The Citizen Goes Shopping:

A framework for the assessment and optimization of production from the perspective of society

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Thesis

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Preface & Acknowledgments

> "It is a great puzzle to me why [the product labeling approach presented in this thesis] ~~political liberalism~~ was not worked out much earlier: it seems such a natural way to [incentivize improvement of the social responsibility of businesses, given the widespread concern about the ethical aspects of production among the international public] ~~present the idea of liberalism, given the fact of reasonable pluralism in political life~~. Does it have deep faults which preceding writers may have found in it which I have not seen and these led them to dismiss it?" *John Rawls* (1995)

Despite widespread efforts to bring necessary improvements in well-identified environmental and socioeconomic shortcomings of markets, the path explored in this work received little attention. And it appears to be a promising path. In a nutshell, this work identifies and partly explores the possibility to use markets themselves as tools against their own bad self. Its innovation consists of describing a product labeling approach that makes consumers aware of the relative performance of products for issues that matter to society; where "what matters to society" is to be decided by society. In this way, consumption of less ethical production, as well as employment and investment in such production will need to happen knowingly, which can motivate improvement. In other words, the labeling institution that is described in this work aspires to reduce information asymmetry so as to initiate competition among supply actors for issues that create concern in society. That is, to initiate a continuous race in which 'the law of supply and demand' incentivizes businesses to compete freely for reputation, transparently and on issues decided by the general public. This approach connects free markets, the democratic governance of market economies, and the socially desirable management of timely issues such as the environmental and income distribution effects of the real economy. Certainly, further research will need to prove the robustness of the conceptual analysis presented in this thesis. I hope that parts of this work can prove useful even if its entirety will not.

In my opinion, the most important part of this thesis is Chapter 2. Methodologically, this chapter casts light on the work presented in subsequent chapters from an angle that explains the choices made later in this book. It presents a critical analysis of present-day 'ethical labeling' for consumer-based market optimization, and introduces an alternative labeling approach meant to address a number of shortcomings. In essence, Chapter 2 presents a story-line that explains the intended usefulness of this work. In my effort to present this analysis objectively, in simple

language and on a straight line, I often thought I was dealing with a 'wicked problem' subject to complex interdependencies that sometimes go against conventional wisdom. These often led progress to pause until progressive insights developed. I am happy with the result achieved. This was the first chapter to start and the last to finalize.

Among the people that contributed directly to this thesis I want to thank especially my supervisors. Particularly, I want to thank Professor Alfons Oude Lansink for his patient, longstanding and kind multi-level support that made the completion of this work possible. Even when I was not happy with it, I appreciated Alfons' concise, direct and to the point remarks. Similar was the support I received from my other two supervisors, Professor Michiel Korthals and Professor Henk Hogeveen. I owe to Michiel for enrolling me in this research project regardless my lack of background in social sciences. This allowed me a change of career towards issues where my heart rested. Henk has always been approachable and supportive at a personal level, sharing optimism and a smile when I was concerned. I hope I did not let them down. At the early stages of my research, while shaping the basic concepts I later focused on, I benefited from discussions with Henk van den Belt, Volkert Beekman, Prof. Bart Gremmen, and with Prof. Carlos Romero. The entire departments of Applied Philosophy and Business Economics of Wageningen University provided me with a warm, inspiring and functional research environment; I want to mention especially Gilbert Leistra and Clemens Driessen, and also Bea Prijn and Anne Houwers. The list of people I want to thank includes friends and family that offered me life-changing opportunities and a peaceful personal environment in which I could develop and conclude this work: Kaeti Christou, Michalis Michalopoulos, Giorgos Christou, Vassilis Michalopoulos, Aggeliki Pegkou, Dora Modinou, Fons Timmermans, Tonio Robles Flores, Jacoba Wassenberg, and Tzortzia Michali, thank you. The scholars referred to in this book, and upon whose insights this work builds, must also be acknowledged. I am happy that this book can now be published.

Rawls, John. 1995. "Political Liberalism: Reply to Habermas." *The Journal of Philosophy* 92 (3): 132–80. doi:10.2307/2940843.

CHAPTER 1

General Introduction

1. 'Ethical' concerns about food and its production

Food offers a convenient case for the study of production technologies and practices of concern to society. This is because "food has become one of the backgrounds where all kinds of groups and individuals debate on norms and values" (Brom and Gremmen 2000), which are typically discussed under the heading of 'Food Ethics' (Thompson 1988; Mepham 1996; Zwart 2000; Korthals 2004). In recent years, societal concerns motivated the analysis of a large number of food production aspects from an ethical perspective. These include, among others, concerns about consumer health (Cellini et al. 2004; Korthals 2011), food entitlements and nutrition (Sen 1990), environmental sustainability (Carson 1962), the fair treatment of labor and farmers (Macdonald 2007; Nicholls and Opal 2008) communities (de Jonge and Korthals 2006), the welfare of production animals (Singer 1995; Regan 2004; Foer 2010) and the perceived lack of naturalness of the dominant inputs-and-technology-intensive food production paradigm (Verhoog et al. 2003; Honkanen, Verplanken, and Olsen 2006).

Food-related concerns are qualitatively important because of the intimate nature and social function of food consumption (Visser 1986, 12; Symons 1993; Fraser 2001; Korthals 2002).[1] Food–related concerns also have a strong quantitative dimension because every human being is a food consumer, and immense volumes of human, animal, and natural resources are used for food production daily. Therefore, concerns about food have a central place in broader discussions about the environmental, social, animal welfare and health effects of production. According to the most inclusive estimates (Molla 2014), agriculture emits one third (Gilbert 2012) and the broader food supply chain up to 50% (UNCTAD 2013, 20) of the global manmade atmospheric emissions of greenhouse gasses that cause climate change (Bernstein et al. 2007; IPCC 2013). Climate change and its anthropogenic origin are supported now by a scientific consensus (NASA 2016), while scientists widely report

[1] "Food […] is experienced contextually, bodily, and relationally" (Fraser 2001). It is part of the "means by which a society creates itself and acts out its aims and fantasies" (Visser 1986, 12). Through food consumption practices we "engage most convincingly with our environment and with our physical bodies, we share most intimately with other people, and also feel in closest touch with traditions" (Symons 1993, 71). "[F]ood is made of living organisms, and enters our body, thereby in the end functioning as a bridge between the world, nature, and ourselves; having a meal means living and killing in the same time and mirrors the paradoxical character of living beings" (Korthals 2002)

a broad range of adverse effects: Among others, it expectedly affects negatively weather extremes (Fischer and Knutti 2015), human conflict and societal stability (Hsiang, Burke, and Miguel 2013), vulnerable populations and migration (Lelieveld et al. 2016), species extinctions (Urban 2015), food security and social equity (Vermeulen, Campbell, and Ingram 2012; Asseng et al. 2014), and epidemics of infectious diseases (Hoberg and Brooks 2015). In this light, the US President Barak Obama stated that there is "no greater threat to our planet than climate change" (Park 2015), and the 'Bulletin of the Atomic Scientists' (2015) cited climate change as one of the two reasons (the other being nuclear weapons) for moving "the minute hand of the Doomsday Clock, which for decades has signaled the urgency of threats to humanity, to the second most critical position in its history: three minutes to midnight."

Food production has a wide range of problematic implications besides climate change. These include among others deforestation, soil and land degradation (Alexandratos and Bruinsma 2012), the collapse of global fish stocks (Worm and Branch 2012), the depletion and pollution of surface and ground water reserves (Baldock et al. 2000), agrochemicals' impact on the collapse of bees populations (Pettis et al. 2013; Chensheng, Warchol, and Callahan 2014; Rundlöf et al. 2015), and unknown long-term health effects from the consumption of suspect carcinogenic agro-chemicals (Séralini et al. 2014; Guyton et al. 2015; Nestle 2016). Broader socioeconomic concerns with direct relevance to the food sector include market power concentration across supply chains (Bracke et al. 2005; Howard 2009), and income inequality with its effects on social stability and economic growth (Piketty and Goldhammer 2014; Ostry, Berg, and Tsangarides 2014; OECD 2015).

Technological innovation has also been a frequent source of public concern in food production. The introduction of novel production processes and technologies in food production sometimes have unintended and undesirable social and environmental side-effects that raise concern in society. For instance, improving crop yield can affect negatively nutritional content (Morris and Sands 2006), while efficiency improvements in industrialized animal farming also enhance animal welfare concerns (Singer 1995; Foer 2010). Plant genomics and broader food bio-technologies serve as an example of innovative technology with several ethically-relevant effects in food production.

Plant genomics is a 'high-throughput technology' that elucidates 'the way genes, RNA, proteins and metabolites interact in the functioning of cells, tissues, organs and the complete organism and its environment', at individual, population, species, and

ecosystem level (Nap et al. 2002; Osterlund and Paterson 2002). Plant genomics can have 'conventional' or 'recombinant DNA' (i.e. genetic modification) applications in food production. Conventional applications merely aim to increase the effectiveness and efficiency of plant methods and always concern the transfer of genes within different varieties of a species using traditional plant breeding methods. Contrarily, recombinant DNA applications replace much of traditional plant breeding methods. They concern the in vitro transfer of genes to plant varieties also from different species, leading in this way to new plant varieties that can have functions unprecedented to a species (e.g. to emit pesticides).

Plant genomics can raise a range of environmental, healthfulness, naturalness, and fairness concerns in society. These can relate to the ends targeted by genomics research, to the means used to achieve these ends, and to the way that innovations are protected in the market (Kryder 2000; Korthals 2002; Cellini et al. 2004; Gremmen 2005; Brookes and Barfoot 2005; COGEM 2006; G. Gaskell and Bauer 2006; de Jonge and Korthals 2006; Kumar and Prasad 2007; Lammerts van Bueren et al. 2007; COGEM 2009). A complex set of choices determines what part of genomics' potential will be researched and applied. These include 'upstream' political decisions on research priorities and possible application scenarios that set the research agenda (Wynne 2006; Felt and Wynne 2007), 'midstream' decisions on research practices and on the approval of considered application scenarios (Fisher, Mahajan, and Mitcham 2006; Schuurbiers and Fisher 2009), and 'downstream' decisions like what information will be made available to end-product users (Scholderer and Frewer 2003; Frewer 2003; Beekman 2007). These complexities suggest that the societal benefits of plant genomics technology in food production should be assessed on a case by case basis and should account for spatial and temporal variation in societal values (Gaskell et al. 2010).

2. Problem Statement

As suggested by their name, 'market democracies' offer to members of society two mutually non-exclusive action paths to affect the management of real[2] economy

[2] 'Real Economy' is defined as 'The part of the economy that is concerned with actually producing goods and services, as opposed to the part of the economy that is concerned with buying and selling on the financial markets'
(http://dictionary.cambridge.org/dictionary/business-english/real-economy)

aspects in a way that is democratic (i.e. roughly proportional) at the level of the broader lay public:[3] Either to vote as citizens for governments that enact agreeable policies, or to shop as consumers in order to steer the supply sector towards the practices and technologies revealed by one's preferences. The latter option is termed 'ethical' or 'political' consumption. This type of consumption is constrained by the availability of relevant information. Contrary to 'use' or 'experience' attributes like taste, color and function, ethical issues unexceptionally correspond to "credence"[4] (Nelson 1970; Darby and Karni 1973; Andersen and Philipsen 1998) product attributes: Either before or after consuming a product, consumers cannot perceive for instance, its environmental impact, its fairness, the technologies used and the treatment of animals during its production. Consequently, ethical or political consumption is possible only when consumers have access to information on product performance for ethical aspects of concern. A large variety of more and less institutionalized and/or credible information schemes have developed to inform consumers on such aspects. The most readily available information is communicated to consumers through front-of-pack labels. Despite initial optimism that ethical consumerism could provide the motivation for socially responsible production, and in spite of consistent survey results showing increased ethical concern among the international public, ethical consumption has remained a market niche. So far, it has failed to develop into a market force of a magnitude sufficient to incentivize much needed improvements in the environmental, societal, and animal welfare performance of production, and more generally in the socially responsible conduct of businesses (Vogel 2006; Smith 2007; Vogel 2008; Kassel 2008; Higgins 2010; Carroll and Shabana 2010).

