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Analysis

# Estimating the demand curve for sustainable use of pesticides from contingent-valuation data

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ABSTRACT

Stated-preference valuation techniques are often used to assess consumers' willingness-to-pay for food items produced in farming systems that adopt a sustainable use of pesticides (SUP). We propose an innovative valuation methodology in which dichotomous-choice contingent valuation is used to estimate the demand curve (price-quantity relationship) for such food items where price means price premium for the SUP output, quantity is the probability of choosing SUP and the conventional food product is kept available in the market at the current market price. This methodology can be used to evaluate market differentiation as a policy option to promote the SUP.

The methodology is tested with data from a sample of urban consumers of fruits and vegetables in Portugal. The estimated demand curve is used to define the price level maximizing the total premium revenue for the SUP sector as a whole. This optimal level of the price premium is €77.55 (or 163% of the value of the monthly basket of fruits and vegetables at current prices). Adopting the optimal price premium will decrease the number of consumers of SUP food by 54%. The reduction is even higher for low income consumers (80%) leaving them more exposed to the risks of pesticide use.

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## 1. Introduction

The negative effects of pesticide use are a major concern for food, environmental and agricultural policies. Therefore, the European Union has established rules for the sustainable use of pesticides (SUP), through integrated pest management (promotion of low pesticide-input management including non-chemical methods), to reduce pesticide impacts on human health and the environment (COM (2002) 349 final, 01.07.2002). Different policy tools can be used to promote a generalised adoption of SUP practices: regulation, economic incentives, either positive (agri-environment schemes) or negative (pesticide taxes), and market differentiation where higher-cost SUP food commands a price premium.

All these policy tools may have an impact on food prices. However, options for consumers are different: while with regulation (pesticide withdrawal) consumers have no choice but to buy safer and more expensive food, with other policy tools (for example market differentiation) consumers will have a choice between cheaper, but less safe food, and more expensive, but safer, food. Other tools (as agri-environment schemes) may deliver safer but not necessarily more expensive food with costs being incurred by general taxpayers.

Defining a strategy to promote the SUP requires that policy makers are able to assess consumers' response to price premiums or price raises for safer and environmentally friendlier food that would result from different policy options. As regards market differentiation, there is a need to estimate the demand curve for SUP food when conventional food is also available.

Many stated-preference[1] valuation studies have been carried out to assess consumers' preferences related to SUP food. Most of these studies pursue one of two well defined goals: (1) selecting an optimal level of health or environmental benefits; or (2) estimating the average consumer's willingness-to-pay (WTP) for a discrete improvement in health and environmental benefits to develop an aggregated benefit estimate for the overall consumer population. We first discuss the achievements and limitations of both approaches, and then propose a third new valuation approach to estimate the demand curve for SUP food when conventional food is also available to consumers. This is the valuation methodology used and tested in this article, with the

[1] The methods used in environmental valuation can be divided into revealed preference and stated-preference approaches. The revealed preference methods assume that observed behaviour is relevant for welfare analysis and is the basis for standard market and non-market valuation approaches such as the hedonic price and travel cost methods. In contrast, stated-preference elicits individual valuations that are assumed to be contingent upon the alternative goods that are offered in a 'hypothetical market' (Pearce, 2002). Stated preference methods include contingent valuation, choice experiments, contingent ranking, contingent rating, and conjoint analysis.

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demand curve being then used to estimate the impact of different price policies within the differentiated market approach for the promotion of SUP, namely the impact of higher prices for SUP food on the purchase of safer food by low-income consumers. This focus on low-income consumers is justified by a concern that potentially higher health risks might be faced by this group when market differentiation is used to promote the SUP, which is related to lower information levels about pesticide risks and lower affordability of differentiated food for these consumers (Laisney, 2013; Toma, 2014).

### 1.1. Uses of Stated-Preference Techniques to Assess Consumers' Preferences Related to SUP Food

A large number of stated-preference valuation studies have estimated WTP for food safety and health and environmental outcomes of SUP along the last three decades (Adams and Salois, 2010; Baskaran et al., 2010; Batte et al., 2007; Buzby et al., 1995; Combris et al., 2009; Cranfield and Magnusson, 2003; Hamilton et al., 2003; Kiruthika and Selvaraj, 2013; Mourato et al., 2000; Schou et al., 2006).

Among those studies, only a few tried to estimate WTP for marginal levels of pesticide risk reductions in order to select an optimal level of health or environmental benefits (Baskaran et al., 2010; Mourato et al., 2000; Mullen et al., 1997; Schou et al., 2006). The results of these studies indicate that it is difficult for survey respondents to process scenarios related to small, marginal changes in pesticide use and risks, and its complex effects, and thus to make rational choices in this context.

There are different reasons that explain such difficulty: the scientific uncertainty that surrounds the physical effects of particular changes, how these effects affect human well-being, how to translate these changes into terms and sentences that might be understood by respondents or how to achieve a correct description of small changes without amplifying them (Pearce et al., 2006; Wätzold et al., 2008).

