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Master Degree Project in Economics

Food Waste in Retailing Stores in Sweden

A welfare simulation analysis

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Abstract

The purpose of this paper is to investigate the current food waste situation among food retailers in Sweden, to introduce the emerging practice of social entrepreneurship in attempts to utilize food waste from food retailers, and to simulate different social welfare scenarios with different alternatives . The analysis of food waste is based on the collection of food waste data from 9 ICA stores with different store size in Gothenburg from 2013 to 2014 period. Welfare models and simulations are conducted with interviews from participating ICA stores and commonly adopted proxies to project the most welfare-generating scenario for food retailers to manage food wastes. The simulation results show that using social enterprise to manage food wastes yields similar social welfare as giving away to NGOs directly. Governmental policy such as a corrective lump sum tax is not desirable according to the simulation, as there are no economic benefits of reputation gain from utilizing non-sold food; neither social benefits of reused food wastes among people in need. Findings suggest that while the social welfare is similar, social enterprise is more likely to reach various goals of reduction in food waste, and governmental regulation would be a more resource efficient option if it leads to prevention of food waste from the beginning. The paper addresses the emerging attention to food waste issue and social enterprise phenomenon using information collected from retailers and offers insight into food waste resolutions.

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1. Introduction

1.1. Food waste in the world

About 30 to 40 percent of the global food production is lost or wasted every year, leading to a 1.3 billion tons every year, according to the Food and Agriculture Organization of the United Nations (FAO). Of all this wasted food, rich countries waste about 220 million-tons (FAO 2011). However, on a per-capita basis, much more food by consumers are wasted in Europe and North America countries with estimated 95-115 kg per capita, compared to 6-11 kg per capita in Sub-Saharan Africa, South/South East Asia. Estimated by EU, over 100 million tons of food are wasted in 2014 inside the European Union every year (European Comssion 2015) Swedish Environmental Protection Agency's most recent research indicates that totaled food waste in Sweden was more than 1.2 million tons, equals to 127 kg per capita in 2012, which is much higher than the per capita number of Europe and North America (Swedish Envrionmetnal Protection Agency 2014). Supermarkets sector in Sweden contributed to 70,000 tons of food waste, of which 91% of them are unnecessary waste. The related wasted food production contributes to 3 percent of the total greenhouse gas emissions in Sweden (Swedish Envrionmetnal Protection Agency 2014)

The supply chain of the food system involves many sectors from supply of agricultural inputs, primary production, primary food processing, secondary food processing, and food distribution. Such a complex supply chain with the globalization of many agricultural products nowadays makes waste regulation and management extremely difficult. Furthermore, as food waste is not generally considered as the biggest culprit of environmental issues, there have not been many initiatives or attention to food waste until recently.

1.2. Environmental and social impact

Food production in general has significant impacts on environment in terms of climate, ecotoxicity, acidification, eutrophication and biodiversity. According to FAO, the

production of food generates 3.3 billion tons of greenhouse gases. And 50 percent of all eutrophication are related to food production (FAO 2011) When food is wasted resources used to produce them such as water, fertilizers, pesticides, seeds, energy, labor, and land are wasted too. Therefore even if the direct contribution of food waste to environment may not seem to be very large, utilizing the unnecessarily wasted food means that we as a society don't need to produce as much and that would lead to reduced negative environmental impacts from the food supply chain.

In medium, and high-income countries food waste is mainly at consumption stage where consumption suitable food is discarded due to quality and appearance standards (FAO 2011). Stated by the UK sustainable development commission, "As gatekeepers of the food system, supermarkets are in a powerful position to create a greener, healthier, fairer food system through their influence on supply chains, consumer behavior and their own operations" (Sustainable Development Commission 2008). Therefore if non-sold food from supermarkets were reutilized, it can potentially lead to a large proportion of food waste reduction in medium and high-income countries. Furthermore, the concept of "food insecurity" has been brought into attention in medium and high-income countries as obesity become one of the main health issues in developed world. "Food security" here refers to sustainable, and healthy food supply to people. Obesity has been related to low social-economic status in general such as low income, low education, and long unemployment as researches indicated across many countries (McGuire 2008). As potential food wastes utilized and a more sustainable food supply chain developed, it can help developed countries to resolve the imbalance between food waste and food insecurity issues.

On the other hand, food must be produced to meet the 9 billion world growing population. Estimation from FAO shows that over 1 billion of people were undernourished in the world (FAO 2011). However, the population with hunger could lifted out of malnutrition from less than a quarter of the food waste of United States, United kingdom and Europe in total, according to the Stuart Report in 2009 (Stuart 2009).

Finally, as our world has limited natural resources, how to use resources in the most efficient way is critical. A sustainable food system would be beneficial in economics, ecological, social and health aspects.

1.3. Definition of Social entrepreneurship, NGO, and private Companies

In this paper the new stakeholder "social enterprise/entrepreneurship or social innovation" is introduced and included in discussion of welfare comparison in utilizing food waste. As this concept is relative new in the world of economics and business, a brief comparison is discussed below.

The World Bank (2013) firstly uses the term NGO for any not-governmental-represented organization that aims to relive suffering in the world though improvements of education, health, integration, and poverty (The World Bank 2013). Nowadays NGOs are in the form of charity, for profit organization, not-for-profit organization, and can range from community, regional, national to international level.

Both NGO and private company create value. The fundamental difference between private company and an NGO is that private company create value with shareholders in mind, and the values are measured financially while NGOs create social wealth that is measured by the contribution to the society.

Social entrepreneurship lies between NGOs and private companies. In fact, Michael E. Porter and Mark R. Kramer introduced a new concept "Share Value" of the business world in Harvard Business Review that focuses on the connection between societal and economic progress. The new kind of enterprise as they mentioned, blurs the line between for-profit and not-for-profit organizations. They make profits to manage the enterprise, which are measured financially, but they also have numerous social contributions since most of their services are oriented around solving societal issues (Porter and Kramer 2011).

Allwin is such a social enterprise because they both aim at re-utilizing non-sold food from supermarkets to people in need of healthy food as NGO (food banks in the USA) as well as aim to function as a private company from charging service fees from supermarkets.

From the ideology perspective, social entrepreneurship like Allwin is closer to a for-profit NGO instead of a private company. Also, with the purpose of measuring the social welfare of the social entrepreneurship, measuring only financial performance will undermine a variety of contributions of social entrepreneurship to the society.

1.4. Possible contribution of this paper

As economics is about allocating resources in most efficient way, what is missing that creates the loss of resources? If the whole food supply chain became more efficient, it would reduce the imbalances between increase in consumption and production. In 2012 the European Parliament initiated the goal of reduce food waste by 50 percent by 2020. However, there is a major data gap in the knowledge of global food loss and especially in retailing industry. Food waste issues have been brought forward to attention in a few north American and European countries, but as lot of those reports suggested, there is no integrated system of food waste exist in regional, country, and world level (Göbel, et al. 2015). This paper aims to shed some light on the retailing waste system in Sweden, introducing the new stakeholder "social enterprise" into the discussion of the most welfare generating improving way to regulate the food waste market, and promote attention and further research in the related area.

2. Literature review

2.1 Cause of waste

In Sweden Swedish Agricultural University has conducted several researches in the supermarket food waste domain. Case studies based on 6 Willy stores in the Uppsala-Stockholm region has shown that waste is not part of intentional strategic act of those supermarkets but as a result of unpredictable consumer reactions in special period such as holiday season promotions and turnover rate of consumer goods (M. Eriksson 2012). Shelf-life (expire of best-before date), decreasing minimal order size (packaging size), and lower turnover is found connected to higher waste of food (Andersson et al. 2010). This connection is especially strong in organic food section (M. Eriksson 2012). Findings from Newsome and others, confirmed that the misunderstanding of date labeling in food leads to significant amount of unnecessary consumable food loss and waste in retailing stores in UK and US (Newsome, et al. 2014). Eriksson also points out that environmental policies that support the sales of organic products contribute to this systematic high percentage of waste in organic food in Sweden (M. Eriksson 2012).

