**

| Peer reviewed literature | 'Grey' literature |
|---|---|
| - ISI Web of Knowledge | - World Bank |
| - IngentaConnect | - AgEcon Search |
| - JSTOR | - Eldis, Institute of Development Studies |
| - ScienceDirect | - USAID (US Agency for International Development) |
| - EconLit | - FAO (UN Food and Agriculture Organization) |
| - EconBiz | - IFPRI (International Food Policy Research Institute) |
| - MEDLINE | - CABI's database Global Health |
| - PubMed | - RePEc (Research Papers in Economics) databases |
| - PMC (PubMed Central) | - OpenGrey |
| - African Journals OnLine (AJOL) | - Google Scholar |
| | - Google |

[3] A subsequent search (after the completion of the meta sample) using "AIDS" (Almost Ideal Demand System) as a search term found three studies written in french studies. We thus suggest that future similar studies consider using this search term.

The selection process was first based on the relevance of the abstract to the research objectives. In particular, the decision to accept or reject the study was based on whether the abstract mentioned a combination of the words "food", "calorie", "nutrient", "income", and "elasticity". In situations of doubt, the studies were scanned for clarification.

It is crucial that the estimates included in the meta-sample be reasonably comparable. To avoid problems of comparability between estimates, the meta-regression only considered unit-free elasticity estimates of food demand with respect to income.

### *2.1.2 Data extraction*

Once a study was selected, a process of data extraction was initiated following a specific protocol about which aspects of the study to select in the meta-sample. The list of features considered in the construction of the meta-sample is given in Table 3. All elasticity estimates available from a single study were included in the meta-sample to increase sample size and allow for the control of within-study variation in estimates.

While the vast majority of the attributes listed in Table 3 were derived directly from the studies included in the meta-sample (i.e. internal variables), a number of external country level attributes were, ex-post, added to the database on the grounds that they may contribute to heterogeneity in the observed income elasticities (i.e. external variables). The justification for these variables and how they were derived is described below.

### *2.1.3 External variables*

**Geographic characteristics of countries**

To control for the effect of a country's geographic characteristics on the variation in estimated income elasticities, we identified three indicators of countries' geography.

First, we identify five distinct geographic sub-regions of Africa namely North, Southern, East, West and Central Africa. At the sub-regional level, strong commonalities in climate patterns and soil characteristics across countries affects the suitability and yields of foods that are grown in the regions. This may have implications for prices and taste, and thus demand for locally grown foods as well as imported substitutes. Also cultural influences and proclivities for foods are likely to be stronger across the countries making up a region.

Each country in our sample was assigned a region according to its membership of five main sub-regional economic organisations namely the Arab Maghreb Union (UMA), Southern African Development Community (SADC), East African Community (EAC), Economic Community of West African States (ECOWAS) and the Economic Community of Central African States (ECCAS). Some countries such as Egypt do not belong to any of these organisations but their regional placement is unambiguous (i.e. North Africa). Other countries such as Angola, Burundi, DR Congo and Tanzania[4] belong to more than one of these organisations, perhaps due to the ambiguity in their regional placements. For purposes of our analysis, we require each country to be uniquely identified with a region. Thus these countries were assigned their most appropriate region by considering the grouping used by the United Nations Statistical Divisions (UNSD) of Africa. Angola and DR Congo were included within the Central region of Africa, and Tanzania and Burundi in the Eastern region of Africa. Figure 1 shows our grouping of countries in the meta-sampel into the five sub-regions.

[4] Angola (SADC and ECCAS), Burundi (EAC and ECCAS), DR Congo (SADC and ECCAS) and Tanzania (SADC and EAC).

**Table 3. List of features considered in the construction of the meta-sample**

| Internal variable - Attributes of the study | Internal variables - Attributes of the income elasticity estimate | External variables (at country level) |
|---|---|---|
| - Date of publication (e.g. 2013)<br>- Type of publication (e.g. peer reviewed journal, report from international organisation, conference or working paper)<br>- Number of income elasticity estimates<br>- Quality of publication, if available (e.g. impact factor or journal ranking)[5] | - Type of estimate (e.g. elasticity vs. semi-elasticity)<br>- Standard error or t-statistic of income elasticity estimate<br>- Sample size (cross-sectional and time dimension, e.g. 30 regions over 10 years)<br>- Focus of demand (e.g. foodstuffs, calories, nutrients)<br>- Type of food (e.g. cereals, pulses, meat, fish, eggs, fruits, vegetables, dairy, fat and oils, alcoholic drinks)<br>- Source of data (e.g. primary or secondary)<br>- Nature of data (e.g. household or individual data vs. aggregate data)<br>- Structure of data (e.g. time series vs. cross-sectional vs. panel data)<br>- Geographical coverage – country (e.g. Angola)<br>- Geographical coverage – type of area (e.g. rural vs. urban area)<br>- Income segment (if applicable) the elasticity refers to (e.g. bottom quintile vs. top quintile households)<br>- Time period (e.g. 1991-1995, 1996-2000, 2001-2005)<br>- Time horizon of elasticity (e.g. short-run elasticity vs. long-run elasticity)<br>- Consumption measure: monetary value (expenditure) or quantity<br>- Income measure: income data or total expenditure<br>- Measurement approach to estimate calorie-income elasticity (e.g. direct approach vs. indirect approach)[6]<br>- Modelling approach (e.g. linear vs. nonlinear)<br>- Functional form of the demand model (e.g. double-log, semi-log)<br>- Type of demand model (e.g. single-equation vs. demand system)<br>- Type of estimator (e.g. OLS, panel data random-effects, panel data fixed-effects, IV)<br>- Potential model mis-specification (e.g. omitted variable bias, measurement error in calorie consumption, simultaneity bias) | - Income level (e.g. GDP per capita if available, or WB classification in terms of low, lower middle, upper middle, high income)<br>- Sub-region in Africa<br>- Whether the country is landlocked<br>- Whether the country is in the Sahel region |

[5] This is an external variable but, unlike the other external variables listed in the third column of the table represents an attribute of the study.

[6] The 'direct' approach to estimating calorie income elasticity involves the conversion of given quantities of food into aggregate calories before estimation. In the 'indirect' approach, a weighted average of food group expenditure elasticities is computed post estimation to give the calorie income elasticity.

Second, we included an indicator of whether or not a country is landlocked. For landlocked African countries, structural challenges in access to world markets are compounded by their reliance on neighbouring maritime countries for the import of goods. The administrative and transportation costs incurred on goods in transit through these neighbouring countries has implications for food prices and hence for food demand and income elasticities, particularly for those foods in which the landlocked countries are not self-sufficient.

The third and final geographic characteristic captured in our sample is in respect of whether a country is in the Sahel region of Africa. Countries in this region frequently face droughts and have a significant proportion of their landmass made up of semi-arid soil that is agriculturally difficult to manage. This situation has fostered significant food insecurity and recurrent famines in the region hence the inclusion of this characteristic in our sample.

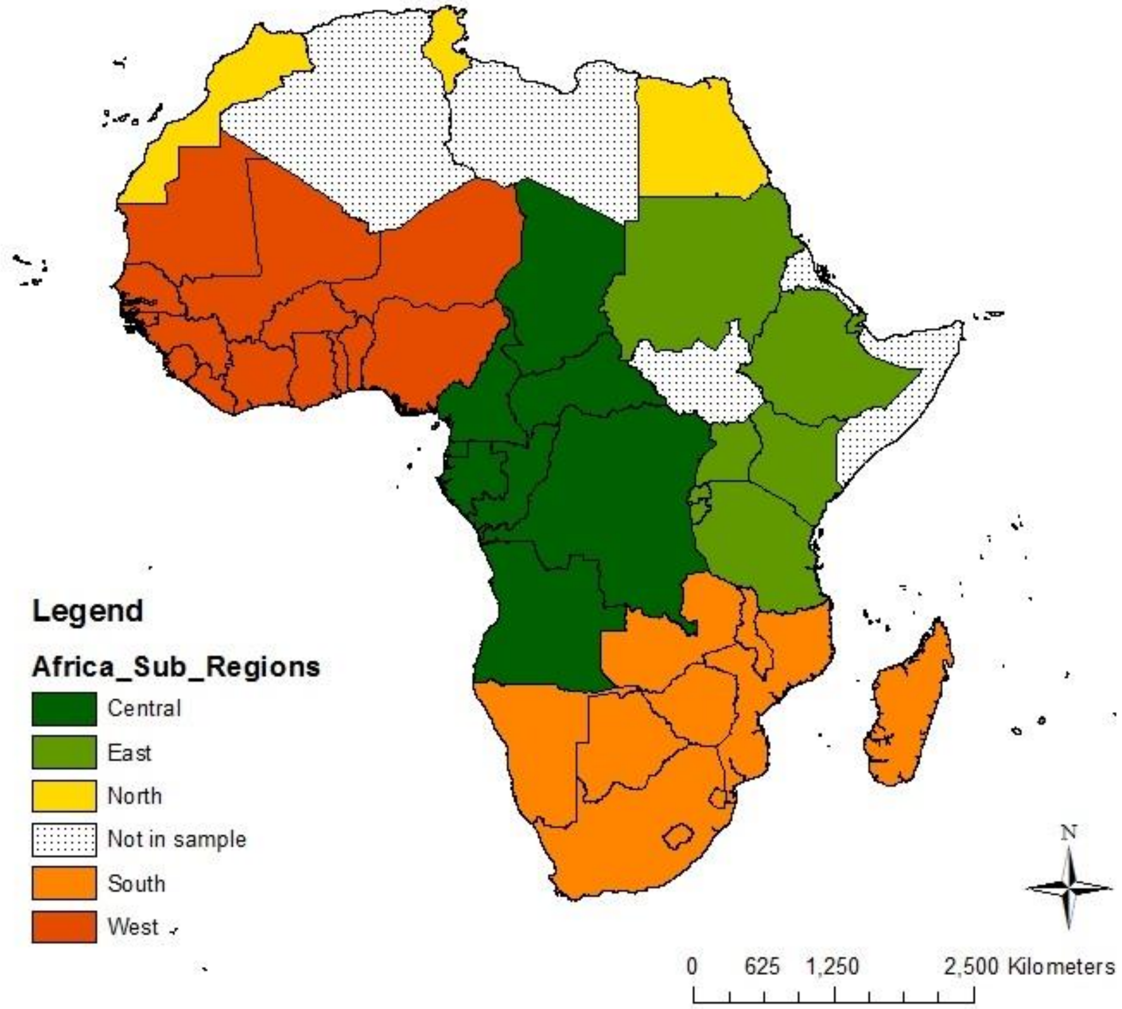


**Figure 1. Map of Africa showing grouping of countries in the meta-sample into five sub regions**

**Urbanisation**

Urbanisation influences food demand in a number of ways. Typically, households in urban locations purchase the foods they consume. They therefore have greater exposure to food prices which influences their consumption patterns and income elasticities. In contrast, rural communities in much of Africa are agrarian with households consuming a greater proportion of the foods they produce. They are therefore more insulated from market prices as a result of which consumption patterns and income elasticities may be different. In addition, urban consumers are more likely to use convenience foods whilst rural households have greater reliance on home-cooked foods. We include a measure of urbanisation based on the percentage of population in urban areas. This is high in countries such as Nigeria and South Africa which have very large and densely populated mega cities. Urbanisation data were taken from the World Development Indicators dataset (World Bank WDI, 2015). For studies using panel and time series data, we take the average of these variables for the period of the data in the underlying study.

### National income

The level of a country's income determines the amount as well as composition of its food demand. On average, high income countries spend 16% of their incomes on food while low income countries spend 55% (Regmi et al., 2001). Low income countries are therefore more responsive to volatility in food prices and income shocks especially for the high value products. To control for the effects of countries' income levels on the variation of income elasticities across studies, we include each country's income level in our meta-sample according to the year of the data used in the underlying studies. For completeness, two indicators of income from the World Bank's WDI data are considered. The first is the gross domestic product per capita (GDP pc) which is provided in constant 2005 dollar terms[7]. For studies using panel and time series data, we take the average of these incomes for the period of the data in the underlying study. The second is based on the World Bank's income classification of countries into low (L), lower middle (LM), upper middle (UM) and high (H) income levels. For time series and panel data, we use the most frequent occurring classification in the underlying study's data period. Our preference is to use the GDP pc indicator, but we were conscious that a lack of sufficient data may require the use of the proxy based on income classification.

### Journal Impact Factor

There is a potential inclination for peer reviewed journals to publish studies that find compelling empirical results of a particular magnitude and/or statistical significance. If this inclination exists, it engenders a situation where authors are tempted to submit their manuscripts according to an established trend of published results. Papers based on poor data, or with inconclusive or weak findings may not be submitted to high impact journals or may miss out in the competition for space in those journals (Murtaugh, 2002). This preferential publication phenomenon may foster a relationship between journal quality and the trend of published results. In meta-regression analysis, it introduces so-called 'publication bias' which we aim to investigate.

To ascertain the relative quality of the journals in our sample, we first determined the 5-year average impact factors of those that are present in the most recent Web of Science Journal Citation Report (WoS JCR, 2014). These range from 0.50 (China Agricultural Economic Review) to 3.11 (Journal of Development Economics). However, 17 out of the 29 journals in our sample are not present in the WoS JCR. Given the extensive coverage of the WoS JCR, it is reasonable to assume that un-represented journals are generally of lower quality. To standardise our ranking therefore, we created an internal ordinal scale and classify all the journals that are not represented in the WoS JCR in the lower end of that scale. As shown in Table 4 below, these are ranked 1 (i.e. lowest). Following this, four bands were then created and an internal ranking of journals was established according to the appropriate range of their impact factors.

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[7] We could not use GDP pc in PPP terms due to insufficient data.

**Table 4. Distribution of journals and observations in the meta-sample by Journal Quality**

| JCR 5-year impact factor | Internal ranking | Number of Journals | Number of observations |
|---|---|---|---|
| >3 | 5 (highest) | 1 | 11 |
| 2>3 | 4 | 4 | 257 |
| 1>2 | 3 | 3 | 29 |
| 0>1 | 2 | 4 | 376 |
| Not in JCR | 1 (lowest) | 17 | 189 |
| **Total** | **-** | **29** | **862** |

## 2.2 Meta-regression analysis

### *2.2.1 Specification of the meta-regression model*

The specification of the meta-regression is based on the internal (i.e. study- and estimate-specific attributes) and external variables listed in Table 3. It needs to consider the potential interaction and overlap between some of the different attributes in the table (e.g. cross-sectional data studies tend to use disaggregate data while time series data studies tend to use aggregate data) in order to avoid issues of multicollinearity and model over-specification. Moreover, it may not be possible to include some of the variables because of the presence of missing values (e.g. standard error or t-statistic). Therefore, it is in principle not possible to include all variables together, but only a subset including what are thought to be the main drivers of variation across estimates of the income elasticity of food demand.

There are three potential types of income elasticities, assessing the demand for nutrients, calories, and food. For each of these we will estimate separate meta- regression models. To reduce the level of heterogeneity in the latter group, we also estimate separate meta-regressions for different groups of foods (see section 4.4 for a description of the groups adopted in the analysis).

Using generic terms, the meta-regression model can be described as follows,

$$\varepsilon_{ij} = \sum_{k=1}^{K} \alpha_k X_{ki} + \sum_{m=1}^{M} \beta_m Z_{mj} + \sum_{n=1}^{N} \beta_n Y_{ni(c)} + \nu_{ij} \quad (1)$$

where $\varepsilon_{ij}$ is the value of the estimate of the income elasticity of demand, *i* denotes the elasticity estimate and *j* identifies the study to which the elasticity estimate belongs to. The term $X_{ki}$ represents the *k* variables that contain the *attributes of the individual elasticity estimate i* hypothesised to explain part of the variation in the value of the income elasticity of food demand, while $\alpha_k$ estimates the impact of each of the *k* variables ($k=1,2,\ldots,K$). Similarly, $Z_{mj}$ represents the *m* variables that contain the *attributes of the study j* hypothesised to explain part of the variation in the value of the income elasticity of food demand, while $\beta_m$ estimates the impact of each of the *m* variables ($m=1,2,\ldots,M$). The term $Y_{ni(c)}$ represents the *n country-level external variables*, which measure the effect of country's *c* attributes (e.g. income level, urbanisation level) on the income elasticity estimate *i*. $\beta_n$ estimates the impact of each of the *n* country-level external variables ($n=1,2,\ldots,N$). Finally, $v_{ij}$ is the error term.

The model above can be estimated using pooled OLS or panel data estimators based on random-effects and fixed-effects. Both panel data type estimators control for possible study-specific unobserved heterogeneity not captured by the study-level variables (i.e. $Z_{mj}$) included in the meta-regression. However, the choice between the two panel data estimators is not straight forward. The random-effects estimator requires that there be no correlation between study-specific unobserved heterogeneity and the model covariates, while the fixed-effects estimator allows for non-zero correlation. In the absence of correlation, the random-effects estimator should be preferred to the fixed-effects estimator due to greater efficiency. If however there is non-zero correlation, the fixed-effects should be selected as it is the only estimator able to provide consistent model parameter estimates.

Typically, the choice between random- or fixed-effects is based on the Hausman test and the Breusch-Pagan Lagrange Multiplier (B-P/LM) test (e.g. Green, 2008), but the former has tended to be more popular. There have been criticisms on the ability of the Hausman test to test the null hypothesis of no correlation between model covariates and the unit effects (see Clark and Linzer, 2014). Traditionally, researchers prefer to use fixed-effects over random-effects estimators, as a way to avoid endogeneity issues due to correlated unobserved heterogeneity. However, the cost of using models with unit fixed-effects (here, study fixed-effects), is the loss of a great deal of the variation in the sample and hence a potential loss of efficiency in the estimation of the coefficients for covariates that have little within-study variation. This is the case of our meta-sample. Moreover, the use of study fixed-effects in our meta-sample can give rise to serious issues of multicollinearity and dropping of several covariates. We will therefore consider the three estimators – pooled OLS, random-effects, and fixed-effects estimators – and select the one which presents a better balance between model parameter efficiency and consistency.

### *2.2.2 Potential estimation issues in the meta-regression model and sensitivity analysis*

Despite its advantages in providing an objective review of empirical findings, meta-regression also faces some estimation difficulties, in particular those arising from the mis-specification of the sources of heterogeneity, the weighting scheme adopted to deal with the presence of varying size multiple-estimate studies, and within-study dependence. First, as with any regression model, the decision about which study and estimate characteristics to consider in the model can affect the results. This should be based on the understanding of the key issues, both theoretical and methodological, in the literature of food demand in developing countries. Second, if each study is given equal weight regardless of its share in the total number of estimates included in the meta-sample, there is the risk of overweighting smaller studies that contribute only with a single estimate and underweighting larger studies that produce multiple estimates. Moreover, multiple-estimate studies introduce issues of correlation within primary studies in the meta-regression. There may be issues of heteroskedasticity in the variances of the elasticity estimates, due to differences in the sample size and estimation methods across the primary studies (see Stanley, 2001, Florax, 2002). If data are available for the variances (e.g. standard errors) of the elasticity estimates obtained from the different primary studies, it is possible to account for heteroskedasticity by giving greater weight to the more reliable estimates in the meta-regression. Less ideal approaches are based on data for the sample size or degrees of freedom of the primary study.

### *2.2.3 Sensitivity testing*

The meta-regression analysis can suffer from different sources of bias, namely *language bias*, *availability bias*, *reporting bias* and *publication bias*. Language bias may arise from the selective choice of studies using a specific language, typically English. Availability bias results from the fact that not all studies may be obtainable due to either, or both, availability and cost issues. This source of bias was not expected to posit threats to the proposed research given the option to use Inter-Library Loans to access documents which are not available online. Reporting bias occurs if researchers chose to report only some of their 'preferable' results for non-scientific reasons (i.e. file drawer effect). Publication bias arises when the publication of research depends on its findings and especially whether they are in agreement with a certain (expected or preferred) theory or hypothesis (see Florax, 2001, Stanley, 2005). Publication bias can also arise when research is sponsored by institutions that have interest in a specific set of results. The consequence of these different sources of bias is that the empirical literature included in the meta-regression may not be representative of the whole population of studies undertaken on a given topic.

Perhaps the most concerning issue is that of publication bias. One simple sensitivity test can be to consider the impact of including separate categories for type of publication (e.g. peer reviewed studies vs. 'grey' literature) and type of research sponsor (e.g. academic institution vs. international organisation). The presence of significant differences between groups may be indicative of publication bias. It is also possible to test whether there appears to be a systematic relationship between journal impact factor (or an indicator of journal ranking) and the income elasticity estimates, for the sample containing estimates from peer reviewed journals. In addition, visual inspection of the association between the (absolute) value of the income elasticity estimates and their respective standard errors for peer reviewed studies and 'grey' literature, separately, may also be informative. A more systematic version of the visual test of publication bias is to include the standard error of the income elasticity in the meta-regression (e.g. Knell and Stix, 2005, Stanley, 2005, Rose and Stanley, 2005), as illustrated in equation (2).

$$\left|\varepsilon_{ij}\right| = \sigma SE(\varepsilon)_{ij} + \sum_{k=1}^{K}\alpha_k X_{ki} + \sum_{m=1}^{M}\beta_m Z_{mj} + \sum_{n=1}^{N}\beta_n Y_{ni(c)} + \nu_{ij} \tag{2}$$

where $SE(\varepsilon)_{ij}$ is the standard error of the elasticity estimate, which is included to capture the presence of publication bias. Presence of bias towards the reporting of statistically significant income elasticities is flagged by the positive association between the absolute size of the elasticity estimates and their respective standard errors, so that the (absolute) value of the t-statistic is equal to or greater than 1.96 (for 95% confidence level).