Another strong limit to these approaches is that respondents usually lack the cognitive skills required to understand and value risk in a continuous scale or to make choices between different levels of the attribute. In addition, because peoples' preferences might be formed during the valuation process, based on the information provided, apparently inconsequential changes in the formulation of choice problems may cause significant preference shifts. This might lead to distorted estimates of environmental values (Johansson et al., 2012; Loewenstein et al., 2001; Pearce et al., 2006; Spash, 2002; Tversky and Kahneman, 1981; Wätzold et al., 2008). For example, if people are uninformed about the issues and have no previous preferences, the fact that there is a survey employing resources to value them gives a value sign leading to preference formation: “If they think that it's important, so should I” (Fischhoff, 2005, p. 950). Two examples from the valuation literature are Mourato et al. (2000) and Schou et al. (2006). Both valued the effects of different agricultural practices, including pesticide use, on biodiversity, specified as species richness, and on health, specified as cases of illness, and concluded that, when different levels of pesticides were included in the choice set, they led to higher WTP values. In these studies, the authors concluded that marginal risks of pesticide use were so low that respondents had difficulty in realizing the risk changes that were actually at stake.

Even if the valuation of marginal changes would be informative for selecting optimal risk levels, the empirical limitations of stated-preference valuation techniques suggest looking for alternative sounder ways for setting risk reduction targets.

Other stated-preference valuation studies were used to value the aggregated benefits of SUP, assuming discrete (as opposed to marginal) risk changes (Baskaran et al., 2010; Buzby et al., 1995; Takatsuka et al., 2005; Wätzold et al., 2008). Based on these studies, and if the payment vehicle is a tax, annual household donation or payment, it is possible to estimate the average WTP (per consumer or Kg) for that discrete change and to calculate the aggregated benefits of SUP adoption by multiplying the average WTP by the number of consumers or by the total consumption of a product (in Kg). Several studies have used this method to estimate a ceiling for the amount of financial resources that should be allocated to SUP promotion (Baskaran et al., 2010; Takatsuka et al., 2005).

However, if the payment vehicle is a price premium (additional payment above the base price of a product, or stated as a percentage of a monthly grocery bill or the value of a food basket), then multiplying it by the consumption of a product (in Kg or percentage of grocery bill) might raise validity issues because it assumes constant consumption irrespective of price (and quality) change. When the supply-side price increases with quality (because of cost consideration), the demand of the product (or the number of consumers choosing the product) will in general change, except for those consumers for whom the price increase is exactly equal to their marginal WTP for quality.

Buzby et al. (1995) and Mullen et al. (1997) used price premium as a payment vehicle to assess the WTP for SUP in different food products. Both studies obtained the aggregate benefit, multiplying the average WTP by the total produce (kg) or by the number of households, assuming that consumption is fixed even when prices rise due to the proposed premium. These authors pointed out that the WTP estimates should be interpreted with caution, as the aggregated WTP was estimated based on a single purchase/payment which is far from a realistic hypothetical scenario (for example if WTP was elicited based on a years' supply, it would likely have been lower).

To overcome these limitations, we develop and test in this article a methodology that deals, in an explicit way, with the price-quantity demand relationship. In the proposed approach, discrete-choice contingent-valuation data are analysed in an unconventional way that is: not to estimate consumers' WTP for a discrete gain in quality/safety (as usual), but to estimate the price-quantity relationship, where price means price premium for the SUP output, quantity is the probability of choosing the SUP output and the conventional food product is kept available in the market at the current price. This scenario simulates the case when market differentiation, and not regulation or agri-environment schemes, is the policy choice to promote the SUP. This model also enables us to estimate the impacts of alternative price premium levels within this policy approach.

For this purpose, we assume a discrete quality change, namely the health and environmental safety increase yielded by a shift from conventional to SUP standards, which, as was revealed by the literature review, is easier for respondents to understand and value than marginal risk changes.

This innovative methodology is used to define an optimal price policy for SUP food, that is: the price premium level maximizing the total premium revenue for the SUP sector as a whole. Given the low share of SUP food in the overall food expenditure, we assume that 100% of the food currently purchased is conventional. The impacts of that optimal price policy on low-income consumers are then assessed, to identify possible limitations of the market differentiation approach to promote the SUP.

The proposed analytical approach is developed and tested based on a specific contingent-valuation survey of a sample Portuguese urban consumers, which was aimed at modelling their choices for SUP as opposed to conventional output. In this case, fruits and vegetables from integrated pest management at different price-premium levels and conventional output at current market prices were the options proposed to consumer. Including a significant segment of low-income consumers in the sample allowed us to estimate the impact of different price policies on these consumers' choices.

## 2. Methodology

### 2.1. A Contingent Valuation Survey to Value the SUP — The Questionnaire

Economic valuation aims at eliciting public preferences for changes in the state of the environment and health benefits in monetary terms.

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