Swedish Environmental Protection Agency's research from 2013 to 2015 shows that households' food waste contains the highest amount of food waste in Sweden, corresponding to 81 kg per capita. Industry, restaurant and supermarkets are the other main sources of food waste, with 18 kg, 15 kg, and 7 kg per person. However in terms of unnecessary food wastes, supermarkets have the highest percentage of 91%, followed by 62% from restaurant and 52% from catering facility (Swedish Envrionmetnal Protection Agency 2014).

2.2 Environmental and social impacts of food waste

FAO estimated the carbon footprint of the wasted food in 2007 is 3.3 billion metric tons of CO_2 equivalent and the estimated economic cost is 750 billion U.S. dollars (FAO 2011). Along the entire supply chain from input generation to distribution to final consumption greenhouse gas consisted of CO_2, CH_4 and N_2O are created. Even though

landfills have been reduced inside European Union, it remains the most common way of resolving food waste in the world and landfills furthermore release greenhouse gas (Sonesson, Davis and Ziegler 2010). Animal products usually have the higher negative environmental impacts however negative environmental impacts, associated with planting fruit and vegetables such as emissions from soils and use of fossil fuels etc. are also significant (Cederberg, et al. 2009).

Sweden Agriculture University (SLU) and Swedish institute for food and biotechnology are among the first institutes that have done research on food wastes from supermarkets in Sweden. Katharina Scholz (2013) from SLU conducted the carbon footprint of retail food waste based on six stores from Willys in the Uppsala-Stockholm region from 2010 to 2012 (Scholz 2013). The total waste of food was 1565 tons and the calculated average carbon footprint of food waste was 1.6 tons carbon dioxide per ton of waste (Scholz 2013). Among the wasted food, 85% of them are fruit and vegetables. However, the carbon footprint of fruit and vegetable is only 46% of the total carbon footprint among the waste, considering meat has much higher carbon footprint than fruit and vegetables (Scholz 2013). Wastes of meat therefore have the second highest share of total carbon footprint, with 29% total carbon footprint, even if the mass amount of waste is only 3.5% (Scholz 2013). Looking at food waste in terms of carbon footprint give us better picture on the potential environmental impact of food waste from retailer stores.

Annika Carlsson (2001) mentioned in her research a drastically increasing trend in vegetable consumption in Sweden due to the influences of other cultures (Carlsson-Kanyama 2001), which is in line with the findings in Scholz (Scholz 2013) that fruit and vegetable account for a large proportion of food waste because most of them cannot be stored for a long time and are imported or grown in greenhouses. For instance, the energy used for growing, storing, and transporting exotic vegetables like tomatoes is 15 times higher than root vegetable (Scholz 2013). This trend in vegetable consumption culture with the high share of vegetable wastes in the entire retailing waste make the loss of resources more significant.

Dowler and Connor (2012) have discussed the arising food poverty or food insecurity in industrialized countries. As defined with "the inability to consume an adequate quality or sufficient quantity of food in socially acceptable ways, or the uncertainty that one will be able to do so"(Dowler and O'Connor 2012), food poverty has been discussed to be the result of consumerism and trade revolution from logistics-led management since the 1960s (Sustainable Development Commission 2008).The concept of "sustainable diet" has been proposed by some organizations as "those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations" (FAO 2010).

Obesity has been one of the serious social issues in developed countries and there have been many studies all over the world that indicate the associated relationship between obesity and inferior social economics status such as lower income, long unemployment, and lower education (McGuire 2008). Unlike hunger problems in developing countries, the imbalance between over-consumption of calories and under-consumption of sustainable healthy diet calls for attention of a reform in food management in developed countries. As SDC commissioner Lang (Sustainable Development Commission 2008) points out, the problem of obesity, waste and climate change are intertwined with each other, making working with supermarkets on those intertwined issues critical as they are in the position with enormous influence to food system (Sustainable Development Commission 2008).

2.3 Drivers and barriers among retailers

Chkanikova and Mont (2012) identified drivers and barriers of retailing companies in Sweden to establish sustainable retailing. Confirmed with empirical evidence from retailing stores in Sweden from ICA, Coop, and Axfood, cost saving is considered as one of the most effective drivers to implement the material and energy efficiency as companies try to retain competitive position by reducing risks. Same as the previous research, market demand, regulatory requirements, and social factors such as media attention are main drivers for more efficient resources management. On the other hand,

barriers such as lack of knowledge and expertise, or financial resources, prevent retailers from utilizing green technologies (Chkanikova and Mont 2012).

Jones and Comfort (2012) reviewed the governmental policies and retailers initiatives in UK and argue that retailing companies in UK that are only motivated by cost savings and public relation do not really integrate sustainability into their core business, neither consider waste management as an integrated resources issue (Jones, Hiller and Comfort 2012). Furthermore, since sustainable development is a rather complex concept that includes many industries and sectors, it has been very challenging to develop governmental policy to a longer, common, and consistent vision.

2.4 Attempts and initiatives to food waste issue

The food waste issue is relatively new and has only recently been brought into discussion as important environmental and social issue. In 2013 FAO (2013) started its first initiative in reducing global Food Wastage Footprint, the European Commission initiated the goal of reducing edible food waste by 50% by 2020, and the Food Waste Challenge was initiated in the United States by the U.S. Environmental Protection Agency in 2013 (FAO 2011) (Swedish Envrionmetnal Protection Agency 2014).

Industries started to take action as well. In the United States a cross-industry initiative was established in 2010, and analysis based on surveys of Grocery Manufacturers Association (2010) in the United States have shown willingness to donate food waste (BSR 2013). The industry Council for Packaging and the Environment (WRAP 2013) suggests also that changing food labels into use of “best before dates” instead of “use by dates”, informing consumers about date marking, and incorporating label storage advice are beneficial to maximize the maintaining of product quality and shelf life and therefore leads to reduction of food wastes of this kind (WRAP 2013). Furthermore, importance of packaging technology innovations was addressed to extend shelf life, enhance safety, and provide information of potential problems (Yam, Takhistov and Miltz 2005).

Most importantly, the Swedish Environmental Protection Agency (2014) proposed new goal of reducing the amount of food waste among different stakeholders recently, aiming to reduce the amount of food waste based on 2010 level by at least 20% by 2020 (Swedish Envrionmetnal Protection Agency 2014). This goal is specialized into interim goals of utilizing at least 50% of eatable wastes from household, large scale kitchens, supermarkets and restaurants, and at least 40% of eatable wastes are treated into biological energy in 2018 with cooperation of Swedish Environmental Protection Agency, National Food Agency in Sweden and Swedish Board of Agriculture departments (Swedish Envrionmetnal Protection Agency 2014). Their cooperation has led to researches in quantity and causes of wastes, current legal framework for food waste, and development of food waste prevention with consumer campaign (Swedish Envrionmetnal Protection Agency 2014). The Nordic Council of ministers also initiated projects to conduct research in the larger Nordic area and discussion of developing food bank among Nordic countries (Swedish Envrionmetnal Protection Agency 2014).

In May 2015, France's parliament voted to ban food wastes in big supermarkets that all large-sized supermarkets have to sign contracts with NGOs to donate all non-sold food. This attempt aims at reaching the goal of reduce food waste in half by 2025 (Aljazeera 2015).

Eriksson (2012) offers several suggestions in reducing food waste based on the case studies in Sweden such as stores need to work on prediction of holiday special promotions for occasional food wastes (M. Eriksson 2012), and reduce the wholesale pack size of the sold goods. Findings from Andersson and others (2010) confirmed that a 50 % reduction in the wholesale pack size would potentially lead to the same amount of reduction in food wastes (Andersson, et al. 2010). Furthermore, introducing more advanced packaging is considered to be an efficient way in reducing wastes from food products with low turnover such as organic food (M. Eriksson 2012).

3. Methods and Materials

3.1. Cost and Benefits Analysis

Costs Benefits to Retailers	Social Entrepreneurship	NGOs	Policies
Costs	Service fees; Risk of damaging public relation in case of bad food scandal	Human resources to find partners; Possible transport costs; Risk of damaging public relation in case of bad food scandal	Discourage retailing business; Costs to retailer (i.e., tax), is a transfer to government.
Benefits	Positive environmental and social image to the public; Less vulnerable to possible future waste policy change	Positive environmental and social image to the public;	

Table 1 Cost and Benefits to retailers.

