Resources, Conservation and Recycling 122 (2017) 202–209

Contents lists available at ScienceDirect

Resources, Conservation and Recycling

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

Full length article

Economic impact assessment of food waste reduction on European countries through social accounting matrices

P. Campoy-Muñoz [a,*,1], M.A. Cardenete [a,b,1], M.C. Delgado [a,1]

[a] Department of Economics, Universidad Loyola Andalucía, C/Energía Solar, 1, Building G, 41014, Seville, Spain
[b] School of Management and Business, Universidad Autónoma de Chile, Santiago, Chile

ARTICLE INFO

Article history:
Received 9 September 2016
Received in revised form 19 January 2017
Accepted 16 February 2017
Available online 17 March 2017

JEL Classification:
C67
D57
Q18

Keywords:
Linear CGE models
Social accounting matrix
Food waste

ABSTRACT

Food waste is becoming a major global issue, threatening sustainable food systems and generating negative externalities in environmental terms. To highlight the associated cost to society from an economic perspective, studies estimate the amount and monetary value of the wasted food by households and along the supply chain. In this paper, we adopt a different point of view by assessing the effects of food waste reduction on national economies in terms of total output, Gross Domestic Product (GDP) and employment. We use linear multiplier models based on social accounting matrices with a highly disaggregated agricultural account for the year 2007. The proposed methodology is applied to a sample of European countries with different economic structure, i.e., Spain, Germany and Poland. The results show that the most significant impacts are due to a reduction in the avoidable portion of the wasted food by households across the countries. However, the size of these impacts depends on the economic structure of the country in which reduction could be implemented, highlighting the need to tailor measures intended to reduce food waste.

Introduction

Approximately one-third of food produced for human consumption gets lost or wasted, a major global issue that threatens sustainable food systems and generates negative externalities in environmental terms. Although the patterns of food waste vary widely across the world, developed countries emerge as the largest food wasters, particularly at consumer levels. On a per capita basis, a study by Gustavsson et al. (2011) estimates the food waste in Europe and North America at 95–115 kg annually, sharply higher than estimates in Sub-Saharan Africa or South/Southeast Asia of 6–11 kg annually. Focusing on the European Union, this figure totals 76 kg per person per year, which represents approximately 45% of the total food waste in the entire supply chain, excluding agricultural production (Monier et al., 2010). In view of this situation, the European Commission has established the target of reducing food waste by one-half by 2020 throughout the European Union (EU). Accordingly, national campaigns against food waste have been launched and governments have supported research to obtain a deeper understanding of food waste within their borders (Monier et al., 2010; Viel and Prigent, 2011). As a result, the majority of economic reports and studies aim to estimate the amount of food wasted (Göbel et al., 2012; Hanssen and Møller, 2013), whereas fewer studies attempt to estimate the monetary value of food waste (Segrè and Falasconi, 2011; Williams et al., 2011) and, to a much lesser extent, to monetize its social and environmental costs (ARC, 2012; BCFN, 2012). In those cases, two approaches are primarily employed to monetize the economic impact of food waste, focusing on the production cost of the food wasted or on its market prices. Both methodologies could be extended to estimate the economic impact on the usefulness of the entire society, including an estimation of the society's willingness to pay the price that avoids negative externalities produced by food waste or the opportunity cost of the resources necessary for producing the food wasted. Thus, reducing food waste is intended as a benefit for supply chain members, households, and the entire society by translating this reduction into monetary saving.

However, calculating the economic impact of food waste reduction involves more than just a one-to-one translation in savings; instead, this calculation should take into account the interactions between actors and sectors in the food system and in the entire economy (Rutten, 2013). In this vein, the Computable General Equilibrium (CGE) framework becomes a powerful tool for assessing the economic impact of food waste reduction, encompassing

* Corresponding author.
E-mail addresses: mpcampoy@uloyola.es (P. Campoy-Muñoz), macardenete@uloyola.es (M.A. Cardenete), mcdelgado@uloyola.es (M.C. Delgado).
[1] All share equal responsibility for this manuscript.

http://dx.doi.org/10.1016/j.resconrec.2017.02.010
0921-3449/

Table 1
Structure of an AgroSAM: Spain – 2007. Millions of euros.