Concurrently, certain aspects of the dominant approach to ethical information have been criticized. Some of this criticism concerns for instance the price premiums required to reveal preference for ethically certified products, the confusing plurality of labels, the effects of low credibility labels, the inability of ethical certifications to incentivize improvement beyond certification standard, and that information

[3] This focus on decision-making that is roughly proportional at the level of members of society is consistent to the dictionary meaning of the term 'democracy'. It leaves out of scope indirect and negatively disproportional citizen participation to stakeholder-level decision-making, which is achieved through supporting some (e.g. civil society organizations) of the various stakeholders involved indecision-making at stakeholder level.

[4] 'Credence', 'unobservable', or 'imperceptible' are termed those attributes that consumers cannot assess with their senses (therefore, they are neither 'search' nor 'experience' attributes). These three terms are used in this thesis interchangeably.

asymmetry remains for uncertified products. Therefore, given the essentiality of information for making ethical consumerism possible, and also given the importance of ethical consumption as a democratic driver for positive change on issues of societal concern in production, it is meaningful to examine the functionality of the dominant approach to ethical information for consumer-based optimization and ways to improve it.

3. Objectives

The overall objective of this thesis is to develop an approach to generate information that can be used to address some of the limitations of currently available information schemes for the consumer-based market optimization of production practices and technologies of concern to society.

The overall objective was divided in four sub-objectives.

Sub-objective 1

Discuss limitations in the functionality of ethical labels for consumer-based optimization and present possible improvements of ethical labels.

Sub-objective 2

Develop the conceptual outline of a method to generate information whose properties can facilitate consumer-based optimization of production practices and technologies of concern to society.

Sub-objective 3

Identify and quantify the relative importance of public concerns that are relevant to fresh tomato production.

Sub-objective 4

Apply the outlined assessment approach to the case of existing and hypothetical fresh tomatoes that differ in terms of their use of genomics technology and other production practices.

An outline of these sub-objectives is presented at Fig. 1.

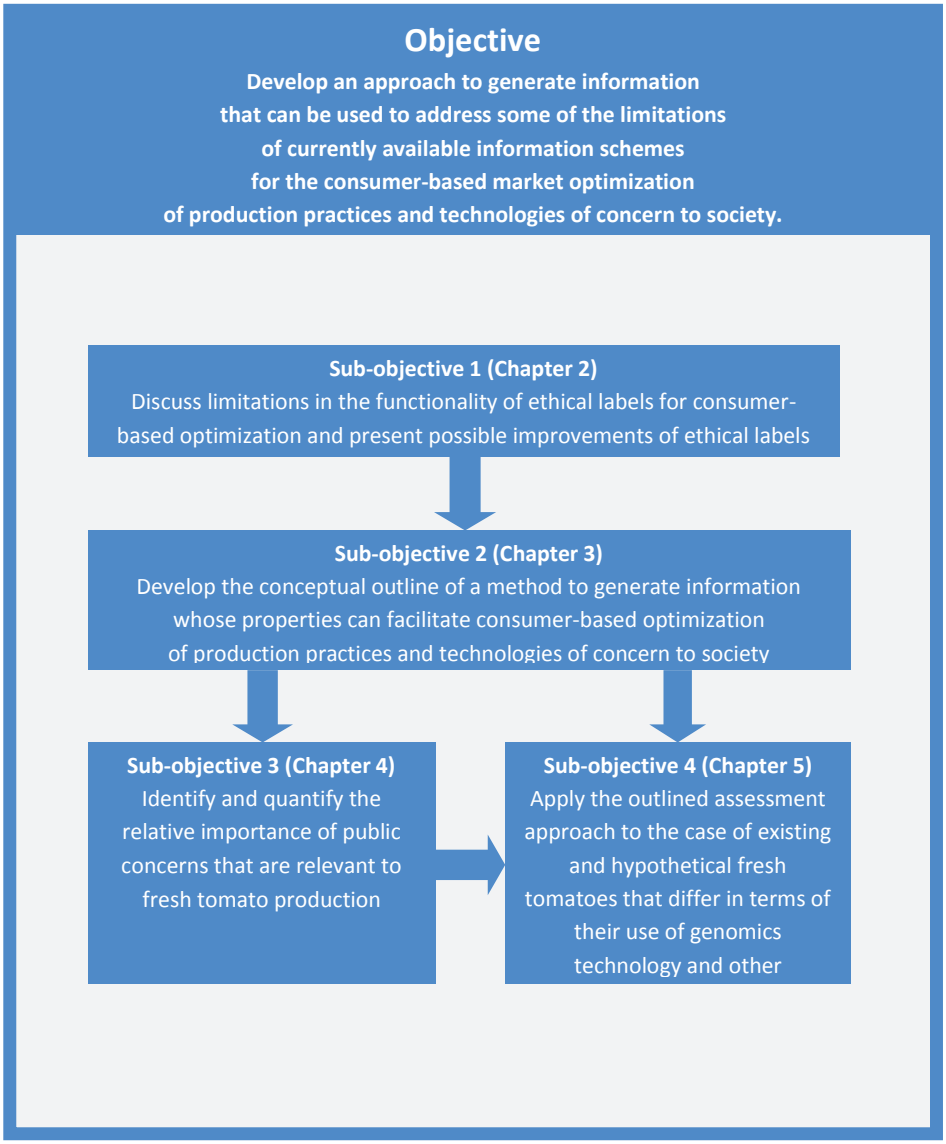

Figure 1: Outline of objectives and sub-objectives. Arrows indicate the flow of output from addressing each sub-objective.

4. Thesis Outline

Chapter 2 provides the conceptual background of this thesis. It identifies limitations in the functionality of ethical labels denoting third-party certifications (which are the most credible types of information on unobservable production aspects available to consumers) for the consumer-based optimization of ethical production aspects production aspects. Based on that analysis, Chapter 2 discusses an adapted version of a frequently used type of label that does not share the identified limitations, and proceeds to discuss its expected functionality in market optimization. It concludes by calling for the development of methods to generate the required type of information, and for further research of its effects.

Chapter 3 presents the conceptual outline of an assessment framework designed to generate the type of information suggested in Chapter 2. This outline mainly focuses on input and output information flows, defines conditions for the selection of assessment criteria and weights. It discusses a product ranking method that can be used to assess products, and describes the overall function of the framework.

Chapter 4 presents and discusses a statistical analysis of survey results that indicate the relative importance attached by consumers to a list of 21 criteria relevant to fresh tomato production. The survey concerns the stated ethical preferences of a small and local consumer sample for four categories of concerns: Healthfulness, Environmental impact, Naturalness and Fairness of production. It includes four socio-demographic parameters: food outlet, gender, age, and educational level.

Chapter 5 uses the assessment criteria and weights presented in Chapter 4 and the ranking method introduced in Chapter 3, to illustrate the generation of the type of information suggested in Chapter 2. Four existing and seven hypothetical fresh tomato production options are assessed. Special emphasis is given to different plant genomics technology applications.

Chapter 6 provides the general discussion of this thesis. It presents a synthesis of results from previous chapters, which describes how the investigation of the sub-objectives contributes to achieving the overall objective of the thesis and also discusses the contributions of the thesis to the literature. Chapter 6 also identifies limitations of the data and methods used in this research and outlines business, policy and research implications.

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CHAPTER 2

The Citizen Goes Shopping:
Towards ethical labels that work

Tassos Michalopoulos

1. Introduction

> "Whenever there are "externalities"—where the actions of an individual have impacts on others for which they do not pay, or for which they are not compensated—markets will not work well. Some of the important instances have long understood environmental externalities. Markets, by themselves, produce too much pollution. Markets, by themselves, also produce too little basic research. [...] But recent research has shown that these externalities are pervasive, whenever there is imperfect information or imperfect risk markets—that is always." (Stiglitz 2006)

> "The theories that I (and others) helped develop explained why unfettered markets often not only do not lead to social justice, but do not even produce efficient outcomes. Interestingly, there has been no intellectual challenge to the refutation of Adam Smith's invisible hand: individuals and firms, in the pursuit of their self-interest, are not necessarily, or in general, led as if by an invisible hand, to economic efficiency. The only question that has been raised concerns the ability of government to remedy the deficiencies of the market." (Stiglitz 2007)

Environmental, fairness, animal welfare, naturalness and healthfulness aspects of the real economy are the shared subject matter of economic analyses of production externalities, ethical analyses of public concerns, and of stakeholder efforts to stimulate corporate social responsibility. There is reason for this attention. The present state of aspects of production that fall within these categories limits the efficiency of market optimization outcomes, risks multiple irreversible adverse environmental effects, fuels critiques of the democratic credentials of contemporary market economies, and incentivizes social instability (e.g. Stiglitz 2001; Hertz 2001; Reich 2007; Worm and Branch 2012; IPCC 2013; Piketty and Goldhammer 2014; Park 2015; Urban 2015; Rundlöf et al. 2015; OECD 2015; 350.org 2016; Wikipedia 2016; NASA 2016).

These production aspects are subject to 'information asymmetry': Impact on climate and on biodiversity, the distribution of profits, the treatment of labor and production animals, the technologies used, as well as the tolerance levels for non-acute consumer health risks, are all credence goods that are unobservable as product attributes: Consumers cannot differentiate products according to the levels of these attributes by using their senses either before or after consumption. Interestingly, unobservable are all attributes that relate to endangered public goods (like environmental impact) and also the entire set of attributes that relate to altruism

and solidarity (like effects on labor and on animals). Namely, unobservable are all attributes that correspond to concerns commonly referred to as 'ethical'. Contrarily, the observable category is composed of 'use' attributes (like product taste and function) that relate exclusively to narrow consumer self-interest.

As a consequence of information asymmetry, the consumer-based optimization of credence goods is impeded by what is referred to as "information barriers" (e.g. Ecofys 2014, 76). Namely, by limitations in the availability and quality of relevant information. This is true for ethical goods: To reveal preferences on credence goods, consumers need information on product performance for the corresponding unobservable attributes before a purchase takes place. If that information is absent, then these preferences are not revealed in the market and rational profit-maximizing suppliers have no incentive to take ethical preferences into account. Then, as well as when information is imperfect (Stiglitz 2001), markets for unobservables fail:[5] Markets do not provide optimal levels of unobservable attributes, and consumers do not maximize their utility or the satisfaction of their preferences, insofar ethical goods are concerned. To say that rational profit-maximizing suppliers have no incentive to take ethical preferences into account, is not to say that the supply of credence goods just remains unaffected by the optimization process. Contrarily, credence goods are generally[6] undersupplied to the extent that they actually deteriorate[7] because rational profit-maximizing suppliers have a market incentive to minimize costs associated with unobservable attributes for as long as these cannot be detected by consumers.

[5] Adverse effects of imperfect information on market optimization were identified by George Akerlof, Michael Spence, and Joseph E. Stiglitz in their 'analyses of markets with asymmetric information'. These effects include moral hazard, adverse selection, rents, and the free-rider problem, which are referred to in passing in the remainder of this article. Herbert Simon also identified cognitive constraints in gathering and processing information, among the factors that "bound" individuals from making rational optimization choices. This suggests that easily accessible and easy to understand information contributes in rationalizing consumer choices, and permeates the argument for intuitive front-of-pack labeling.

[6] Unless improvement of performance for unobservable characteristics is positively coupled to production efficiency and, therefore, to economic gains: For instance, to reduce production costs, fish farms tend to reduce environmental emissions while improving feed use efficiency (Tlusty 2012). In these cases, rational profit maximizing suppliers have an incentive to improve ethical performance that does not depend on consumer preferences.

[7] As compared to some basic reference situation, like for instance to non-globalized local markets where consumers have some knowledge of production's performance for credence goods like environmental impact or treatment of labor by virtue of living in the same community with suppliers.