If retailers signed partnership with a private social entrepreneurship, they would need to pay the service of taking care of and utilize the waste. They face the slight risk of damaging public relation in case of a food scandal but they gain reputation benefits as contributing to sustainable retailing. To consumers there will be benefits of utilized non-sold food and general social and environmental benefits to the society.

On the other hand, if retailers give away non-sold food to NGOs, they will need to pay their employees to find receivers, which can be costly if partnerships vary from time to time. Furthermore, they might need to transport non-sold goods to different locations, which would further increase their costs. Besides physical costs, if any sickness were linked to giveaways from non-sold goods from them, they would face brand crisis and

lose competitiveness in the market. Similarly as scenario 1, the benefits would be the utilized non-sellable food and general social and environmental benefits to the society.

Environmental issues have been following the phrase of rise of attention, initiatives and more research for understanding towards regulation such as climate change issue. In May 2015, France became the first country in Europe to ban all the food waste in big supermarkets, aiming to reduce food waste in half by 2025 (Aljazeera 2015). As one of the major economies in Europe, this policy signals the raising attention of food waste issue. The increase in attention of food waste signals a higher chance of further regulations in Sweden as well such as the carbon tax for climate change issue due to ineffective global initiates. By establishing long-term waste management strategy, retailers would face less risk in the future in terms of random shocks such as governmental regulations in wastes.

Costs Benefits to society	Social Entrepreneurship	NGOs	Policies
Costs	Service fees; Risk of damaging public relation in case of bad food scandal	Human resources to find partners; Possible transport costs; Risk of damaging public relation in case of bad food scandal	Discourage retailing business; Costs to retailer (i.e.. tax), a social transfer to government. Cost to consumers as administration cost, mainly from collecting tax
Benefits	Positive environmental image to the public; Positive environmental benefits as reduction of carbon footprint from food wastes Positive social benefits as alleviation of social assistance Positive benefits of consumers who benefits from those non-sellable food Less vulnerable to possible future waste policy change Long term benefits of more sustainable business model	Positive environmental and social image to the public; Positive environmental benefits as reduction of carbon footprint from food wastes Positive social benefits as alleviation of social assistance Positive benefits of consumers who benefits from those non-sellable food	Environmental benefits: carbon footprint from all food waste; Governmental income (money transfer between retailers and government).

Table 2 Cost and Benefits to Society

For social planner, however, the benefits of each alternative are different. The social planner wants to choose the alternative that maximizes the social welfare of the society. Besides those two alternatives the retailers have to deal with food wastes, social planner can impose a policy such as taxation of the waste or set quota of the waste retailers can incur.

In both scenarios of giveaway, it would be better for the environment and for the society. Producing, and transporting foods cause carbon footprint as much as 1.6 tons carbon dioxide per ton of waste (Scholz 2013). Just by utilizing the non-sold food, it is contributing to using resources more efficiently. Socially the welfare is also increased since some disadvantaged population would be able to eat more and even healthier food, considering most of those reusable foods are fruit and vegetables (Scholz 2013). Moreover, this would alleviate social assistance when more basic needs are satisfied among low-income population. One additional benefit to the society, social entrepreneurship as private company contributes to more employment, and in the long run promotes a greener business that support a more sustainable economy. In the scenario of governmental policy, carbon footprints are reduced but not utilized from implementing environmental policy; Government or municipalities would gain income from the policy. Depending on how this income is utilized, it would affect the social welfare and how much would they be.

For simplicity, we assume that the society is formed of retailers and the rest of the populations are consumers. Furthermore, we assume that consumers as the general public would benefit or suffer from environmental and social impacts of retailers' action on handling food waste and in the end consumers are divided into underprivileged who benefit from reuse of non-sold food from retailers and the rest who may not benefit from reuse of non-sold food directly but still enjoy overall environmental benefits and social benefits as non-sellable food are utilized without being wasted instead.

3.2. Social welfare scenarios and models

This paper compares the social welfare in the following scenarios:

1. Use social enterprise to deal with waste,
2. Give away the waste to NGO,
3. And let the government implement a policy on the waste.

3.2.1 Scenario 1

The utility equation of the retailers includes the cost of managing waste in terms of social enterprise fee, and the benefits from positive public image. Those public relation benefits are considered to increase retailers' credibility among consumers. Here U_{RE1} represent the utility of the retailers, C in the utility function U_{RE1} is the cost for retailers from managing non-sold food, and E is the reputation retailers gain from managing non-sellable food through this channel. The reputation gain can be in form of economic or non-economic benefits. In the simulation economic benefits is adopted as form of market shares increase.

$$U_{RE1} = f_1(C, E)$$

The cost for social enterprise (Allwin) is furthermore:

$$C_S = g_1(f)$$

C_S is the cost of social enterprise to retailers. $g_1(f)$ Is the cost of social enterprise and is a function that relates to the amount of non-sold food and the frequency of the service.

The utility equation of the consumers includes the reused food some of them received, as well as the environmental and social benefits to all consumers, e.g., reduced carbon footprint from utilized non-sold food and alleviation of social assistance. Here $U_{C1}$is the utility of consumers, F represents the benefits of reused food to underprivileged consumers, and EN, S are corresponding to environmental and social benefits to the general public. F is a function related to the amount of reduced non-sellable food and the proportion of which is utilized.

$$U_{C1} = f_2(F, EN, S)$$
$$F = g_2(f)$$

Generally Utilitarianism or Rawlsian social welfare model is used with different purposes in measuring welfare level. The Utilitarianism social welfare function measures social welfare as a total sum of individual incomes. And the Rawlsian social welfare function measures the social welfare of society on the basis welfare of the least well-off individual members of society. As effects of waste are involved with environmental and social benefits as a whole, and the purpose of the paper is the see which scenario would bring most welfare to the society, the Utilitarianism social welfare model is chosen in this paper,

$$W_{u1} = U_{RE1} + U_{C1}$$

Then the corresponding social welfare function would be:

$$W_{U1} = U_{RE1} + U_{C1} = f_1(C, E) + f_2(F, EN, S) = f_1(g_1(f), E) + f_2(g_2(f), EN, S)$$

3.2.3 scenario 2

All retailers give away food waste to NGO, the cost is therefore transportation costs to individual NGOs and human resources costs in terms of contacting and managing relationships with NGOs. Here U_{RE2} represent the utility of the retailers, C in the utility function U_{RE2} is the cost for retailers from managing non-sellable food, and E is the reputation retailers gain from managing waste through this channel. The reputation gain can be in form of economic or non-economic benefits. In the simulation economic benefits is used as form of market shares increase.

C_N is the cost of giving away non-sellable food to NGO, and T, HR corresponds to functions of transportation cost and human resources cost incurred from scenario 2. Here U_{C2} is the utility of consumers, F represents the benefits of reused non-sellable food to some consumers, and EN, S corresponding to environmental and social benefits to the

general public. F is a function related to the amount of reduced waste and the proportion of which is utilized.

$$U_{RE2} = f_3(C, E)$$
$$U_{C2} = f_4(F, EN, S)$$

The cost for NGOs is furthermore as shown below:

$$C_N = g_3(T, HR)$$

The function of cost to NGOs is associated with the amount of time and human resources needed for retailers to give away non-sellable food.

$$F = g_2(f)$$

F represents the benefits from the utilized non-sellable food to under privileged population, and it is a function related to the amount of utilized food wastes from NGOs.

Therefore the corresponding social welfare function under scenario 2 in Utilitarianism model is:

$$W_{U2} = U_{RE2} + U_{C2} = f_3(C, E) + f_4(F, EN, S) = f_3(g_3(T, HR), E) + f_4(g_2(f), EN, S)$$

3.2.4 scenario 3

The government will implement a policy to reduce waste. Arrangements can be in the form of taxes, quotas, subsidies, a permit system or direct regulations such as ban on food waste. Common tax instruments for environmental issues are such as production/input tax and direct damage/emission tax. And subsidies can be in the forms of variable and fixed subsidies.