Clearly the characteristics of the meta-sample influence the type of meta-regressions that can be done. It also can give rise to specific estimation issues. For this reason, the following chapter provides a summary of the meta-sample, describes its key characteristics, and shows the distribution of income elasticity estimates for certain key variables.

# 3. Description of the meta-sample

## 3.1 Studies included in the meta-sample

This chapter provides an overview of the meta-sample with full information provided in the spreadsheet. There were 89 candidate studies selected to be included in the meta-sample. Of these, 23 studies were excluded for different reasons, namely: inappropriate dependent variable (3 studies), inaccessible articles (9 studies)[8], unrelated subject matter (4 studies), elasticity estimates not reported in the study (6 studies), and non-African country (1 study). As a consequence, 66 (about 74% of all studies) have been fully included in the meta-sample reporting a total of 2,101 elasticity estimates.

Of the 66 studies included, 43 are studies which have not been included in previous meta-analyses. 11 studies were produced by international organizations (9 of which are from IFPRI), 10 are working papers, while the remaining 45 are studies published in peer reviewed journals. Note that all studies considered in the final sample are in English, despite having specified search terms in Portugues, French and Spanish as well. Altogether, 48 out of 54 African countries are represented in our sample although some have few observations. Appendix A lists the studies included in the meta-sample, Appendix B those selected but subsequently excluded from the analysis.

## 3.2 Sample size and distribution by study

The table below summarises the number and percentage of individual elasticity estimates reported for the current meta-sample. Although the vast majority of studies accounts for a very small part of the meta-sample, four studies alone represent 58% of the whole sample, with one study (Muhammad, Seale, Meade and Regmi, 2011) representing 21% of the whole sample. As a result, the meta-sample is heavily dominated by a small number of studies.

**Table 5. Distribution of estimates by study**

| Study | No. Estimates | Frequency (%) | Average |
|---|---|---|---|
| Abdulai and Aubert, 2004[9] | 4 | 0.19% | 0.52 |
| Abdulai and Aubert, 2004[10] | 15 | 0.71% | 0.85 |
| Abdulai and Aubert, 2002 | 4 | 0.19% | 0.57 |
| Ackah and Appleton, 2007 | 12 | 0.57% | 1.19 |
| Agbola, 2003 | 6 | 0.29% | 0.91 |
| Akinleye, 2007 | 8 | 0.38% | 0.48 |
| Akinleye, 2009 | 21 | 1.00% | 0.59 |
| Akinleye and Rahji, 2006 | 14 | 0.67% | -0.04 |
| Akinleyea and Rahji, 2007 | 252 | 11.99% | 0.27 |
| Alboghdady and Alashry, 2010 | 6 | 0.29% | 0.78 |
| Alderman and del Ninno, 1999 | 42 | 2.00% | 0.78 |
| Amao, Oluwatayo and Osuntope, 2006 | 1 | 0.05% | 0.01 |
| Aromolaran, 2010 | 4 | 0.19% | 0.10 |
| Aromolaran, 2004 | 9 | 0.43% | 0.23 |
| Ayalew, 2000 | 18 | 0.86% | 2.76 |

[8] An inter-library loan request to retrieve these studies was unsuccessful.
[9] This refers to Study no. 3 in Appendix A.
[10] This refers to Study no. 2 in Appendix A.

| Study | No. Estimates | Frequency (%) | Average |
|---|---|---|---|
| Babatunde, 2008 | 2 | 0.10% | 0.16 |
| Babatunde, Olanrewaju, Adedeji and Fakayode, 2010 | 2 | 0.10% | 0.10 |
| Balarabe and Chikwendu, 2006 | 4 | 0.19% | 0.57 |
| Bocoum and Dury, 2009 | 2 | 0.10% | 1.71 |
| Bopape and Myers, 2007 | 42 | 2.00% | 1.00 |
| Bouis, Haddad and Kennedy, 1992 | 6 | 0.29% | 0.27 |
| Camara, 2013 | 35 | 1.67% | 0.24 |
| Conte, 2006 | 8 | 0.38% | -0.01 |
| Dalhatu and Ala, 2010 | 1 | 0.05% | 0.08 |
| Dawoud, 2005 | 100 | 4.76% | 0.57 |
| Dawson, 1997 | 1 | 0.05% | 0.08 |
| Ecker, Weinberger and Qaim, 2010 | 12 | 0.57% | 0.74 |
| Ecker and Qaim, 2011 | 228 | 10.85% | 0.68 |
| Fashogbon and Oni, 2013 | 8 | 0.38% | 1.04 |
| Gbakou and Sousa-Poza, 2011 | 16 | 0.76% | 1.00 |
| Greer and Thorbecke, 1986 | 7 | 0.33% | 0.65 |
| Hancock, Nieuwoudt and Lyne, 1984 | 11 | 0.52% | 1.44 |
| Hendriks and Lyne, 2003 | 56 | 2.67% | 1.06 |
| Honfoga and van den Boom, 2003 | 6 | 0.29% | 0.42 |
| Kennedy and Payongayong, 1992 | 9 | 0.43% | 0.19 |
| Kennedy, 1989 | 1 | 0.05% | 0.15 |
| Kennedy and Cogill, 1987 | 2 | 0.10% | 0.03 |
| Knudsen and Scandizzo, 1982 | 3 | 0.14% | 0.53 |
| Maxwell, Levin, Armar-Klemesu, Ruel, Morris and Ahiadeke, 2000 | 2 | 0.10% | 0.34 |
| Mckenzie and Nieuwoudt, 1985 | 2 | 0.10% | 0.66 |
| Muhammad, Seale, Meade and Regmi, 2011 | 450 | 21.42% | 0.80 |
| Obayelu, Okoruwa and Ajani, 2009 | 6 | 0.29% | 0.89 |
| Ogundari, 2014 | 9 | 0.43% | 0.10 |
| Ogunniyi, Ajao and Oladejo, 2012 | 12 | 0.57% | 0.50 |
| Ohajianya, 2005 | 3 | 0.14% | -0.14 |
| Ojogho, 2010 | 1 | 0.05% | 0.00 |
| Ojogho and Alufohai, 2010 | 9 | 0.43% | 1.02 |
| Omojola, Effiong and Pepple, 2006 | 1 | 0.05% | 4.20 |
| Omonon, Nkang and Ajao, 2009 | 19 | 0.90% | 2.06 |
| Orewa and Iyanbe, 2010 | 2 | 0.10% | 0.13 |
| Phillip and Ashaolu, 2013 | 6 | 0.29% | 1.36 |
| Sarris and Tinios, 1994 | 3 | 0.14% | 0.57 |
| Seale, Regmi and Bernstein, 2003 | 292 | 13.90% | 0.75 |
| Strauss, 1984 | 4 | 0.19% | 0.87 |
| Tiffin and Dawson, 2002 | 1 | 0.05% | 0.31 |
| Titilola, Ajiboye, and Sanusi, 2012 | 8 | 0.38% | 0.20 |
| Ulimwengu and Ramadan, 2009 | 40 | 1.90% | 0.70 |
| Ulimwengu, Roberts and Randriamamonjy, 2012 | 102 | 4.85% | 0.80 |
| Ulimwengu, Workneh and Paulos, 2009 | 110 | 5.24% | 0.51 |
| Van Zyl, 1986 | 1 | 0.05% | -0.24 |
| von Bach and van Zyl, 1994 | 6 | 0.29% | 0.01 |

| Study | No. Estimates | Frequency (%) | Average |
|---|---|---|---|
| von Braun, de Haen and Blanke, 1991 | 16 | 0.76% | 1.69 |
| von Braun, Puetz and Webb, 1989 | 2 | 0.10% | 0.43 |
| Weliwita, Nyange and Tsujii, 2003 | 12 | 0.57% | 0.99 |
| Yusuf, 2012 | 3 | 0.14% | 0.93 |
| **Grand Total** | **2,101** | **100.00%** | **0.70** |

## 3.3 Type of publication

Table 6 below reports the meta-sample structure by origin of research. Of the 2,101 observations, 49% were taken from international organisation (IO) reports and 10% were collected from conference and/or working papers therefore making the grey literature the most important source of reported elasticities in our sample[11]. Peer reviewed journal articles make up the remaining 42% of the sample. The average of reported elasticities in peer reviewed journals is 0.59. The marked difference between average elasticity in peer reviewed journals and the grey literature could be indicative of publication bias, and this is investigated in Chapter 5.

**Table 6. Distribution of estimates by type of publication**

| By origin of research | No. estimates | Frequency (%) | Average |
|---|---|---|---|
| Peer reviewed journal article | 862 | 41.0% | 0.59 |
| Report by international organisations | 1026 | 48.8% | 0.76 |
| Working papers/conference papers | 213 | 10.1% | 0.89 |
| **Total** | **2101** | **100.0%** | **0.70** |

## 3.4 Type of food demand

Of the three categories of food demand (calories, foodstuffs and nutrients), the number of reported elasticities attributed to foodstuffs was by far the majority, constituting about 76% of the observations in our sample. The average elasticity in this group is 0.77. The number of elasticities attributed to calorie intake contributes the least number of observations, about 6% of the total sample with an average elasticity of 0.79. The remaining observations, attributed to the nutrient group had an average elasticity lower than the other two groups.

**Table 7. Distribution of estimates by focus of food demand**

| Focus of food demand | No. estimates | Frequency (%) | Average |
|---|---|---|---|
| Calorie | 118 | 5.62% | 0.79 |
| Foodstuff | 1588 | 75.58% | 0.77 |
| Nutrient | 159 | 7.57% | 0.62 |
| Foodstuff/nutrient[12] | 231 | 10.99% | 0.25 |
| Foodstuff/calorie[13] | 5 | 0.24% | 0.07 |
| **Total** | **2101** | **100.00%** | **0.70** |

[11] Note that about a fifth of all observations are taken from a single paper classified under the grey literature.
[12] This classification refers to a situation where nutrient elasticities are estimated for a specific foodstuff.
[13] This classification refers to a situation where calorie elasticities are estimated for a specific foodstuff.

## 3.5 Food groups

Foodstuffs were aggregated to the food categories shown in Table 8 according to their degree of substitution (i.e. foods within the same group should be more substitutable than foods in different groups). The main food groups are: Beverages, Cereals, Dairy, Fat and oil, Fruits and vegetables, Legumes and nuts, Meat fish and eggs, Tubers, Staple foods, Sugar and sweets, and Other. Given the limited number of observations in the staple foods and sugar and sweets groups, for the purpose of meta-regression analysis, "Staple foods" were aggregated with "Tubers", while "Sugar and sweets" were aggregated with "Other".

Overall, the food groups with the lowest average income elasticities are those that would normally constitute the basis of a basic diet (staples, legumes and nuts, cereals,) ranging between 0.32 and 0.41, whilst those with the highest elasticities would typically be supplements to basic diet requirements in most African countries (meat, fish and eggs, dairy products and beverages). This observation is as expected. The cereals group contributes the highest number of reported elasticities (373) constituting about 20% of the observations in our sample with an average elasticity of 0.41. The food category with the highest elasticity is the beverage group, with an average elasticity of 1.38. Tubers have a higher than expected average elasticity value but this appears to be due to one category – roots and tubers – for which there is a particularly high average elasticity value (1.32)[14].

**Table 8. Distribution of estimates by types of food**

| Food groups and types of food | No. of estimates | Frequency (%) | Average |
|---|---|---|---|
| **Beverages** | **96** | **5.26%** | **1.38** |
| alcohol | 4 | 0.22% | 0.95 |
| beverages | 40 | 2.19% | 1.25 |
| beverages and tobacco | 45 | 2.47% | 1.52 |
| bottled beer and soft drinks | 6 | 0.33% | 1.53 |
| sorghum and banana beer | 1 | 0.05% | 1.02 |
| **Cereals** | **373** | **20.45%** | **0.41** |
| cereals | 153 | 8.39% | 0.59 |
| cereals and pulses | 2 | 0.11% | 0.36 |
| grains | 10 | 0.55% | 0.57 |
| maize | 105 | 5.76% | 0.15 |
| millet | 37 | 2.03% | 0.22 |
| other cereals | 6 | 0.33% | 1.29 |
| rice | 58 | 3.18% | 0.36 |
| sorghum | 2 | 0.11% | 2.55 |
| **Dairy** | **114** | **6.25%** | **0.83** |
| animal products | 1 | 0.05% | 1.40 |
| milk and dairy products | 113 | 6.20% | 0.82 |
| **Fat and oil** | **113** | **6.20%** | **0.60** |
| fat and oil | 110 | 6.03% | 0.60 |
| oil | 3 | 0.16% | 0.49 |
| **Fruits and vegetables** | **218** | **11.95%** | **0.76** |
| bananas | 6 | 0.33% | 0.42 |

[14] One study reports unusually high elasticities for Tubers.

| Food groups and types of food | No. of estimates | Frequency (%) | Average |
|---|---|---|---|
| fruits | 10 | 0.55% | 0.51 |
| green leafy vegetables | 6 | 0.33% | 0.49 |
| horticultural | 8 | 0.44% | 5.50 |
| other vegetables | 11 | 0.60% | 0.46 |
| pumpkin | 6 | 0.33% | 0.73 |
| tomato | 6 | 0.33% | 0.83 |
| vegetables and fruit | 165 | 9.05% | 0.59 |
| **Legumes and nuts** | **124** | **6.80%** | **0.39** |
| groundnuts | 6 | 0.33% | 0.54 |
| legumes and nuts | 41 | 2.25% | 0.54 |
| peas and beans | 57 | 3.13% | 0.21 |
| peas and soybeans | 6 | 0.33% | 0.43 |
| pulses | 8 | 0.44% | 0.50 |
| regular beans | 6 | 0.33% | 0.75 |
| **Meat, fish, eggs** | **336** | **18.42%** | **0.91** |
| animal products | 16 | 0.88% | 1.03 |
| chicken | 2 | 0.11% | 0.28 |
| eggs | 22 | 1.21% | 0.75 |
| fish | 106 | 5.81% | 0.78 |
| meat | 152 | 8.33% | 0.96 |
| meat and fish | 25 | 1.37% | 1.15 |
| meat fish and eggs | 1 | 0.05% | 1.04 |
| red meat | 6 | 0.33% | 1.10 |
| white meat | 6 | 0.33% | 1.14 |
| **Other** | **252** | **13.82%** | **0.79** |
| all | 137 | 7.51% | 0.55 |
| condiments | 6 | 0.33% | -2.45 |
| meal compliments | 6 | 0.33% | 0.93 |
| other | 94 | 5.15% | 1.35 |
| own production | 1 | 0.05% | 0.80 |
| spices | 1 | 0.05% | 0.00 |
| starch | 7 | 0.38% | 0.89 |
| **Staple foods** | **17** | **0.93%** | **0.32** |
| staple foods | 17 | 0.93% | 0.32 |
| **Sugar and sweets** | **49** | **2.69%** | **0.63** |
| sugar | 43 | 2.36% | 0.55 |
| sugar and sweets | 6 | 0.33% | 1.20 |
| **Tubers** | **132** | **7.24%** | **0.62** |
| cassava | 43 | 2.36% | 0.32 |
| potatoes | 7 | 0.38% | 0.90 |
| root and tuber | 25 | 1.37% | 1.32 |
| sweet potatoes | 1 | 0.05% | 0.08 |
| tubers | 55 | 3.02% | 0.46 |
| wheat, rice, bread, manioc, cooking bananas, colocase and soya | 1 | 0.05% | 2.96 |
| **Grand Total** | **1824** | **100.00%** | **0.70** |

## 3.6 Nutrients

We report statistics for 17 individual nutrients in our sample. Carbohydrates, iron and protein have the highest number of reported elasticities, with an average elasticity of 0.23, 0.43 and 0.39 respectively. Collectively, there were more elasticities reported for vitamins, with the unweighted average elasticity for this nutrient being 0.69. As the basic components of most African diets are carbohydrate based (cereals, tubers, etc.), it is not surprising that the income elasticity for this nutrient is low because it constitutes the main part of most household diets. On the other hand, protein based products (meat, fish, eggs, etc.) are supplementary to the diets of most African households and are seen as high income household products. It is therefore as expected that the income elasticity for these nutrients is higher. The average elasticity for carbohydrates in our sample is considerably lower than the average for protein and fat products which are 0.39 and 0.31 respectively.

**Table 9. Distribution of estimates by type of nutrient**

| Nutrients | No. estimates | Frequency (%) | Average |
|---|---|---|---|
| Calcium | 29 | 7.44% | 0.23 |
| Carbohydrate | 42 | 10.77% | 0.23 |
| Fat | 26 | 6.67% | 0.31 |
| Folate (Folic Acid/B9) | 12 | 3.08% | 0.66 |
| Iron | 42 | 10.77% | 0.43 |
| Moisture | 21 | 5.38% | 0.23 |
| Niacin (B3) | 22 | 5.64% | 0.26 |
| Phosphorus | 21 | 5.38% | 0.25 |
| Protein | 43 | 11.03% | 0.39 |
| Riboflavin (B2) | 34 | 8.72% | 0.44 |
| Thiamine (B1) | 22 | 5.64% | 0.25 |
| Vitamin A | 22 | 5.64% | 0.62 |
| Vitamin B12 | 13 | 3.33% | 0.96 |
| Vitamin B6 | 6 | 1.54% | 0.66 |
| Vitamin C | 13 | 3.33% | 0.43 |
| Vitamin E | 6 | 1.54% | 0.75 |
| Zinc | 16 | 4.10% | 0.73 |
| **Total** | **390** | **100.00%** | **0.40** |

## 3.7 Regions

Table 10 summarises the estimates from each of the five regions of Africa identified in this report. Estimates from Southern and Western African countries dominate, together accounting for 63% of the total. There appear to be relatively large differences between the magnitude of income elasticities between regions, with East Africa having the highest (0.80), West and North Africa the lowest (0.60). Individual country analysis revealed that almost a fifth of the reported elasticities in our sample are estimated for Nigeria with an average elasticity for that country being 0.46. This is somewhat lower than the average reported for other countries in the continent, with the median across countries being 0.76. The highest average elasticity is calculated for Liberia, with an elasticity of 1.45. Rwanda and Gambia also have elasticity values above 1.

**Table 10. Distribution of estimates by region**

| Region | No. of estimates | Frequency (%) | Average |
|---|---|---|---|
| Central Africa | 228 | 11% | 0.79 |
| East Africa | 366 | 17% | 0.80 |
| North Africa | 176 | 8% | 0.60 |
| Southern Africa | 569 | 27% | 0.79 |
| West Africa | 746 | 36% | 0.60 |
| **Grand Total** | **2101** | **100%** | **0.70** |

## 3.8 Urban versus rural location and degree of urbanisation

The average elasticity for studies focusing on rural areas is higher than that for urban areas (0.83 as compared to 0.54). This suggests that food demand in rural areas is more responsive to changes in income. This is not surprising because poverty in rural locations tends to be higher and food accounts for a much greater share of rural household budgets. Studies that sourced data from both urban and rural locations contribute about 62% of the observations in our sample and have an average elasticity of about 0.70, lying within the range of the rural and urban averages.

**Table 11. Distribution of estimates by urban vs. rural location**

| Location | No. estimates | Frequency (%) | Average |
|---|---|---|---|
| Rural | 422 | 20.09% | 0.83 |
| Urban | 352 | 16.75% | 0.54 |
| Urban and Rural | 1301 | 61.92% | 0.70 |
| Not stated | 26 | 1.24% | 0.86 |
| **Total** | **2101** | **100.00%** | **0.70** |

Table 12 summarises the correlation between income elasticities, urbanisation rate and income level (i.e. GDP pc) for all foods, main food groups, calories and nutrients.

**Table 12. Correlation between urbanisation rate, income level and income elasticities**

| | Correlation between elasticity and urbanisation | Correlation between elasticity and GDP pc | Correlation between urbanisation and GDP pc |
|---|---|---|---|
| **All foods*** | **-0.010** | **-0.007** | **0.789** |
| Beverages | -0.130 | -0.243 | 0.694 |
| Cereals | -0.199 | -0.138 | 0.788 |
| Dairy | -0.287 | -0.297 | 0.699 |
| Fat and oil | -0.256 | -0.287 | 0.707 |
| Fruits and vegetables | 0.070 | 0.098 | 0.849 |
| Legumes and nuts | -0.325 | -0.201 | 0.933 |
| Meat, fish, eggs | -0.035 | -0.031 | 0.769 |
| Tubers | 0.197 | 0.207 | 0.764 |
| **Calories** | **-0.172** | **-0.282** | **0.530** |
| **Nutrients** | **-0.189** | **-0.562** | **0.383** |

*Excludes “Other”.

