Food Policy 69 (2017) 58–67

Contents lists available at ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

On food security and the economic valuation of food

Jean-Paul Chavas [1]

Agricultural and Applied Economics at the University of Wisconsin, Madison, United States

ARTICLE INFO

Article history:
Received 19 October 2016
Received in revised form 15 February 2017
Accepted 13 March 2017

JEL code:
Q11
Q18
D12

Keywords:
Food security
Value of food
Benefit
Risk

ABSTRACT

The paper presents an economic evaluation of food and the cost of food insecurity. Building on behavioral regularities of consumer behavior, the analysis estimates the benefit of food at the individual level and at the world level. It finds an inverted-U relationship between food benefit and income. At the individual level, the "food benefit/income" ratio starts at 0 under extreme poverty, increases with income to reach a maximum of 4.4 when income per capita is around $13,000, and then declines slowly as income rises. The paper shows very large aggregate net benefit of food. The analysis also evaluates the cost of food insecurity. It shows that aversion to food insecurity is pervasive, the coefficient of relative risk aversion to food insecurity being around 2.7. The analysis evaluates empirically the cost of food insecurity. We report the cost of food insecurity under alternative scenarios, documenting that it can be large in situations of exposure to significant downside risk.

1. Introduction

Food consumption is required to support human life. Any situation where individual food consumption fails to sustain a healthy diet raises concerns about food insecurity (Webb et al., 2006; Leathers and Foster, 2009; Barrett, 2010; IFPRI, 2014). FAO (1996) defines food security as situations where "all people at all times have the physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Thus, under food security, no individual faces hunger or starvation. Alternatively, food insecurity arises when some individuals face limited or uncertain access to nutritionally adequate and safe food. Situations of undernutrition are pervasive. FAO (2015) reported that 795 million people were chronically undernourished in the years 2014–2016, representing 10.9% of the world population. Most live in developing countries. This is important since food security is an important component of the process of economic development (e.g., Fogel, 2004). Over the last few decades, improvements in food security have come from increase in agricultural productivity as well as reduction in extreme poverty (Charles et al., 2010; FAO, 2015).

The importance of food provides strong arguments to motivate the analysis of food security issues (e.g., Newbery and Stiglitz, 1981; Barrett, 2010; FAO, 2015). Recent increases in food price volatility and adverse effects of climate change on the food system have raised renewed concerns (Gouel, 2013; Nelson, 2014). But assessing the economic value of food and of food security remains challenging (Webb et al., 2006; Cafiero, 2013). This is due in large part to the complexities of the world food system. Food production varies greatly over space and depends on food products, prices, technology and local agro-climatic conditions. Food consumption also varies across individuals/countries depending on tastes and preferences, prices and income distribution. And individual access to food is complex. In general, food insecurity varies over time and across space. It depends on food availability. Food insecurity develops in periods and locations where food scarcity occurs due to high food demand (e.g., from a rapid rise in population) and/or to food production shortfalls (e.g., from a drought). But food insecurity can also arise when food is plentiful. As argued by Sen (1981), food insecurity (or even famine) can occur when consumers are too poor to acquire a nutritionally adequate diet. In this case, food access is constrained by household purchasing power. Finally, the consumer value of food relates to its nutritional and health attributes that remain difficult to measure (Barrett, 2010). These complexities have made it difficult for economists and policy analysts to assess food security issues and to design and evaluate programs intended to reduce food insecurity (Webb et al., 2006). Thus, there is need for a refined exploration of the economics of food and its

[1] The author would like to thank two anonymous reviewers for useful comments on an earlier draft of the paper. This research was supported in part by a grant from the Graduate School, University of Wisconsin, Madison.

E-mail address: jchavas@wisc.edu

http://dx.doi.org/10.1016/j.foodpol.2017.03.008
0306-9192/

linkages with the empirical assessment of the value of food and of the welfare evaluation of food security.

The objective of this paper is to develop new insights into the economics and welfare of food and food security. For simplicity, our analysis focuses on the case where food is treated as an aggregate good.[2] The analysis starts with the microeconomics of food demand. It then examines the evaluation of consumer welfare at both the micro level and the aggregate level. The paper addresses two key questions. What is the value of food? And what is the cost of food insecurity? In the process of answering these questions, we provide new and useful information to economists and policy analysts interested in the food sector and in the evaluation of policies affecting food security.

The paper makes three contributions. First, it develops a conceptual framework to evaluate the economics and welfare of food. Our analysis relies on consumer's willingness-to-pay for food. We propose to measure the willingness-to-pay for food using a benefit function. As discussed in Luenberger (1992, 1995, 1996), the benefit function has two attractive properties: (1) it provides an evaluation of consumer willingness-to-pay; and (2) it can be easily aggregated (with aggregate benefit being the sum of individual benefits). This paper seems to be the first paper using the benefit function in the investigation of the value of food and food security. Applied to the consumer level, our approach stands on strong foundations of microeconomic theory. We develop linkages between Engel's law (expressing the relationship between food expenditure and household income) and food benefit (measuring the consumer's willingness-to-pay for food). And following Sen (1981), our analysis also captures how limited purchasing power can affect the consumer's willingness-to-pay for food. This allows us to obtain new relationships between income and food benefit. And applied at the aggregate level, our approach provides a basis to evaluate the economics and welfare of food and food policy for human society. Importantly, the analysis allows for consumer heterogeneity (especially heterogeneity in household income).