A plurality of approaches and schemes have emerged to undo information asymmetry and to create consumer markets for ethical goods. Broadly perceived, this type of information includes commitments to codes of ethical conduct and corporate social responsibility reports, which are mainly communicated through press releases that consumers must gather and process. More readily accessible information is communicated through product labels. These include "self-declared, manufacturer-invented" ones (Saunders 2009), and also more institutionalized and standardized labels which are the focus of this article. This type of labels signify third-party issued and monitored certifications (Bernstein and Cashore 2007) that can be state-sponsored or not. Environmental, social, and economic effects of these information schemes are analyzed in an extensive and rapidly growing literature. Nevertheless, their functionality for the consumer-based market optimization of the corresponding production aspects has received little attention. This is not consistent with the central role of consumer preferences satisfaction in neoclassical economic theory, and also with the extensive use of market optimization as substitute for command and control regulations in democratic societies.

This article contributes to the literature by making a conceptual analysis of ethical labels from the perspective of consumer-based optimization. This means that labels are not approached as instruments meant to achieve an incremental level of improvement in production practices by informing consumers on whether products meet a certain level (standard) of ethical performance. Instead, labels are examined as instruments meant to enable market optimization of ethical aspects based on the law of supply and demand. According to standard neoclassical economic theory (Lancaster 1966), this perspective requires perceiving ethical aspects of production as product characteristics (i.e. attributes) the levels of which are to be optimized. Optimization requires that consumers make tradeoffs between levels of different characteristics, so as to choose "bundles of characteristics" (i.e. products) that yield maximal utility or satisfaction of their subjective preferences. As noted, while this process can happen in an unassisted way for observable attributes, in the case of unobservables it depends upon information. In this context, the desired function of information is to 'transform' unobservable attributes into observable ones, in order to achieve (based on normal market forces) a market outcome that is optimal also with regards to the levels of ethical unobservables. Therefore ethical aspects are perceived as attributes like all others, and which merely happen to suffer from unobservability.

This approach, i.e. to examine ethical labels as means for consumer-based optimization of ethical aspects in production, inevitably relates this article to a vivid

public discourse and a growing body of literature concerned with the democratic control of market economies (e.g. Hertz 2001; Reich 2007). This connection becomes apparent when the role of market optimization in governance is considered. Market democracies offer to their members two mutually non-exclusive options for direct positive action at the level of members of society: to vote and/or to shop. Voting and shopping are both regarded here as 'democratic' options because they provide lay members of society with constructive and roughly proportional access to decision-making on aspects of concern: In their function as citizens, members of society can vote for governments that enact policies to address their concerns. In their function as consumers, members of society can reveal preferences that steer markets towards production choices that align with their preferences. This type of consumption is known as 'ethical' or 'political' consumerism (Stolle 2005; Harrison, Newholm, and Shaw 2005, 25; Deirdre Shaw, Terry Newholm, and Roger Dickinson 2006). Once market-based optimization is perceived as an alternative to state regulation within the context of democratic decision-making, it becomes meaningful to examine to what extent the demand-side of the intended allocation of resources expresses the preferences of consumers.

Accordingly, the objective of this article is to discuss limitations in the functionality of ethical labels for consumer-based optimization and present possible improvements of ethical labels. The next section examines functionally limitations stemming from four properties that are widely common in ethical labels. Next is examined the development of an ethical label that addresses these limitations. The suggested type of ethical label is based on a type that is commonly used for unobservable use attributes (e.g. energy labels). The last section discusses likely effects from using the suggested type of ethical labeling.

2. Imperfections in the dominant ethical labeling approach

2.1. Single-grade, voluntary, static, and stakeholder-defined information

Labels can be divided in two main categories: 'endorsement' labels and 'comparative' labels. The first type of labels indicates that a product achieves a certain standard, while the second type indicates product performance for ethical attributes as compared to the rest of the market(Brown and Caithness 2014). Ethical labeling is dominated by endorsement labels (see e.g. Ecolabel Index 2016).At least four features that are common among endorsement schemes limit the functionality of information conveyed by these labels for consumer-based optimization of

unobservable ethical attributes. These features are briefly introduced below, and their interweaving effects on consumer-based optimization are analyzed in the remainder of this section.

a) Ethical labels are mostly 'single-grade' (binary): Most consist of a single certification grade that informs that a product 'endorses' (i.e. respects, satisfies, achieves, complies to) the standard set by the certification scheme behind the label.
b) Ethical labels are typically 'voluntary': Suppliers decide whether to adopt them or not on a voluntary basis. A notable exception is the EU-wide system of compulsory labeling on animal welfare for table eggs (EC 2016).
c) Ethical label standards are typically 'static': The performance threshold levels required by endorsement labels, and also by those comparative labels that use predefined categories, are non-dynamic (they have fixed values that are not a function of market dynamics).
d) Ethical label standards are invariably stakeholder-defined: The technical meaning of labels, namely the criteria, their relative importance, and performance thresholds that constitute the terms of assessment of a certification standard, are derived from stakeholder opinion.

2.2. Single-grade

The number of certification grades affects the allocation function of the market regarding ethically-relevant production practices. Tlusty (2012) reviewed research by previous authors and calculated that single-grade environmental labels "translocate" the distribution of producer practices by creating a zone of "pull" before the certification threshold and a sharp decline after: Suppliers performing at a level near below the certification requirements are incentivized to improve and get certified, while suppliers far below these requirements have less incentives to improve because certification "is likely beyond their technical or financial means". Moreover, the shape of the distribution curve above the threshold is usually concave because certified suppliers lack incentives to improve beyond threshold; unless improvement is positively correlated to economic efficiency (Tlusty 2012). However, "With [single-grade] labelling there are two prices clearing the market, since the label makes it possible to identify the two qualities by segmenting the market" (Van Tongeren, Beghin, and Marette 2009 [OECD]). If a simplified model that regards only domestic production is assumed, the second quality is set by the minimal requirements defined in law (e.g. in environmental, labor, or animal welfare law). Other qualities

besides these two –which means every other performance level for unobservable attributes that is not represented by a labeling grade– will not be identifiable by consumers and therefore will not yield a new price to incentivize producers achieve that performance. Based on these, Fig.1a complements Tlusty's model by applying the same reasoning on an added legal threshold 'T_L' to the left of the certification threshold 'T_C'. This figure visually illustrates the sub-optimal allocation function of single-grade labels. The distribution of ethically-relevant supplier practices incentivized by a single-grade label deviates greatly from normality, while by reasonable assumption (because of the very large number of consumers and the absence of apparent reasons to the contrary) the distribution of ethical preferences among consumers can be expected to be rather normal.

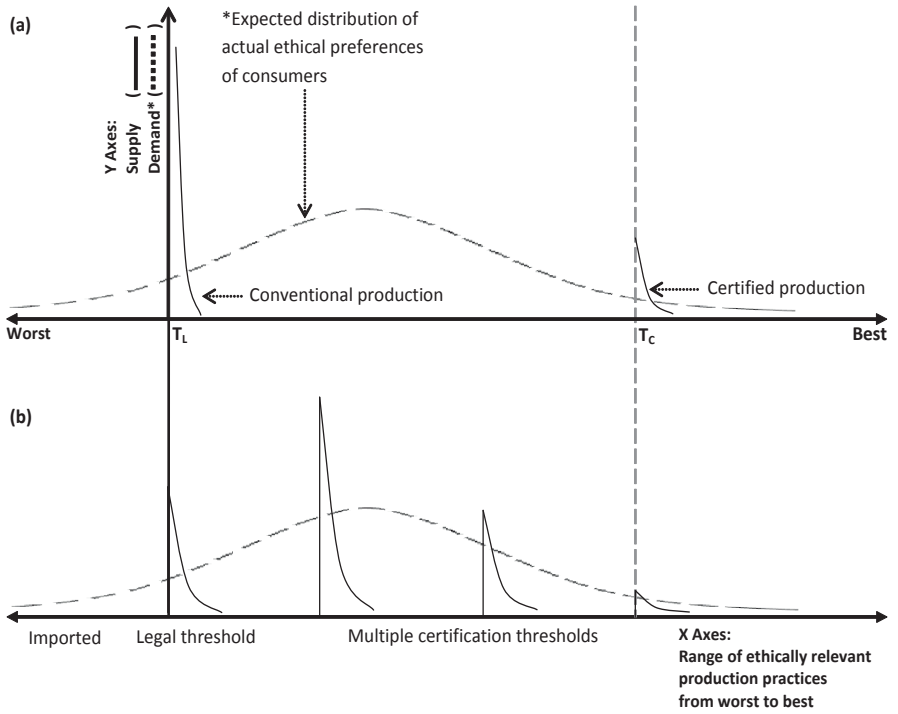

Figure 1. 'T_L', 'T_C': Threshold values that represent, respectively, the legal and certification requirements for an ethically-relevant production practice. **(a)** The distribution of ethically-relevant production practices (supply) that is incentivized by a single-grade label, as compared to the expected distribution of actual ethical preferences of consumers (demand). **(b)** Modification of the above in the case of multi-grade schemes.

The simplified model of Fig.1a differs from reality in that it does not account for the phenomenon that a large number of single-grade schemes with similar standards often coexist in the same markets(see e.g. Ecolabel Index 2016). Taken together, a series of single-grade schemes could work synergistically to act as a multi-grade one (Tlusty 2012). Fig.1b illustrates that a multi-grade label, or a system composed of multiple single-grade ones, can incentivize the market to arrive at a distribution of supplier practices that resembles more closely the expectedly normal distribution of preferences among consumers. However, besides other requirements identified in the literature (Tlusty 2012), the synthesis of single-grade certifications into a composite multi-grade one requires to rank its single-grade parts against each other with regards to their performance for a common dimension of consumer concern.[8] In addition, this ranking of different certifications should be available to consumers. For as long both of these requirements are not met, a large number of single-grade tiered schemes does not function as a multi-grade one. Furthermore, as discussed below, the synthesis of single-grade schemes into a multi-grade one is likely to be limited to high performance grades, because the communication of information about unfavorably low performance is unlikely in a voluntary certification context.

2.3. Voluntary

The voluntary nature of information schemes has a negative effect on market optimization. A direct effect of voluntariness is that information barriers persist for non-certified products. This concerns especially 'negative' information: i.e., information that indicates low product performances for unobservable ethical attributes.

Negative information is unlikely to be communicated voluntarily by suppliers because it might be unfavorable to a business. The corporate social responsibility (CSR) literature suggests that the reputation damage suffered by firms when

[8] The system of "tiered" single-threshold certifications that develops around the Marine Stewardship Council (MSC) certification offers an example of a system of single-grade labels that could exhibit this function (Bush and Oosterveer 2015; see also Bush et al. 2013). Relevantly, the MSC certification has developed a "benchmarking and tracking tool" designed to assess the status of less demanding (left hand side) schemes in relation to the MSC standard (their progress towards MSC pre-assessment). This type of assessments, if extended also to the right hand side of a scheme and if communicated to consumers, could create a composite multi-grade scheme from single-grade ones.

negative information becomes public is a main "business-case" incentive for CSR because it leads to reduction of sales, ethical divestment, drop of employees' morale and decreased ability to attract qualified employees (N. C. Smith 2007; Higgins 2010; Carroll and Shabana 2010). Several studies also indicate that information on low ethical performances motivate a measurable segment of consumers to engage in product or firm boycotts (Monroe Friedman 1999; Klein, Smith, and John 2004; Hoffmann and Müller 2009; Neilson 2010). Moreover, the limited market data and experimental evidence available suggest that information about low ethical performances offers a much stronger incentive for ethical consumption than information about high ethical performances.[9] These indicate that information on low ethical performances is a valuable driving force for market-based optimization of ethical issues. However, these also explain why it is irrational for suppliers to communicate voluntarily negative information. Indeed, suppliers generally appear unwilling to disclose credible ethically-relevant data that might be assessed negatively by consumers and other stakeholders.[10]

The result of supplier unwillingness to disclose voluntarily unfavorable information is that voluntary information schemes, either single-grade or multi-grade, at best cover only the segment of traded products that can be assessed favorably. Therefore, under voluntary labeling approaches the sources of negative information are mainly limited to 'leaks' by whistleblowers and to 'naming and shaming' campaigns by civil society activists (Feddersen and Gilligan 2001). At the same time, sources of positive information on the ethical performance of non-certified production are mainly limited to self-issued labels, CSR reports and brand promotion campaigns by

[9]For instance and as discussed later in this article, a remarkable ethical shift observed in the British and Dutch eggs market mainly consists of decreased consumption of ethically worst products (i.e. of 'caged' eggs), rather than increased consumption of best products (i.e. of 'organic' eggs). Similarly, in a comparative carbon labeling experiment by Vanclay et al. (2010), the reduction in consumption of most polluting products was greater rather than the increase in consumption of least-polluting products. In both cases, the difference was gained by middle-performing products.