Overall, the coefficients indicate that increased urbanisation (measured as the share of the country's population living in urben areas) is associated with lower income elasticities (with only few exceptions); increased levels of income (in terms of GDP per capita) also tend to be associated with lower income elasticities (with only few exceptions), and that there is a positive association between country's urbanisation rate and income level.

## 3.9 Household income segment and diet

The nomenclature for income groups used in this study reflects the classifications used in the primary studies underlying our sample. In an attempt to aggregate the numerous classifications that were found, we subjectively reconciled some classifications that seemed aligned. For example, the 'subsistence income' classification from one study is aggregated with 'low expenditure' classification used in many other studies. The resulting categorization is shown in Table 13.

As expected, the average elasticity for households in the bottom quintile (i.e. 0.81) is higher than the average for households in the top quintile (i.e. 0.60). Similarly, households in the low expenditure group (i.e. 0.62) have a higher average elasticity than households in the high expenditure group (i.e. 0.36). However, the average elasticity estimate for the middle expenditure group is lowest at 0.29. This highlights difficulties in straightforward comparisons between income groups because the averages shown in Table 13 refer to different types of foodstuffs, nutrients and calories. Moreover, the underlying methodologies and data types also differ across studies.

For studies that do not distinguish between income groups (i.e. 'whole sample'), which constitutes the majority of estimates, the average elasticity is somewhat closer to the average for bottom quintile and low expenditure averages.

**Table 13. Distribution of estimates by household income segment**

| Income class | No. estimates | Frequency (%) | Average |
|---|---|---|---|
| At The Poverty Line | 7 | 0.33% | 0.65 |
| Bottom Quintile | 120 | 5.71% | 0.81 |
| Commercial Farming | 5 | 0.24% | 0.69 |
| High Expenditure Group | 119 | 5.66% | 0.36 |
| Low Expenditure Group | 115 | 5.47% | 0.62 |
| Mean | 111 | 5.28% | 0.74 |
| Middle Expenditure Group | 96 | 4.57% | 0.29 |
| Non-Agricultural Enterprise | 5 | 0.24% | 0.71 |
| Organisational Support | 5 | 0.24% | 0.76 |
| Other | 17 | 0.81% | 2.94 |
| Top Quintile | 110 | 5.24% | 0.60 |
| Whole Sample | 1391 | 66.21% | 0.73 |
| **Total** | **2101** | **100.00%** | **0.70** |

Further analysis of the relationship between the average elasticity of household income segments with respect to food groups revealed expected trends that conform to analogous observations made for Table 9 and Table 12 above. For example, median average elasticity for foods that constitute the basis of basic diets (staples, cereals, tubers, legumes and nuts) is relatively low (i.e. 0.63) across all income segments compared with the median average elasticity for high income diet constituents (beverages, meat, fish and eggs, dairy) (i.e. 0.96).

With regards differentiation in the income elasticity of foods that constitute basic diets, poorer households have higher median responses (i.e. 0.55) than wealthier households (i.e. 0.39). Similarly, for higher end food products, median elasticity of poorer households is higher (i.e. 1.13) than for wealthier households (i.e.0.92). Again this trend conforms to the observations made previously and is consistent with broader observations of dietary convergence as income levels rise.

Table 14 illustrates the income elasticity patterns discussed above for three groups of foods that distinctively capture the basic diet (cereals, tubers) and perceived high-end diet (meat, fish and eggs). If we contrast only low-to-middle and middle-to-high income households, income elasticity patterns are as expected both across food groups and household income groups. For reasons explained earlier, the pattern is however not so clear when middle income households are also considered.

**Table 14. Distribution of estimates by income segment groups and food groups[15]**

| **Income groups** | **Cereals** | **Tubers** | **Meat, fish, eggs** |
|---|---|---|---|
| Low to middle income | 0.49 | 0.60 | 1.23 |
| Middle income | 0.50 | 0.36 | 0.81 |
| Middle to high income | 0.21 | 0.42 | 0.97 |
| **Average** | **0.44** | **0.44** | **0.84** |

## 3.10 Country income level

As discussed in Chapter 2, an external variable was added to the meta sample to reflect the income level of the country, expressed in logarithm of GDP pc. Table 15 summarises the correlation between income elasticities and income level (logarithm of GDP pc) for all foods, main food groups, calories and nutrients. In line with Engel's law, a positive correlation is found between the elasticity estimates and the countries income level for almost all food groups.

**Table 15. Correlation between income elasticity and GDP pc by food groups**

| | **Correlation between elasticity and GDP pc** |
|---|---|
| **All foods*** | **-0.007** |
| Beverages | -0.243 |
| Cereals | -0.138 |
| Dairy | -0.297 |
| Fat and oil | -0.287 |
| Fruits and vegetables | 0.098 |
| Legumes and nuts | -0.201 |
| Meat, fish, eggs | -0.031 |
| Tubers | 0.207 |
| **Calories** | **-0.282** |
| **Nutrients** | **-0.562** |

[15] Note: The following household income segments were excluded in the computation of the averages in the table – "non-agricultural enterprise", "other" and "whole sample".

*Excludes "Other".

## 3.11 Time period

Table 16 shows that most of the income elasticity estimates in the meta-sample (84%) relate to the between 1996 and 2005 period. Very few are post 2005. This reflects, at least in part, the time lag in data availability but also a possible reduction in research effort on understanding the relationship between income and food demand in recent years. Average elasticities in each time period are very variable with no distinct pattern emerging. This runs counter to expectations that, with income growth over time, elasticities will fall. However it may be masking several other factors such as the type of foods being analysed and/or focus on different regions. Controlling for these factors in the meta-regression analysis may clarify this.

**Table 16. Distribution of estimates by time period analysed**

| Time period | No. estimates | Frequency (%) | Average |
|---|---|---|---|
| Pre-1990 | 73 | 3.47% | 0.80 |
| 1991/95 | 130 | 6.19% | 1.16 |
| 1996/00 | 901 | 42.88% | 0.56 |
| 2001/05 | 857 | 40.79% | 0.75 |
| 2006/15 | 116 | 5.52% | 0.97 |
| Unclassifiable | 24 | 1.14% | 0.35 |
| **Grand Total** | **2101** | **100.00%** | **0.70** |

## 3.12 Journal ranking

As noted earlier, 862 of the income elasticities in the meta-sample were taken from journal publications. Table 17 shows how these were spread across journals of different quality, according to the classification system described in chapter 3. Very few fell into the middle and highest ranking quality segments with the most frequently occurring quality (44% of all journal publications) being that classified within the second lowest category. No clear pattern of elasticity values emerges from Table 15, the highest average elasticity (0.73) is found for the highest quality journals, which suggests it is worthwhile investigating for evidence of publication bias within the meta-regression analysis.

**Table 17. Distribution of estimates by journal ranking**

| Journal ranking | No. estimates | Frequency (%) | Average |
|---|---|---|---|
| 1 (lowest quality) | 189 | 8.37% | 0.65 |
| 2 | 376 | 12.42% | 0.49 |
| 3 | 29 | 1.40% | 0.71 |
| 4 | 257 | 11.57% | 0.66 |
| 5 (Highest quality) | 11 | 0.55% | 0.73 |
| N/A | 1239 | 65.70% | 0.78 |
| **Grand Total** | **2101** | **100.00%** | **0.70** |

This chapter has provided a description of the estimated income elasticities in the meta-sample with respect to various different criteria. In large part, the pattern of elasticities found confirmed expectations. On the other hand, these descriptive results also indicate the high degree of variability in the relative magnitude of income elasticities associated with, for example, different African countries and different household income groups. The next chapter explains how these findings were used to inform the meta-regression stage of analysis.

# 4 Meta-Regression Analyses

## 4.1 Estimation issues

This chapter presents the results from the second stage of the study – the meta-regressions. As described in Chapter 3, a large number of variables were collected during the construction of the meta–sample. Many of these could not be included in the analysis due to multicollinearity or because missing values resulted in a large reduction in the sample size. The latter was especially the case for some of the external variables in Table 3. The scope of multicollinearity between explanatory variables was evaluated using coefficients of pairwise correlation and measures of between- and within-study variation.

As far as possible the results below are based on a similar model specification so as to facilitate comparison across food types and between food, nutrient and calorie estimations. In each case, the results from three versions of the pooled OLS and random-effects models are presented: the "baseline model" based on only internal study-specific or elasticity-specific variables (columns 1 and 2 of Table 3); "extended model I" and "extended model II" which include information collected from external sources (i.e. not directly from the studies on which the meta-sample is based). The difference between extended models I and II lies in the regional groupings used: extended model I considers African sub-regions (North, Central, West, East, and Southern Africa), while extended model II focuses on the regional classification into Sahelian/non-Sahelian and landlocked/non-landlocked countries. Because of high multicollinearity between the two types of regional groupings we estimate separate models for each type.

While (study-speficic) fixed-effects versions of each model were also estimated, the results are not presented because there is not enough variation across studies and, in the majority of cases, the model failed to produce estimates. Further, for many of the food groups, the random-effects estimator reduces to the pooled OLS estimator as a result of no (uncorrelated) study-specific variance.[16]

To reduce the potential for biased results, we estimate the meta-regressions using a sample that excludes elasticity estimates considered to be outliers. The range of the elasticity estimates with and without outliers is shown in Table 18, as well as the associated sample sizes and outliers. Figure 2 shows the distribution of the elasticity estimates for the sample with and without outliers.

**Table 18. Meta-sample with and without outliers**

| | | **Full sample (with outliers)** | **Sample without outliers** |
|---|---|---|---|
| • Foodstuffs | Range | [-6.43,18.22] | [-0.57,3.86] |
| | Sample size | 1824 | 1787 |
| | Outliers | No | <P1 & >P99 |
| • Nutrients | Range | [-0.70,1.33] | [-0.12,1.33] |
| | Sample size | 390 | 330 |
| | Outliers | No | <P10 |
| • Calories | Range | [-0.03,21.18] | [-0.03,1.28] |
| | Sample size | 123 | 116 |
| | Outliers | No | >P95 |

[16] The Breusch and Pagan Lagrange Multiplier (LM) test for random effects failed to reject the null hypothesis, suggesting that study random-effects are not needed and the pooled OLS model is appropriate.

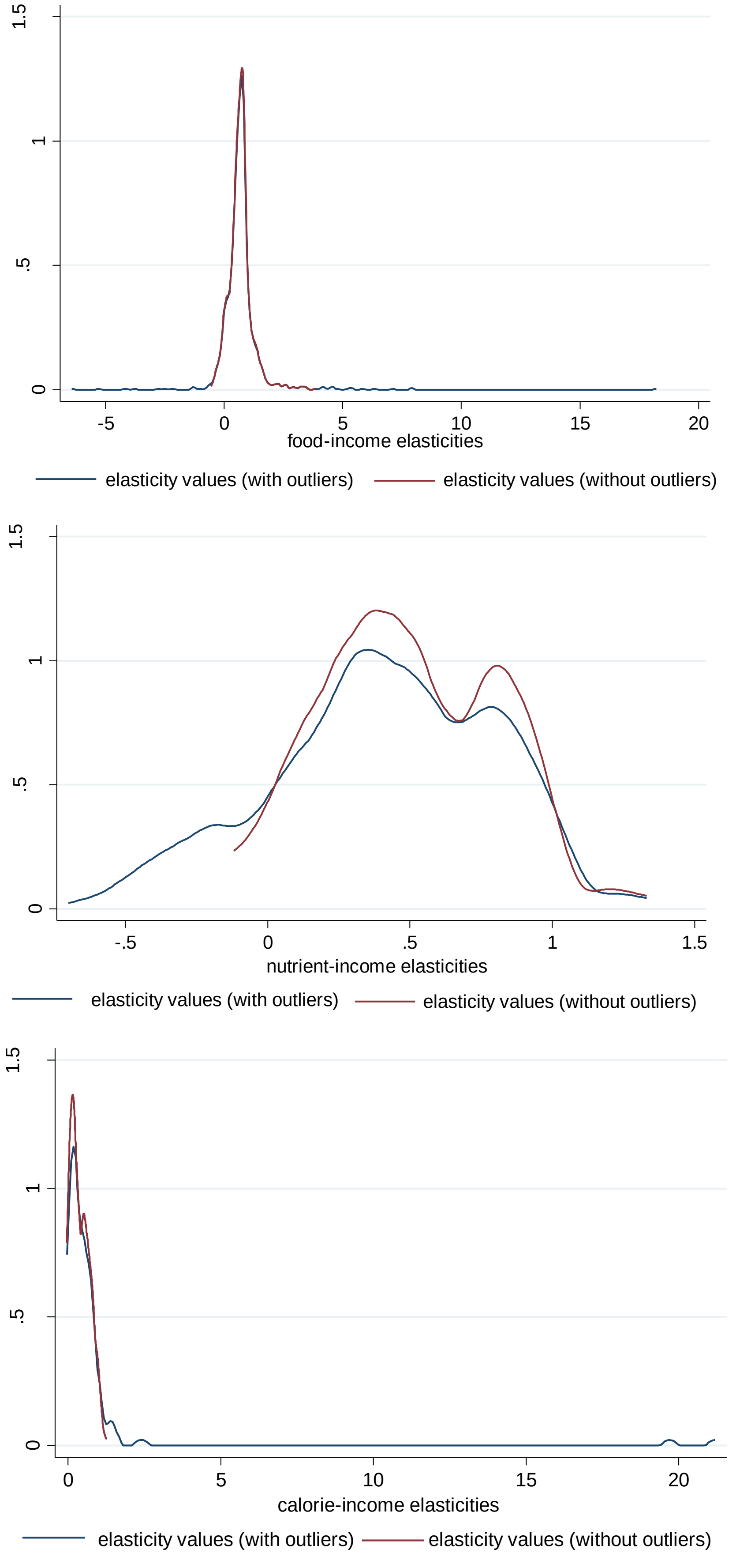


**Figure 2. Kernel density plots of meta-sample with and without outliers for foods, nutrients and calories**

We estimate meta-regressions for foods (section 4.2.), nutrients (section 4.3.), and calories (section 4.4). In all cases, the coefficients of the meta-regressions measure the deviation (in percentage points) from the elasticity value predicted by the models.

## 4.2 Foods

### *4.2.1 All foods*

Table 19 presents the results for all foods pooled together. The baseline model uses 1,768 estimates of income elasticities from 37 studies, while the extended models use 1,754 estimates of income elasticities from 34 studies. Although the magnitude of some of the coefficients differ, qualitatively the baseline and extended versions of the model produce similar results. Extending the model to include country-specific external variables leads only to a marginal increase in the models' explanatory power. Between-study variation contributes more to the explanatory power of the models than within-study variation, which is in line with our expectations since differences across elasticity estimates are likely to be larger between rather than within studies.

The bullet points below provide a summary of the main findings:

- Working papers have significantly higher income elasticities compared to peer reviewed journal studies. On the other hand, there is no clear difference between income elasticities obtained from international organisations (i.e. reports) and peer reviewed journals.
- Food demand is more responsive to changes in income for beverages, meat, fish and eggs, compared to foods that tend to constitute basic diets (e.g. cereals, legumes and nuts, fruit and vegetables and fats and oils, tubers). The trends across food groups are generally in line with our expectations and reflect the nature of demand for stable products versus more luxury food items.
- Time series studies appear to produce significantly lower estimates than cross sectional and panel data studies, after controlling for other study and estimate attributes, and external variables.
- In relation to the separate time periods, the period between 1996 and 2005 was a period of income growth across Africa. The finding that elasticities estimated during this period are significantly lower than those estimated for the early 1990s in the baseline model is therefore as expected. However, there is no evidence that the trend of decreasing elasticities has continued after 2005.
- The coefficient on the GDP per capita variable suggests that as income increases the income elasticity of demand for food falls: demands becomes less responsive to changes in income.
- Again as expected, studies focusing on urban populations find significantly lower elasticities than those looking at rural populations, or rural and urban populations jointly, even after having controlled for the other study, elasticity and country attributes.
- In line with other studies (Strauss and Thomas (1990) and Ogundari and Abdulai (2013)), estimated elsticities are lower when using household expenditures as a proxy for income.
- The type of demand model (single equation versus demand system) produced limited differences. However, the type of estimator used appears to significantly affect the income elasticity estimates although the direction of influence is inconclusive. For example, the baseline model suggests LS and ML methods significantly estimate higher elasticities than IV methods whilst the extended models suggest the opposite.
- Income elasticities of demand for food in countries with greater degree of urbanisation are lower. This conforms with our expectations.
- There is some evidence of differences in the magnitude of food demand elasticities across the sub-regions of Africa. On average, the income elasticity is higher for countries in Central

Africa, followed by Southern Africa, West Africa and East Africa (compared to countries in North Africa). This suggests that the impact of income-based food policies may differ across African regions.

- There is some evidence that countries in the Sahel region of Africa have lower elasticities than those in non- Sahel Africa while landlocked countries have significantly higher elasticities than maritime countries.

**Table 19. Results from the meta-regression of income elasticities for all foods**

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Journal | Report | 0.1306 | 0.1113 | 0.0739 | 0.0488 | 0.0613 | 0.0502 |
| | | (0.0902) | (0.1576) | (0.0822) | (0.1616) | (0.0956) | (0.1750) |
| | Working paper/conference | 0.1577* | 0.2828** | 0.2827*** | 0.3206*** | 0.2159*** | 0.2987*** |
| | | (0.0821) | (0.1253) | (0.0758) | (0.1118) | (0.0757) | (0.1070) |
| Meat, fish and eggs | Beverages | 0.4268*** | 0.4283*** | 0.4362*** | 0.4305*** | 0.4375*** | 0.4309*** |
| | | (0.0758) | (0.0748) | (0.0745) | (0.0750) | (0.0729) | (0.0743) |
| | Cereals | -0.2931*** | -0.2896*** | -0.2792*** | -0.2857*** | -0.2835*** | -0.2837*** |
| | | (0.0743) | (0.0727) | (0.0731) | (0.0726) | (0.0737) | (0.0722) |
| | Dairy | -0.0301 | -0.0094 | -0.0051 | -0.0067 | -0.0047 | -0.0059 |
| | | (0.0546) | (0.0453) | (0.0462) | (0.0449) | (0.0460) | (0.0447) |
| | Fat and oil | -0.2429*** | -0.2592*** | -0.2374*** | -0.2573*** | -0.2331*** | -0.2560*** |
| | | (0.0458) | (0.0469) | (0.0447) | (0.0468) | (0.0445) | (0.0465) |
| | Fruits and vegetabes | -0.2429*** | -0.2588*** | -0.2387*** | -0.2566*** | -0.2355*** | -0.2551*** |
| | | (0.0733) | (0.0741) | (0.0728) | (0.0739) | (0.0723) | (0.0736) |
| | Legumes and nuts | -0.3625*** | -0.3577*** | -0.3569*** | -0.3555*** | -0.3580*** | -0.3545*** |
| | | (0.0721) | (0.0686) | (0.0699) | (0.0685) | (0.0707) | (0.0681) |
| | Other | -0.0021 | -0.0323 | -0.0007 | -0.0287 | 0.0049 | -0.0269 |
| | | (0.0693) | (0.0667) | (0.0672) | (0.0663) | (0.0676) | (0.0661) |
| | Tubers | -0.2289* | -0.2384* | -0.2271* | -0.2358* | -0.2258* | -0.2341* |
| | | (0.1270) | (0.1352) | (0.1304) | (0.1356) | (0.1281) | (0.1351) |
| Cross-sectional | Panel | -0.1577 | -0.0788 | -0.1806* | -0.0126 | -0.1197 | -0.0061 |
| | | (0.0935) | (0.1370) | (0.0987) | (0.1513) | (0.0971) | (0.1544) |
| | Time series | -0.6443*** | -0.5600*** | -0.6728*** | -0.5091*** | -0.6303*** | -0.5315*** |
| | | (0.1941) | (0.1890) | (0.1742) | (0.1879) | (0.2062) | (0.1987) |
| Aggregate | Micro | 0.1397 | -0.0358 | 0.0233 | -0.0462 | 0.0263 | -0.0323 |
| | | (0.1483) | (0.2108) | (0.1367) | (0.1927) | (0.1578) | (0.2106) |
| 1991/95 | 1996/00 | -0.3433*** | -0.2041** | -0.3821*** | -0.2292* | -0.4032*** | -0.2638** |
| | | (0.0626) | (0.1019) | (0.0619) | (0.1200) | (0.0771) | (0.1264) |
| | 2001/05 | -0.2292*** | -0.1468 | -0.3072*** | -0.1963 | -0.2960*** | -0.1889 |
| | | (0.0783) | (0.1293) | (0.0716) | (0.1351) | (0.0878) | (0.1395) |
| | 2006/15 | -0.0559 | 0.1165 | 0.0065 | 0.1388 | -0.0625 | 0.1072 |
| | | (0.1347) | (0.1561) | (0.1340) | (0.1632) | (0.1402) | (0.1593) |
| | Pre-1990 | 1.0320*** | 0.5777* | -0.4599* | -0.4411 | -0.3599 | |
| | | (0.2937) | (0.3024) | (0.2496) | (0.3038) | (0.2850) | |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Both | Rural | 0.0293 | 0.0367 | 0.0437 | 0.0347 | 0.0707 | 0.0268 |
| | | (0.0930) | (0.0598) | (0.0870) | (0.0621) | (0.0949) | (0.0678) |
| | Urban | -0.1615 | -0.1381** | -0.1532 | -0.1409** | -0.1210 | -0.1502** |
| | | (0.1156) | (0.0579) | (0.1068) | (0.0610) | (0.1155) | (0.0680) |
| Income proxy: expenditure | Income | -0.1840*** | -0.0401 | -0.1277** | -0.0386 | -0.1627*** | -0.0424 |
| | | (0.0564) | (0.0458) | (0.0554) | (0.0453) | (0.0575) | (0.0467) |
| Consumption expenditure | Quantity | 0.0942 | 0.0961 | 0.0449 | 0.0479 | 0.0192 | 0.0250 |
| | | (0.1159) | (0.1472) | (0.0903) | (0.1388) | (0.1163) | (0.1396) |
| Single eqn. | Demand system | 0.0499 | 0.1525 | -0.0743 | 0.1487 | -0.0225 | 0.1353 |
| | | (0.1151) | (0.1469) | (0.1078) | (0.1549) | (0.1151) | (0.1640) |
| IV | FD/FE/GMM | 1.3373*** | 1.1061*** | | | | 0.4292 |
| | | (0.2788) | (0.4085) | | | | (0.3233) |
| | LS/ML | 0.9394*** | 0.6332 | -0.4920*** | -0.4580*** | -0.4457*** | -0.0520 |
| | | (0.2438) | (0.3918) | (0.0953) | (0.1513) | (0.1145) | (0.3106) |
| | Log of GDP per capita | | | -0.0895*** | -0.0667*** | -0.0677*** | -0.0613*** |
| | | | | (0.0238) | (0.0031) | (0.0180) | (0.0072) |
| | Urbanisation | | | 0.0010 | -0.0008** | 0.0002 | -0.0006** |
| | | | | (0.0015) | (0.0003) | (0.0010) | (0.0003) |
| North Africa | Central Africa | | | 0.1865*** | 0.1014*** | | |
| | | | | (0.0570) | (0.0052) | | |
| | East Africa | | | 0.0232 | 0.0340** | | |
| | | | | (0.0551) | (0.0159) | | |
| | Southern Africa | | | 0.1555** | 0.0689*** | | |
| | | | | (0.0611) | (0.0164) | | |
| | West Africa | | | 0.0586 | 0.0451*** | | |
| | | | | (0.0498) | (0.0053) | | |
| | Sahelian | | | | | -0.0881 | -0.0412*** |
| | | | | | | (0.0570) | (0.0099) |
| | Landlocked | | | | | 0.0068 | 0.0352*** |
| | | | | | | (0.0388) | (0.0081) |
| | Constant | -0.0224 | 0.1470 | 2.0991*** | 1.7003*** | 2.0075*** | 1.3258*** |
| | | (0.3237) | (0.3624) | (0.2371) | (0.2791) | (0.2481) | (0.2942) |
| Number of observations | | 1768 | 1768 | 1754 | 1754 | 1754 | 1754 |
| Number of studies | | | 37 | | 34 | | 34 |
| Number of countries | | 47 | 47 | 47 | 47 | 47 | 47 |
| $R^2$ | | 0.3065 | | 0.3226 | | 0.3154 | |
| $R^2$ - overall | | | 0.2664 | | 0.2915 | | 0.2904 |
| $R^2$ - between | | | 0.4633 | | 0.4964 | | 0.4894 |
| $R^2$ - within | | | 0.1629 | | 0.1795 | | 0.1786 |
| sigma_u | | | 0.4290 | | 0.3719 | | 0.2996 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