In this paper food waste is considered as “pollution”, and there is obviously a divergence between private and social costs in which the social costs of food waste are much bigger. The focus of the paper considers the maximum welfare of the society therefore governmental policy that lead to the most of waste reduction will be used. Zerbe (1971) argues that theoretically pollution damage taxes and emission taxes provide the most

incentives for polluters to adopt intervention to reduce waste creation among all other types of taxes (Zerbe 1971). Peck and others (1993) compared the global economic performance of those instruments for controlling carbon footprint and conclude that emission tax and emission limit policy are better alternatives in the situation with known costs and benefits of control or uncertain benefits of emission reduction. However, emission tax is the best alternative when cost of emission reduction is unknown (Peck and Teisberg 1993). Due to the difficulties in calculating damage of food waste, a first best Pigouvian tax as a lump-sum tax as corrective tool is more likely to be used in reality.

Here U_{RE3} represent the utility of the retailers, C_E in the utility function U_{RE2} is the cost for retailers from managing non-sellable food, and E is the reputation retailers gain from managing waste through this channel. The reputation gain can be in form of economic or non-economic benefits. In the simulation economic benefits is adopted as a form of market shares increase.

Here U_{C3} is the utility of consumers, F represents the benefits of reused food to some consumers, and EN, S corresponding to environmental and social benefits to the general public. F is a function related to the amount of reduced waste and the proportion of which is utilized.

$$U_{RE3} = f_5(C_E)$$
$$C_E = g_4(f)$$
$$U_{C3} = f_6(EN, S)$$

The lump-sum fine assumes that retailers are polluters that need to be regulated. The retailers hence do not have opportunity to re-utilize food waste voluntarily. As a result, they do not gain benefits from good reputation. Neither would consumers benefit from reutilizing food wastes as in previous two scenarios. The tax from retailers becomes a government income and it therefore is a social transfer since in this paper we assume the society is based on only retailers and consumers. The U_{RE4} hence does not contribute to social welfare unless the taxes from retailers, C_E, are used to address certain

environmental problem. If C_E is used to clean environment, the benefits come into U_{C3}. In this paper the welfare model is built with the concern of retailers and consumers welfare, cost of emission is viewed a transfer cost to income to the government, and consequently it is cancelled out with each other in the model.

Furthermore As Zerbe (1971) mentioned, relevant control costs have an impact on the policy conclusions and therefore administration cost incurred from the corresponding regulatory agency should be included in the cost of the society too when policy is implemented. C_A is the administration costs to the society from regulating the emission (Zerbe 1971). Theoretically, the administrate cost might be a function of total food waste. However, in reality it is difficult to link the cost to the magnitude of food waste. I hence assume a fixed administration on regulating food waste.

$$C_A = A$$

In that case, the social welfare with governmental policy in Utilitarianism model would be:

$$W_{U3} = U_{C3} = f_6(C_A, EN, S) = f_6(A, EN, S)$$

However as Hanssen (2011) points out, it is about 10 times as efficient to stop the food wastes than utilizing them for biological treatment from the perspective of resource efficiency (Hanssen 2011). The Environmental and social benefits would be bigger compared to utilize them with NGOs or social enterprise.

3.3 Data collection and description

ICA stores are highly decentralized compared to other retailing companies in Sweden such as Axfood, and Coop Corporation. Each individual store is responsible for its own waste and there is no national company level data available. Because of the lack of systematic cooperation in collecting data, each individual store only has waste data from the last passing year. Furthermore each store records their waste in different methods,

some record them by weights while others record them by units. However, all of them have the data of waste in terms of how much they bought them for, therefore I choose to use that to measure and compare food wastes.

There is a total of 37 ICA stores in Gothenburg according to the store list on ICA website (2015). Out of those 37 stores, 16 of them are ICA Nära, 12 of them are ICA Supermarket, 5 of them are ICA Kvantum, and 4 of them are ICA Maxi (ICA Group 2015). The proportion of each kind of stores are similar to the proportion in the whole of Sweden, as there are 676 Nära stores, 431 Supermarket stores 123 Kvantum stores, and 79 Maxi stores in Sweden. Stores of ICA are categorized through the amount of products they have, from 4000 items in Nära to 38,000 items in Maxi (ICA Group 2015). By proportion, the data of waste in terms of ingoing price in Swedish Kronor among 4 Nära, 3 Supermarket, 1 Kvantum, and 1 Maxi are collected in Gothenburg. Furthermore, none of the ICA Maxi stores in the list of Gothenburg stores is willing to participate in this study, therefore one Maxi is chosen from the municipality next to Gothenburg. Considering ICA stores differ through type of stores rather than location, I consider the Maxi just outside Gothenburg having similar food wastes quantity and structure.

The data on food are very detailed but some of those categories on food entries vary across individual stores. For example some stores categorize all kinds of bread in one category versus others who divide them into baked in store, hard bread etc. For simplicity all kinds of bread products are put together such as hard bread, crisp bread, bread that is baked outside the store and bread that baked inside the store as category “bread”; I put salad bar, ready-made salad, fruit and vegetable together as fruit and vegetable category; and I put fish and meat as meat category.

The following table illustrates the amount of food wasted from 2013 to 2014 in retailing stores. The numbers are calculated for the value of wasted food retailers bought for without taxes. The full summary of total food wastes in each kind of stores can be found in the Appendix page.

Units (SEK)	Nära (4)	Supermarket (3)	Kvantum (1)	Maxi (1)	Total
Fresh Fruit & Vegetable	941,092	569,422	514,534	452,637	2,477,685.00
Bread	411,024	326,018	300,729	593,136	1,630,907.00
Meat	501,720	460,244	296,525	264,872	1,523,361.00

Table 3 Top three food waste category in ICA in Gothenburg

Average (SEK)	Nära	Supermarket	Kvantum	Maxi	Total
Fresh Fruit & Vegetable	235,273	189,807	514,534	452,637	1,392,251
Bread	102,756	108,673	300,729	593,136	1,105,294
Meat	125,430	153,415	296,525	264,872	840,242

Table 4 Top three food waste category (average values)

3.4 Estimation method

ICA together with Coop and Axfood compose 87% of food retailing s in Sweden in 2014 (Delfi 2015). Using those collected data from 16 stores in Gothenburg in each kind of ICA stores, the total food wastes in all ICA stores in Sweden is estimated based on the number of each kind of stores for the year 2013-2014 period. Furthermore, I estimate the food wastes quantity from Coop and Axfood stores by matching the store with similar sales with ICA stores. The waste of every Krona of sales is calculated and uses it as a waste factor for each kind of stores. The average ingoing price of food wastes in ICA in Sweden is listed as follows:

	ICA Nära (672 stores)	ICA Supermarket (432 stores)	ICA Kvantum (123 stores)	ICA Maxi (80 stores)
Average (SEK)	411,630	669,702	1,640,318	1,793,300
Total (SEK)	276,615,360	289,311,264	201,759,114	143,464,000

Table 5 Average and Total food wastes in ICA in Sweden

ICA	Nära	Supermarket	Kvantum	Maxi
Store article	4000-8000	7000-11000	12000-19000	29000-38000
Store sales (SEK)	18.2861 Billion	37.4199 Billion	29.3062 Billion	36.2089 Billion
Waste per SEK sales	0.015	0.0073	0.00688	0.00392

Table 6 Store information: ICA (ICA Group 2015)

Axfood	Willys	Hemköp
Store article	9000	10000-12000
Store sales (SEK)	24.3272 Billion	13.2728 Billion

Table 7 Store information: Axfood (Axfood 2015)

Coop	Online	Nära	Konsum	Forum
Store sales (SEK)	0.1461 Billion	2.9707 Billion	15.84 Billion	18.7982 Billion

Table 8 Store information: Coop (Delfi 2005)

3.5 Price simulations

3.5.1 proxies for simulations

In order to generate simulation for social welfare for each scenario, further clarifications of the model are necessary. For three scenarios that retailers choose to take action, environmental benefits for retailers and consumers are simulated as the carbon footprint they reduced.