[10] Real-world examples are abundant. They include high profile cases of food biotechnology industry's opposition to disclosure of genetic modification data to European and US food consumers, electronics industry's secrecy on labor conditions at subcontracted offshore factories, and industrial lobbying for the criminalization of unauthorized whistle-blower investigations of animal welfare in factory farms. Widespread avoidance of reporting negative data on the Dow Jones Sustainability Index led Sridhar and Jones to wonder whether the few highly-transparent firms become reluctant to publicize low CSR performances in order to avoid appear worse than non-transparent firms (Sridhar and Jones 2012).

suppliers. Therefore, information on uncertified production is sporadic in time because it typically refers to major events and major corporations; spatially scattered because of its diverse sources; and it is vulnerable to manipulation by all types of interest parties because it is not institutionalized. Consequently, gathering and processing information on non-certified production has increased cognitive costs that bound consumers' ability to make optimal decisions. Particularly with regards to information on low performances, this reaches the majority of consumers only when effects of production practices are severe or large-scale enough (i.e. they affect for instance a substantially large region, number of people or animals) to create headlines. Therefore, consumers remain effectively uninformed on the performance of most uncertified products. This entails that the power of negative information as a driver for ethical optimization remains largely unutilized: It becomes by virtue of its scarcity much more relevant to sporadic ethical consumerism outbreaks (boycotts), than to a consistent and systemic utilization of ethical performances in consumer-driven market optimization.

Information asymmetries due to persisting information barriers regarding the performance of uncertified products can be exploited by suppliers that wish to communicate misleadingly positive information to consumers.[11] Communication of misleadingly positive information happens either by withholding negative information or by misreporting. Examples are "weak or unsubstantiated self-declared label claims" (Atkinson 2014) and misleading claims that are communicated through selective reporting in CSR reports and indices (Porter and Kramer 2006; Ten Kate 2011; Sridhar and Jones 2012), and also through advertisements. In the context of environmental concerns these practices are usually termed as 'greenwashing' (Laufer 2003; Ramus 2005; Lyon and Maxwell 2011; Delmas and Burbano 2011; Lynes 2015). Misleading brand promotion campaigns use subtle psychology-based normatively-charged colors, symbols and images to create unsubstantiated ethically positive impressions to consumers: "You will see the farm pictured on the package to suggest the product is close to Creation, free of contrivance, and authentic or expressive of rural virtues" (Sagoff 2001), even though the product sold is industrially-produced.

Theoretical defense of the communication of misleadingly positive information by suppliers dates back at least since the early days of the CSR debate literature. In a

[11] While this analysis focuses on misleadingly positive information by suppliers, the remedies sought must also address misleadingly negative information. Sources of misleadingly negative information can be third parties that have a relevant incentive, like civil society actors and competitors.

classic illustration of a rather outdated (though not eclipsed) business mentality behind the CSR problem, Albert Z. Carr boldly claimed in a Harvard Business Review article that "the ethics of business are not those of society, but rather those of the poker game": "from time to time every business man, like every poker player, is offered a choice between certain loss or bluffing within the legal rules of the game" (Carr 1968). Milton Friedman conceded this type of practices to be "hypocritical window dressing" "approximating fraud" "cloaks of social responsibility" (Milton Friedman 1970). However, Friedman also robustly –though conditionally– defended such practices and admitted that he could not summon much indignation to call on rational businessmen to denounce them "If our institutions, and the attitudes of the public make it in their self-interest to cloak their actions in this way".

Friedman's remark can be readily applied today: suppliers are not institutionally obliged to disclose to consumers the actual ethical performance of products, while the attitudes of the public often indicate preference for higher ethical performance than that set in law (e.g. in environmental or labor legislation). In such cases, the voluntary nature of informational institutions effectively makes it within the legal rules of the game to bluff using information cloaks of CSR that guise ethically inferior performance, instead of actually investing on the performance improvements preferred by consumers, when these improvements conflict with business self-interest.

The direct effect of misleadingly positive information is that it blurs the ethical differentiation of certified products, because it creates among consumers false impressions that uncertified products meet higher standards than they do in reality. This gives to uncertified production unjustified competitive advantage due to lower costs associated with lower ethical production standards. Consequently, the allocation function of the market is distorted as compared to the allocation that would be achieved if the ethical attributes at stake were observable. Broader adverse effects can also be significant. Akerlof (1970) studied markets where "dishonest" sellers exploit information asymmetry to create uncertainty about the quality of inferior products. Applied to this case, this would refer to ethically inferior products that are promoted as ethically superior ones. Akerlof's analysis indicates that "dishonest dealings tend to drive honest dealings out of the market", to the effect that "The presence of people in the market who are willing to offer inferior goods tends to drive the market out of existence". "The cost of dishonesty, therefore, lies not only in the amount by which the purchaser is cheated; the cost

also must include the loss incurred from driving legitimate business out of existence".[12]

– ***Voluntary single-grade schemes and moderately concerned consumers***

A particularly unfortunate effect of single-grade voluntary labels is that the market allocation they incentivize is suboptimal mainly with regards to the preferences of moderately concerned consumers. 'Moderately concerned' refers here to ethically concerned consumers whose preferences for ethically certified products are dominated by ethically-irrelevant ones. 'Ethically-irrelevant' refers for instance to preferences about product price, taste and convenience of retailer. In the simplified model of Fig.1a, the segment of consumers with actual ethical preferences above T_C will reveal preference for T_C because that provides the highest standard available in the market. The segment above T_C consists of strongly concerned consumers. By purchasing certified products, even when these fall short of their actual preferences, these consumers at least succeed to affect the allocation function of the market towards their desired direction. The segment of consumers with preferences between T_L and T_C consists of moderately concerned consumers. Besides consumers with relatively low concern about the ethical implications of their consumption, this segment also includes otherwise strongly concerned consumers, who are nevertheless categorized as moderate by virtue of time constraints that prevent them from visiting multiple or inconveniently located retailers. Whether this type of consumers can reveal preference for T_C depends upon retailer choices regarding the range of certified products to be available in store. The segment between T_L and T_C also includes income-constrained consumers (Carrigan and Attalla 2001; Bray, Johns, and Kilburn 2010; Grunert 2011) with a strong preference for ethical production. This includes for instance low-income consumers with preference and need for ethical production, which however cannot afford to purchase products certified as "Fair" or "Ethical" because of the price premiums attached to ethical labels. To affect the market allocation of ethical production practices in a systematic way, moderately

[12]Akerlof's analysis requires lower quality products and higher quality products to trade at the same price, so that price is not an indication of quality. However, as Lancaster observed high price does not need to indicate superior quality (Lancaster 1981). If the ethical superiority of certified products is successfully –though dishonestly– blurred by informational bluffs and cloaks, then consumers might perceive higher prices as indicatory of inefficient production technologies. Or, inferior quality products might take advantage of the effectiveness of their promotion, as well as of the limited verifiability of and liability for using cloaks and bluffs, so as to level their prices with certified products (Dulleck and Kerschbamer 2006).

concerned consumers must reveal their ethical preferences through the purchase of uncertified products.

However, the territory below T_C is ruled by uncertainty. The absence of certified and monitored information means that the ethical performance of products is unknown to consumers. In the best case scenario, to reveal ethical preferences moderately concerned consumers will rely on information that is self-issued by honest suppliers. What part of self-issued information is honest is not obvious: This territory of uncertainty is precisely where Akerlof's dishonest sellers use Friedman's cloaks to make Carr's bluffs. Moreover, in the area below T_C consumers unknowingly also encounter products that perform even below the minimal legal standards T_L set for domestic production. This happens when state regulation cannot prevent market access to products from locations with lower environmental or labor standards, a segment of which is using sweatshops or polluting technologies to minimize costs (Holmes et al. 2008; Bernaciak 2012). Gathering and processing relevant information, as well as discerning what part of the confusing plurality of available information is honest, imposes added cognitive costs that will bound the rationality of consumer choices; if not lead consumers abandon this task altogether.

Consequently, the absence of certified information on ethical performances below T_C makes it difficult if not impossible to validly identify the most ethical among non-certified products. Therefore, moderately concerned consumers are bound from making optimal trade-offs between lower levels of ethical characteristics and different levels of ethically-irrelevant ones. Worse, particularly when consumers fall victim of ethical bluffs made by dishonest suppliers, or when they unknowingly purchase products that perform below the minimal legal standards T_L, moderately – yet positively– concerned consumers are perceived not only inaccurately but also counterproductively in market optimization as unconcerned. These effects suggest that single-grade and voluntary information schemes not only allocate sub-optimally as discussed previously, but moreover that they are particularly problematic in capturing the ethical preferences of moderately concerned consumers, which by reasonable assumption includes most of society.

2.4. Static

Endorsement labels generally signify achievement of certification standards composed of threshold levels for assessment criteria. These threshold levels indicate the minimum performance that products must achieve to qualify for certification, or

for a certain grade of multi-grade labeling schemes. Owing to being designed for bringing incremental improvement in production practices, these standards are generally 'static' –as opposed to 'dynamic'– in the sense that the levels of certification thresholds are fixed in time until the formal revision of a standard by the authorized body. Fixed threshold levels do not evolve with the evolution of relevant performances among marketed products: They are not a function of the range of performances among marketed substitutes, and remain unaffected by the appearance of better (or worse) products in the market. An example of dynamic certification thresholds is given by a UNEP (2013, 85) report, which refers to endorsement labels attributed to products that "are in the top range of performance". Such excellence-based thresholds can require from a product to be, for instance, among the 15-25% top performers for specified assessment criteria in order to be certified (*ibid*.). Consequently, the precise level of dynamic thresholds fluctuates according to the state of relevant technology and practices applied in production, such as the use of environmentally friendly technological innovation or the levels of labor wages. (This is not to say that this type of certification thresholds work better than static ones in the context of voluntary single-grade labeling.)

Static thresholds have the optimization drawback that they do not provide incentives for improvement beyond the certification standard (e.g. Tlusty 2012).[13] Therefore, the creation of demand for additional improvement, and for innovation that enables this improvement, requires the upwards revision of certification standards. This would correspond to moving T_C to the right of its current position (Fig.1a). Standard revision is a complex, time-demanding and, therefore, infrequent process.[14] Moreover, standard revision is subject to incentives for "more relaxed" (lower) instead of higher standards so at to improve the reach of a voluntary certification scheme among suppliers (Bernstein and Cashore 2007).

The ineffectiveness of the static-threshold approach becomes apparent once it is contrasted to the pace of improvement of observable product attributes. Consider for instance an experience attribute like the processing speed of smart-phones and of computers. In this case, there is no static performance threshold at which a computer processor is fast enough. Contrarily, and similarly as for other observable

[13] With regards to this limitation, static-threshold certifications resemble "command and control" regulations such as state regulation of the market (e.g. Sunstein 1990).

[14] Characteristically, the ISO 26000 (2010) standard for "guidance" on social responsibility "was launched in 2010 following five years of negotiations between many different stakeholders" (representatives from government, NGOs, industry, consumer groups and labor organizations) across the world. ISO standards are revised every five years.

attributes, there is an implicit consumer acceptability threshold that is dynamic and market-defined. This is set by the evolution of processor speed among marketed products, and is continuously raised by suppliers that compete in incorporating innovative technology to improve the speed of their products. In this continuous race for improvement, novel improvements by competitors effectively downgrade in the eyes of consumers the performance of products that until that moment were regarded satisfactory. That is to say, as combined with consumer awareness of all levels of product performances, dynamic standards create the inherently 'free-market' optimization dynamics spontaneously at work in the well-studied and much less problematic markets for observable attributes: In these markets, products and firms must continuously innovate and improve, or else they will become obsolete and vanish. Although this dynamics is business as usual in markets for observables, it sounds alien in markets for ethical attributes that are ruled by the dominant information approach of voluntary and single-grade static compliance labeling.