### 4.2.2 Results by food types

As noted in the introduction, the interactions between income growth, food consumption and thus nutrition and health are likely to vary by food group. It follows that distinguishing between food types in the meta-analysis will provide information which is useful from a policy perspective. It can also help to improve the comparability of estimates between studies. This section therefore presents the results from separate analysis of the different food groups defined in the previous chapter. Six sets of results for the food groups are presented in detail (i.e. cereals, diary, tubers, legumes and nuts, fruits and vegetables, meat, fish and eggs), with the remaining two which had smaller sample sizes (i.e. beverages, fats and oils) included in Appendix C. Note that for some of the meta-regressions, sample sizes become rather small and multicollinearity between the different variables may become problematic for the correct interpretation of results.

#### *Cereals*

Results from the meta-analysis of income elasticities of demand for cereals are given in Table 20.

**Table 20. Results from the meta-regression of income elasticities for cereals**

| **Reference** | **Variable** | **Baseline model** | | **Extended model I** | | **Extended model II** | |
|---|---|---|---|---|---|---|---|
| | | **OLS** | **RE** | **OLS** | **RE** | **OLS** | **RE** |
| Journal | Report | 0.4892*** | 0.6048*** | 0.4060*** | 0.4749** | 0.4299** | 0.5221** |
| | | (0.1488) | (0.2129) | (0.1082) | (0.1879) | (0.1641) | (0.2255) |
| | Working paper/conference | 0.1742 | 0.1723* | 0.1575** | 0.1805** | 0.1652 | 0.1708* |
| | | (0.1159) | (0.0902) | (0.0656) | (0.0865) | (0.0991) | (0.0944) |
| Cross-sectional | Panel | -0.7443*** | -0.6719*** | -0.6675*** | -0.6001*** | -0.6570*** | -0.5759*** |
| | | (0.1646) | (0.1195) | (0.1022) | (0.1212) | (0.1576) | (0.1298) |
| | Time series | | -0.0746 | | 0.9937*** | 0.1692 | |
| | | | (0.3838) | | (0.2095) | (0.2910) | |
| Aggregate | Micro | 0.7479*** | 0.7283*** | 0.6124*** | 0.5849** | 0.6310** | 0.6228** |
| | | (0.2241) | (0.2606) | (0.1535) | (0.2383) | (0.2380) | (0.2796) |
| 1991/95 | 1996/00 | -0.2776*** | -0.3931*** | -0.3445*** | -0.4178*** | -0.3445*** | -0.4224*** |
| | | (0.0530) | (0.1103) | (0.0390) | (0.1070) | (0.0606) | (0.1225) |
| | 2001/05 | -0.0810 | -0.1698 | -0.2341*** | -0.2351 | -0.1490 | -0.2027 |
| | | (0.1173) | (0.2464) | (0.0556) | (0.2161) | (0.1130) | (0.2516) |
| | 2006/15 | -0.2006* | -0.1570 | -0.1001 | -0.1093 | -0.1806 | -0.1380 |
| | | (0.1036) | (0.1379) | (0.1010) | (0.1422) | (0.1093) | (0.1500) |
| | Pre-1990 | 0.1094 | | -0.0290 | | | |
| | | (0.3775) | | (0.1672) | | | |
| Both | Rural | 0.1061 | 0.0734 | 0.0801 | 0.0873 | 0.1355 | 0.0847 |
| | | (0.1158) | (0.0710) | (0.0972) | (0.0730) | (0.1214) | (0.0702) |
| | Urban | 0.0181 | -0.0305 | -0.0155 | -0.0159 | 0.0442 | -0.0187 |
| | | (0.0894) | (0.0545) | (0.0872) | (0.0605) | (0.1037) | (0.0558) |
| Income proxy: expenditure | Income | -0.4845*** | -0.4534*** | -0.4181*** | -0.4092*** | -0.4632*** | -0.4261*** |
| | | (0.0726) | (0.1072) | (0.0468) | (0.0931) | (0.0685) | (0.1057) |
| Consumption expenditure | Quantity | -0.0681 | 0.0463 | -0.0654 | 0.0180 | -0.0682 | 0.0188 |
| | | (0.1765) | (0.1587) | (0.1016) | (0.1364) | (0.1614) | (0.1559) |
| Single eqn. | Demand system | 0.0045 | -0.0333 | -0.0616 | -0.0506 | -0.0097 | -0.0409 |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| | | (0.1006) | (0.0549) | (0.0657) | (0.0621) | (0.0886) | (0.0565) |
| IV | FD/FE/GMM | -0.1170 | -0.1159 | | 1.0503*** | | -0.0383 |
| | | (0.1352) | (0.1296) | | (0.2394) | | (0.3628) |
| | LS/ML | -0.2401*** | -0.2590*** | -0.2067** | 0.8893*** | -0.1108 | -0.1690 |
| | | (0.0503) | (0.0275) | (0.0988) | (0.2401) | (0.1251) | (0.4092) |
| | Log of GDP per capita | | | -0.1163*** | -0.0786*** | -0.0588*** | -0.0544*** |
| | | | | (0.0281) | (0.0174) | (0.0154) | (0.0070) |
| | Urbanisation | | | 0.0016 | 0.0006 | 0.0005 | -0.0002 |
| | | | | (0.0016) | (0.0010) | (0.0014) | (0.0005) |
| North Africa | Central Africa | | | 0.1781*** | 0.1413*** | | |
| | | | | (0.0492) | (0.0296) | | |
| | East Africa | | | -0.1854* | -0.0138 | | |
| | | | | (0.1002) | (0.0479) | | |
| | Southern Africa | | | 0.0560** | 0.0706*** | | |
| | | | | (0.0236) | (0.0229) | | |
| | West Africa | | | -0.1063 | 0.0116 | | |
| | | | | (0.0671) | (0.0393) | | |
| | Sahelian | | | | | -0.0719 | -0.0422 |
| | | | | | | (0.0627) | (0.0276) |
| | Landlocked | | | | | -0.0471 | -0.0105 |
| | | | | | | (0.0541) | (0.0258) |
| | Constant | 0.4483** | 0.5057** | 1.4086*** | | 0.8532*** | 0.9124*** |
| | | (0.1853) | (0.2353) | (0.2328) | | (0.2151) | (0.1913) |
| Number of observations | | 365 | 365 | 364 | 364 | 364 | 364 |
| Number of studies | | | 27 | | 26 | | 26 |
| Number of countries | | 47 | 47 | 47 | 47 | 47 | 47 |
| $R^2$ | | 0.4358 | | 0.4555 | | 0.4373 | |
| $R^2$ - overall | | | 0.4197 | | 0.4375 | | 0.4226 |
| $R^2$ - between | | | 0.6578 | | 0.6322 | | 0.6009 |
| $R^2$ - within | | | 0.0050 | | 0.0131 | | 0.0126 |
| sigma_u | | | 0.3084 | | 0.2554 | | 0.3057 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

As in the analysis for all foods, between-study variation contributes much more to the explanatory power of the models than within-study variation. The main findings are summarised below:

- With the exception of one model, evidence suggests that income elasticities obtained from international organisations (i.e. reports) and working papers are significantly higher than income elasticities obtained from peer reviewed journal studies.
- There is some evidence that the elasticities obtained from panel data studies are lower after controlling for other study, estimate, and external variables.
- Estimates of the income elasticity of cereals for the period between 1996 and 2000 appear to be significantly lower than those estimated for the early 1990s. There is some evidence that

this trend has continued to recent years, although this is not consistently affirmed across the set of models.

- The income elasticity of cereals appears to not differ significantly across urban and rural populations.
- There is evidence of lower income elasticity estimates for studies that use income data instead of actual expenditure on cereals.
- There is no evidence of clear differences between proxy for consumption (expenditure or quantity) and type of demand model (single equation versus demand system). Whilst the type of estimator used appears to affect elasticity estimates, the direction of the effect is inconclusive as the results are mixed across our set of models.
- There is evidence in favour of lower income elasticities for cereals in higher income African countries, as measured by GDP pc.
- There is no effect of degree of urbanisation of a country on the magnitude of the income elasticities of cereals.
- The results suggest that the elasticity estimates for cereals in East Africa are significantly lower than in North Africa while the elasticities in Central and Southern Africa are significantly higher. No significant differences are found across the other geography indicators i.e. a countries' placement in Sahel region and whether it is landlocked.

### *Dairy*

Results from the meta analysis of income elasticities of demand for dairy products are given in Table 21.

**Table 21. Results from the meta-regression of income elasticities for dairy**

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | **OLS** | **RE** | **OLS** | **RE** | **OLS** | **RE** |
| Journal | Report | 0.3045 | | 0.3251 | 0.3251 | 0.2930 | 0.2930 |
| | | (0.4015) | | (0.4231) | (0.4231) | (0.3907) | (0.3907) |
| | Working paper/conference | -0.2791** | 0.1551 | -0.2304 | -0.2304 | -0.2854* | -0.2854** |
| | | (0.1286) | (0.3388) | (0.1473) | (0.1473) | (0.1313) | (0.1313) |
| Cross-sectional | Panel | -0.0207 | -0.3968 | -0.0095 | -0.0095 | 0.0537 | 0.0537 |
| | | (0.1868) | (0.3397) | (0.2334) | (0.2334) | (0.2132) | (0.2132) |
| | Time series | | -0.4849 | | | | |
| | | | (0.3110) | | | | |
| Aggregate | Micro | | -0.2088 | | | | |
| | | | (0.3405) | | | | |
| 1991/95 | 1996/00 | -0.3829 | -0.5604* | -0.4159 | -0.4159 | -0.3802 | -0.3802 |
| | | (0.4030) | (0.3051) | (0.4282) | (0.4282) | (0.3954) | (0.3954) |
| | 2001/05 | -0.3629 | 0.0102 | -0.3966 | -0.3966 | -0.3545 | -0.3545 |
| | | (0.4008) | (0.3093) | (0.4260) | (0.4260) | (0.3951) | (0.3951) |
| | 2006/15 | 0.1947 | 0.1947 | 0.1889 | 0.1889 | 0.1885 | 0.1885 |
| | | (0.2542) | (0.2542) | (0.2649) | (0.2649) | (0.2610) | (0.2610) |
| Both | Rural | 0.1764 | -0.0192 | 0.1812 | 0.1812 | 0.1673 | 0.1673 |
| | | (0.1812) | (0.0771) | (0.1904) | (0.1904) | (0.1731) | (0.1731) |
| | Urban | 0.2152 | 0.0619 | 0.2189 | 0.2189 | 0.2080 | 0.2080 |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| | | (0.2036) | (0.0854) | (0.2130) | (0.2130) | (0.1989) | (0.1989) |
| Income proxy: expenditure | Income | -0.0680 | 0.0483*** | -0.0118 | -0.0118 | -0.0013 | -0.0013 |
| | | (0.1169) | (0.0140) | (0.1411) | (0.1411) | (0.1314) | (0.1314) |
| Consumption expenditure | Quantity | 0.4128 | 0.2141 | 0.3859 | 0.3859 | 0.3568 | 0.3568 |
| | | (0.4053) | (0.3101) | (0.4262) | (0.4262) | (0.3975) | (0.3975) |
| Single eqn. | Demand system | 0.5672 | | | | | |
| | | (0.4480) | | | | | |
| FD/FE/GMM | LS/ML | -0.4996** | -0.8757*** | -0.5162** | -0.5162*** | -0.4831** | -0.4831*** |
| | | (0.1856) | (0.3391) | (0.1934) | (0.1934) | (0.1686) | (0.1686) |
| | Log of GDP per capita | | | -0.0340** | -0.0340*** | -0.0363** | -0.0363** |
| | | | | (0.0128) | (0.0128) | (0.0151) | (0.0151) |
| | Urbanisation | | | -0.0003 | -0.0003 | -0.0010** | -0.0010** |
| | | | | (0.0003) | (0.0003) | (0.0004) | (0.0004) |
| North Africa | Central Africa | | | 0.0696*** | 0.0696*** | | |
| | | | | (0.0097) | (0.0097) | | |
| | East Africa | | | 0.0414*** | 0.0414*** | | |
| | | | | (0.0133) | (0.0133) | | |
| | Southern Africa | | | 0.0417*** | 0.0417*** | | |
| | | | | (0.0109) | (0.0109) | | |
| | West Africa | | | 0.0499*** | 0.0499*** | | |
| | | | | (0.0103) | (0.0103) | | |
| | Sahelian | | | | | -0.0508 | -0.0508 |
| | | | | | | (0.0452) | (0.0452) |
| | Landlocked | | | | | -0.0322 | -0.0322 |
| | | | | | | (0.0316) | (0.0316) |
| | Constant | 0.8149 | 1.9671*** | 1.5998*** | 1.5998*** | 1.6628*** | 1.6628*** |
| | | (0.5608) | (0.4776) | (0.2043) | (0.2043) | (0.2190) | (0.2190) |
| Number of observations | | 114 | 114 | 112 | 112 | 112 | 112 |
| Number of studies | | | 14 | | 13 | | 13 |
| Number of countries | | 46 | 46 | 46 | 46 | 46 | 46 |
| $R^2$ | | 0.4327 | | 0.4789 | | 0.4851 | |
| $R^2$ - overall | | | 0.1042 | | 0.4789 | | 0.4851 |
| $R^2$ - between | | | 0.6399 | | 0.5368 | | 0.5839 |
| $R^2$ - within | | | 0.0287 | | 0.1018 | | 0.0780 |
| sigma_u | | | 0.3154 | | 0.0000 | | 0.0000 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

Between-study variation contributes largely more to the explanatory power of the models than within-study variation. The main findings are summarised below:

- Income elasticities obtained from peer reviewed journal studies are significantly higher than those obtained from working papers in some but not all versions of the model.

- The only methodological aspects that matter relate to the choice of estimator; LS and ML are associated with lower estimates compared to FD/FE/GMM estimators. The effect of other methodological aspects are either insignificant or inconsistently verified across the set of models.
- The results suggest that the income elasticity of demand for dairy products has essentially been stagnant from the early 1990s to the present. Only the RE version of extended model II suggests a significant decline between 1995 to 2000.
- There is some evidence of higher income elasticities for dairy as income increases, as measured by GDP pc.
- There is some evidence of lower income elasticities for dairy in countries with higher degree of urbanisation.
- There is some evidence of lower income elasticities of demand for dairy for countries in North Africa, compared to countries in most other African sub-regions. This result may partially result from differences in diets across regions, and in particular the relative greater importance of dairy in North Africa.

### *Tubers*

Results from the meta-regression of income elasticities of demand for tubers are given in Table 22.

- There are strong regional differences in the income elasticities of demand for tubers possibly reflecting supply-side factors. In particular, West African has significantly higher income elasticity than Central Africa, but significantly lower elasticity than East Africa. Landlocked countries also have significantly higher income elasticities for tubers than maritime countries. Association with the Sahel region however does not significantly affect elasticities for tubers.
- There are also strong differences in elasticities associated with countries' degree of urbanisation. It would appear that countries with greater degrees of urbanisation have higher income elasticities for tubers.

**Table 22. Results from the meta-regression of income elasticities for tubers**

| **Reference** | **Variable** | **Baseline model** | | **Extended model I** | | **Extended model II** | |
|---|---|---|---|---|---|---|---|
| | | **OLS** | **RE** | **OLS** | **RE** | **OLS** | **RE** |
| Journal | Report | 0.2650<br>(0.1648) | 0.1414<br>(0.1685) | 2.2343***<br>(0.4745) | -1.3865**<br>(0.5743) | 0.1482<br>(0.1237) | 0.0069<br>(0.1176) |
| | Working paper/conference | 0.2457<br>(0.2086) | 0.4170*<br>(0.2233) | 0.3724<br>(0.2114) | 0.6929**<br>(0.3225) | 0.4400**<br>(0.1863) | 0.7176***<br>(0.2765) |
| Cross-sectional | Panel | -0.2243<br>(0.1391) | -0.3239*<br>(0.1709) | -1.3928***<br>(0.1486) | | -1.3711***<br>(0.1312) | -3.0034***<br>(0.3490) |
| Aggregate | Micro | | 0.6606*<br>(0.3440) | | | | |
| 1991/95 | 1996/00 | -0.2139<br>(0.2412) | 0.0068<br>(0.2923) | 0.7185***<br>(0.0485) | 0.7201***<br>(0.0227) | 0.7201***<br>(0.0412) | 0.7177***<br>(0.0186) |
| | 2001/05 | -0.5312*<br>(0.2831) | -0.2617<br>(0.3412) | 2.6420***<br>(0.3536) | 1.9715***<br>(0.4350) | 0.4520**<br>(0.1645) | 0.5995**<br>(0.2692) |
| | 2006/15 | -0.1694<br>(0.3281) | 0.0842<br>(0.3406) | 0.0998<br>(0.2752) | 0.4174<br>(0.3240) | 0.2055<br>(0.2294) | 0.4528*<br>(0.2492) |
| Both | Rural | -0.4655*<br>(0.2517) | -0.3304<br>(0.2783) | -0.5975**<br>(0.2369) | -0.3245<br>(0.2680) | -0.5984**<br>(0.2366) | -0.3252<br>(0.2680) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Urban | -0.5263* (0.2592) | -0.3897 (0.2806) | -0.6365** (0.2196) | -0.3592 (0.2555) | -0.6372** (0.2194) | -0.3594 (0.2555) |
| Income prox expenditure | Income | -0.2566* (0.1285) | -0.1049 (0.1583) | -0.2694* (0.1457) | -0.0030 (0.2117) | -0.2694* (0.1459) | 0.0011 (0.2143) |
| Cons. expenditure | Quantity | 0.6886*** (0.1680) | 0.5397*** (0.1875) | | | | |
| Single eqn. | Demand system | | | | 1.1796*** (0.2138) | | -1.8427*** (0.3661) |
| | LS/ML | | | | -3.1467*** (0.5051) | | |
| | Log of GDP pc | | | 0.0379 (0.0647) | 0.0793* (0.0474) | 0.0459 (0.0648) | 0.0822* (0.0451) |
| | Urbanisation | | | 0.0647*** (0.0129) | 0.0397** (0.0172) | 0.0525*** (0.0106) | 0.0353*** (0.0110) |
| West Africa | Central Africa | | | -4.3378*** (0.8446) | | | |
| | East Africa | | | | 2.7394** (1.2042) | | |
| | Southern Africa | | | -0.2363 (0.1511) | -0.0776 (0.2241) | | |
| | Sahelian | | | | | 0.3766 (0.2407) | 0.1060 (0.3619) |
| | Landlocked | | | | | 1.7441*** (0.2669) | 1.2224*** (0.3215) |
| | Constant | 0.9422** (0.3159) | | -2.3549*** (0.3388) | | -2.0038*** (0.2778) | |
| Number of observations | | 139 | 139 | 139 | 139 | 139 | 139 |
| Number of studies | | | 14 | | 14 | | 14 |
| Number of countries | | 7 | 7 | 7 | 7 | 7 | 7 |
| $R^2$ | | 0.2537 | | 0.2783 | | 0.2782 | |
| $R^2$ - overall | | | 0.2355 | | 0.2521 | | 0.2515 |
| $R^2$ - between | | | 0.7546 | | 0.8494 | | 0.8491 |
| $R^2$ - within | | | 0.0001 | | 0.0115 | | 0.0115 |
| sigma_u | | | 0.1775 | | 0.3305 | | 0.3305 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

### ***Legumes and nuts***

Results from the meta-regression of income elasticities of demand for legumes and nuts are given in Table 23.