Social cost of carbon (SCC) has been developed and estimated by the Environmental Protection Agency in the United States and many economists. Integrated Assessment Models have been established to calculate the environmental, social and health impact of carbon pollution. There have been estimations based on different discount rates. In 2015 the central SCC estimates of a ton of carbon emission is 37 US dollars using a 3 percent discount rate (IWG 2014). That leads to 310 Kronor with the average currency exchange rate of 1:8.39 in 2015 and that will be used to simulate the environmental and social benefits to the society in scenarios where retailers will choose Social enterprise service or NGOs to reutilize the food wastes. For scenario 4 when a regulation is implemented, there will be not production of food wastes. As I mentioned before the environmental and social benefits would be higher in this scenario, therefore the SCC of 57 US dollars (478 Kronor) with a 2.5 percent discount rate is used to simulate the benefits.

The economic benefits from reputation are assumed to be the possible market share growth in the long run. From 1994 to 2002 ICA's market share is stable around 44% of the market share in Sweden, in 2010 it reached to almost 50% of market share and remained so in 2014 (Delfi 2015). Coop's market share has been slowly dropping from around 25% in 1994 to 20.5% in 2014. Axfood's market share has also dropped from over 22% in 1998 to about 16% in 2014. Still being the minority of the food retailer, Bergendahls' market share increased from about 2% in 1994 to 7% in 2014 (Daunfeldt, Orth and Runholm 2010). Those three food retailers remain dominant in Sweden and their total market shares have been rather stable over the past 10 years (Gullstrand and Jörgensen 2011). Due to the relative small changes in market share structure among food

retailers in Sweden, the long run is assumed to be around 50 years and I will therefore choose to simulate increase of market share due to reputation as 2%, 5%, and 10%.

In scenario 1, cost for retailers is from utilizing Allwin for food wastes. Proxy for that is based on interviews with ICA stores with cooperation with Allwin. The utility for consumers includes the benefits of reused food to consumers, the environmental benefits as carbon footprints reductions, and social benefits as the reduced amount of alleviated social assistance. Since the data I collected is based on the price retailers paid for those wasted food, they can be used as a proxy for benefits of reused food to consumers. And the SCC can be used as proxy to estimate the environmental and social benefits.

$$W_{U1} = U_{RE1} + U_{C1} = f_1(C, E) + f_2(F, EN, S) = f_1(g_1(f), E) + f_2(g_2(f), EN, S)$$

In scenario 2, the cost to retailers is the cost of transportation and human resources to connect and maintain relationship with NGOs. Proxies of those costs are based on interviews with ICA stores that have been donating food wastes to NGOs. The utility function of consumers is simulated as the same way as in scenario 1.

$$W_{U2} = U_{RE2} + U_{C2} = f_3(C, E) + f_4(F, EN, S) = f_3(g_3(T, HR), E) + f_4(g_2(f), EN, S)$$

In scenario 3, the cost to retailers is the lump-sum of fine to emission, and the calculation of the fine equals to the SCC of 478 Kronor per ton of emitted carbon dioxide. The cost of consumers is the administration costs to the society from regulating the emission, and the benefits would be the environmental benefits as reduction of carbon footprint and social benefits as alleviation of social assistance. The Swedish Agency for Economic & Regional Growth (2007) estimated that the total administrative costs of complying with all environmental laws, regulations and monitoring is about 3.6 billion SEK in 2006 (OECD 2007). Considering there is no food wastes law in Sweden right now, there is no direct estimation of how much administration cost particularly for food waste in the retailer section in Sweden, the administration cost is not included in the simulation models.

$$W_{U3} = U_{C3} = f_6(C_A, EN, S) = f_6(A, EN, S)$$

3.5.2 Interviews

Interviews are made among ICA stores in Gothenburg in order to estimate the amount of human resources, transportation, and the deals with Allwin. Prices that Allwin charge are100-170 Kronor per day for the service to pick up non-frozen and not broken packaged food that expires on the same day. The days that Allwin go to pick up range from 3 days to 5 days every week and Allwin use 34 Liter boxes to measure the amount of food waste they collect. No extra human resources are necessary for cooperation with Allwin since ICA stores generally register the amount of food wastes anyway.

A few stores in the interview have cooperated with local churches to donate almost expired food. Churches usually are the ones responsible for picking up food but the quantity and frequencies of pick up is much less compared to Allwin. Stores in the interview do think they spent a bit more time to organize food wastes for churches due to the infrequent pickups but the difference is not significant. Every week estimated time for stores to prepare donation to churches is on average 30 minutes. Stores who cooperated with churches points out that there is more food safety concern with churches because they usually have no refrigerator truck when they pick up, neither did they conduct proper documentation of donated food, which is actually required in Sweden according to the food regulation (Eriksson, Fellenius and Norman 2014).

4.Results and discussions

4.1 Quantification of food wastes with ingoing price

According to the sales comparison, I categorize Hemköp, Konsum, and Forum as similar sales level as ICA Nära for sales under 20 billion in 2014. ICA Kvantum and Willys are matched together as total sales under 30 billion Kronor but higher than 20 billion Kronor.

The total estimated wastes from ICA, Axfood, and Coop in Sweden are accordingly estimated as 1.84 Billion Kronor. The three food retailer chains compose 87% of market share in Sweden (Delfi 2015), and therefore their estimated food wastes are good representation of the majority food wastes in Sweden. Finally the estimation the total wastes from retailers in Sweden are scaled from estimated food waste in the biggest three food retailing chains as 2.12 Billion Kronor in incoming values.

Represented with ingoing food prices, the fresh fruit and vegetable dominate the value of food wastes due to its large quantity. Surprisingly Nära stores have average higher fresh fruits and vegetable wastes even if the store is the smallest among ICA stores. As Scholz(2013) suggested, meat should have the highest food wastes if economic allocation is applied due to the relative high prices. However, meat is not the highest category as Scholz (2013) presumed, but still is among the top three categories, which contributes to food wastes in ingoing prices. Furthermore, on average Nära stores have higher bread wastes in ingoing prices compared with Supermarket, and similar meat wastes in ingoing prices with supermarket.

4.2 Simulation with various reuse rate

Simulation is calculated in three different reuse rates of 20%, 50%, and 100%. In all scenarios food retailers' long-term economic benefits is assumed as market share growth.

In scenario 1 I use the average price from the interview (135 Kronor per day) the cost of using social enterprises service every day, average service days (4 days a week),

estimated reduced waste as benefit to consumers and SCC as social and environmental benefits to the society. The weights of food wastes are adopted the quantity Stare and others estimated from 2013. The working days are 249 days in 2014 in Sweden. In scenario 2 the average hourly rate of employment in retailing stores is used to estimate the cost for retailers to cooperate with NGOs. According to Statistics Sweden (2014), the average income per hour as cashiers is 150.2 Kronor in 2013. (Statistics Sweden 2014) In Scenario 3 I use the social cost of carbon emission (478 Kronor per ton) as proxy of the lump sum fine. The following tables are the welfare simulations with no market share increase and the table of detailed costs and benefits in the welfare simulation with no market share increase. The simulation with 2%, 5%, and 10% is included in the appendix.