In short, the dominant approach in ethical labeling does not unleash market forces from the leashes of unobservability, and keeps the market's capacity to optimize the ethical aspects of production largely unutilized.

2.5. Stakeholder-defined

> "If the purpose of capitalism is to allow corporations to play the market as aggressively as possible, the challenge for citizens is to stop these economic entities from being the authors of the rules by which we live." (Reich 2007)

With the exception of single-issue labels whose single criterion is accurately captured by the label's title, assessments of product performance for unobservable ethical attributes are always to some extent subjective. This subjectivity permeates less sophisticated information approaches based on non-standardized assessment tools like Triple Bottom Line analyses, and is not avoided even by the most well-meaning and scientifically robust certification schemes available, like those based on comprehensive Life Cycle Analyses and rigorously science-based multicriteria assessments. Specifically, subjectivity enters assessments meant to inform consumers on the ethical performance of products through three aspects of assessment methods. These are the definition of (a) assessment criteria, (b) relative importance weights used to aggregate product performance for different assessment criteria, and (c) threshold performance levels that products must achieve to qualify for single-grade certifications, or for a certain grade of multi-grade labeling

Box 1. Subjectivity in the terms of science-based ethical assessments

The subjectivity of weights is a common weakness of assessment methodologies that aggregate performance of indicators with different dimensions. To clarify, if e.g. emissions from activity A is X, emissions from activity B is Y, and activity A happens twice as often as B, then total emissions of A+B are 2/3*X+1/3*Y: Which is objective. Contrarily, to regard that the socioeconomic category is Z times more important than the environmental category is subjective. Weighting cannot be avoided by simply averaging performance for different indicators because an average implicitly assumes that parts are equally important. Using equal weights without justification is a subjective value judgment as arbitrary as choosing any other set of weights. Life Cycle Analyses (LCA)-based certifications are vulnerable to this subjectivity: "Because weighting is not a scientific process, it is vital that the weighting methodology is clearly explained and documented. Although weighting is widely used in LCAs, the weighting stage is the least developed of the impact assessment steps and also is the one most likely to be challenged for integrity. […] Several issues exist that make weighting a challenge. The first issue is subjectivity. According to ISO 14042 [(2000)], any judgment of preferability is a subjective judgment regarding the relative importance of one impact category over another. Additionally, these value judgments may change with location or time of year. […] The second issue is derived from the first: how should users fairly and consistently make decisions based on environmental preferability, given the subjective nature of weighting? Developing a truly objective (or universally agreeable) set of weights or weighting methods is not feasible." (SAIC 2006). "ISO 14044:2006 [(2006)] generally advises against weighting, stating that 'weighting, shall not be used in LCA studies intended to be used in comparative assertions intended to be disclosed to the public.' This advice is often ignored, resulting in comparisons that can reflect a high degree of subjectivity due to weighting" (Trusty 2010). "If desired the LCA study can be concluded with a single figure, or environmental index, in which each environmental problem is weighted in terms of its importance. This figure or index allows an easy and direct comparison of different products or options. The weights used are of course subjective." (De Haes and Van Rooijen 2005). Weights are important because they can transform trivial aspects into decisive, and the other way around: "Different interpretations of the weights assigned to each of the principles by different people preclude a definitive ethical judgment" (Mepham et al. 2006). Subjective aspects of rigorously science-based certifications, such as the Marine Stewardship Council (MSC) certification and vertically differentiated satellite labels, include threshold-setting. Relevantly, Bush and Oosterveer concluded that "What these results ultimately show is that the emergence of any quality standard is not the predetermined reflection of a rational or scientific process, but instead a negotiated process open to social dynamics within and external to the supply chain" (Bush and Oosterveer 2015). Subjective aspects of non-comprehensive assessments such as Triple Bottom Line-based ones include the selection of assessment criteria (Porter and Kramer 2006; Ten Kate 2011; Sridhar and Jones 2012). Mayer and Stirling (2004) nail the relevance of criteria selection to the meaning of generated information by remarking that "Those who choose the questions determine the answers" of ethical assessments.

schemes. These aspects of ethical assessments define 'what issues matter' and 'how much do they matter' within a certain category of concerns in production. They define a certification's standard, and specify what a label regards to be, for instance, 'Green' or 'Fair' or 'Animal friendly'. Subjectivity enters the definition of these assessment aspects because they often involve value judgments that relate to one's opinion, ideology or interests, and which (as Wynne phrased it in the related context of participatory technology development) "relate to the science […] but are not scientific issues" (Wynne 2007). A more detailed overview of the subjectivity of assessments meant to inform consumers on the ethical performance of products through certification and labeling is provided at Box 1. This subjectivity of ethical assessments must be somehow addressed for information on product performance to be produced.

In the dominant and WTO-endorsed approach, the above types of subjectivity in ethical assessments are addressed by referring to stakeholder opinion. Third-party labels rely on consensus politics among stakeholder panels that increasingly include representatives of societal groups. This multi-stakeholder approach aspires to improve legitimacy by improving accountability to broader affected publics and "to 'democratize' global governance" with improved collaboration and deliberation "among states, business, and the civil society" (Bernstein and Cashore 2007). The dynamics of these processes are captured in reviews of the "political economy" of label standard-setting (B. E. Roe, Teisl, and Deans 2014; also Bush and Oosterveer 2015). This political economy is well-summarized by Bonroy and Constantatos (2015), who remark that "The introduction of a label or a modification of its standard creates gainers and losers, who stand on opposite sides with respect to implementing such regulatory intervention. […] The relative political power of such groups, as well as the benefits at stake, will most likely shape the type of regulation finally observed."

The multi-stakeholder approach is progressive as compared to self-declared, manufacturer-invented labels (Saunders 2009; Atkinson 2014) that are self-defined, self-issued and self-monitored by individual suppliers. Nevertheless, it is 'democratic' at the level of stakeholders and not democratic at the level of the members of society. Obviously, the opinion, ideologies and interests of involved stakeholders might often differ from the collective opinion in society about what matters and how much in production. When this happens, the technical specifications of ethical labels differ from what consumers believe that a label signifies. Conspicuous real-world examples where the supply side requirements of a label deviate from its demand

side understanding include ‘natural’ food that might be genetically-modified or contain hormones and pesticides (Rock 2016), ‘free range’ chickens that are bred indoors (Foer 2010, 61), and industrially-produced ‘organic meals’ (Pollan 2001). Smaller deviations of this type are rather commonplace among voluntary endorsement labels. This is because rational supply-side stakeholders will adopt a certification standard voluntarily only if that is compatible to their strategic interests. Therefore, rational profit-maximizing suppliers have reason to resist the inclusion of certain assessment criteria either entirely or at levels that are too costly to address. Accordingly, “some entrepreneurial environmental groups have opted for a ‘third way’ of initiating programs that fit the NSMD [i.e. non-state market-driven] governance category, but with more relaxed standards than earlier programs” (Bernstein and Cashore 2007). Particularly the need to respect economic parameters is inevitably present even in the context of standards-setting for “low input” animal production such as organic (Jensen et al. forthcoming).

While this ‘relaxing’ (which means lowering) of ethical standards to respect economic concerns of suppliers might be rational in the context of voluntary labeling, it is nevertheless problematic from the perspective of consumer-based optimization. The consideration of economic issues such as production costs by ethical assessments is inconsistent with neoclassical economic theory. As indicated by Lancaster (Lancaster 1966), market optimization presupposes that consumers maximize their satisfaction from bundles of independent product characteristics (in this case ethical consumers of labeled products). Therefore, economic parameters are irrelevant to ethical assessments. This is because the reply to the analytical question “how much ethical is the treatment of this human or animal?” simply does not depend upon the cost of that treatment. While the final decision on how to treat an animal or a human might require to consider both ethical and economic inputs, (particularly if a utilitarian cost-benefit calculus is used,) the said ethical input in itself should only indicate how the treatment under examination compares to the ideal treatment of the said human or animal from an ethical perspective. Accordingly, labels that convey information meant to enable consumer tradeoffs between product price and ethical performance must assess the ethical performance of products strictly based on ethical criteria that are relevant to the particular ethical aspect assessed (i.e. e.g. independently of production costs), if those tradeoffs are to be optimal from a market optimization perspective. Otherwise, if economic parameters are allowed to affect ethical assessments, then economic aspects are double-counted during the market optimization of ethical issues: They are counted one time while stakeholder panels define ‘what is’ ethical performance, and a

second time when consumers assess different levels of that performance against product price. In practice, by affecting ethical assessments, supply-side interests in effect bias the demand-side of market optimization. Consequently, they also bias market optimization's ends. Consider for instance the US 'free range' label mentioned above: For as long technical specifications of "free range" permit indoor production that merely provides theoretical access to the outside (AWI 2016),[15] chickens farmed by rational profit maximizing suppliers will not spend their short lives running freely under the sky *regardless* the level of consumer spending for free range-labeled poultry. This example straightforwardly illustrates that labels whose subjective aspects do not capture the value-judgments of society malfunction as signals from the demand side to the supply side of the market.

The significance of this becomes apparent when ethical consumerism is perceived as a means for democratic (i.e. consumer-based) market optimization. Although consumers spend money on label premium to reveal a certain ethical preference with the expectation to incentivize suppliers to that direction, the demand-side incentives that are actually perceived by suppliers deviate from those intended and paid for by consumers. Regardless what preferences consumers may think they reveal by buying a certain labeled product, in reality the levels of unobservable attributes according to which consumers differentiate business performance are defined by the label's technical specifications (i.e. by the assessment criteria, weights, and thresholds used). Therefore, these specifications define the ethical terms with regards to which businesses compete, and consequently the ethical issues with regards to which the market optimizes. Consequently, the decision-making power to determine whether fairness or greenness includes one issue or the other, and how important is one issue as compared to the other, is not a trivial power: It is the power to determine no less than the societal goals towards the optimization of which the real economy will be allowed to evolve through the democratic path of consumer choice. For instance, the US Securities and Exchange Commission proposed since 2013 (Michaels 2013) and eventually decided in 2015 (SEC 2015) the public disclosure of CEO-to-Worker Pay-Ratio as mandated under the

[15] FSIS (USDA) only requires that birds have the ability to go outdoors and does not define "continuous, free access" or the number of doors, minimum door size, amount of outdoor space, or vegetation in the outdoor space. Producers can raise birds in a variety of ways like for instance packed by the tens of thousands into "a barn with a single, small door that provides access to a small, barren lot, and the door need only be open for a few minutes each day". Contrarily, consumer research indicates that consumers expect free range birds "to be able to move freely between the indoors and outside, have access to shade, and protection from weather or predators while they are outdoors" (AWI 2016).

2010 Dodd-Frank law. Despite the internationally widespread and often volatile public concern regarding extreme inequalities in income distribution, apparently no stakeholder-defined certification scheme enables consumer choice on pay disparity attributes by incorporating this type of indicator to its standard. Nor should that be normally expected by information schemes co-defined by large market players. On the basis of these, the stakeholder-based approach to addressing subjective aspects in standard-setting is suboptimal from the perspective of consumer-based optimization insofar it obstructs[16] the market optimization of certain unobservable production aspects of concern to society.

If the stakeholder approach to addressing the subjectivity involved in producing information on the ethical performance of products is sub-optimal, then the question remains how this subjectivity should be addressed. In a relevant remark, the guidelines for LCA published by EPA acknowledge that "LCA does not take into account […] social acceptance" (SAIC 2006). However, a meaningful angle from which to examine the problem of addressing this subjectivity is to ask precisely 'whose acceptance?', which implies 'whose value judgments?', should the subjective aspects of ethical assessments meant to inform consumers must take into account. The above analysis logically points towards adopting a 'societal assessment' approach to defining subjective criteria, relative importance weights and performance thresholds used in ethical assessments. Namely, to define subjective assessment terms based on public opinion about what matters in production within the domain defined by a label's scope, so that the produced information accurately informs consumers precisely about that.