- Income elasticities declined between 1996 to 2000 compared to 1991 and 1995. Extended model II suggested they declined throughout the whole period covered by the meta sample.
- Consumption is measured in quantity as opposed to expenditure terms had significantly higher income elasticities of demand for legumes and nuts.
- As GDP pc increases the responsiveness of demand for legumes and nuts also increases.

- As with tubers, there are strong regional differences in income elasticities of demand for legumes (again possibly reflecting supply-side factors).
- Sahel and maritime countries have higher income elasticities that non Sahel and landlocked countries respectively.

### Table 23. Results from the meta-regression of income elasticities for legumes and nuts

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | **OLS** | **RE** | **OLS** | **RE** | **OLS** | RE |
| Journal | Report | 0.0594 | 0.0602 | 0.9846 | 0.9855 | 0.5167*** | 0.5167*** |
| | | (0.0656) | (0.0880) | (0.8610) | (0.7527) | (0.0919) | (0.0919) |
| | Working paper/conference | -0.0842 | -0.0665 | | | -0.6563*** | -0.6563*** |
| | | (0.0581) | (0.0581) | | | (0.1837) | (0.1837) |
| Cross-sectional | Panel | 1.1436*** | | | 5.8187* | | |
| | | (0.1464) | | | (3.2102) | | |
| Aggregate | Micro | | 1.9600*** | | | | 9.1464*** |
| | | | (0.2021) | | | | (1.9234) |
| 1991/95 | 1996/00 | -0.7195*** | -0.8074*** | -2.5161* | -2.6794** | -2.8014*** | -2.8014*** |
| | | (0.1180) | (0.1266) | (1.2620) | (1.1200) | (0.4995) | (0.4995) |
| | 2001/05 | -0.4320*** | -0.5584*** | -2.1727 | -2.2768 | -1.9982*** | -1.9982*** |
| | | (0.1314) | (0.1533) | (1.8329) | (1.5685) | (0.4056) | (0.4056) |
| | 2006/15 | -0.0168 | 0.0097 | -1.3858 | -1.4083* | -0.8889*** | -0.8889*** |
| | | (0.2017) | (0.2264) | (0.8309) | (0.7556) | (0.1818) | (0.1818) |
| Both | Rural | -0.0322 | 0.0174 | 0.1111 | 0.1301 | 0.1165 | 0.1165 |
| | | (0.1392) | (0.1247) | (0.1215) | (0.1133) | (0.1224) | (0.1224) |
| | Urban | -0.3094** | -0.2593** | -0.1655 | -0.1465 | -0.1599 | -0.1599 |
| | | (0.1405) | (0.1231) | (0.1210) | (0.1138) | (0.1215) | (0.1215) |
| Income proxy: expenditure | Income | 0.1037 | 0.0304 | 0.2700*** | 0.3087*** | 0.2740*** | 0.2740*** |
| | | (0.0835) | (0.1065) | (0.0653) | (0.0795) | (0.0659) | (0.0659) |
| Consumption expenditure | Quantity | 0.3847*** | 0.4092*** | 0.9928* | 1.0737** | 1.9982*** | 1.9982*** |
| | | (0.0396) | (0.0539) | (0.4664) | (0.4235) | (0.3946) | (0.3946) |
| Single eqn. | Demand system | | -1.1127*** | -3.2314** | 2.3937 | -3.7215*** | -3.7215*** |
| | | | (0.1300) | (1.3640) | (1.9926) | (0.6218) | (0.6218) |
| | Log of GDP per capita | | | 0.2489** | 0.2056 | 0.3394*** | 0.3394*** |
| | | | | (0.1077) | (0.1271) | (0.0892) | (0.0892) |
| | Urbanisation | | | -0.0544 | -0.0523 | -0.1474*** | -0.1474*** |
| | | | | (0.0373) | (0.0340) | (0.0292) | (0.0292) |
| North Africa | East Africa | | | -1.8416 | -1.8769 | | |
| | | | | (1.8859) | (1.6369) | | |
| | Southern Africa | | | -0.9069** | -0.9429** | | |
| | | | | (0.4041) | (0.3767) | | |
| | West Africa | | | 0.4899** | 0.5786*** | | |
| | | | | (0.1833) | (0.1881) | | |
| | Sahelian | | | | | 3.7178*** | 3.7178*** |
| | | | | | | (0.8449) | (0.8449) |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| | Landlocked | | | | | -4.4559*** (0.9729) | -4.4559*** (0.9729) |
| | Constant | 0.7781*** (0.1556) | | 5.3832 (3.6956) | | 9.1464*** (1.9234) | |
| Number of observations | | 121 | 121 | 121 | 121 | 121 | 121 |
| Number of studies | | | | | 15 | | 15 |
| Number of countries | | 8 | 8 | 8 | 8 | 8 | 8 |
| $R^2$ | | 0.4931 | | 0.5128 | | 0.5220 | |
| $R^2$ - overall | | | 0.4858 | | 0.5112 | | 0.5220 |
| $R^2$ - between | | | 0.8351 | | 0.9015 | | 0.9417 |
| $R^2$ - within | | | 0.1194 | | 0.1201 | | 0.1201 |
| sigma_u | | | 0.2808 | | 0.5092 | | 0.0000 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

### *Fruit and vegetables*

Results from the meta analysis of income elasticities of demand for fruit and vegetables are given in Table 24.

**Table 24. Results from the meta-regression of income elasticities for fruit and vegetables**

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Journal | Report | -0.0736 (0.2471) | 0.0946 (0.2927) | -0.1150 (0.2123) | 0.0284 (0.2945) | -0.1183 (0.2255) | 0.0399 (0.3037) |
| | Working paper/conference | 0.3096 (0.2611) | 0.6577*** (0.2541) | 0.4193 (0.2561) | 0.7186*** (0.2419) | 0.3145 (0.2499) | 0.6975*** (0.2495) |
| Cross-sectional | Panel | -0.2970 (0.3745) | -0.6692** (0.3277) | -0.3673 (0.3522) | -0.6799** (0.2998) | -0.2767 (0.3496) | -0.6591** (0.3079) |
| Aggregate | Micro | -0.0170 (0.1990) | -0.2194 (0.2874) | -0.1815 (0.1794) | -0.3175 (0.2969) | -0.0917 (0.1891) | -0.2899 (0.3042) |
| 1991/95 | 1996/00 | -0.3118 (0.3387) | -0.8323*** (0.2263) | -0.4786 (0.2906) | -0.8994*** (0.2119) | -0.4040 (0.3197) | -0.8785*** (0.2203) |
| | 2001/05 | -0.2291 (0.3072) | -0.5266** (0.2249) | -0.4197 (0.2713) | -0.6060*** (0.2043) | -0.3184 (0.2916) | -0.5786*** (0.2131) |
| | 2006/15 | -0.2016 (0.1802) | -0.0760 (0.1849) | -0.2198 (0.1469) | -0.0793 (0.1787) | -0.2495 (0.1667) | -0.0826 (0.1789) |
| Both | Rural | 0.1367 (0.1507) | 0.0930 (0.0979) | 0.1215 (0.1305) | 0.0969 (0.1009) | 0.1173 (0.1435) | 0.0972 (0.0997) |
| | Urban | -0.0535 (0.1956) | -0.1236 (0.1207) | -0.0755 (0.1863) | -0.1206 (0.1169) | -0.0736 (0.1908) | -0.1198 (0.1188) |
| Income proxy: expenditure | Income | -0.1334 (0.2200) | -0.1869 (0.2092) | -0.0617 (0.1944) | -0.1742 (0.2025) | -0.1137 (0.2065) | -0.1796 (0.2076) |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Consumption expenditure | Quantity | -0.1796 | 0.1400 | -0.0923 | 0.1387 | -0.1569 | 0.1097 |
| | | (0.2558) | (0.1521) | (0.2341) | (0.1459) | (0.2495) | (0.1513) |
| Single eqn. | Demand system | | 1.7887*** | | | | |
| | | | (0.2518) | | | | |
| FD/FG/FE | LS/ML | -0.4213** | -0.5790*** | -0.4919*** | -0.5742*** | -0.3706** | -0.5807*** |
| | | (0.1610) | (0.1626) | (0.1608) | (0.1673) | (0.1494) | (0.1694) |
| | Log of GDP per capita | | | -0.0941** | -0.0466*** | -0.0722** | -0.0429*** |
| | | | | (0.0414) | (0.0067) | (0.0328) | (0.0083) |
| | Urbanisation | | | 0.0032 | -0.0001 | 0.0019 | -0.0002 |
| | | | | (0.0029) | (0.0003) | (0.0024) | (0.0002) |
| North Africa | Central Africa | | | 0.2564* | 0.0835*** | | |
| | | | | (0.1382) | (0.0098) | | |
| | East Africa | | | 0.0389 | 0.0303*** | | |
| | | | | (0.0825) | (0.0050) | | |
| | Southern Africa | | | 0.1502 | 0.0402*** | | |
| | | | | (0.1029) | (0.0100) | | |
| | West Africa | | | 0.1048 | 0.0385*** | | |
| | | | | (0.0945) | (0.0096) | | |
| | Sahelian | | | | | -0.0717 | -0.0168*** |
| | | | | | | (0.0622) | (0.0047) |
| | Landlocked | | | | | -0.0453 | 0.0055 |
| | | | | | | (0.0492) | (0.0076) |
| | Constant | 1.3855*** | | 2.0554*** | 2.1921*** | 1.8997*** | 2.1831*** |
| | | (0.2280) | | (0.3563) | (0.2860) | (0.2862) | (0.2986) |
| Number of observations | | 206 | 206 | 206 | 206 | 206 | 206 |
| Number of studies | | | 21 | | 21 | | 21 |
| Number of countries | | 47 | 47 | 47 | 47 | 47 | 47 |
| $R^2$ | | 0.3332 | | 0.3798 | | 0.3561 | |
| $R^2$ - overall | | | 0.2538 | | 0.2693 | | 0.2591 |
| $R^2$ - between | | | 0.4213 | | 0.4474 | | 0.4297 |
| $R^2$ - within | | | 0.1404 | | 0.1626 | | 0.1595 |
| sigma_u | | | 0.3842 | | 0.4885 | | 0.4309 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

As with the previous models, between-study variation contributes largely more to the explanatory power of the models than within-study variation. The main findings are summarised below:

- Income elasticities obtained from peer reviewed journal studies are significantly lower than those obtained from working papers.
- The results suggest that the income elasticity of demand for fruits and vegetables has been falling over time with a significantly lower rate between 1996 and 2005 than in the period 1991 to 1995. There is no evidence however that this trend had continued between 2006 and the present.

- There is evidence of lower estimates for studies using single equation demand models instead of demand systems; and studies using LS and ML methods instead of FD, FG and FE methods. On the other hand, there appears to be no effect for the other methodological factors.
- There is evidence of higher income elasticities for fruits and vegetables for low income countries, compared to higher income African countries.
- There is no effect of degree of urbanisation of a country on the magnitude of the income elasticities of fruits and vegetables.
- In the RE version of the extended models I, there is evidence of significant regional differences in the magnitude of income elasticities for fruits and vegetables across Africa. Also, the RE version of extended model II suggests Sahelian countries have lower income elasticities. In contrast, being land-locked had no influence on the magnitude of income elasticities for fruit and vegetables.

### *Meat, Fish and eggs*

Results from the meta-regression of income elasticities of demand for meat, fish and eggs are given in Table 25.

**Table 25. Results from the meta-regression of income elasticities for meat, fish and eggs**

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Journal | Report | -0.1872 | 0.2041 | -0.2489 | 0.1323 | -0.2603 | 0.1534 |
| | | (0.3479) | (0.2996) | (0.3616) | (0.3076) | (0.3616) | (0.3033) |
| | Working paper/conference | -0.3600 | 0.2850 | -0.2960 | 0.2914 | -0.3997 | 0.3022 |
| | | (0.3262) | (0.3368) | (0.3449) | (0.3412) | (0.3310) | (0.3428) |
| Cross-sectional | Panel | 0.2450 | 0.3396 | 0.2963 | 0.4127 | 0.3588 | 0.4066 |
| | | (0.4528) | (0.6599) | (0.4926) | (0.6715) | (0.4725) | (0.6759) |
| | Time series | -1.2501** | -0.2368 | -1.3236** | -0.2348 | -1.2934** | -0.1782 |
| | | (0.5576) | (0.3680) | (0.5462) | (0.3765) | (0.5682) | (0.3791) |
| Aggregate | Micro | 0.6515** | 0.1949 | 0.4881 | 0.1258 | 0.5533 | 0.1380 |
| | | (0.3071) | (0.2783) | (0.3240) | (0.2924) | (0.3331) | (0.2896) |
| 1991/95 | 1996/00 | 0.3754 | -0.3823*** | 0.3326 | -0.3796*** | 0.3454 | -0.3975*** |
| | | (0.4206) | (0.0944) | (0.3751) | (0.0996) | (0.4030) | (0.0734) |
| | 2001/05 | 0.3509 | -0.1876 | 0.2807 | -0.2060 | 0.3236 | -0.2124 |
| | | (0.4077) | (0.2339) | (0.3627) | (0.2389) | (0.3911) | (0.2353) |
| | 2006/15 | -0.0745 | 0.2249 | 0.0101 | 0.2360 | -0.0709 | 0.2456 |
| | | (0.3083) | (0.3509) | (0.2929) | (0.3621) | (0.2998) | (0.3651) |
| | Pre-1990 | 2.3498*** | 1.3546*** | | | | |
| | | (0.5591) | (0.3748) | | | | |
| Both | Rural | -0.4818 | -0.0535 | -0.4656 | -0.0530 | -0.4775 | -0.0435 |
| | | (0.2996) | (0.0674) | (0.2906) | (0.0687) | (0.2995) | (0.0612) |
| | Urban | -0.5560* | -0.0336 | -0.5455* | -0.0333 | -0.5486* | -0.0219 |
| | | (0.2978) | (0.0649) | (0.2881) | (0.0662) | (0.2963) | (0.0595) |
| Income prox expenditure | Income | 0.0331 | -0.3021*** | 0.1496 | -0.2933** | 0.0818 | -0.3184*** |
| | | (0.2992) | (0.1077) | (0.3237) | (0.1167) | (0.3103) | (0.0867) |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Cons. expenditure | Quantity | -0.1232<br>(0.3174) | 0.1568<br>(0.1789) | -0.1061<br>(0.3006) | 0.1506<br>(0.1838) | -0.1241<br>(0.3277) | 0.1336<br>(0.1807) |
| Single eqn. | Demand system | 0.1585<br>(0.6088) | 0.3831<br>(0.4283) | 0.0919<br>(0.5998) | 0.3934<br>(0.4380) | 0.1830<br>(0.6053) | 0.4007<br>(0.4305) |
| FD/FE/GMM | LS/ML | 0.4534<br>(0.3296) | -0.2192<br>(0.2149) | 0.3123<br>(0.3218) | -0.1740<br>(0.2187) | 0.4960<br>(0.3487) | -0.2001<br>(0.2178) |
| | Log of GDP per capita | | | -0.0972<br>(0.0696) | -0.0328***<br>(0.0120) | -0.0678<br>(0.0548) | -0.0342***<br>(0.0121) |
| | Urbanisation | | | 0.0032<br>(0.0031) | -0.0006<br>(0.0005) | 0.0013<br>(0.0025) | -0.0008<br>(0.0005) |
| North Africa | Central Africa | | | 0.2486*<br>(0.1411) | 0.0774***<br>(0.0066) | | |
| | East Africa | | | 0.0010<br>(0.1074) | 0.0477***<br>(0.0122) | | |
| | Southern Africa | | | 0.1731<br>(0.1205) | 0.0403***<br>(0.0050) | | |
| | West Africa | | | 0.0798<br>(0.1033) | 0.0543***<br>(0.0100) | | |
| | Sahelian | | | | | -0.0817<br>(0.0929) | -0.0072*<br>(0.0041) |
| | Landlocked | | | | | -0.0624<br>(0.0715) | -0.0001<br>(0.0069) |
| | Constant | -0.0221<br>(0.8582) | 0.6875<br>(0.4452) | 0.7162<br>(0.8602) | 0.9026*<br>(0.4788) | 0.4387<br>(0.8876) | 0.9769**<br>(0.4745) |
| Number of observations | | 327 | 327 | 316 | 316 | 316 | 316 |
| Number of studies | | | 27 | | 26 | | 26 |
| Number of countries | | 47 | 47 | 47 | 47 | 47 | 47 |
| $R^2$ | | 0.2368 | | 0.2353 | | 0.2169 | |
| $R^2$ - overall | | | 0.0505 | | 0.0285 | | 0.0240 |
| $R^2$ - between | | | 0.1931 | | 0.1584 | | 0.1506 |
| $R^2$ - within | | | 0.0213 | | 0.0464 | | 0.0440 |
| sigma_u | | | 0.7512 | | 0.6600 | | 0.7968 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

Between-study variation contributes substantially more to the explanatory power of the models than within-study variation. The main findings are summarised below:

- There is evidence that income elasticities for meat, fish and eggs in Africa declines as GDP pc increases.
- The income elasticity of demand for meat, fish and eggs is lower for countries in North Africa, compared to other sub-regions of Africa. The elasticity estimate is higher for countries in Central Africa, followed by West, East and Southern Africa.

- Other than the factors above, there is evidence of significantly higher elasticities for the period before 1990, and lower elasticities between 1996-2000 (compared to 1991-1995).
- Studies using time series data (versus cross-sectional data), and studies using income as proxy for consumption instead of expenditure tend to produce lower income elasticity estimates.

### *Key results from the Beverages and Fats and oils*

The results for the remaining two food types for which sample sizes are small are given in Appendix C. Amongst other factors, the results suggest:

- Landlocked countries in Africa have significantly higher income elasticities of demand for beverages than in non-landlocked countries.
- The income elasticities of demand for fats and oils show a significant negative association with income.

### Nutrients

For the purpose of estimating the meta-regression, we grouped the various different categories of nutrients shown in Chapter 3 into the following groups: Carbohydrates, Proteins, Vitamins, Mineral, Fat. Table 26 presents the results for these five pooled groups. All models are based on 324 estimates of income elasticities from 7 studies.