The second contribution is to use our conceptual framework to support an empirical evaluation of the value of food. The analysis starts at the micro level and then proceeds at the aggregate level where both supply factors and demand factors are discussed. On the demand side, we link demand elasticities with willingness-to-pay measures. Food being a necessity, the approach reflects that a minimum consumption of food is required to sustain individual life. It allows for situations where individual willingness-to-pay is constrained by ability-to-pay. Building on behavioral regularities of consumer behavior, the analysis estimates the benefit of food at the individual level and at the world level. It finds an inverted-U relationship between individual food benefit and income. On a per capita basis, the "food benefit/income" ratio starts at 0 under extreme poverty, increases with income to reach a maximum o of 4.4 when income per capita is around $13,000, and then declines slowly as income rises. Applied to the world level, the analysis also shows that the aggregate net benefit of food is very large.

The third contribution is to evaluate the cost of food insecurity. We define food insecurity as the risk associated with individual access to food.[3] In this context, we propose to measure the cost of food insecurity by the consumer willingness-to-pay to eliminate this risk. We establish linkages between the Hicksian price elasticity of food demand and the degree of aversion to food insecurity. The coefficient of relative risk aversion to food insecurity is found to be around 2.7, indicating that aversion to food insecurity is pervasive among households. The approach provides a basis to evaluate empirically the cost of food insecurity. We report estimates of the cost of food insecurity under alternative scenarios. The results show that the cost of food insecurity can be large in situations of exposure to significant downside risk. Applications at both the micro level and the aggregate level illustrate how the analysis can help economists and policy analysts assess food insecurity issues and evaluate food policy.

The paper is organized as follows. The analysis starts with a review of empirical regularities related to the demand and supply of food. This includes Engel's law and supply/demand elasticities of food. The consumer benefit of food is then evaluated at the individual level and at the world level. Next, we examine the measurement and valuation of food insecurity. Finally, concluding remarks are presented.

2. Literature review

Much research has been done on the supply and demand of food. Below, we review some key empirical regularities characterizing the economics of food. We start with the consumer side of the food system.

2.1. Food demand

The effects of prices and consumer income on food consumption have been studied extensively (e.g., Pinstrup-Andersen and Caicedo, 1978; Alderman, 1986; Deaton, 1992; Subramanian and Deaton, 1996; Huang and Lin, 2000; Seale et al., 2003; Gao, 2012). From consumer theory, these effects can be expressed in terms of the properties of Marshallian demands. The Marshallian demand for food $x^*(p,I)$ expresses utility-maximizing food consumption x^* as a function of food price p and consumer income I (Deaton and Muellbauer, 1980; Deaton, 1992). In this context, define food purchasing power by I/p, measuring the largest quantity of food that can be purchased with income I. The first empirical regularity relates to the effects of income on food consumption.

2.1.1. A1 (Engel's law): The food budget share $W = px^*(p,I)/I$ declines with consumer income I

This empirical regularity was first noted by the German statistician Ernst Engel in 1857. A1 is now commonly called "Engel's law" stating that poorer families tend to have a larger share of their budget spent on food. Engel's law is well documented and widely used in the evaluation of welfare and poverty (e.g., Chai and Moneta, 2010). It can be illustrated in cross-country analyses of food consumption patterns (e.g., Seale et al., 2003; Gao, 2012). As reported in Table 1, on average, the food budget share $W = px^*(p,I)/I$ goes from 0.526 in low income countries, to 0.347 in medium income countries, and to 0.170 in high income countries (Seale et al., 2003).

By definition, the income elasticity of food demand is $E_I = \partial \ln(x^*)/\partial \ln(I)$. Given $W = px^*(p,I)/I$, the income elasticity can be alternatively written as $E_I = 1 + \partial \ln(W)/\partial \ln(I)$. To the extent that $\partial \ln(W)/\partial \ln(I) < 0$ from A1, this suggests the following corollary.

2.1.2. A1′: The income elasticity of food demand E_I is between 0 and 1, and declines with consumer income I

The properties A1 and A1′ are associated with food being a necessity: human life cannot be sustained without food

[2] This simplification also means that this paper does not address issues related to heterogeneity among food products (e.g., cereals versus fruits versus vegetables) and/or among nutrients (e.g., macronutrients versus micronutrients). Extending our analysis to examine such issues is a good topic for further research.

[3] As such, our analysis is not about income insecurity or price uncertainty. While there are strong linkages between income, food and food prices (e.g., as analyzed by Turnovsky et al. (1980) and Newbery and Stiglitz (1981)), our investigation focuses on the benefit of food and its implications for the evaluation of food insecurity when consumer's access to food in uncertain. A brief discussion of the differences between our approach and the analysis of food price uncertainty is presented in section 4.