A societal assessment approach implicates a twofold function for members of society in market optimization: First, members of society must define the unobservable attributes about which they are concerned. Second, after being informed by labels that report on product performance for these attributes, they

[16] Other obstructions include that different sets of stakeholders with variable aspirations, goals and interests result in an excessive plurality of similarly-titled labels that is confusing to consumers (Brécard 2014). For instance, in 2014 the Ecolabel Index listed about 455 eco-labels within 25 industry categories (Atkinson 2014). In line with the analysis provided by Akerlof (1970), contagion from less credible labels risk consumer trust in more credible labels (Giannakas 2002) and in labeling as an institution. By reducing the credibility of labeling, less credible labels invalidate ethical consumerism as a path towards democratic optimization. Another issue is that supply stakeholders might reject (Camp, Hooker, and Souza Monteiro 2009; Brownell and Koplan 2011) labeling approaches that relax cognitive bounds on rational consumer choice (Hersey et al. 2013).

must reveal individual preferences about different levels of that performance as compared to levels of other attributes like price, taste and function. This type of assessments (specifically: personalized assessments) are available online (Ethical Consumer 2016). However, to date no applied labeling scheme determines its terms by what matters and to what extent to society. Without doubt, a societal approach to ethical labeling introduces a whole new range of challenges, some of which are identified in following sections of this article. Moreover, it points towards compulsory labeling because suppliers of products that perform low for what matters to society are unlikely to communicate this information to consumers voluntarily.

3. Towards functional ethical labels

The logical way to achieve an optimally functioning market for ethical aspects of production is to provide information of a type that enables markets for ethical aspects to work as they would if the corresponding attributes were observable. The qualitative analysis of the previous section points towards labels that are compulsory; dynamic; multi-grade or continuous; and society-defined. These points are consistent with formal economic analyses. Roe and Sheldon (2007) suggest that a state-issued –either mandatory or voluntary–continuous labeling regime (and by reasonable assumption a discrete multi-grade regime with a well-considered number of grades) "delivers the same prices and qualities as would be delivered under perfect information, i.e., these labeling regimes are nondistorting". Bonroy and Constantatos (2008) also observe that their "analysis reveals that the difference between perfect and imperfect labels is not just quantitative, but also qualitative: perfect labels can never be welfare reducing, while imperfect labels can be so. Special care is, therefore, needed with the latter". However, perfect labels intensify competition and may reduce firm profits: "While such outcome is desirable to the extent that it benefits consumers, it also implies that voluntary labelling may not be functional, since even the high quality producer may in some cases wish to avoid it. In those situations mandatory labelling may be the appropriate solution". According to Bonroy and Constantatos (2008), factors that determine the degree of imperfection of a label are its accuracy and the trust consumers place on the organization that grants the label. Also, how easy it is for consumers "to understand" the label: Labels may "fail to restore full information" when consumers do not make full use of them because the labels' signal is unclear or insufficiently publicized. The

'accuracy' requirement is consistent with defining the subjective aspects of a label in accordance to the public understanding of what a label stands for. Namely, accurate 'natural', 'free-range', or 'fair' labels must signify what society regards to be natural, free-range and fair. Other research indicates that the use of grades (as opposed to continuous data), 'color-coding' (i.e. normatively charged colors assigned to performance grades), and front-of-pack labeling can increase a label's effectiveness by helping consumers to identify faster different levels of product performance for the unobservable attributes at stake (Wansink, Sonka, and Hasler 2004; Balcombe, Fraser, and Falco 2010; Food Standards Agency 2010; Watson et al. 2012; Ares et al. 2012; Hersey et al. 2013).

3.1. Use examples

Several information schemes that aim to enable consumer choice on unobservable attributes are largely consistent with the above requirements. These are generally termed as "comparative" labels, and are widely known from their application to the unobservable 'use' attribute of energy efficiency of electrical appliances.

As reported at a global report commissioned by the Department of Industry in Australia (Brown and Caithness 2014), throughout the world comparative energy labels for all product categories (either used or proposed) have more than trebled to 1149 in 2013 from 354 in 2004. During the same period, endorsement energy labels have more than doubled to 1002. About 80% of comparative labels are compulsory, while "more than 95% of all endorsement labels [are] voluntary and applicable to or targeted at the most energy efficient of products" (*ibid*.). Compulsory comparative labels permit no market segment to be ruled by uncertainty. They provide information that allows consumers to compare levels of energy consumption among all substitute products, including low performing ones.

In-store, energy labels often take the form of stickers applied on the front of exhibited products. Some convey only non-interpreted (non-graded) continuous data on product performance. For instance, US energy labels convey continuous raw data either on energy consumption or on the cost of energy consumption in dollars. This data is indicated on a scale that represents the range of performances observed in the market. This type of label is dynamic insofar the scale on which products are scored is updated as more efficient products enter the market: The end points of US energy labels are updated every year. The EU energy label indicates product efficiency using a number of grades. It is dynamic insofar new energy grades are

added on top of already existing ones through EC Directives, so as to capture technological innovation that improves the energy efficiency of electrical appliances in the market. The grades of EU energy labels are colored red (worst) to green (best), which makes it easier for consumers to discern the most efficient products. The thresholds of these grades are stakeholder-defined.[17] When grades are not directly proportional to energy efficiency they indicate only the order of appliances' efficiency (i.e. they provide qualitative information; not quantitative), and therefore their functionality for comparing different levels of energy efficiency to levels of other attributes such as price is reduced. Otherwise, energy labels allow little margins for inaccuracy because they report on a single and well-defined attribute (energy efficiency) that is well-captured by the label's title.

These features allow comparative energy labels to exhibit a dynamic optimization functionality which resembles that of observable attributes: Products that do not improve their efficiency are effectively downgraded when more efficient products enter the market. This functionality distinguishes comparative labels aiming in consumer-based market optimization, from endorsement ones that aim in stakeholder-based incremental improvement.

3.2. Developing an ethical equivalent to energy labels

The development of dynamic comparative labels that inform on product performance for societal concerns regarding composite (i.e. multi-issue) ethical (e.g. environmental or social) product attributes has received minimal attention in the literature. This task requires addressing methodological challenges that are not present in the case of single-issue and objectively-defined labels. Major methodological challenges are posed by the 'societal' (as opposed to 'stakeholder') perspective in determining subjective aspects of ethical assessments. The societal perspective needs to address several well-known shortcomings of public opinion. For instance, that public opinion is diverse, changes over time, and is vulnerable to scientific illiteracy, unjustified scares, hypes, populism, propaganda, non-objective media coverage (Boykoff and Boykoff 2007), and "psychological bias" that leads to selective sourcing and processing of information (Frewer 2003). Furthermore, public opinion must respect normative constraints. Democratic societies of the liberal tradition acknowledge normative restrictions upon the will of the public, for instance

[17] "Disadvantages: […] Conflicts with stakeholders during the implementation process are possible e.g. on the definition of the energy efficiency levels for the label classes: some may want the requirements to be stricter, some looser." (bigEE 2012)

insofar the majority ought not to be allowed to discriminate against the rights of minorities.

Application of appropriately adapted state-of-the-art political philosophy concepts and instruments might help overcome some of these difficulties. For instance, within the domains of deliberative and direct democracy have been developed and applied public deliberation instruments (Abelson et al. 2003), such as "deliberative polling" (Fishkin and Luskin 2005), that have demonstrated an ability to shift participant opinion towards more considered positions (Cabrera and Cavatorto 2009). These instruments could be complemented, as deemed appropriate, by established weights elicitation methods (e.g. see Hämäläinen et al. 2002). Relevant is also the concept of "reasonableness", as developed by John Rawls in "Political Liberalism" (1993), which demands scientific irrefutability and respect for the basic principles of justice (Streiffer and Hedemann 2005). Combined, a public deliberation process subject to a normative requirement for Rawlsian reasonableness, provide the means to extract from a representative sample of society collective, inter-subjective, well-considered, and reasonably-qualified assessment terms that are not arbitrary, subjective, poorly-considered, scientifically refutable, or unfair (such as discriminatory) within a politically liberal democratic context.

Relevant to the observed differences of opinion among members of society is the concept of "overlapping consensus"[18] (Rawls 1999, 340). As applied to this context, to observe an overlapping consensus would mean that members of society which ascribe to different worldviews and ideologies nevertheless agree at the level of specific issues at stake. This seems to be true with regards to the normative direction of certain unobservable ethical attributes: Notwithstanding the diversity of ideological perspectives, it seems uncontroversial to claim that members of society seem to generally share an analytic (i.e. if everything else is kept equal) agreement that less environmental emissions is better than more environmental emissions, less animal suffering is better than more animal suffering, and less unequal distribution of profits is better than more unequal distribution of profits. This consensus can support normatively-charged measures within the context of democratic governance. For instance, to term products as 'better' and 'worse', and to assign correspondingly charged color-coding on label grades can be justified on the grounds of the overlapping opinion of society. Accordingly, in the remainder of this article normatively-charged terms such as 'positive', 'better' and 'improved' signify changes

[18] The concept of the 'overlapping consensus' differs from the stricter and more elaborate concepts of 'strict consensus' and of 'reasonable overlapping consensus'. See Ch6:2.4.

to the direction that society regards as positive, better and improved (and the opposite for antonyms).

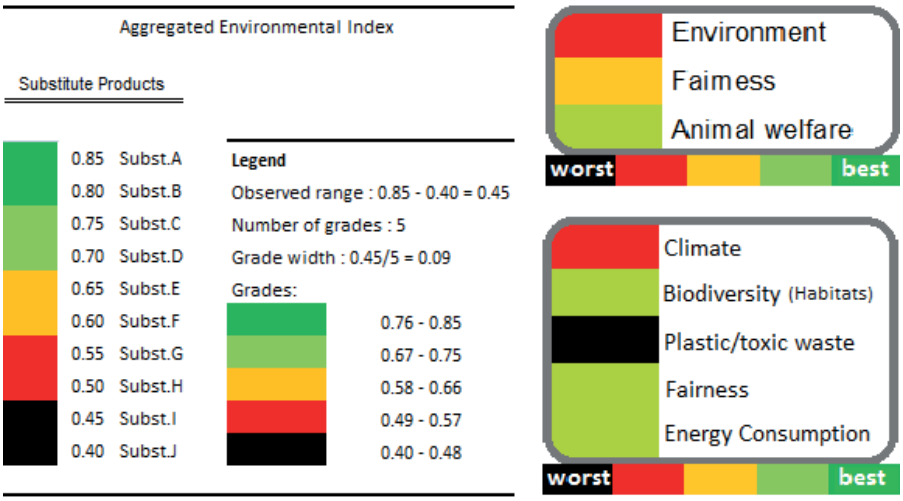

Figure 2. Left: Illustration of a dynamic comparative grading method that does not require definition of threshold levels, and example normatively-charged color-coding of grades. **Right:** Two variations of an example intuitive color-coded label format based on the grading method described on the left. The two variations (upper and lower) depict different sets of unobservable product attributes, and also different aggregation levels of the environmental impact attribute.

Grading product performance for composite (i.e. multi-issue) assessment categories of concern (like for instance the environmental impact or the animal welfare category) requires the integration of product performances for different assessment criteria. Díaz-Balteiro and Romero (2004) developed a multiple criteria method that can be used to rank the performances of substitutable products for an extensive set of weighted criteria into interval indices. Among[19] the merits of their approach is that the generated product rankings are normalized with regards to 'ideal' and 'anti-ideal' vectors that are composed, respectively, by the best and worst performances observed among assessed products for each assessment criterion. This results in

[19] Another interesting feature of this method is that it generates simultaneously compensatory and non-compensatory indices as the opposite end-points of a range of different degrees of compensation. The non-compensatory indices represent 'most balanced' rankings and correspond to the "maxi-min" aggregation function proposed by John Rawls (ref xx).

product rankings that can support a dynamic grading method that is fit for market optimization.