**Table 26. Results from the meta-regression of income elasticities for all nutrients**

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Journal | Report | | -0.2916***<br>(0.1008) | -0.0274<br>(0.0512) | 0.3050***<br>(0.0219) | 0.3984***<br>(0.0206) | -0.6047***<br>(0.0785) |
| Carbohydrates | Fats | 0.1764**<br>(0.0510) | 0.1764***<br>(0.0510) | 0.1764**<br>(0.0512) | 0.1764***<br>(0.0512) | 0.1764**<br>(0.0512) | 0.1764***<br>(0.0512) |
| | Minerals | 0.0688**<br>(0.0205) | 0.0688***<br>(0.0205) | 0.0688**<br>(0.0206) | 0.0688***<br>(0.0206) | 0.0688**<br>(0.0206) | 0.0688***<br>(0.0206) |
| | Proteins | 0.0657**<br>(0.0259) | 0.0657**<br>(0.0259) | 0.0657**<br>(0.0260) | 0.0657**<br>(0.0260) | 0.0657**<br>(0.0260) | 0.0657**<br>(0.0260) |
| | Vitamins | 0.0868**<br>(0.0247) | 0.0868***<br>(0.0247) | 0.0868**<br>(0.0248) | 0.0868***<br>(0.0248) | 0.0868**<br>(0.0248) | 0.0868***<br>(0.0248) |
| Cross-sectional | Panel | -0.1491<br>(0.1903) | | | -0.6648***<br>(0.1330) | | |
| Aggregate | Micro | | 1.0514***<br>(0.1987) | | | | |
| 1996/00 | 2001/05 | 0.0064<br>(0.0951) | 0.1358<br>(0.1893) | 0.7738***<br>(0.1439) | 0.4414***<br>(0.0775) | -0.0517<br>(0.0977) | -0.0819<br>(0.0961) |
| | Pre-1990 | -0.1425<br>(0.0947) | | | | | |
| Both | Rural | -0.0131<br>(0.1915) | | -0.0131<br>(0.1922) | -0.0131<br>(0.1922) | -0.0131<br>(0.1922) | -0.0131<br>(0.1922) |
| | Urban | | 0.0131 | | | | |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | **OLS** | **RE** | **OLS** | **RE** | **OLS** | **RE** |
| | | | (0.1915) | | | | |
| Income proxy: expenditure | Income | -0.3529*** | -0.5021*** | | | -1.4009*** | -1.5353*** |
| | | (0.0075) | (0.1900) | | | (0.0907) | (0.0984) |
| Consumption expenditure | Quantity | -0.0584*** | -0.3501*** | | | | -1.2415*** |
| | | (0.0033) | (0.0996) | | | | (0.0719) |
| Single eqn. | Demand system | -0.0957 | -0.0957 | 0.9029*** | -0.0943 | 0.2588** | -0.0486 |
| | | (0.0981) | (0.0981) | (0.1424) | (0.0575) | (0.0738) | (0.0915) |
| IV | LS/ML | | -0.1425 | 0.1273 | -0.5376*** | | |
| | | | (0.0947) | (0.1903) | (0.0575) | | |
| | Log of GDP per capita | | | 0.2937*** | 0.2937*** | 1.5654*** | 0.4236*** |
| | | | | (0.0000) | (0.0000) | (0.0919) | (0.0258) |
| | Urbanisation | | | -0.0275*** | -0.0275*** | 0.0120*** | -0.0235*** |
| | | | | (0.0000) | (0.0000) | (0.0029) | (0.0008) |
| West Africa | East Africa | | | 0.2951 | -0.3697*** | | |
| | | | | (0.1906) | (0.0577) | | |
| | Southern Africa | | | -0.6914*** | -0.3590*** | | |
| | | | | (0.0500) | (0.0205) | | |
| | Sahelian | | | | | 0.1147 | 1.1390*** |
| | | | | | | (0.1733) | (0.1165) |
| | Landlocked | | | | | 0.6425*** | 0.0656*** |
| | | | | | | (0.0464) | (0.0131) |
| | Constant | 0.7598*** | | -1.6620*** | | -8.8112*** | |
| | | (0.0980) | | (0.3325) | | (0.5101) | |
| Number of observations | | 324 | 324 | 324 | 324 | 324 | 324 |
| Number of studies | | | 7 | | 7 | | 7 |
| Number of countries | | 8 | 8 | 8 | 8 | 8 | 8 |
| $R^2$ | | 0.3608 | | 0.3646 | | 0.3646 | |
| $R^2$ - overall | | | 0.3608 | | 0.3646 | | 0.3646 |
| $R^2$ - between | | | 1.0000 | | 1.0000 | | 1.0000 |
| $R^2$ - within | | | 0.0207 | | 0.0265 | | 0.0265 |
| sigma_u | | | 0.0000 | | 0.0000 | | 0.0000 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

The key findings from the nutrients meta regression are as follows:

- Reports include significantly lower income elasticities for nutrients than journal papers.
- Using expenditure as a proxy for income appears to increase the magnitude of the nutrient elasticities.
- The elasticities are lowest for carbohydrates followed by proteins, minerals, vitamins and finally fats.
- The positive coefficient on the GDP per capita variable suggests that as income increases the income elasticity of demand for nutrients increases: demand for nutrients becomes more responsive to changes in income.

- West Africa has significantly higher income elasticities for nutrients than the other regions included in the model.
- The impact of urbanisation on the demand for nutrients is unclear, with different versions of the model producing coefficients of different sign. However the impact appears small in all cases.

### Calories

Table 27 below summarises the findings for the calorie meta-regression analysis. The baseline model uses 103 estimates of income elasticities from 26 studies, while the extended model uses 98 estimates of income elasticities from 24 studies. The between-study variation contributes nearly exclusively to the explanatory power of the models (within-study $R^2$ is equal to zero in both the baseline and extended models).

**Table 27. Results from the meta-regression of income elasticities for calories**

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Journal | Report | -0.2234** | -0.2064** | -0.0905 | -0.0905 | -0.2734** | -0.2436** |
| | | (0.0922) | (0.0854) | (0.0956) | (0.0956) | (0.1217) | (0.1087) |
| | Working paper/conference | -0.0486 | -0.0295 | 0.0834 | 0.0834 | 0.0249 | 0.0423 |
| | | (0.1499) | (0.1515) | (0.0651) | (0.0651) | (0.1322) | (0.1319) |
| Cross-sectional | Panel | 0.1106 | 0.1228 | 0.1433 | 0.1433* | -0.0017 | 0.0186 |
| | | (0.1027) | (0.1021) | (0.0846) | (0.0846) | (0.1130) | (0.1087) |
| Aggregate | Micro | -0.2819 | -0.2438 | | | | |
| | | (0.1654) | (0.1580) | | | | |
| 1991/95 | 1996/00 | 0.2132 | 0.1435 | 0.5400** | 0.5400*** | 0.4493* | 0.3439 |
| | | (0.1987) | (0.1812) | (0.1940) | (0.1940) | (0.2507) | (0.2315) |
| | 2001/05 | 0.3724** | 0.3451** | 0.4902*** | 0.4902*** | 0.4774** | 0.4360** |
| | | (0.1641) | (0.1471) | (0.1516) | (0.1516) | (0.1985) | (0.1861) |
| | 2006/15 | 0.3585** | 0.3208* | 0.8541*** | 0.8541*** | 0.6753** | 0.6187** |
| | | (0.1702) | (0.1657) | (0.2629) | (0.2629) | (0.2920) | (0.2807) |
| | Pre-1990 | 0.4001** | 0.3656** | 0.5098** | 0.5098** | 0.6146** | 0.5715** |
| | | (0.1782) | (0.1666) | (0.2293) | (0.2293) | (0.2768) | (0.2545) |
| Both | Rural | 0.2507** | 0.2177* | 0.3375*** | 0.3375*** | 0.1825 | 0.1432 |
| | | (0.1174) | (0.1140) | (0.0521) | (0.0521) | (0.1070) | (0.0983) |
| | Urban | 0.2447** | 0.2072* | 0.3884*** | 0.3884*** | 0.1939 | 0.1495 |
| | | (0.1186) | (0.1201) | (0.0913) | (0.0913) | (0.1350) | (0.1333) |
| Income proxy: expenditure | Income | -0.5161*** | -0.5127*** | -0.5713*** | -0.5713*** | -0.3992*** | -0.4173*** |
| | | (0.1032) | (0.1031) | (0.0883) | (0.0883) | (0.1240) | (0.1188) |
| Consumption expenditure | Quantity | -0.2806*** | -0.2578*** | -0.2066** | -0.2066*** | -0.2783*** | -0.2554*** |
| | | (0.0986) | (0.0910) | (0.0745) | (0.0745) | (0.0974) | (0.0845) |
| Single eqn. | Demand system | 0.1502** | 0.1580** | -0.0827 | -0.0827 | 0.1309 | 0.1399* |
| | | (0.0718) | (0.0736) | (0.0576) | (0.0576) | (0.0867) | (0.0841) |
| IV | FD/FE/GMM | 0.2610** | 0.2109** | 0.0048 | 0.0048 | 0.1567** | 0.1169** |
| | | (0.0987) | (0.0910) | (0.0627) | (0.0627) | (0.0739) | (0.0593) |
| | LS/ML | 0.0567 | 0.0392 | 0.0240 | 0.0240 | 0.0938 | 0.0576 |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | **OLS** | **RE** | **OLS** | **RE** | **OLS** | **RE** |
| | | (0.0594) | (0.0528) | (0.0528) | (0.0528) | (0.0600) | (0.0545) |
| | Log of GDP per capita | | | -0.2187 | -0.2187 | -0.2886 | -0.2666 |
| | | | | (0.1528) | (0.1528) | (0.1688) | (0.1648) |
| | Urbanisation | | | -0.0112** | -0.0112** | -0.0005 | 0.0002 |
| | | | | (0.0045) | (0.0045) | (0.0050) | (0.0042) |
| North Africa | Central Africa | | | -0.8234*** | -0.8234*** | | |
| | | | | (0.1501) | (0.1501) | | |
| | East Africa | | | -1.0385*** | -1.0385*** | | |
| | | | | (0.1832) | (0.1832) | | |
| | Southern Africa | | | -0.9981*** | -0.9981*** | | |
| | | | | (0.1943) | (0.1943) | | |
| | West Africa | | | -0.9613*** | -0.9613*** | | |
| | | | | (0.1331) | (0.1331) | | |
| | Sahelian | | | | | 0.1382 | 0.1303 |
| | | | | | | (0.1712) | (0.1687) |
| | Landlocked | | | | | -0.0714 | -0.0403 |
| | | | | | | (0.1116) | (0.0954) |
| | Constant | 0.4987** | 0.5166** | 2.5185*** | 2.5185*** | 1.7915* | 1.7277* |
| | | (0.2295) | (0.2215) | (0.7451) | (0.7451) | (0.8941) | (0.8974) |
| Number of observations | | 103 | 103 | 98 | 98 | 98 | 98 |
| Number of studies | | | 26 | | 24 | | 24 |
| Number of countries | | 14 | 14 | 12 | 12 | 12 | 12 |
| $R^2$ | | 0.5523 | | 0.6064 | | 0.5276 | |
| $R^2$ - overall | | | 0.5501 | | 0.6064 | | 0.5231 |
| $R^2$ - between | | | 0.8209 | | 0.9079 | | 0.8348 |
| $R^2$ - within | | | 0.0107 | | 0.0110 | | 0.0118 |
| sigma_u | | | 0.0687 | | 0.0000 | | 0.0960 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

Ogundari and Abdulai (2013) estimated a meta-regression of calorie-income elasticities based on 99 observations obtained from 40 studies. It is not straight forward to compare our results with those obtained by Ogundari and Abdulai (2013) because our analysis is focused on developing African countries only, whereas Ogundari and Abdulai included countries across all continents and hence at very different stages of economic and social development. Furthermore, we include a considerably larger number of both internal and external variables in the model specification. Nevertheless, we provide some highlights of their main findings and how they compare to ours.

- Consistent with Ogundari and Abdulai (2013), we do not find statistically significant differences between estimates obtained from journals and estimates obtained from conferences, working papers. However there is some evidence that estimates produced from reports by International organisations are lower than those in journals, which is in line with the higher elasticities found for peer-reviewed papers in some other studies (e.g. Zhou and Yu (2014)).

- Ogundari and Abdulai find evidence in favour of higher calorie-income elasticities for studies based on panel data and time series data, compared to cross-sectional data. They also find that the year of the primary study and the number of years of primary data affect (reduce) the magnitude of the calorie-income elasticity. However, they do not find any significant effect for the use of IV type estimators nor the number of regressors used in the primary study.
- Compared to their analysis, methodological factors do not appear to play an important role in explaining the variation across income elasticities in our study. The baseline model suggests that demand systems produce higher income elasticities than single equation models but this difference is not evident in the extended versions of the model. Our findins also confirm that using expenditure as a proxy for income results in higher calorie-income elasticity estimates.
- While Ogundari and Abdulai (2013) find evidence of significant differences in the calorie-income elasticity between Europe, North America and South America (but not between Europe, Africa, Asia and Oceania): calorie-income elasticities in Europe are found to be higher (lower) than in North America (South America). Our analysis considers only African countries and suggests that countries in East and South Africa have lower calorie income elasticities than countries in North Africa.

Other findings include:

- There is evidence that between 1990 and 1995, calorie elasticities fell but then increased in later periods. It is difficult to reconcile these results to those obtained for all foods and the more limited sample size might be influencing the robustness of these findings.
- There is no effect of GDP per capita on the magnitude of the calorie-income elasticities.
- There is evidence that the degree of urbanisation of a country negatively affects the magnitude of the calorie-income elasticities with calorie income elasticities smaller for more urbanised economies, all other factors being the same.

# 5. Sensitivity Analysis

## 5.1 Sample-size weighted meta-regressions

This section explores the robustness of the results. Ideally, we would like to have weighted each individual income elasticity estimate according to its standard error so that estimates with greater precision receive greater weight in the meta-regression. However, because there are only 120 income elasticity estimates with data available for respective standard errors, we adopt a different (and inferior) approach. In particular, we explore the effect of adjusting the income elasticities obtained from the various primary studies according to the sample size of the respective primary study. The idea is that the statistical power increases with sample size, that is, the t-stat (absolute) value increases with sample size and is proportional to the square root of the degrees of freedom (e.g. Card and Krueger, 1995). We therefore wish to weight each individual income elasticity by the (square root) of the sample size used to estimate it. As this approach is inferior to using the actual standard error of the income elasticity estimate, the findings should be considered with caution. Table 28 reports the results from the model for all pooled food groups. The key issue is how these results compare to the unweighted results reported in Chapter 4, section 4.2.1.

**Table 28. Weight-adjusted meta-regression of all foods**

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Journal | Report | 0.3909*** | 0.4208** | 0.0343 | 0.1492 | 0.2698** | 0.3319 |
| | | (0.0994) | (0.1804) | (0.1799) | (0.3309) | (0.1193) | (0.2180) |
| | Working paper/conference | 0.3514*** | 0.3177 | 0.4736*** | 0.3872 | 0.1647 | 0.3674 |
| | | (0.0806) | (0.2013) | (0.1133) | (0.3142) | (0.1020) | (0.2358) |
| Meat, fish, eggs | Beverages | 0.5888*** | 0.6455*** | 0.6282*** | 0.6481*** | 0.6015*** | 0.6458*** |
| | | (0.1585) | (0.0656) | (0.1628) | (0.0656) | (0.1588) | (0.0656) |
| | Cereals | -0.1169** | -0.1550*** | -0.1472*** | -0.1564*** | -0.1262*** | -0.1553*** |
| | | (0.0448) | (0.0275) | (0.0392) | (0.0275) | (0.0416) | (0.0275) |
| | Dairy | 0.1941* | 0.1998*** | 0.1976* | 0.2003*** | 0.1953* | 0.2001*** |
| | | (0.1072) | (0.0370) | (0.1091) | (0.0370) | (0.1077) | (0.0370) |
| | Fat and oil | -0.1000** | -0.1343*** | -0.1301*** | -0.1356*** | -0.1043*** | -0.1343*** |
| | | (0.0393) | (0.0382) | (0.0273) | (0.0382) | (0.0350) | (0.0382) |
| | Fruits and vegetables | -0.1691 | -0.1753*** | -0.1743 | -0.1756*** | -0.1698 | -0.1753*** |
| | | (0.1186) | (0.0252) | (0.1213) | (0.0252) | (0.1192) | (0.0252) |
| | Legumes and nuts | -0.2816*** | -0.3117*** | -0.3073*** | -0.3130*** | -0.2871*** | -0.3120*** |
| | | (0.0523) | (0.0290) | (0.0516) | (0.0290) | (0.0519) | (0.0290) |
| | Other | -0.0502 | -0.0595* | -0.0566 | -0.0611** | -0.0487 | -0.0599* |
| | | (0.0754) | (0.0309) | (0.0774) | (0.0309) | (0.0760) | (0.0309) |
| | Tubers | -0.1557 | -0.2322*** | -0.2213* | -0.2351*** | -0.1739 | -0.2328*** |
| | | (0.1090) | (0.0399) | (0.1193) | (0.0399) | (0.1119) | (0.0399) |
| Cross-sectional | Panel | -0.4224*** | -0.1156 | -0.4986*** | -0.1294 | -0.2630*** | -0.0587 |
| | | (0.1153) | (0.6362) | (0.1235) | (0.8275) | (0.0884) | (0.6690) |
| | Time series | -1.2199*** | -0.3606 | -0.6503*** | -0.2819 | -1.3378*** | -0.3488 |
| | | (0.2826) | (3.1376) | (0.1693) | (3.6615) | (0.3551) | (3.2036) |
| Aggregate | Micro-level | 0.4714** | 0.2246 | 0.0637 | 0.0124 | 0.2620 | 0.1246 |
| | | (0.1846) | (1.6170) | (0.1908) | (2.0316) | (0.2107) | (1.6734) |

| Reference | Variable | Baseline model OLS | Baseline model RE | Extended model I OLS | Extended model I RE | Extended model II OLS | Extended model II RE |
|---|---|---|---|---|---|---|---|
| 1991/95 | 1996/00 | -0.5206*** | -0.2779* | -0.1800 | -0.1716 | -0.6387*** | -0.2726 |
| | | (0.0827) | (0.1682) | (0.1408) | (0.1931) | (0.1694) | (0.1746) |
| | 2001/05 | -0.2485** | -0.3028 | -0.2298* | -0.2584 | -0.4025** | -0.3047 |
| | | (0.1123) | (0.1978) | (0.1338) | (0.2410) | (0.1894) | (0.2065) |
| | 2006/15 | -0.4105*** | -0.1018 | 0.1062 | 0.0962 | -0.1940 | -0.1026 |
| | | (0.1054) | (0.3320) | (0.1528) | (0.4308) | (0.1334) | (0.3565) |
| Both | Rural | -0.3498** | -0.0316 | -0.1385 | 0.0089 | -0.3670** | -0.0199 |
| | | (0.1444) | (0.0927) | (0.0903) | (0.0963) | (0.1560) | (0.0941) |
| | Urban | -0.4210*** | -0.1255 | -0.2306** | -0.0861 | -0.4416** | -0.1139 |
| | | (0.1501) | (0.0929) | (0.0931) | (0.0964) | (0.1627) | (0.0943) |
| Income proxy: expenditure | Income | -0.2972*** | -0.2032 | -0.2081** | -0.0783 | -0.2944*** | -0.1660 |
| | | (0.0653) | (0.1748) | (0.0873) | (0.2078) | (0.0684) | (0.1830) |
| Consumption expenditure | Quantity | 0.3058** | 0.0716 | 0.1542 | -0.0676 | 0.5010** | -0.0080 |
| | | (0.1121) | (0.1888) | (0.1101) | (0.2869) | (0.1995) | (0.2293) |
| Single eqn. | Demand system | -0.3688* | -0.0328 | -0.1907 | -0.0257 | -0.2775 | -0.0663 |
| | | (0.2087) | (1.1412) | (0.1141) | (1.3573) | (0.2331) | (1.1729) |
| LS/ML | FD/FE/GMM | 0.1910 | 0.5251 | 0.1854 | 0.5683 | -0.0012 | 0.5723 |
| | | (0.1496) | (1.2599) | (0.2034) | (1.5417) | (0.2642) | (1.3038) |
| | Log of GDP per capita | | | -0.0940 | -0.1196 | -0.1656 | -0.0567 |
| | | | | (0.0587) | (0.1135) | (0.1151) | (0.0989) |
| | Urbanisation | | | 0.0057* | 0.0020 | 0.0111 | 0.0007 |
| | | | | (0.0033) | (0.0079) | (0.0090) | (0.0082) |
| North Africa | Central Africa | | | 0.7560** | 0.3031 | | |
| | | | | (0.3345) | (0.3507) | | |
| | East Africa | | | 0.4112 | 0.0841 | | |
| | | | | (0.2967) | (0.3639) | | |
| | Southern | | | 0.5688*** | 0.2973 | | |
| | | | | (0.1812) | (0.3089) | | |
| | West Africa | | | 0.2175 | 0.0436 | | |
| | | | | (0.1674) | (0.3041) | | |
| | Sahelian | | | | | -0.3705* | -0.1364 |
| | | | | | | (0.2113) | (0.2444) |
| | Landlocked | | | | | -0.1106 | 0.0587 |
| | | | | | | (0.1899) | (0.2022) |
| | Constant | 1.0819*** | 0.6639 | 1.1395** | 1.4115 | 2.0163** | 1.1316 |
| | | (0.2165) | (1.9769) | (0.5456) | (2.5731) | (0.8272) | (2.1269) |
| Number of observations | | 1748 | 1748 | 1748 | 1748 | 1748 | 1748 |
| Number of studies | | | 33 | | 33 | | 33 |
| Number of countries | | 47 | 47 | 47 | 47 | 47 | 47 |
| $R^2$-overall | | 0.3126 | 0.2002 | 0.3371 | 0.2915 | 0.3194 | 0.2071 |
| $R^2$-between | | | 0.4153 | | 0.4261 | | 0.3912 |
| $R^2$-within | | | 0.1798 | | 0.1804 | | 0.1802 |
| sigma_u | | | 0.3030 | | 0.3800 | | 0.3129 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

In large part the results replicate those reported previously. There are however some differences in relation to the following points when using the weight-adjusted estimates:

- The coefficient on the GDP per capita variable suggests that as income increases the income elasticity of demand for food falls: demand becomes less responsive to changes in income. However the coefficient is not statistically significant.
- There is no significant (negative) effect of degree of urbanisation on income elasticity values.
- There is no evidence that landlocked countries in Africa have different elasticities to non-landlocked regions after controlling for all other factors.