Receipts \Payments	Activities	Commodities	Labour	Capital	Government & ROW	Enterprises	Capital	WTRD &RTRD	Food services	Households	Total
Activities		1,529,634.2			6,751.6						**1,536,385.8**
Commodities	888,500.0				652,953.1		320,596.0	58,249.6	125,593.3	596,502.2	**2,642,394.3**
Labour	295,248.9				811.2			49,605.5	175,968.4		**521,633.9**
Capital	344,542.5							43,550.9	81,348.0		**469,441.4**
Government & ROW	8,094.2	577,723.8	1,447.5	20,222.9	946,392.2	263,959.9	3,132.4	275.8	603.1	322,126.9	**2,143,978.6**
Enterprises				224,095.7	182,501.3						**406,597.0**
Capital					86,835.7	142,637.1	320,596.1			94,255.6	**644,324.5**
WTRD &RTRD		151,681.8									**151,681.8**
Food services		383,354.7			158.1						**383,512.9**
Households			520,186.8	225,122.7	267,575.4						**1,012,885.0**
Total	**1,536,385.6**	**2,642,394.5**	**521,634.3**	**469,441.3**	**2,143,978.6**	**406,597.0**	**644,324.5**	**151,681.9**	**383,512.8**	**1,012,884.7**	**9,912,835.1**

Sources: Own elaboration based on Philippidis et al. (2014).

the demand and supply interactions, the intersectoral linkages, the substitution effects and the role of price mechanisms therein. Despite these advantages, few attempts have been made using non-linear CGE models. A partial CGE model is developed by Irfanoglu et al. (2014) to evaluate the impacts of reducing food loss and waste on social, environmental and trade dimensions without empirical results. A regionalized CGE model for Finland is performed by Britz et al. (2014), in which the economic impact of food waste is assessed by means of a trade-off between raw or processed food inputs and production factors at farm, food industry and household levels to inform policy design. Finally, a multi-region CGE model (called MAGNET) is employed by Rutten et al. (2013) to simulate the EU-2020 target of halving waste in food demanded at household and supply chain members across the European Union, offering a comparable set of economic indicators and their impact on third countries (Rutten et al., 2013). The MAGNET model has also been employed to assess the economic impact of reducing food loss along the different stages of the agriculture supply chain in Ghana (Rutten and Verma, 2014) and in the Middle East and North Africa (Rutten and Kavallari, 2013).

In the vein of the CGE framework, we employ a linear CGE model to address the economic impact of reducing avoidable food waste on a sample of EU countries with different economic structures (Spain, Poland and Germany), particularly their agri-food sectors. The impact analysis is addressed under five different scenarios to gain a better understanding of waste food reduction along the different levels of the supply chain and also at consumer levels. A multiplier model is developed using a social accounting matrix (SAM) with highly disaggregated agricultural and food industry accounts (AgroSAMs) for the corresponding country member. Each AgroSAM is based on a SAM, which depicts the complete set of relationships among agents in that economy, enlarged with much more detailed information about raw agricultural products and processed food commodities than the database employed in the aforementioned studies.

After this introduction, the AgroSAM database and the SAM-based multiplier models are described to gain a better understanding of the empirical application. Then, the results are presented in terms of gross domestic product (GDP), production and employment, considering both the entire economic setting and the disaggregation by agri-food accounts. The final section provides the main conclusions.

2. Materials and methods

2.1. Social accounting matrices and the AgroSAM database

SAMs are transparent and efficient devices that reflect the circular income flow of an economy over a period of time by means of a square flow matrix (Stone, 1962). In addition to the inter-industry transactions specific to input-output tables, SAMs include balanced accounts for factors, institutions such as producers, consumers, government and foreign sectors, and other auxiliary accounts, closing the cycle of the income distribution and spending. In this structure, each row and the corresponding column form an account, which summarizes all the information on the aforementioned economic agents. Rows show the sources of their income and columns indicate how these revenues are allocated as expenditures. All the values in the cells are monetary flows; thereby, each nonzero value of a cell reflects a transaction between accounts. Given that total income equals the total expenditures for every account, the information in a SAM can be interpreted, in some cases, through zero-benefit conditions, budget constraints, and market clearing equations. Thus, SAMs are crucial databases for quantitative models (e.g., SAM linear models and/or computable general equilibrium