This grading method is depicted at Fig.2. Its dynamic aspect consists in that no fixed threshold performances are specified for the separation of grades. Instead, the total number of grades must first be decided (in this example, 5 grades). Then, the width of the grades is calculated by dividing the distance between the highest ('best') and lowest ('worst') product performances by the number of grades. Namely, the threshold values that define the borders of grades are merely statistical (i.e. e.g. upper 33.3% vs. middle 33.3% vs. lower 33.3% in case three grades are used). Based on this result, products are assigned a colored grade according to their ranking on the respective index. This type of grading is operational for inter-product comparisons because it is proportional to performance. Fig.2 exemplifies the communication of such product grades to consumers through front-of-pack labels that use (and explain) normatively-charged colors to signify product performance for the selected attributes.[20]

This type of product grading is not only comparative by also dynamic. 'Below average vs. average vs. above average' grading is not new in the literature: see e.g. the setup of the carbon labeling experiment by Vanclay et al.(2010). Nevertheless, to the knowledge of the author, its potential functionality in market optimization has not been described. This functionality is described at Fig.3. Section A of Fig.3 depicts an abstraction[21] of the distribution of ethically-relevant supplier practices achieved by a typical endorsement label that has a single grade defined by a static threshold. Certified suppliers generally do not gain from further improvement and therefore, subject to cost minimization incentives, generally remain just above the fixed certification standard and do not invest in innovation. The practices employed by uncertified suppliers are unknown. Domestic suppliers must respect domestic regulatory bottom-lines (e.g. domestic environmental or labor law), however these regulations do not have to be respected by importers of end-products or of parts thereof (unless the state qualifies market access). This distribution remains static until changes are introduced to the certification standard or to state regulation. Uncertified suppliers are also subject to an incentive to minimize costs, which

[20] To avoid fragmenting the market in case of horizontally differentiated attributes the assessment terms of which must be sourced from geographically different publics (Beath and Katsoulacos 1991), sticker labels can be used –as it happens with in-shop labeling of electrical appliances– so that the correct results are communicated at different localities.

[21] This distribution was depicted in more detail at Fig.1a: Fig.1a corresponds to Section A of Fig.3.

probably motivates off-shoring some part of uncertified production to locations less stringently regulated with regards to environmental, labor, or other attributes.

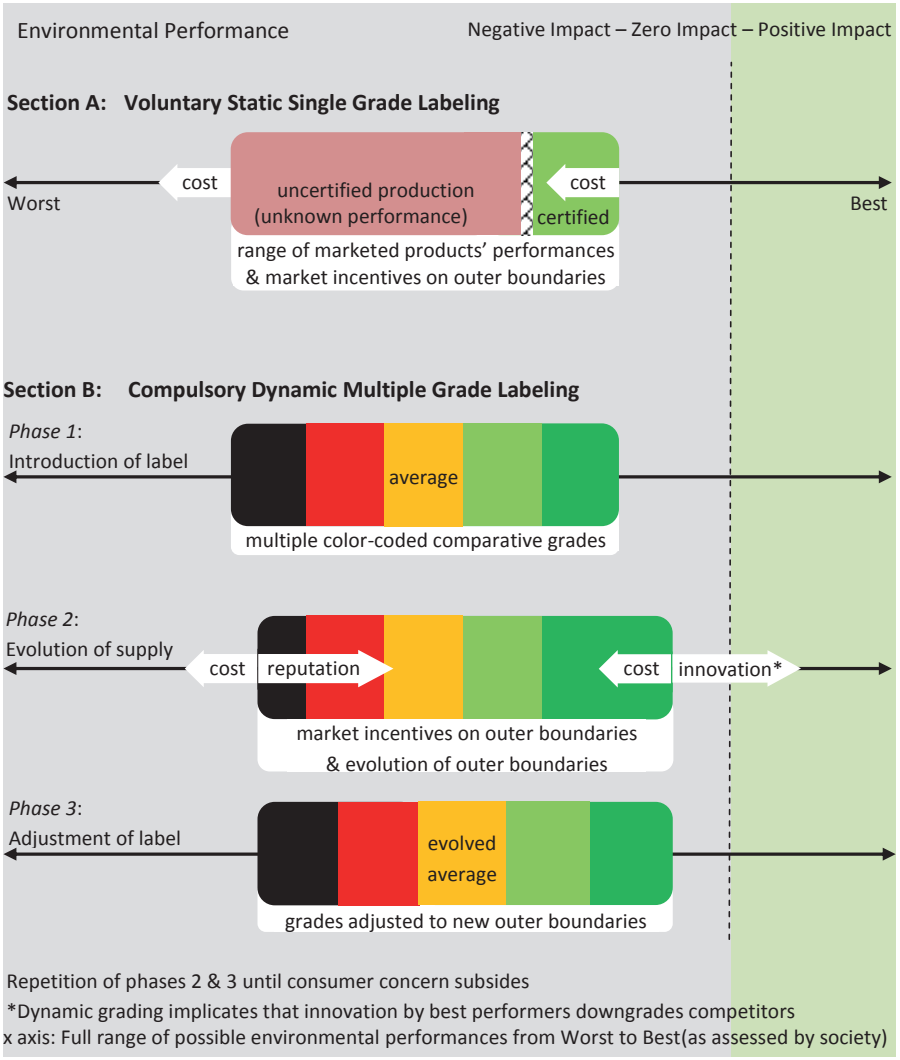

Figure 3: Expected impact on the observed range of environmentally-relevant production practices from the introduction of (Section A) voluntary, static, and single-grade labeling, as compared to the introduction of (Section B) compulsory, multi-grade, dynamic, and normatively-colored labeling. This figure is qualitative: Sizes of arrows and the relative translocation of outer boundaries do not indicate the relative strength of incentives or the expected relative change of upper and lower boundaries.

Figure 3, Section B depicts in three phases the effects of introducing a labeling scheme of the type proposed above. In Phase 1, the label is introduced and colored performance grades are assigned to products. In Phase 2, the market evolves subject to the novel incentives added by the introduction of the label. In addition to minimizing costs, suppliers are now also incentivized to improve the performance of below-average products so as to avoid a range of negative reputation effects. In addition, best-performers are motivated to innovate and improve. This is because improvement of the best (and of worst) performances observed in the market shifts grade thresholds towards the positive direction (i.e., towards the direction desired by society). Therefore, competitors near the lower bound of their grades will be downgraded in the next update of labels if they do not improve sufficiently. This has a positive effect on innovators because competitors their ethical superiority to competitors will become more pronounced .To illustrate by example, consider for instance product 'Substitute A'. According to Fig.2, Substitute A is an environmental leader. Since Substitute D performs just above the lower bound of the green grade, it competes with Substitute A in environmental friendliness. Therefore, environmental leader Substitute A has an incentive to improve its environmental performance further by a marginal amount, in order to downgrade Substitute D out of the 'green' category and to the 'average' (amber) grade. As a side-effect, Substitute F might also be downgraded out of the average category and to the 'red' grade. Consequently, Substitutes D and F become incentivized to also improve their environmental performance, in order to avoid a negative effect to their reputation as a consequence of improvement by Substitute A. Moreover, the optimal selection of the number of grades will maximize incentives for improvement within the range of observed performances by taking advantage of what Tlusty (2012) calls the "pull" of a certification threshold.[22] This will help the discrete allocation of practices depicted at Fig.1b resemble more closely the actual distribution of consumer preferences.[23] Overall, and subject to this dynamics, the market will expectedly evolve towards the

[22] Another aspect to be fine-tuned for maximal effectiveness is whether an odd or an even number of grades should be used. The use of odd numbers of grades is standard practice. An even number of grades does not offer an 'average' grade. Therefore suppliers are incentivized to perform at the positive side.

[23] Fig. 1b was also used to illustrate how a number of single-grade certifications can function as a composite multi-grade one. As mentioned, this requires comparing different certification for a common dimension of public concern. The presented assessment approach can be used for the comparative assessment of different certification labels, or of different grades of these labels. This can be achieved in a practical way by comparing the performance of dummy products designed to just meet the minimum requirements of the selected labels for assessment terms defined by the public.

direction that the public regards as positive. This is because the introduction of the label only adds positive incentives to the current static situation. In Phase 3, the grading of products is updated to adjust to the evolution of observed performances in the market. From then on we have successive rounds of update and evolution (repetition of phases 2 and 3).

In reasonable time intervals, similarly as it happens already within the dominant information approach, the terms of assessment will have to be updated by sourcing new input from the public. This is needed because concerns, and also the relative importance that society attaches to different concerns, are likely to change overtime. Therefore, assessment terms will have to be updated to capture the evolution of these concerns. The rounds of update and evolution will repeat until the levels of ethical and of ethically-irrelevant (e.g. price and function) attributes will be optimal in the market according to the law of supply and demand. However, given the beneficial effects of innovation on cost reduction, the evolution of product performances towards positive impact is more likely to cease when ethical performance improves sufficiently to achieve levels that temporarily remove reason for public concern. At that point consumers will not be motivated to take into account relevant information regardless its normative colors. At next updates of assessment terms, deliberated members of society might attach lower relative importance weight or might entirely omit the particular attribute, as unnecessary, until concerns emerge again. If the above are correct, the socially optimal nature of that likely fluctuating end-point of consumer-based optimization could qualify terming the market competition race that is triggered by the outlined labeling approach as a 'race to the top'.[24]

[24] This analysis does not necessarily apply to all types of indicators. Environmental indicators have no upper bound because, theoretically, after achieving zero impact production could move towards positive impact. An example of positive environmental impact is carbon offsetting (Lovell, Bulkeley, and Liverman 2009). Namely, after reaching zero impact the real economy could move towards repairing environmental damage, driven by the same incentive for positive environmental differentiation as before. On the contrary, income disparity-related indicators have a higher boundary at zero inequality. If we assume that consumer choice on income disparities would shift supplier practices towards less income inequality, then this would mean in practice that equal partnership-type of businesses, such as co-operatives, would be favored. However, inequality has also positive effects on incentives, while capital can finance socially desirable innovation. Therefore, products from less egalitarian firms will still be able to compete against those of more egalitarian firms on the grounds of other qualities. Therefore, the race towards less inequality would likely move the market towards levels of inequality that could be regarded optimal in society. Interestingly, this effect would come close to achieving John Rawls' "Difference Principle" of

4. Discussion

4.1. Behavioral gaps and effectiveness

This optimization functionality and the overall effectiveness of the above-described labeling approach in bringing positive change, largely depend on consumer response. Research on ethical consumerism typically compares stated and revealed consumer reactions to the dominant information approach of single-grade voluntary labels. Based on this research, which is also supported by market data, there is broad consensus in the literature that revealed consumer preferences for ethical labels are disappointingly lower than the high expectations raised consistently and internationally by surveys and willingness-to-pay research that measures the stated preferences of consumers.

This difference between words, values, intentions, and stated preferences on the one hand, versus deeds, actions, behavior, and revealed preferences on the other, is usually termed as a "gap" (e.g. Blake 1999; Boulstridge and Carrigan 2000; Kollmuss and Agyeman 2002; Padel and Foster 2005; Carrington, Neville, and Whitwell 2010). Some of the gap is explained by a "social desirability bias" (Nederhof 1985; Fisher 1993; King and Bruner 2000; Grimm 2010) that leads to overstatement of socially desirable responses during surveys and experimental settings. Notwithstanding elaborate and sophisticated efforts, the gap that persists when bias is removed remains poorly understood (Carrington, Neville, and Whitwell 2010). The size and the persistence of the gap in the context of ethical or political consumerism has limited initial optimism that consumers can be the driving force for corporate social responsibility (Vogel 2006; N. C. Smith 2007; Higgins 2010; Carroll and Shabana 2010). "Narrowing the gap between ethical consumption 'attitudes/intentions' and actual consumption 'behavior' represents a challenge of practical and theoretical significance in light of the variety of top down and bottom up actors currently seeking to 'mobilise the consumer' (Barnett et al. 2010) towards positive environmental and socio-economic outcomes" (Caruana, Carrington, and Chatzidakis 2015).

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justice in a fair society (Rawls 1999, 65–73): inequalities would persist up to the level that they work for the benefit of the least advantaged members of society. Or, as Sandel (2005) described it at his well-known Harvard University lectures, "those at the top can keep on being well-off, up to the level that further reduction of their wealth would make them lose incentive to use their talents, skills and abilities to perform a valuable service to those at the bottom". As intriguing as it might be, this line of thought is merely speculative and serves the purpose to invite further research on the effects of consumer choice informed by different types of indicators, and on its potential desirability.