SEK	**Reduce 20%**	**Reduce 50%**	**Reduce 100%**
Social enterprise	428,206,899	1,070,557,546	2,141,131,956
NGOs	428,230,025	1,070,580,671	2,141,165,081
Lump-sum tax	6,692,000	16,730,000	33,460,000

Table 9 welfare simulations with no market share increase

SEK	**Allwin fee**	**Benefits of reused wastes to under privileged people**	**Environmental and social benefits of reduced food wastes**	**Human resource costs for donating food wastes to NGOs**
Social enterprise	-26,865	423,893,764	4,340,000	NA
NGOs	NA	423,893,764	4,340,000	-3739.98
Lump-sum tax	NA	NA	6,692,000	NA

Table 10 Detailed costs and benefits for 20% reduction in food wastes in all scenarios

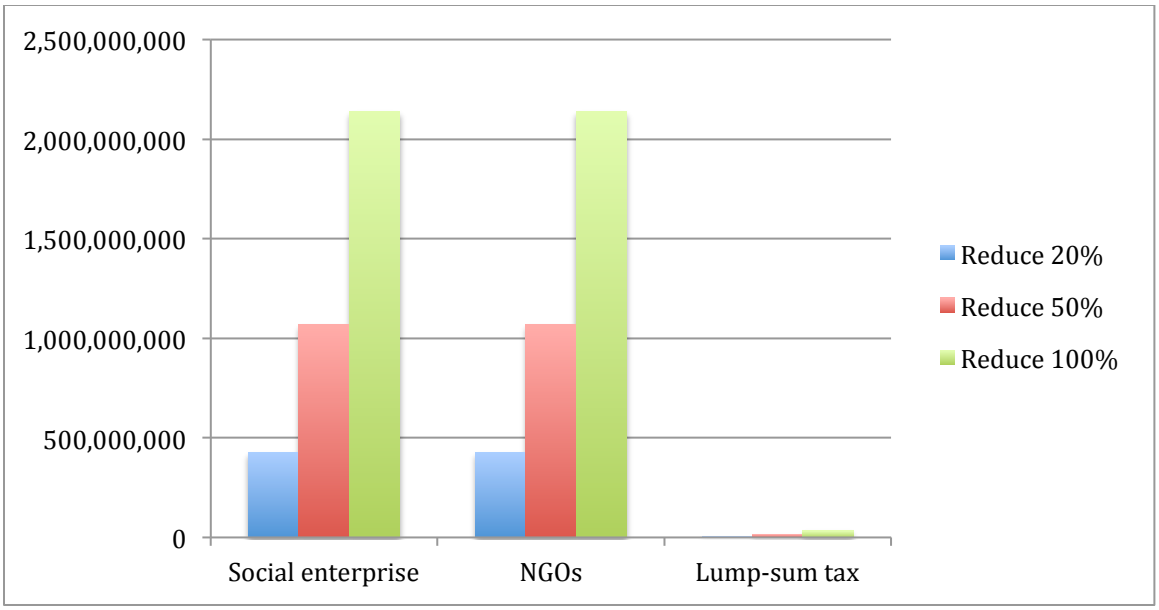

Figure 1 Simulation with various reductions percentages with no market share increase

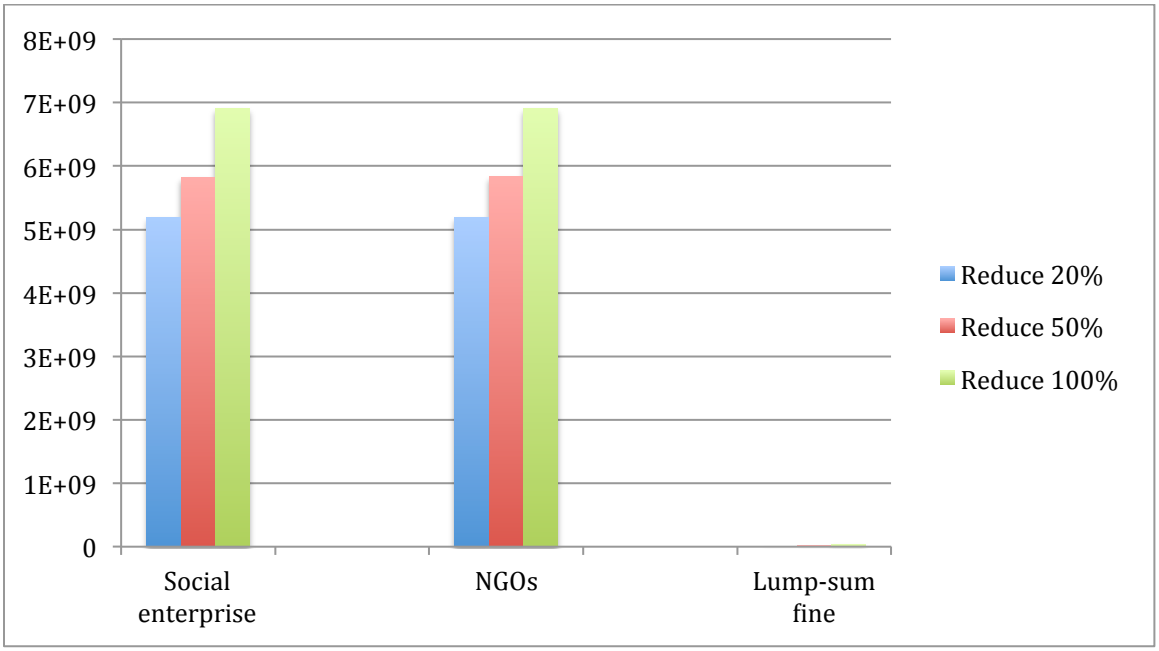

Figure 2 Simulation with various reduction percentages with 2% Market share increase

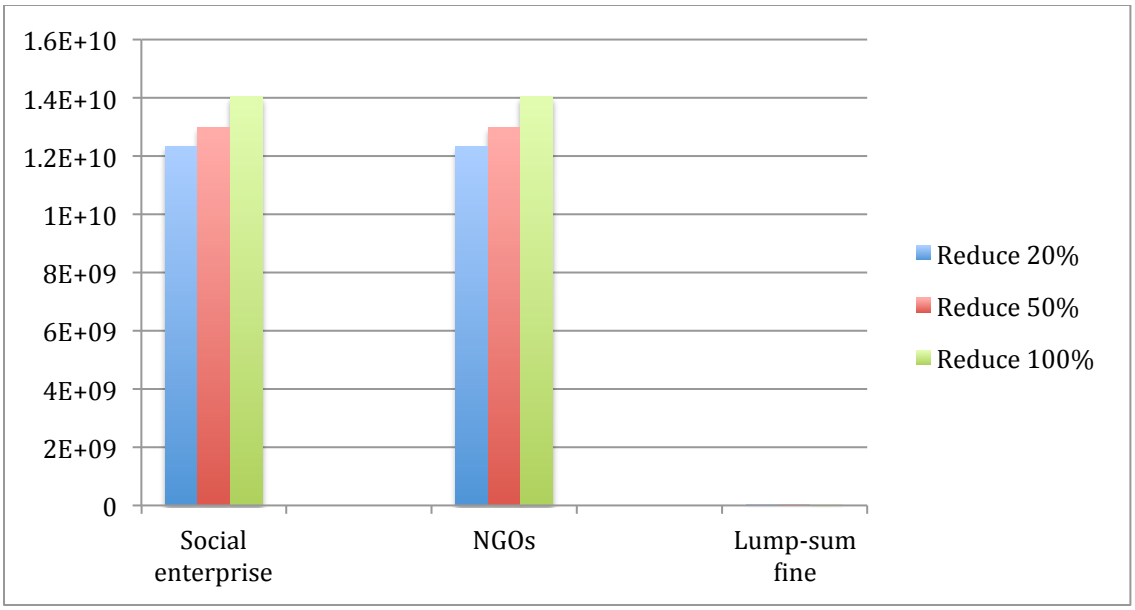

Figure 3 Simulation with various reduction percentages with 5% Market share increase

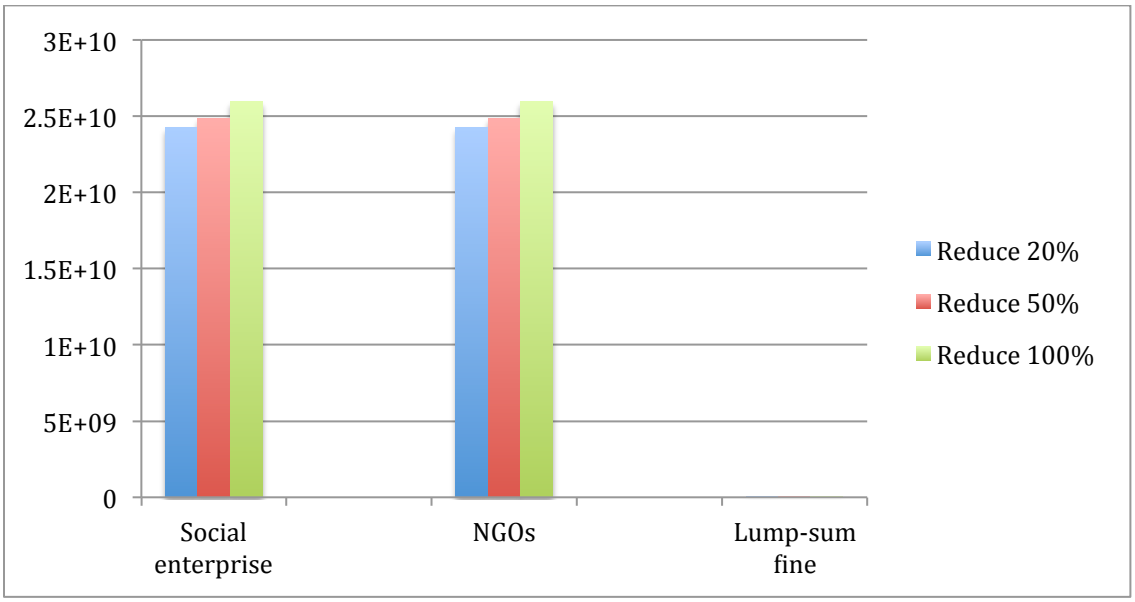

Figure 4 Simulation with various reduction percentages with 10% Market share increase