## 5.2 Publication bias and journal ranking

This section investigates the potential for publication bias. Ideally, we would have used information on the standard errors of the income elasticity estimates included in the meta-sample. Unfortunately, only 6% (or 120) estimates of the income elasticities included in the meta-sample also had a standard error associated with it. This limits considerably our ability to test for the presence of reporting and publication bias between peer reviewed journals and grey literature. The 120 elasticity estimates for which we have information on the associated standard errors include 30 estimates for calories, 75 estimates for foodstuffs, and 15 estimates for nutrients. As for type of publication, they include 47 estimates from peer reviewed journals and 73 from working paper or conference papers. We can therefore only perform a set of very simple statistical tests based on the income elasticity estimates, their standard errors, and controls for the type of food demand (i.e. calories, nutrients or foodstuffs). We estimate two simple statistical models of publication bias by pooling the income elasticity estimates for all three types of food demand. Model 1 considers the relation between the elasticity estimate and its standard error (SE) for both peer reviewed journals and working papers simultaneously, while model two allows the relation between income elasticity estimate and standard error to vary according to type of publication.

Table 29 reports the results obtained for model 1 and model 2 using pooled OLS and random-effects estimators. The model specification is simpler than what we used in previously due to the sample size. The focus of the analysis is on the standard error (SE) and whether or not it is significant, however we include control variables to distinguish between the types of elasticities referred to as their magnitude may differ. The Breusch-Pagan Lagrange multiplier (LM) test fails to reject the null hypothesis of no variance between studies, suggesting that random-effects are not needed and pooled OLS is preferable. The table indicates that the magnitude of the income elasticity is proportional to its standard error and the proportion factor is just over 2, suggesting that the reported income elasticities are systematically statistically significant. Model 2 tests whether this pattern differs significantly between peer reviewed journals and working papers; it does not appear to be the case because the coefficient for the interaction term between SE and peer reviewed journals is not statistically different from zero.

**Table 29. Simple statistical test of publication bias (foodstuffs, calories, nutrients)**

| **Variable** | **Model 1** | | **Model 2** | |
|---|---|---|---|---|
| | **OLS** | **RE** | **OLS** | **RE** |
| Constant | 0.6118*** | 0.9652* | 0.6123*** | 1.0322* |
| | (0.1851) | (0.5229) | (0.1900) | (0.5302) |
| Standard error (SE) | 2.4666** | 2.2114** | 2.5596* | 2.5319* |
| | (1.1446) | (1.0453) | (1.3303) | (1.3915) |
| Journal*SE | | | -0.4688 | -1.7824 |
| | | | (0.9112) | (1.3447) |
| Calories | -0.5096*** | -0.8208 | -0.5044** | -0.8580 |
| | (0.1656) | (0.5161) | (0.1772) | (0.5275) |
| Nutrients | -0.2614 | -0.7917 | -0.2419 | -0.7961 |

| | | | | |
|---|---|---|---|---|
| | (0.2138) | (0.5130) | (0.2405) | (0.5317) |
| Number of observations | 120 | 120 | 120 | 120 |
| Number of studies | | 15 | | 15 |
| Number of countries | 10 | 10 | 10 | 10 |
| Breusch-Pagan LM test | | 0.23 (0.3158) | | 0.20 (0.3278) |
| $R^2$-overall | 0.2523 | 0.2265 | 0.2537 | 0.2195 |
| $R^2$-between | | 0.2097 | | 0.2083 |
| $R^2$-within | | 0.1348 | | 0.1482 |
| $Sigma_u$ | | 0.9509 | | 1.0029 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

We also consider whether the quality of the journal influences the reported income elasticity of food demand. Our hypothesis here is as follows: if publication bias is present, the quality of journal will have an influence on elasticity values. We cannot test whether the quality of journal influences statistical significance levels, only the magnitude of the income elasticity. However, we do not have an *a priori* hypothesis as to whether the effect is upward or downward bias.

Table 30 reports the results from the model for all foods based on estimates obtained only from peer reviewed journals. The model specification is otherwise the same as in the previous section. Overall, the results do not suggest that quality of journal influences elasticity values.

**Table 30. The influence of journal quality on income elasticities**

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | **OLS** | **RE** | **OLS** | **RE** | **OLS** | **RE** |
| Not in JCR | JCR (0.0-0.9) | -0.0716 | -0.0716 | -0.2467 | -0.2467 | -0.2921 | -0.2921 |
| | | (0.2074) | (0.2074) | (0.3116) | (0.3116) | (0.2698) | (0.2698) |
| | JCR (1.0 - 1.99) | -0.1118 | -0.1118 | -0.2027 | -0.2027 | -0.3471 | -0.3471 |
| | | (0.1383) | (0.1383) | (0.2529) | (0.2529) | (0.2166) | (0.2166) |
| | JCR (2.0 - 2.99) | 0.2198 | 0.2198 | 0.2035 | 0.2035 | 0.2397 | 0.2397 |
| | | (0.1525) | (0.1525) | (0.2351) | (0.2351) | (0.2236) | (0.2236) |
| Meat, fish, eggs | Beverages | 0.1503 | 0.1503 | 0.1553 | 0.1553 | 0.1904 | 0.1904 |
| | | (0.1887) | (0.1887) | (0.1940) | (0.1940) | (0.1797) | (0.1797) |
| | Cereals | -0.4769** | -0.4769** | -0.4421** | -0.4421** | -0.4830** | -0.4830** |
| | | (0.1944) | (0.1944) | (0.1893) | (0.1893) | (0.1948) | (0.1948) |
| | Dairy | -0.0755 | -0.0755 | -0.0426 | -0.0426 | -0.0249 | -0.0249 |
| | | (0.1428) | (0.1428) | (0.1345) | (0.1345) | (0.1261) | (0.1261) |
| | Fat and oil | -0.4167** | -0.4167** | -0.3554** | -0.3554** | -0.3419** | -0.3419** |
| | | (0.1675) | (0.1675) | (0.1481) | (0.1481) | (0.1438) | (0.1438) |
| | Fruits and vegetables | -0.4611*** | -0.4611*** | -0.4429*** | -0.4429*** | -0.4466*** | -0.4466*** |
| | | (0.1028) | (0.1028) | (0.1032) | (0.1032) | (0.1010) | (0.1010) |
| | Legumes and nuts | -0.5315*** | -0.5315*** | -0.4940*** | -0.4940*** | -0.5273*** | -0.5273*** |
| | | (0.1282) | (0.1282) | (0.1194) | (0.1194) | (0.1260) | (0.1260) |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| | Other | -0.1763* | -0.1763* | -0.1536* | -0.1536* | -0.1503* | -0.1503* |
| | | (0.0913) | (0.0913) | (0.0790) | (0.0790) | (0.0817) | (0.0817) |
| | Tubers | -0.3574* | -0.3574* | -0.3151 | -0.3151* | -0.3626* | -0.3626* |
| | | (0.1942) | (0.1942) | (0.1912) | (0.1912) | (0.1929) | (0.1929) |
| Cross-sectional | Panel | 0.0335 | 0.0335 | -0.4218* | -0.4218* | 0.4799** | 0.4799** |
| | | (0.2319) | (0.2319) | (0.2420) | (0.2420) | (0.1910) | (0.1910) |
| | Time series | -0.9755*** | -0.9755*** | -1.5117*** | -1.5117*** | -1.2893*** | -1.2893*** |
| | | (0.3027) | (0.3027) | (0.4633) | (0.4633) | (0.3668) | (0.3668) |
| Aggregate | Micro-level | -0.6055*** | -0.6055*** | -1.5244 | | 0.0463 | |
| | | (0.1931) | (0.1931) | (1.1998) | | (0.3471) | |
| 1991/95 | 1996/00 | -0.4571*** | -0.4571*** | 0.4209 | 0.4209 | -0.5952** | -0.5952** |
| | | (0.0960) | (0.0960) | (0.5383) | (0.5383) | (0.2736) | (0.2736) |
| | 2001/05 | -0.7022*** | -0.7022*** | 0.2326 | 0.2326 | -0.8123*** | -0.8123*** |
| | | (0.1138) | (0.1138) | (0.5431) | (0.5431) | (0.1877) | (0.1877) |
| | 2006/15 | -0.0849 | -0.0849 | 0.4313 | 0.4313 | -0.3178 | -0.3178 |
| | | (0.1678) | (0.1678) | (0.5253) | (0.5253) | (0.2867) | (0.2867) |
| | Pre-1990 | 0.0114 | 0.0114 | | 1.5244 | | |
| | | (0.2215) | (0.2215) | | (1.1998) | | |
| Both | Rural | -0.0437 | -0.0437 | -0.1493 | -0.1493 | -0.1641 | -0.1641 |
| | | (0.1285) | (0.1285) | (0.2028) | (0.2028) | (0.1944) | (0.1944) |
| | Urban | -0.4632*** | -0.4632*** | -0.5416** | -0.5416** | -0.5628** | -0.5628*** |
| | | (0.1620) | (0.1620) | (0.2230) | (0.2230) | (0.2143) | (0.2143) |
| Income proxy: expenditure | Income | -0.0347 | -0.0347 | 0.1122 | 0.1122 | 0.0270 | 0.0270 |
| | | (0.2016) | (0.2016) | (0.3034) | (0.3034) | (0.2704) | (0.2704) |
| Consumption expenditure | Quantity | 0.5435*** | 0.5435*** | 1.0547*** | 1.0547*** | 0.7762*** | 0.7762*** |
| | | (0.1500) | (0.1500) | (0.3034) | (0.3034) | (0.1830) | (0.1830) |
| Single eqn. | Demand system | 0.0361 | 0.0361 | 0.3278 | 0.3278 | 0.2014 | 0.2014 |
| | | (0.1940) | (0.1940) | (0.2298) | (0.2298) | (0.1629) | (0.1629) |
| IV | FD/FE/GMM | 0.9898*** | 0.9898*** | | | | 0.0463 |
| | | (0.3435) | (0.3435) | | | | (0.3471) |
| | LS/ML | 0.8748*** | 0.8748*** | 1.5616 | 1.5616 | 0.1040 | 0.1503 |
| | | (0.2359) | (0.2359) | (0.9695) | (0.9695) | (0.3375) | (0.3371) |
| | Log of GDP per capita | | | -0.0374 | -0.0374 | -0.0231 | -0.0231 |
| | | | | (0.1038) | (0.1038) | (0.0996) | (0.0996) |
| | Urbanisation | | | 0.0401* | 0.0401** | -0.0016 | -0.0016 |
| | | | | (0.0201) | (0.0201) | (0.0193) | (0.0193) |
| Southern Africa | East Africa | | | 1.4508* | 1.4508* | | |
| | | | | (0.8045) | (0.8045) | | |
| | West Africa | | | -0.2138 | -0.2138 | | |
| | | | | (0.3306) | (0.3306) | | |
| | Sahelian | | | | | -0.4434 | -0.4434 |
| | | | | | | (0.5139) | (0.5139) |
| | Landlocked | | | | | -0.3939 | -0.3939 |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| | | | | | | (0.6092) | (0.6092) |
| | Constant | 0.9932** | 0.9932*** | -0.8287 | -2.3530 | 1.4458** | 1.4458** |
| | | (0.3773) | (0.3773) | (1.2404) | (2.1639) | (0.6461) | (0.6461) |
| Number of observations | | 675.0000 | 675.0000 | 661.0000 | 661.0000 | 661.0000 | 661.0000 |
| Number of studies | | | 28.0000 | | 25.0000 | | 25.0000 |
| Number countries | | 7 | 7 | 7 | 7 | 7 | 7 |
| Breusch-Pagan LM test | | | 0 (1.000) | | 0 (1.000) | | 0 (1.000) |
| $R^2$-overall | | 0.3783 | 0.3783 | 0.3769 | 0.3769 | 0.3883 | 0.3883 |
| $R^2$-between | | | 0.5364 | | 0.7417 | | 0.7706 |
| $R^2$-within | | | 0.1655 | | 0.1642 | | 0.1668 |
| sigma_u | | | 0.0000 | | 0.0000 | | 0.0000 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; *** - level of significance at 1%.

## 5.2 Additional control variables

Finally, we have also experimented with the introduction of a number of additional control variables. We have tested the inclusion of a country-level (external) variable on the proportion of the population employed in agriculture, taken from the World Development Indicators dataset (World Bank WDI, 2015). Greater urbanisation nurtures rural-urban drift, a phenomenon that fosters the internal migration of people from rural locations to urban locations. These people would have been otherwise engaged in agriculture or related activities in rural economies. Greater urbanisation therefore reduces the proportion of a country's population in agriculture. This also allows capturing, even if only partially, differences in the share of self-produced at home-cooked meals for people in agricultural production vs. purchased foods.

We also constructed a variable to capture the fact that certain types of foods are very common in one region or country, while being rather 'exotic' in other places. For example, rice is the basic staple in several West-African countries, while maize is much more common in East Africa. If rice is considered to be relatively more 'luxurious' in East-Africa, we expect a very different income elasticity there compared to West Africa. More common foods are likely to be foods that are traditionally produced in the country. In order to capture which types of food can be considered as 'basic' we have considered the extent to which a country's diet is dominated by certain types of foods. To capture this we use data for the share of a certain food in total food consumption based on the FAO food balances for African countries. These balances are either based on FAO approximations or data provided by national governments. The unit of measurement for the balances is in quantities (tonnes) of foods consumed, not in monetary value. We have reclassified the food groups in FAO to make them compatible with the food groups used in the meta-sample. Yet, multicollinearity and missing values, especially for the variable on agricultural employment, were very problematic and these variables were therefore not included in the final regressions. Further research testing alternative proxies to capture these variables could provides insights on the role of these variables in explaining the income-food demand relation.

## 6. Conclusion

The aim of this report was to identify the factors underlying differences in estimates of food income elasticities within and between developing countries in Africa and, in doing so, to provide greater understanding of the relationship between income level and the demand of different types of food and nutrients in the region. This will help in understanding how demand for food, and more specifically for different types of food and nutrients, can be expected to evolve in the future and understanding what policies can be used in the fight against malnutrition.

A meta-sample has been constructed including both attributes of the primary studies and external country-level factors thought to influence the income elasticities. Based on this meta-sample, meta-regression analyses have been conducted for food-income elasticities (for all foods and separate types of foods), nutrients, and calorie-income elasticities. The study contributes to previous meta-analyses of food/calorie demand by focusing entirely on African countries.

A major contribution of the study is associated with the creation of a database of primary studies, the meta-sample, that can be used (and improved) by other researchers. The meta-sample contains 2,101 elasticity estimates drawn from 66 studies. This study improves upon existing review studies in a number of ways. First of all, our meta-sample focuses specifically on Africa. Forty-eight out of 54 African countries are represented in the sample. Second, besides demand for calories, we include elasticity estimates for a whole list of food categories and nutrient types. One of the innovative features of the study is the inclusion of several "external" variables thought to potentially explain the heterogeneity across estimated income elasticities. In line with other studies we therefore include the income level, but we also include the country's urbanisation rate and three geographical identifiers. We also control for the potential methodological sources of heterogeneity in estimates. Unfortunately, it has not been possible to develop comprehensive tests for the presence of publication bias due to insufficient data for the standard errors of the income elasticities included in the meta-sample. However, we do explore differences in the income elasticities between studies according to journal quality.

As expected, the descriptive results indicate that food demand is more responsive to changes in income (income elasticities are higher) for beverages, meat, fish and eggs and dairy, compared to foods that tend to constitute basic diets (e.g. cereals, legumes and nuts, fruit and vegetables, and fats and oils, tubers). Also, the relative magnitude of the different nutrient elasticities was as expected with higher values for proteins.

Although not all results are fully consistent or significant across the whole set of meta-regressions, a number of general conclusions can be derived and are in line with our expectations. There is no strong evidence of major methodological and data-related differences across studies although some tendencies can be identified. In line with the earlier literature (Bouis and Haddad, 1992), the use of cross-sectional data tends to result in higher elasticities. The use of household expenditures as a proxy for income generally results in lower income elasticities, which corresponds to the findings by Ogundari and Abdulai (2013) and Zhou and Yu (2015) and may relate to the fact that total expenditure is considered a more reliable proxy than reported income (Deaton, 1997). The use of a demand system tends to provide higher income elasticities than single equation estimates, which confirms the findings of Behrman and Deolalikar (1987) and Zhou and Yu (2015).

External factors relating to country income level, time period of primary data, degree of country urbanisation, and country sub-region have been found to explain heterogeneity in many of the food-income elasticities. The evolution of the income elasticities with the level of income provides some interesting results. For calorie demand and food demand in general, we find that in countries with a higher income level, elasticities are lower. For nutrient demand, we find instead that elasticities are higher in richer countries. This could potentially indicate that as countries grow richer, households tend to spend more on food with a more nutritious value. Further analysis would be needed to investigate this in more detail. Regarding the time period of the study, it is difficult to draw general conclusions. With respect to the urbanization level, elasticities tend to be lower in urban areas or in countries with a larger share of urban population. In terms of geographical heterogeneity, elasticities tend to be consistently higher in North African countries, which is somewhat counter-intuitive given the higher income level in those countries, after controlling for other expected sources of variability in the income elasticities. The considerable regional differences in food-income elasticities across African sub-regions suggests that the impact of food and nutrition policy in Africa is likely to differ by region. Further research could usefully explore in greater detail some of the patterns identified and, in doing so, contribute to the design of policies aimed at addressing malnutrition.

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# Appendix

## A.1. List of studies included in the meta-sample

| No | Study | Year | Title | New study | Type |
|---|---|---|---|---|---|
| 1 | Abdulai and Aubert* | 2002 | Does Income Really Matter? Nonparametric and Parametric Estimates of the Demand for Calories in Tanzania | Yes | WP |
| 2 | Abdulai and Aubert | 2004 | A Cross-Section Analysis of Household Demand for Food and Nutrients in Tanzania | No | J |
| 3 | Abdulai and Aubert | 2004 | Nonparametric and parametric analysis of calorie consumption in Tanzania | No | J |
| 4 | Ackah and Appleton | 2007 | Food price changes and consumer welfare in Ghana in the 1990s | Yes | WP |
| 5 | Agbola | 2003 | Estimation of Food Demand Patterns in South Africa Based on a Survey of Households | Yes | J |
| 6 | Akinleye | 2007 | Nutritional Implications of Food Demand in Rural Nigeria | Yes | J |
| 7 | Akinleye | 2009 | Food Demand in Northern Nigeria: Implications for Food Policy | Yes | J |
| 8 | Akinleye and Rahji | 2006 | Nutritional implications of the demand for food in Nigeria | Yes | J |
| 9 | Akinleyea and Rahji | 2007 | Nutrient elasticities among Nigerian households differentiated by income | Yes | J |
| 10 | Alboghdady and Alashry | 2010 | The demand for meat in Egypt: An almost ideal estimation | Yes | J |
| 11 | Alderman and del Ninno | 1999 | Poverty Issues for Zero Rating VAT in South Africa | Yes | J |
| 12 | Amao, Oluwatayo and Osuntope | 2006 | Economics of Fish Demands in Lagos State, Nigeria | Yes | J |
| 13 | Aromolaran | 2010 | Does increase in women's income relative to men's income increase food calorie intake in poor households? Evidence from Nigeria | Yes | J |
| 14 | Aromolaran | 2004 | Household income, women's income share and food calorie intake in South Western Nigeria | No | J |
| 15 | Aromolaran | 2004 | Intra-Household Redistribution of Income and Calorie Consumption in South-western Nigeria | No | WP |
| 16 | Ayalew | 2000 | Liquidity constraint and the demand for food: income elasticity of caloric consumption in rural Ethiopia | No | WP |
| 17 | Babatunde | 2008 | Empirical Analysis of the Impact of Income on Dietary Calorie Intake in Nigeria | No | J |
| 18 | Babatunde, Adejobi, and Fakayode | 2010 | Income and calorie intake among farming households in rural Nigeria: results of parametric and nonparametric analysis | No | J |
| 19 | Balarabe, Ahmed and Chikwendu | 2006 | Analyses of price and income elasticities for cereals food crops in an Urban Town of Kaduna, Nigeria | Yes | J |
| 20 | Bocoum and Dury | 2009 | Non parametric and parametric analysis of Engel function for calorie, dietary diversity and food shares in the calories, in rural and urban Mali | No | WP |
| 21 | Bopape and Myers | 2007 | Analysis of Household Demand for Food in South Africa: Model Selection, Expenditure Endogeneity, and the Influence of Socio-Demographic Effects | Yes | WP |
| 22 | Bouis, Haddad, Kennedy | 1992 | Does it matter how we survey demand for food?: Evidence from Kenya and the Philippines | No | J |
| 23 | Conte, Anna | 2006 | A Food Demand Analysis For Egypt | Yes | J |
| 24 | Dalhatu and Ala | 2010 | Analysis of Fish Demand in Sokoto Metropolis, Sokoto, Nigeria | Yes | J |
| 25 | Dawoud | 2005 | An analysis of food consumption patterns in Egypt | Yes | WP |
| 26 | Dawson | 1997 | The demand for calories in developing countries | Yes | J |
| 27 | Ecker and Qaim | 2011 | Analyzing Nutritional Impacts of Policies: An Empirical Study for Malawi | No | J |
| 28 | Ecker, Weinberger and Qaim | 2010 | Patterns and determinants of dietary micronutrient deficiencies in rural areas of East Africa | No | J |
| 29 | Fashogbon and Oni | 2013 | Heterogeneity in Rural Household Food Demand and Its Determinants in Ondo State, Nigeria: An Application of Quadratic Almost Ideal Demand System | Yes | J |
| 30 | Gbakou and Sousa-Poza | 2011 | Engel Curves, Spatial Variation in Prices and Demand for Commodities in Côte D'Ivoire | Yes | WP |

