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The income-elasticity of calories, macro- and micro-nutrients: What is the literature telling us?

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ABSTRACT

Food security and nutrition have become central to the policy agendas of governmental and non-governmental organizations due to their consequences on health and economic development. Changes in consumption patterns in response to price and income changes could impact on nutrient intake with related positive or negative consequences. This article aims to systematically review the elasticity of calories, macronutrients and micronutrients to income in developing and developed countries. We consider a large set of estimates on income elasticity for calories, protein, fat, zinc, iron and vitamin A. This is one of the few reviews that examines the estimates for income elasticity of calories, micronutrients, and micronutrients on a comparative basis. Moreover, we investigate the determinants of the heterogeneity in estimates by means of a rigorous and popular approach of meta-analysis. We found a substantial publication bias, and, in particular, we found that the quality of data is very important as it is able to influence estimates.

1. Introduction

In recent times food security, malnutrition and related consequences on health and economic development have received global attention (e.g. Machlis, 2015; Santeramo, 2015a, 2015b; Wals, Brody, Dillon, & Stevenson, 2014). This attention has been highlighted by the Lancet's Series on Maternal and Child Nutrition 2008 and 2013. The 2008 series emphasized the need for adequate child and maternal nutrition to promote optimal child growth including cognitive development with possible long-term consequences on economic development for affected countries (Victora et al., 2008). By limiting cognitive development and physical capacity, micronutrient deficiencies can affect the quality of human capital and impact on poverty and economic development. The most effective interventions to address child and maternal malnutrition have been identified and include addressing micronutrient deficiencies, especially iron, zinc, vitamin A and iodine, as well as addressing nutrition sensitive agriculture (Bhutta et al., 2008; Ruel & Alderman, 2013). Nutrition-sensitive agriculture is important because of its role in making nutritious food available to households for adequate nutrition and food security. However, not all the foods consumed by households are produced by households, even where subsistence farming is the norm. Economic access to food through food markets is, therefore, an important aspect in meeting adequate nutrition (FAO, IFAD and WFP, 2013) but this, in turn, is affected by food price dynamics. A systematic review with meta-regression that included 136 studies conducted in both developed and developing countries demonstrated that food consumption in poor countries was more sensitive to price changes than in developed countries (Green et al., 2013). This is because people in developing countries ordinarily spend a much higher proportion of the household income on food. Diets in developing countries are largely starch based in terms of calories, although many of them derive their protein form plant based sources. People in developing countries would, therefore, be expected to be most vulnerable to changes in related nutrient intakes in response to increased food prices as they substitute more expensive foods like animal source foods with cheaper less nutrient dense staples. The resulting reduction in dietary diversity could impact negatively on nutrient adequacy, especially with respect to micronutrients intake. Ruel (2003) conducted a review of studies that used dietary diversity methodologies as an indicator of diet quality and found that, regardless of the approach used, dietary diversity was positively associated to nutrient adequacy even in poor developing countries.

Although the most severely food insecure people will most definitely be underweight and starving, overweight and obesity may also be caused by food insecurity: research has shown associations between low socioeconomic status and prevalence of overweight and obesity (Martin-Fernandez, Caillavet, & Lhuissier, 2014). There is evidence that by means of economic development, developing countries

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experience changes in food consumption patterns (Vorster, Kruger, & Margetts, 2011) and that the resulting nutrition transition is driven by better economic access to different foods at household level. Some of the changes that take place are positive, e.g. the increasing consumption of animal source protein leading to higher micronutrient intakes like iron, zinc and vitamin A. On the contrary, other changes in dietary patterns are detrimental to health outcomes. Examples include increased calorie consumption from saturated fat and simple sugars, both associated with increased risk of overweight, obesity and other non-communicable diseases (NCDs) (Vorster et al., 2011). A recent review of studies conducted in several Sub-Saharan African Countries has shown an increase in terms of overweight individuals in the population of the Countries under consideration (Steyn and Mchiza, 2014). Micronutrient deficiencies place a significant burden on the national health costs of developing countries making policy intervention an important consideration to mitigate effects of food price volatilities especially in vulnerable countries.

Briggs et al. (2013) conducted a modelling study that explored the effect of a 10% tax on sugar sweetened beverages on obesity in Ireland. The authors reported finding a small but meaningful effect especially for adults aged 24–34. Although the effect identified by this study was small, the fact that the model only included sugar sweetened beverages should be taken into consideration. Other high sugar containing foods like confectionaries, as well as high fat food items, are also important determinants of obesity. Another study by Claro, Levy, Popkin, and Monteiro (2012) found that a tax on sugar-sweetened beverages in Brazil reduced consumption especially for the poor. In the US, food and nutrient price elasticity has been reported to have the potential to influence nutrient intake through substitution of foods, as families adjust eating patterns to cope (Miao, Beghin, & Jensen, 2013). Similar effects have been reported in Africa (Abdulai & Aubert, 2004a; Akinleye & Rahji, 2007) and Asia (Skoufias, Tiwari, & Zaman, 2012). Deaton and Drèze (2010) reported that calorie intake in India has declined over time, thus keeping prices steady, probably due to continuous improvements in health conditions over time. Changes in consumption patterns due to price changes could impact on nutrient intake and bring about positive or negative consequences. It is not yet clear to what extent such price changes would affect specific nutrient intakes in developing countries. Furthermore, the important role of micronutrients like iron, zinc and vitamin A, protein and energy on health warrant a closer look at the effect of price elasticity on their intakes.