According to the simulation using social enterprise service yields the slightly higher social welfare as giving away food wastes to NGOs. This is because for those two scenarios the cost estimated based on interviews for retailers are very similar and as both

scenarios reutilize the food waste; their simulated social and environmental benefits are the same. Moreover, the average cost of using social enterprises service and average of human resources needed for donating to NGOs are used in our simulation, they remain as fixed parameters throughout the various percentage simulations. In the third scenario where administrative cost is not included, the welfare is just the environmental and social benefits to the society simulated by SCC.

The fundamental differences between the social welfare simulated in scenario 3 and pervious 2 scenarios are that there are no social benefits from reused food wastes to underprivileged population and no reputation gain for retailers in scenario 3. Corrective governmental regulation assumed in the paper as lump sum fine prevents the occurrence of food wastes completely and it leads to only environmental benefits as reduction of carbon footprint but no social benefits for reutilized food wastes, neither reputation gain as long term economic benefit to retailers is present in scenario 3.

As I mentioned before environmental impacts from preventing food wastes completely and consequently should be much higher. The higher SCC is adopted in this paper for scenario 3 for this purpose. However, it made relative marginal difference because with lower discount rate SCC used in scenario 3 is not much bigger. The social welfare of a lump-sum tax is not zero, but since the scale is very large it appears to be very small bars in those figures. As we can see from the table and the figures, the difference of social welfare, simulated with various reduction goals in food waste, reduced when market share increases correspondingly from 0% to 10%. In figure 4 with a market share increase of 10% for reduction of wastes of 20%, 50%, 100%, the economics benefits from reputation gain is large enough that it leads to much less difference of social welfare among different reduction in wastage compared with lower market share increase.

The data are only collected through consent of the store manager so there might be self-selection problem as one of the Maxi owners mentioned their concerns of number of waste look large due to their store size. SLU and Swedish Environmental Protection Agency are the only ones who have done research on food waste in Sweden, and they

also share the same issue of only being able to collect short-term data within a limited region. Lack of an integrated food waste system makes it difficult to have adequate quantity of data on this issue.

Stare and others (2013) have estimated the food waste in terms of weight from retailers in Sweden by collecting data from 15 stores in one municipality, calculated the per employee capita of food waste and used the total employees of retailing industries in Sweden to estimate the total food waste from retailers in Sweden. According to Stare and others the estimated food wastes due to retailers are 70000 tons in 2012 (Stare, et al. 2013).

Katharina Scholz (2013) from SLU calculated carbon footprint from food wastage using weighting units. It is a more appropriate unit for the purpose of calculating carbon footprint while waste data in money unit provides more perspective on how a change in demand for one product effect the volume of joint production as economic units are perfect reflection on drivers of production (Weidema 2003). Scholz (2013) estimated the carbon footprint applying economic allocation and it turns out that products that have a large range of prices such as beef tend to have very different carbon footprint using economic allocation. The total carbon footprint of beef and pork in Sweden is estimated to be 27% higher with economic allocation in comparison to the estimation using quantity (Scholz, 2013). Moreover, using currency units can potentially be a future indicator for food wastes as weakening in Swedish Kronor for instance would potentially lead to more imports and lots of vegetable, fruit, and meat are imported in Sweden. However, collected data in a monetary unit makes it more difficult to compare data across a range of years and across countries due to different market factors in different countries and currency fluctuations.

Furthermore, the quantity of food wastes in some area is likely to be under estimated because of retailers deal with bakery and their own special events before expiration sales are not included in the food waste data. For instance one store stated that those special priced food that is close to expiration date are counted as half loss. Some of the bread that

retailers could not sell would be able to return to the bakery. That might lead to food wastes in the end, even if it is not accounted on the retailers' side. Also, some of those special before expiration sales end up as wastes too but they are not included in the food waste data.

In the end, as the data is only from Gothenburg region and only from ICA stores, the quantity of wastage might not be representative to whole Sweden. For instance Scholz (2013) points out that Willys' food wastage might be smaller due to low price policy as discounted chain. As ICA is much more spread out in whole Sweden with relatively higher prices on average, the amount of food wastage might be higher than the average level for the rest of retailing chains in Sweden.

4.3. Theoretical possible reaction from retailers

The disposal market is open in Sweden, each stores are free to choose different disposal service from various waste management companies. The two biggest waste management companies are the Kretslopp och Vatten (waste management division in the municipality) and Renova. There are a variety of options for disposing organic waste, ranging from renting big sized container to emptying small barrel services. Interviews with ICA store owners show that there is no standard option for ICA stores in general, as each individual store decides themselves based on their preferences. Using waste services from standard waste management companies would be the "business-as-usual" case for retailers. A brief comparison of obtained information in 2014 is listed below:

	Kretslopp and Vatten	**Renova**
Owned Container	• 600kr per ton	• 625kr per ton
Barrel	• 140 L: 663kr per year	• 190L: 69kr per time • 370L: 79kr per time
Rental fee Barrel	NA	• 190L: 293kr per year • 370L: 397kr per year

Table 11 Waste management companies comparison in Gothenburg

In the case that the social planner chooses to implement a policy, the welfare would vary greatly depending on the reaction of retailers. Theoretically when emission fines are implemented, retailers will react corresponding to the cost benefit analysis and choose one of the four options that maximize the net outcome. Retailers would choose to let social enterprise deal with the wastes as long as the marginal cost is smaller than the food waste fines, and if the marginal cost of delivering food wastes to NGO is lower, retailers would choose to give away their food wastes to NGOs.

When retailers choose to take action and reduce all food wastes in order not to pay emission taxes, the welfare for the society is the same as the ones under scenario 2 and scenario 3. When retailers choose not to conduct any waste treatment, emission taxes would be an additional cost for them.

4.4 Simulation assumptions and proxies

The simulation shows that the option of using social enterprise service and NGOs yields the similar social welfare, in the assumptions of both options are able to reach 20%, 50%, and 100% of food wastes correspondingly. In reality however, as some ICA storeowners pointed out, the cooperation with NGOs has been spontaneous, limited by food type, and the quantity was much less compared with the quantity with social enterprise. It is not surprising that NGOs cannot reach those quantity in reduction, because after all part of the reason why Allwin exists is to establish the missing link between food retailers and people in need. Despite the result of the simulation lead to a similar welfare level between social enterprise and NGOs options, we would argue in favor of social enterprise option for maximize social welfare.

From the simulation results, the governmental policy is undesirable even if the SCC adopted is bigger than other 2 scenarios due to high efficiency of stopping production of food wastes. However, as no non-sellable food would be utilized, there are no benefits of reutilized food waste in scenario 3. As stated before, the cost of lump-sum tax is considered as social transfer and cancelled out with the governmental income. On the

other hand depending on how the governmental income is utilized, the impacts on social welfare would be different. It may potentially generate more social and environmental benefits if the governmental income is reinvested into environmental projects. The further environmental and social welfare would potentially generate higher social welfare than other two scenarios.