| No | Study | Year | Title | New study | Type |
|---|---|---|---|---|---|
| 31 | Greer and Thorbecke | 1986 | A methodology for measuring food poverty applied to Kenya | No | J |
| 32 | Hancock, Nieuwoudt and Lyne | 1984 | Demand analysis of meats in South Africa | Yes | J |
| 33 | Hendriks and Lyne | 2003 | Expenditure patterns and elasticities of rural households sampled in two communal areas of KwaZulu-Natal | Yes | J |
| 34 | Honfoga and van den Boom | 2003 | Food-consumption patterns in Central West Africa, 1961 to 2000, and challenges to combating malnutrition | Yes | J |
| 35 | Kennedy | 1989 | The effects of sugarcane production on food security, health and nutrition in Kenya: A longitudinal analysis | No | IO |
| 36 | Kennedy and Cogill | 1987 | Income and nutritional effects of the commercialization of agriculture in southwestern Kenya | No | IO |
| 37 | Kennedy and Payongayong | 1992 | Inventory of food and nutrition monitoring systems/ Patterns of Macronutrient and micronutrient and implications of monitoring and evaluation | No | IO |
| 38 | Knudsen and Scandizzo | 1982 | The Demand for Calories in Developing Countries | No | J |
| 39 | Maxwell, Levin, Armar-Klemesu, Ruel, Morris and Ahiadeke | 2000 | Urban livelihoods and food and nutrition security in greater Accra, Ghana | Yes | IO |
| 40 | Mckenzie and Nieuwoudt | 1985 | Estimation of demand and supply functions for fresh and industrial milk in South Africa | Yes | J |
| 41 | Muhammad, Seale, Meade, Regmi | 2011 | International evidence on food consumption patterns: an update using 2005 International Comparison Program Data | Yes | IO |
| 42 | Obayelu, Okoruwa, Ajani | 2009 | Cross-sectional analysis of food demand in the North Central, Nigeria: The quadratic almost ideal demand system (QUAIDS) approach | Yes | J |
| 43 | Ogundari | 2014 | Convergence in nutrient intakes and examination of nutrition-income elasticities in sub Saharan Africa: Implications on Health and welfare | Yes | WP |
| 44 | Ogunniyi, Ajao and Oladejo | 2012 | Food consumption pattern in Ogbomoso Metropolis of Oyo state, Nigeria | Yes | J |
| 45 | Ohajianya | 2005 | Econometric analysis of aggregate demand for meat in Imo state, Nigeria | Yes | J |
| 46 | Ojogho | 2010 | Determinants of Food Insecurity among Arable Farmers in Edo State, Nigeria | No | J |
| 47 | Ojogho and Alufohai | 2010 | Impact of price and total expenditure on food demand in South-Western Nigeria | Yes | J |
| 48 | Omojola, Effiong and Pepple | 2006 | Analysis of the demand for locally processed rice in Niger state, Nigeria | Yes | J |
| 49 | Omonon, Nkang, Ajao | 2009 | Household food demand analysis: a survey of semiurban and rural households in south-west Nigeria | Yes | J |
| 50 | Orewa and Iyanbe | 2010/2009 | Determinants of Daily Food Calorie Intake among Rural and Low-Income Urban Households in Nigeria | No | J |
| 51 | Phillip and Ashaolu | 2013 | Demand for non-alcoholic beverages among urban households in southwest, Nigeria | Yes | J |
| 52 | Sarris and Tinios | 1994 | Structural changes in Tanzanian poverty from 1976 to 1991: A comparison using survey data | Yes | WP |
| 53 | Seale, Regmi and Bernstein | 2003 | International evidence on food consumption patterns | Yes | IO |
| 54 | Strauss | 1984 | Joint determination of food consumption and production in rural Sierra Leone: Estimates of a household-firm model | No | J |
| 55 | Tiffin and Dawson | 2002 | The demand for calories: some further estimates from Zimbabwe | No | J |
| 56 | Titilola, Ajiboye, Sanusi | 2012 | Analysis of urban household demand for poultry products in Ogbomoso north and south local government area Oyo state, Nigeria | Yes | J |
| 57 | Ulimwengu and Ramadan | 2009 | How does food price increase affect Ugandan households?: An augmented multimarket approach | Yes | IO |
| 58 | Ulimwengu, Roberts and Randriamamonjy | 2012 | Resource-Rich Yet Malnourished: Analysis of the demand for food nutrients in the Democratic Republic of Congo | No | IO |
| 59 | Ulimwengu, Workneh and Paulos | 2009 | Impact of soaring food price in Ethiopia: Does location matter? | Yes | IO |
| 60 | Van Zyl | 1986 | A statistical analysis of the demand for maize in South | Yes | J |

| No | Study | Year | Title | New study | Type |
|---|---|---|---|---|---|
| | | | Africa | | |
| 61 | von Bach and van Zyl | 1994 | Human carbohydrate demand in South Africa | Yes | J |
| 62 | von Braun, de Haen, and Blanken | 1991 | Commercialization of agriculture under population pressure: Effects on production, consumption, and nutrition in Rwanda | No | IO |
| 63 | von Braun, Puetz, and Webb | 1989 | Irrigation technology and commercialization of rice in the Gambia: Effects on income and nutririon | No | IO |
| 64 | Weliwita, Nyange, and Tsujii | 2003 | Food demand patterns in Tanzania: A censored Regression Analysis of Microdata | Yes | J |
| 65 | Yusuf | 2012 | A System Analysis of the Demand for Animal Protein in Rural and Urban Nigeria: A Case Study of Ibadan Metropolis | Yes | J |
| 66 | Camara | 2013 | Seasonal price variability and the effective demand for nutrients: Evidence from cereals markets in Mali | Yes | J |

## A.2. List of studies identified but subsequently not included in the meta-sample

| No | Study | Year | Title | New study | Type | Reason |
|---|---|---|---|---|---|---|
| 1 | Anyiro, Ezeh, Osondu, Madu | 2013 | Meat Consumption Patterns among Different Income Groups in Imo State, Nigeria | Yes | J | Not found |
| 2 | Asumugha, Njoku, Okoye, Aniedu, Ogbonna, Nwosu | 2009 | Demand function and elasticities for seed yam in northern Nigeria | Yes | J | Not found |
| 3 | Dury, Medou,Foudjem Tita, Nolte | 2004 | Limites du système local d'approvisionnement alimentaire urbain en Afrique subsaharienne : le cas des féculents au Sud-Cameroun | Yes | J | Not found |
| 4 | Hayward-Butt and Ortmann | 1994 | Demand analysis of oranges in South Africa | Yes | J | Not found |
| 5 | Ismail and Lofti | 2007 | An Econometric Study on the Demand for Animal Products in Egypt | Yes | J | Not found |
| 6 | Muhammad-Lawal and Omotesho | 2013 | Analysis of food demand among rural households in Kwara State, North Central Nigeria | Yes | J | Not found |
| 7 | Nzeh, Eboh, Agwu, Nweze, Oji, Orebiyi, Lemch, Okpupara, Aura | 2009 | Comparative analysis of the demand for beef and mutton among households in enugu metropolis, Nigeria | Yes | J | Not found |
| 8 | Onwuka, Ekwe, Ekwe, Asumusha | 2010 | Comparative Analysis of Foreign and Local Rice Demand in Ikwuano and Umuahia North Local Government Areas of Abia State, Nigeria | Yes | J | Not found |
| 9 | Ragab et al. | 2008 | Demand for Fish in Egypt | Yes | J | Not found |
| 10 | Aidoo, Nurah, Fialor and Ohene-Yankyera | 2009 | Determinants of dairy consumption expenditure in urban communities of southern Ghana | Yes | J | Inappropriate dependent variable |
| 11 | Ortmann | 1982 | Demand analysis of vegetables and subtropical fruit in South Africa | Yes | J | Inappropriate dependent variable |
| 12 | Vosloo and Groenewald | 1969 | The demand for apples in South Africa—a statistical analysis | Yes | J | Inappropriate dependent variable |
| 13 | Bouis | 1994 | The effect of income on demand for food in poor countries:are our food consumption databases giving us reliable estimates? | No | J | No estimate |
| 14 | Effiong and Eze | 2010 | Food product prices and its implictaions for food security in Nigeria | No | J | No estimate |
| 15 | Higgins and Alderman | 1992 | Labor and women's nutrition : a study of energy expenditure, fertility, and nutritional status in Ghana | No | IO | No estimate |
| 16 | Ramadan and Thomas | 2011 | Evaluating the impact of reforming the food subsidy program in Egypt: A Mixed Demand approach | Yes | J | No estimate |
| 17 | Tafesse | 2005 | The Contributions of Agricultural Growth to Poverty Reduction in Ethiopia | Yes | J | No estimate |
| 18 | von Braun | 1991 | A policy agenda for famine prevention in Africa | No | IO | No estimate |
| 19 | Salois, Tiffin and Balcombe | 2012 | Impact of Income on Nutrient Intakes: Implications for Undernourishment and Obesity | Yes | J | Non-African |

| No | Study | Year | Title | New study | Type | Reason |
|---|---|---|---|---|---|---|
| 20 | Babatunde | 2008 | Income Inequality in Rural Nigeria: Evidence from Farming Households Survey Data | Yes | J | Different subject matter |
| 21 | Ojo, Salami and Mohammed | 2008 | Profitability, inputs elasticities and resource-use efficiency in small scale cowpea production in Niger state, Nigeria | Yes | J | Different subject matter |
| 22 | Onoja and Unaeze | 2008 | Socio-economic determinants of productivity and income of rice farmers in Udenu local government areas, Enugu state, Nigeria | Yes | J | Different subject matter |
| 23 | Tsue, Lawal, Ayuba | 2012 | Profit efficiency among catfish farmers in Benue state, Nigeria | Yes | J | Different subject matter |

## A.3. Results from the regression analyses by food type

**Table 31. Results from the meta-regression of income elasticities for beverages**

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | OLS | RE | OLS | RE | OLS | RE |
| Journal | Report | | 1.0348*** | | 1.0868*** | | 1.1053*** |
| | | | (0.2080) | | (0.2645) | | (0.2581) |
| | Working paper/conference | 0.9518*** | 0.9518*** | 0.9808*** | 0.9808*** | 0.9636*** | 0.9636*** |
| | | (0.2067) | (0.2067) | (0.2589) | (0.2589) | (0.2570) | (0.2570) |
| Cross-sectional | Panel | | -0.3356 | | 1.5294*** | | 1.5770*** |
| | | | (0.2090) | | (0.3624) | | (0.3585) |
| Aggregate | Micro | -1.0348*** | | -1.0868*** | | -1.1053*** | |
| | | (0.2080) | | (0.2645) | | (0.2581) | |
| 1991/95 | 1996/00 | | -0.1600*** | -0.1363*** | -0.1363*** | -0.1381*** | -0.1381*** |
| | | | (0.0000) | (0.0045) | (0.0045) | (0.0003) | (0.0003) |
| | 2001/05 | -0.0649*** | -0.0649*** | -0.0291 | -0.0291 | -0.0449** | -0.0449*** |
| | | (0.0115) | (0.0115) | (0.0197) | (0.0197) | (0.0168) | (0.0168) |
| | 2006/15 | 0.7458*** | 0.7458*** | 0.9960*** | 0.9960*** | 0.9531*** | 0.9531*** |
| | | (0.2067) | (0.2067) | (0.2593) | (0.2593) | (0.2577) | (0.2577) |
| Both | Rural | 0.8164** | 0.8164*** | 0.8860** | 0.8860*** | 0.8801** | 0.8801*** |
| | | (0.2779) | (0.2779) | (0.3410) | (0.3410) | (0.3372) | (0.3372) |
| | Urban | -0.3436* | -0.3436** | -0.2847 | -0.2847 | -0.2898 | -0.2898 |
| | | (0.1670) | (0.1670) | (0.2103) | (0.2103) | (0.2046) | (0.2046) |
| Income proxy: expenditure | Income | 0.8316*** | 0.8316*** | 1.1654*** | 1.1654*** | 1.2850*** | 1.2850*** |
| | | (0.1606) | (0.1606) | (0.2239) | (0.2239) | (0.2000) | (0.2000) |
| Consumption expenditure | Quantity | 0.8660*** | 0.8660*** | 0.4256 | 0.4256 | 0.4440* | 0.4440** |
| | | (0.1759) | (0.1759) | (0.2747) | (0.2747) | (0.2179) | (0.2179) |
| Single eqn. | Demand system | 0.3356 | | 0.0391 | 1.5685*** | -0.0813 | 1.4957*** |
| | | (0.2090) | | (0.2802) | (0.3530) | (0.2561) | (0.2682) |
| | LS/ML | | 0.3542* | | | | |
| | | | (0.2067) | | | | |
| | Log of GDP per capita | | | -0.2014*** | -0.2014*** | -0.1864*** | -0.1864*** |
| | | | | (0.0384) | (0.0384) | (0.0029) | (0.0029) |
| | Urbanisation | | | -0.0025 | -0.0025 | -0.0011 | -0.0011 |
| | | | | (0.0018) | (0.0018) | (0.0017) | (0.0017) |
| North Africa | Central Africa | | | 0.2113*** | 0.2113*** | | |
| | | | | (0.0272) | (0.0272) | | |
| | East Africa | | | 0.0620 | 0.0620 | | |
| | | | | (0.0938) | (0.0938) | | |
| | Southern Africa | | | 0.2429** | 0.2429*** | | |
| | | | | (0.0844) | (0.0844) | | |
| | West Africa | | | 0.0516 | 0.0516 | | |
| | | | | (0.0712) | (0.0712) | | |
| | Sahelian | | | | | -0.2193*** | -0.2193*** |

| Reference | Variable | Baseline model | | Extended model I | | Extended model II | |
|---|---|---|---|---|---|---|---|
| | | **OLS** | **RE** | **OLS** | **RE** | **OLS** | **RE** |
| | | | | | | (0.0623) | (0.0623) |
| | Landlocked | | | | | 0.2178** | 0.2178*** |
| | | | | | | (0.0679) | (0.0679) |
| | Constant | 1.0533*** | | 2.6162*** | | 2.6823*** | |
| | | (0.2076) | | (0.2712) | | (0.2877) | |
| Number of observations | | 92.0000 | 92.0000 | 92.0000 | 92.0000 | 92.0000 | 92.0000 |
| Number of studies | | | 9.0000 | | 9.0000 | | 9.0000 |
| Number of countries | | 45 | 45 | 45 | 45 | 45 | 45 |
| $R^2$ | | 0.3146 | | 0.5449 | | 0.5635 | |
| $R^2$ - overall | | | 0.3146 | | 0.5449 | | 0.5635 |
| $R^2$ - between | | | 0.9697 | | 0.9520 | | 0.9537 |
| $R^2$ - within | | | 0.1847 | | 0.4634 | | 0.4854 |
| sigma_u | | | 0.0000 | | 0.0000 | | 0.0000 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; ***- level of significance at 1%.

**Table 32. Results from the meta-regression of income elasticities for fats and oils**

| Reference | Variable | Baseline model OLS | Baseline model RE | Extended model I OLS | Extended model I RE | Extended model II OLS | Extended model II RE |
|---|---|---|---|---|---|---|---|
| Journal | Report | -0.0955 | 0.5047*** | -0.0662 | -0.0662 | -0.1119 | -0.1119 |
| | | (0.4181) | (0.1489) | (0.4191) | (0.4191) | (0.4026) | (0.4026) |
| | Working paper/conference | 0.5727* | 0.5964*** | 0.6441* | 0.6441** | 0.4516 | 0.4516* |
| | | (0.2810) | (0.1215) | (0.3159) | (0.3159) | (0.2673) | (0.2673) |
| Aggregate | Micro | -0.0070 | 0.2367 | -0.1293 | -0.1293 | -0.0920 | -0.0920 |
| | | (0.3282) | (0.1780) | (0.3418) | (0.3418) | (0.3411) | (0.3411) |
| 1991/95 | 1996/00 | -0.3435 | -0.8279*** | -0.4279 | -0.4279 | -0.2928 | -0.2928 |
| | | (0.2985) | (0.1069) | (0.2882) | (0.2882) | (0.2472) | (0.2472) |
| | 2001/05 | -0.2353 | -0.4538*** | -0.3349 | -0.3349 | -0.1891 | -0.1891 |
| | | (0.2637) | (0.0988) | (0.2576) | (0.2576) | (0.2208) | (0.2208) |
| | 2006/15 | -0.5687* | -0.4361 | -0.4902 | -0.4902 | -0.4424 | -0.4424 |
| | | (0.2960) | (0.3437) | (0.3087) | (0.3087) | (0.3068) | (0.3068) |
| Both | Rural | 0.5756 | 0.1832 | 0.5804 | 0.5804* | 0.5817 | 0.5817* |
| | | (0.3257) | (0.1233) | (0.3393) | (0.3393) | (0.3366) | (0.3366) |
| | Urban | 0.3519 | -0.0193 | 0.3564 | 0.3564 | 0.3576 | 0.3576 |
| | | (0.3365) | (0.1246) | (0.3504) | (0.3504) | (0.3476) | (0.3476) |
| Income proxy: expenditure | Income | -0.6808*** | -0.4263*** | -0.5419** | -0.5419** | -0.4515* | -0.4515** |
| | | (0.2178) | (0.0747) | (0.2290) | (0.2290) | (0.2293) | (0.2293) |
| Consumption expenditure | Quantity | -0.3682 | 0.2447 | -0.3019 | -0.3019 | -0.4015 | -0.4015 |
| | | (0.3934) | (0.1491) | (0.3971) | (0.3971) | (0.3854) | (0.3854) |
| Single eqn. | Demand system | | 1.2944*** | | 2.0576*** | | 2.0963*** |
| | | | (0.2938) | | (0.7003) | | (0.7080) |
| FD/FE/GMM | LS/ML | -0.7447* | -0.6162*** | -0.7849* | -0.7849** | -0.7733* | -0.7733** |
| | | (0.3613) | (0.1513) | (0.3693) | (0.3693) | (0.3634) | (0.3634) |
| | Log of GDP per capita | | | -0.0632*** | -0.0632*** | -0.0617*** | -0.0617*** |
| | | | | (0.0076) | (0.0076) | (0.0133) | (0.0133) |
| | Urbanisation | | | 0.0002 | 0.0002 | -0.0005 | -0.0005 |
| | | | | (0.0005) | (0.0005) | (0.0004) | (0.0004) |
| North Africa | Central Africa | | | 0.1707** | 0.1707*** | | |
| | | | | (0.0600) | (0.0600) | | |
| | East Africa | | | 0.1046* | 0.1046** | | |
| | | | | (0.0512) | (0.0512) | | |
| | Southern Africa | | | 0.1538* | 0.1538* | | |
| | | | | (0.0846) | (0.0846) | | |
| | West Africa | | | 0.1163* | 0.1163** | | |
| | | | | (0.0567) | (0.0567) | | |
| | Sahelian | | | | | -0.0888 | -0.0888 |
| | | | | | | (0.0604) | (0.0604) |
| | Landlocked | | | | | 0.0172 | 0.0172 |
| | | | | | | (0.0136) | (0.0136) |
| | Constant | 1.6666** | | 2.0576** | | 2.0963** | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.6778) | | (0.7003) | | (0.7080) | |
| Number of observations | 112 | 112 | 1120000 | 112.0000 | 112.0000 | 112.0000 |
| Number of studies | | 12.0000 | | 12.0000 | | 12.0000 |
| Number of countries | 47 | 47 | 47 | 47 | 47 | 47 |
| $R^2$ | 0.5719 | | 0.6639 | | 0.6465 | |
| $R^2$ - overall | | 0.3520 | | 0.6639 | | 0.6465 |
| $R^2$ - between | | 0.6857 | | 0.8258 | | 0.8045 |
| $R^2$ - within | | 0.1584 | | 0.2928 | | 0.2613 |
| sigma_u | | 0.2792 | | 0.0000 | | 0.0000 |

The estimates in parentheses are standard errors. * - level of significance at 10%; ** - level of significance at 5%; ***- level of significance at 1%.

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## JRC Mission

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