The debate regarding calorie-income relationship is well documented in literature (*cfr*. Zhou & Yu, 2014 for a recent review), whereas there is limited research on the relationship between income and key macro- and micro-nutrients. Several authors such as Bouis and Haddad (1992), Grimard (1996), Subramanian and Deaton (1996), Gibson and Rozelle (2002), Aromolaran (2004a, 2004b), and Abdulai and Aubert (2004a, 2004b) reported the strong relationship between level of per capita expenditure and calorie consumption. On the contrary, Behrman and Wolfe (1984), Behrman and Deolalikar (1987), Bouis (1994), and Skoufias et al. (2012) argued that the relationship between household income and calorie intake is not significantly different from zero. These authors concluded that income subsidizing policies will have limited impact on nutritional policies. A further aspect that deserves to be mentioned is the curve of the relationship between income and nutrient consumption. According to Engel's Law as income increases, the proportion of income spent on food decreases. Moreover, Bennett's Law states that as income increases, households change the allocation of food budget, thus shifting from starchy staple foods that are inexpensive source of calories to more expensive foods such as fruits and animal products that are rich sources of nutrients. The changing behaviour in diet as function of income is likely to be captured by non-linear specification of household food commodities and nutrient demand functions (e.g. Abdulai & Aubert, 2004a; Ecker & Qaim, 2011).

The literature on income elasticity in relation to calories is extensive, while few studies present income-elasticities for nutrients. In both cases there is a large heterogeneity in estimates due to differences in research designs, or temporal and spatial dynamics. Indeed many factors tend to influence empirical estimates of income elasticity to nutrients intake: our article aims to systematically review the elasticity of calories, macronutrients and micronutrients to income. In particular we consider a large set of estimates on income elasticity for calories, protein, fat, zinc, iron and vitamin A. The analysis includes studies conducted in developed and developing countries. While previous studies have revised impacts of income on calories intake and on consumption of categories of food (e.g. Gandhi & Zhou, 2014; Ogundari & Abdulai, 2013), to the best of our knowledge this is the first review that examines the estimates for income elasticity of calories, micronutrients, and micronutrients on a comparative basis. Moreover we investigate the determinants of the heterogeneity in estimates by means of a rigorous and popular approach: meta-analysis. Moreover we test for biases in estimations induced by models, publication type, and data quality in order to provide suggestions on the reliability of estimates provided by official publications' estimates. The information generated may have food pricing policy implications to mitigate possible consequences on nutrient intakes and related health consequences.

2. Dataset and preliminary analysis

The data employed in the present analysis include numerous studies and estimates on income elasticity. Papers have been collected through most relevant websites for the purposes of the present paper, i.e., Web of Science, Scopus, and Google Scholar. The latter allowed us to cover grey literature (working papers and discussion papers) in order to make sure that that publication bias and the effects of factors such as the journal prestige, and its impact factor can be correctly identified. The studies have been selected according to the presence of information on sample sizes, elasticity, and the associated standard errors or t-values. The inclusion criteria led us to select 26 studies in total (Table 1). However, the number of observations is larger since some studies include several estimates that differ for type of estimation, subpopulation, or nutrient of reference. Far from being comprehensive, our study includes more than 100 observations, resulting in a benchmark for future investigations.

In Table 2 we present a summary of descriptive statistics of our dataset. It shows that on average income elasticity ranges from 0.38 to 0.62, with an even lower median value (between 0.27 and 0.63). In other words, calories and nutrients tend to be income-inelastic.

The next paragraph is devoted to illustrate the methodological approach that we have followed to review the literature and to gain further insights.

3. Methodology

Meta-analysis is becoming increasingly popular in economics, and it has been applied to review decades of research on several topics: trade (Cipollina & Salvatici, 2010; Disdier & Head, 2008; Havránek, 2010; Li & Beghin, 2012), price elasticity of demand (Dalhuisen, Florax, de Groot, & Nijkamp, 2003; Espey, 1998; Gallet, 2010; Gallet & List, 2003; Knell & Stix, 2005), technical efficiency and factor productivity (Bravo-Ureta et al., 2007; Tian & Yu, 2012), income inequality and economic growth (De Dominicis, Florax, & De Groot, 2008; Doucouliagos, 2005), and food safety (Totton et al., 2012; Xavier, Gonzales-Barron, Paula, Estevinho, & Cadavez, 2014). Recently, attention has been also paid to calorie-income elasticity (Ogundari & Abdulai, 2013), a topic of great interest for its potential policy implications.

A preliminary outcome of the meta-analysis, and indeed a very important step itself, consists in identifying the existence of publication bias. Publication bias may be generated by several factors: preference by authors, reviewers, and editors for statistically significant results to