5. Conclusion

The estimated food wastes in whole Sweden from 2013 to 2014 is 2.12 Billion Kronor in ingoing value. Fruit and vegetables have the highest among of food waste base on ingoing values, followed by bread and meat as the three highest food wastes in ingoing values.

Based on the simulation results and discussion I argue that from the perspective of reusing non-sellable food, social enterprise is considered to be the most desirable option for food retailers in Sweden in terms of efficiency in reducing wastes, the significant benefits to retailers and social welfare they generate. However, from a resource efficiency perspective preventing occurrence of food waste is more efficient, governmental regulation that can prevent food waste completely would be potentially most social welfare generating option. Further estimations of social and environmental benefits from avoiding food wastes are crucial in this discussion. Furthermore, social entrepreneurship is relatively a new phenomenon with inadequate amount of research resources so long-term development in terms of for example profitability is unclear.

In the end with the motivation to raise attention on food wastes issue and to fill the gap of food waste research especially for the biggest retailer chain in Sweden, continuous efforts in research, collection of data in food wastes and related important proxies are called for better understanding of this issue.

6. Further research

In the simulation the lump-sum fine equals to the social cost of carbon from the amount of carbon footprint from retailers as the corrective regulation. It is supposedly justified from social welfare perspective, as Pigouvian tax is the first best alternative. This proxy is chosen to make the simulation possible but it might not be the most efficient governmental policy to reduce food wastes and to promote social welfare. Moreover, as the report from Swedish Agency for Economic & Regional Growth (2006) points out, the total cost of complying with all environmental laws, regulations and monitoring is about 3.6 billion SEK in 2006 (OECD 2007). The environmental code in Sweden (2009) consists of 33 chapters and almost 500 sections (Swedish Envrionmental Protection Agency 2009). Perhaps one can estimate the administrative cost from possible proportion of food waste laws among all environmental laws, but further research is necessary for the estimation. Therefore if the administrative cost for food wastes policy were significant, it would lead to negative social welfare in the model.

Moreover, in the simulation SCC is used to estimate the total environmental, social and health benefit. The social cost of carbon, which is developed by the Environmental Protection Agency in the United States, is relatively vague as estimation of climate change damage to net agricultural productivity, human health etc. It is very likely an underestimated proxy according to IPCC Fourth Assessment Report (IPCC 2009). The alleviation of social assistance from the government is also included in the estimation from SCC. It is likely to underestimate the benefits of reducing governmental social assistance as the saved budget can be used to increase social welfare of other areas. The SCC used in the paper for scenario 3 is bigger using smaller discount rate in order to reflect the higher environmental benefits from preventing food wastes from the beginning. However, there is no current literature discussing what SCC should be used in this case, it is uncertain that if the SCC adopted in scenario 3 is proper, and further research and estimations are crucial.

Traditional private companies that majorly only function on profitability have been viewed as a major cause of social, environmental, and economic problems (Porter and Kramer 2011). The rise of social enterprise globally that aims to creating economic and social value potentially contributes to the long-run welfare of the corporate world and the society as a whole. This created value from social enterprise, however, is very difficult to capture and simulate. So far research on social enterprise is only in embryonic phrase that it lacks of data, formal hypothesis and rigorous methods to estimate the long-term performance, and social value created from social enterprise (Short, Moss and Lumpkin 2009).

7. Appendix

Kronor	Nära total	Supermarket	Kvantum	Maxi
canned food]	73,166	89,649	63,378	130,621
pick up candy	18,592	25,719	12,372	46,703
drinks	3,794	6,032	1,815	18,207
crisp bread/crackers	8,206	10,550	10,093	9,792
bread	249,552	61,246	94,274	40,286
fruit, vegetables	726,668	441,748	485,938	387,714
frozen]	31,400	27,085	19,742	65,764
dairy	174,534	118,916	89,398	188,631
cheese	104,992	73,911	55,927	104,184
meat	470,184	415,694	238,320	247,555
charcuteire	207,750	214,877	62,657	200,378
delicacy	NA	NA	210,296	144,030
fish	31,536	44,550	58,205	17,317
own foodmanufacturing	NA	NA	NA	108,052
konditorei	NA	NA	NA	19,143
sallad/made food	214,424	127,674	NA	64,923
special	1,716	13,692	12,850	NA
bakery	153,266	254,222	196,362	543,058
cold dishes	NA	NA	95	NA

Table 12 Detailed food wastes by type of stores of ICA in Gothenburg

SEK	Nära 1	Nära 2	Nära 3	Nära 4
canned food]	5,648	20,258	36,583	10,677
pick up candy	2,300	2,894	9,296	4,102
drinks	176	968	1,897	753
crisp bread/crackers	759	2,207	4,103	1,137
bread	111501	11773	124776	1502
fruit, vegetables]	103,484	201,766	363,334	58,084
frozen]	1,348	9,832	15,700	4,520
dairy	27,004	47,132	87,267	13,131
cheese	15,414	27,500	52,496	9,582
meat	63,149	95,281	235,092	76,662
charcuteire	33,786	31,102	103,875	38,987
delicacy	NA	NA	NA	NA
fish	5,984	2,051	15,768	7,733
own foodmanufacturing	NA	NA	NA	NA
konditorei	NA	NA	NA	NA
sallad/made food	73,940	19,483	107,212	13,789
special	261	597	858	NA
bakery	NA	37,260	76,633	39,373
cold dishes	NA	NA	NA	NA

Table 13 Detailed food wastes of ICA Nära in Gothenburg

SEK	Supermarket 1	Supermarket 2	Supermarket 3	Kvantum	Maxi
canned food]	25,604	48,320	15,725	63,378	130,621
pick up candy	5,294	18,768	1,657	12,372	46,703
drinks	3,177	2,097	758	1,815	18,207
crisp bread/crackers	3,696	2,313	4,541	10,093	9,792
bread	10690	47883	2673	94,274	40,286
fruit, vegetables]	96,917	306,729	38,102	485,938	387,714
frozen]	10,970	12,919	3,196	19,742	65,764
dairy	51,167	50,004	17,745	89,398	188,631
cheese	32,285	35,087	6,539	55,927	104,184
meat	155,352	221,646	38,696	238,320	247,555
charcuteire	123,328	61,774	29,775	62,657	200,378
delicacy	NA	NA	NA	210,296	144,030
fish	30,443	9,954	4,153	58,205	17,317
own foodmanufacturing	NA	NA	NA	NA	108,052
konditorei	NA	NA	NA	NA	19,143
sallad/made food	43,638	81,045	2,991	28,596	64923
special	6,342	4,735	2,615	12,850	NA
bakery	103,427	146,392	4,403	196,362	543058
cold dishes	NA	NA	NA	95	NA

Table 14 Detailed food wastes of Supermarket, Kvantum, and Maxi in Gothenburg

	ICA Nära	ICA Supermaket	ICA Kvantum	ICA MAXI
Count	14	14	16	15
Mean	171,187	131,137	96,559	110,845
Median	129,129	67,578	57,066	65,764
Standard Deviation	207,114	147,115	128,904	106,821
Minimum	1,716	6,032	95	9,792
Maximum	726,688	441,748	485,938	387,714
Range	724,952	435,716	485,843	377,922
Sum	2,396,614	1,835,916	1,576,940	1,662,679

Table 15 Data description on food wastes in ICA in Gothenburg

SEK	Reduce 20%	Reduce 50%	Reduce 100%
Social enterprise	5190206899	5,823,557,546	6903131956
NGOs	5190230025.04	5832580671.04	6903165081.04
Lump-sum fine	6,692,000	16,730,000	33,460,000

Table 16 Welfare simulations with 2% increase in market share

SEK	Reduce 20%	Reduce 50%	Reduce 100%
Social enterprise	12333206900	12977555755	14046131960
NGOs	12333230030	12975580670	14046165080
Lump-sum fine	6,692,000	16,730,000	33,460,000

Table 17 Welfare simulations with 5% increase in market share

SEK	Reduce 20%	Reduce 50%	Reduce 100%
Social enterprise	24238206873	24880557550	25951131960
NGOs	24238230030	24880580670	25951165080
Lump-sum fine	6,692,000	16,730,000	33,460,000

Table 18 Welfare simulations with 10% increase in market share

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