Conceptual analysis and market observation suggest that mandatory multi-grade ethical labels lead to narrower gap between words and deeds. This is because mandatory multi-grade labels address at technical level functionality limitations of voluntary binary labels that could explain some of the gap observed in the preferences of moderately –yet positively– concerned consumers. These labels also change the cognitive environment in which preferences are revealed. Appropriately for within the dominant approach of single-grade voluntary labeling, market research typically compares consumer preferences for labeled products to preferences for unlabeled ones.

However, this research approach is inappropriate for measuring consumer preferences in the context of compulsory gradient labeling. This is because unknown performances do not exist under compulsory gradient labeling. Therefore to draw conclusions from comparing consumer preferences for labeled products to preferences for unlabeled ones makes the category mistake that it compares preference for the ethically superior to preference for the ethically unknown, while it should compare it to preference for the ethically inferior. Namely, to measure the gap when information is compulsory and multi-grade requires comparing consumer preferences for high-graded products to preferences for low-graded ones, while unlabeled products can be used only as control (see Vanclay et al. 2010). This way of measuring the gap rules out inconsistencies between words and deeds that can be attributed e.g. to effective brand promotion campaigns that support wishful consumer assumptions that their favorite uncertified products have decent ethical performance. Among the research questions that are relevant, is to what extent consumers *knowingly* prefer products that pollute the environment and cause avoidable animal suffering, over products that do not, in relation to different levels for ethically-irrelevant attributes such as taste and price. This type of data on non-use (ethical) attributes is scarce to non-existent.

Vanclay et al. (2010) conducted a market-based mandatory carbon-labeling experiment that is on spot with regards to many labeling and research requirements identified above. Overall results reported a modest 6%, decrease in sales of black-labeled products, 4% increase of green-labeled, and a much larger switch from black to green (20%) when green products were also cheaper than black. During the 3-month period studied, and as demanded by codes of ethics in participatory research, the customers were aware they were participating in an experiment and that the labels were prepared for this purpose. The authors identify the type of shop (convenience groceries) and desirability bias from the high publicity created in the early days of the experiment as factors that might limit the generalization of results.

Another factor that might have affected the predictive value of the experiment is customer trust in the labels (e.g. Bonroy and Constantatos 2008). Also, that the labels were placed on the shelves and not on the products. This means that consumers would not be reminded of their ethical choices after exiting the shop and when sharing the product with their friends and family. Therefore, well-known motives of ethical consumption, like "extrinsic social factors such as the concern for one's own reputation among peers" (Grunert, Hieke, and Wills 2014), which help increase consumer words-deeds consistency and reduce e.g. environmental free-riding in consumption, were disabled. On the contrary, front of pack labels ensure that buyers of ethically inferior products are confronted with their ethical choice every time they use or share the product, (same as it happens with buyers of slow computers and of non-tasty foods,) though visual contact with a dark mark on the front of its otherwise attractively-designed packaging. This might also result in changes in the perceptual experience of a product (Sörqvist et al. 2013; 2015), with possible added effects in consumption changes towards the socially desirable direction.

Perhaps the only large-scale real market data available comes from the table eggs sector. The graded labeling of the welfare of laying hens is compulsory on table eggs in EU (EC 2016).[25] Color coding and front of pack labeling is not required, with the implication that it is not provided by suppliers of low ethical quality 'caged' eggs. Nevertheless, the Noble Foods website reports a radical consumer-driven animal welfare change in the UK eggs market during the last ten years, to the direction of avoiding the worst-performing products (Noble Foods 2016).[26] Similar results are reported from The Netherlands.[27] While the case of eggs labeling does not meet

[25]EU requires that the first entry of the code stamped on each egg signifies its welfare grade. Zero is the best option and it signifies organic eggs, while "6" signifies the most intensive "caged" eggs (worst). Since 'lower is better' and zero is already used, this coding system has no potential for dynamic improvement between formal revisions of standards. Grade thresholds are stakeholder-defined.

[26]"The market has changed radically over the past ten years with consumers becoming more discerning about where their eggs come from. An increase in welfare conscious consumers has result in Free Range achieving [51.4% volume market share and 63.3% value market share] and continues to grow, Cage share has fallen to 44%, with Barn, Organic and Speciality combined representing 4.9%" (total UK eggs market).

[27] From 2006 till 2012 the share of free range systems increased from 34% to 63%, whereas cage systems decreased from 47% to 18%. During this period, the combined share of organic and outdoor systems increased from 2% to 5%. Between 2012 and 2014 the market stabilized.
(http://www.agrimatie.nl/ThemaResultaat.aspx?subpubID=2232&themaID=2270&indicatorID=2098)

several of the requirements identified above (e.g. table eggs labels are static and front of pack labeling is not compulsory) and it is generally regarded to be an outlier in ethical consumer behavior, it nevertheless illustrates that ethical consumerism can be mainstream consumer behavior and invites for more thorough research on consumer response to mandatory multi-grade labeling.

Indirect[28] market evidence of the likely response of firms to mandatory graded labeling is less ambiguous. Withholding negative information generally has costs that range from production site security to anti-disclosure lobbying and to promotional greenwash. Minimization of these costs incentivizes firms to disclose information in an "unraveling result"-like response (Milgrom 1981; B. E. Roe, Teisl, and Deans 2014). Nevertheless, firms respond strategically (Baron 2001; Glazer, Kanniainen, and Poutvaara 2010) to potential large scale negative publicity by promising improvements, so as to protect sales and brand image: Global sector leaders in food, drink, automobiles, sportswear, and electronics promise to improve on palm-oil-related deforestation, fairness of coffee-beans sourcing, greenhouse gasses emissions, work conditions and suicide rates of subcontracted employees at offshore sweatshops; instead of simply admitting and continuing business as usual. We are yet to witness the rational firm that takes seriously enough in real life the narration of the consumer as a simple 'self-interested' being, so as to disclose openly and clearly that it pollutes the environment, its animals suffer and its labor slaves, and then still expect a good return on profits. This type of positive firm responses cannot be fully attributed to expected consumer reaction. As mentioned earlier, firm motives for maintaining a good reputation include high employee morale, attracting talented employees and attracting ethically concerned investors (Carroll and Shabana 2010; Higgins 2010). It is useful though to notice that these motives also refer to positive market effects, just from different markets. Such synergistic side-effects indicate that the outlined information approach can also be useful to the labor and investments[29] markets, and just add to the expected effectiveness of mandatory multi-grade labeling in bringing positive change for the issues at stake.

[28]Balcombe et al. (2010) also draw upon indirect market evidence reported by Grunert and Wills (2007) to deduct consumer use of the TLS front of pack nutrition label from retailer reformulation of products to remove Red lights.

[29]Sridhar and Jones (2012) identify subjectivity-related limitations of triple-bottom-line-based tools used to guide ethical investment, such as the Dow Jones Sustainability Index (DJSI).

4.2. Effects

– ***On the business case for CSR***

The core argument against CSR, and more generally against the social responsibility of any type of business, was explicated in Milton Friedman's (1970) seminal article "*The Social Responsibility of Business is to Increase its Profits*". The firm, with the shareholder profits and the work positions it offers, must be cost-efficient to survive in competitive markets. Therefore, it is rational for firms to invest on 'cloaks of CSR'-type of brand image promotion, instead of investing on improving the ethical aspects of their production, when the public has preference for levels of ethical attributes that are costly to address. This makes economic sense because ethical attributes are unobservable, and insofar the institutions (e.g. the state) do not oblige disclosure of relevant data.

Since Friedman's analysis in the seventies, the CSR landscape evolved and diversified. Yet its subject matter is not achieved. Numerous certification schemes, prestigious standards and global initiatives have had only moderate, sometimes if any, and in any case always insufficient positive impact on the ethical performance of the market (Fauset 2006). Numerous scholars analyzed and provided solid moral reasons for CSR in the light of pressing environmental and social problems (Higgins 2010). However, we largely still live in the world that Friedman described. From the perspective of a business, no moral reason to perform any better than what is minimally required can withstand the threat of critical loss of profits. The heart of the CSR problem continues to be the difficulty to establish the "business case" for CSR (Carroll and Shabana 2010): To establish that doing good to the society makes a business do well financially, and not only morally, especially as compared to competitors that use cloaks, bluff, and free-ride. Namely, the core vulnerability of CSR continues to be the difficulty to align the inherent profit-maximization instincts of a business to the ethical compass of society. Such is the importance of achieving the business case, that Smith (2007) called it the "holy grail" of CSR.

A similar interests coordination problem was observed in corporate management when the interests of executives diverged from the interests of shareholders. Executives could then favor decisions beneficial to their interests but damaging to shareholders. That problem was largely solved when executives started being partly paid in stock options.[30] That technical fix instantly aligned the interests of one actor

[30] The cases are not completely comparable and, notably, paying CEOs partly in stock options created a different problem: CEOs would now target short term gains that would increase

to those of the other. It did not do that by lecturing CEOs on morality. The technical fix solved the problem by changing the rules of the game so as to make the profits of one dependent on the advance of the interests of the other.

This article outlines a similar type of technical fix. This one changes the rules of the game from ones in which disclosure of levels of unobservable attributes that matter to the public is voluntary, to ones in which it is obligatory. In that way, non-ethical and irresponsible performances come in public sight, cloaks cannot be used because they are confronted to front-of-pack labels denoting ethical performance 'for what matters in society', and effectively the proposed labeling approach opens up perspectives for firms to compete freely for reputation, transparently and on issues decided by the public. Similarly as in the case of stock options, this technical fix changes the rules of the game so as to make the profits of one (businesses) dependent on the advance of the interests of the other (society). The interests of the two actors are then aligned. The company becomes embedded in society and we are in a world that is different from the one experienced by Friedman. To do well in that world, a company must do ethically average or better. Once this is established, the dynamics offered by the grading method merely aim to make the optimization of unobservables work as it would if these attributes were observable, so as to incentivize that the race towards the non-negative will continue for as long as there is reason for societal concern.

– ***On economics***

From an economics viewpoint, the presented information approach offers a way to address information asymmetries so as to undo market failures and to create consumer-driven markets for unobservables. Although the described approach does not incorporate the costs of production externalities into product prices, the compulsory disclosure of comparative ethical performances addresses 'moral hazard' by businesses that exercise e.g. environmental 'free-riding', through enabling their identification by consumers, employees, and investors; which motivates their improvement. Similarly the presented approach addresses 'adverse selection' of ethically inferior firms to the cost of superior ones: The transparency on business performance for unobservable ethical attributes introduced by label grades will expectedly reduce the effectiveness of brand promotion campaigns of the bluffs-

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the value of the options. However, insofar the original problem is concerned, some parallels can be drawn.

and-cloaks type. Finally, the adopted 'societal perspective' in managing the unavoidable subjectivity in ethical assessments also addresses 'regulatory capture'-related effects of information asymmetry: Sourcing assessment criteria and weights from society, (remember that fixed grade thresholds are not defined,) entails that supply stakeholders cannot extract 'rents' by (co-)determining the technical meaning of labels and the thresholds of grades so that their products are assessed more favorably than they would if ethical attributes were observable.

This last point can be examined in more depth. Namely, that this article uses the much less problematic market optimization process for observable attributes as a yardstick. Markets are generally criticized for multiple adverse effects, among which environmental, animal welfare and socioeconomic ones (e.g. income inequality). These are usually attributed, at least partly, to the 'self-interested' (i.e., 'egoist') personalities that members of society 'reveal' when they function as consumers. However, as mentioned also in the introduction of this article, 'use' attributes differ from altruism-related, solidarity-related, and public goods-related ones in an important practical way: Use attributes are mainly[31] observable while attributes of the latter type are always unobservable. Namely, consumers can reveal preferences that relate to self-interest, but cannot reveal preferences that relate to altruism, solidarity and community-related aspects of their personalities insofar information asymmetry persists. Therefore, unless assisted by information approaches designed to remove asymmetric information from ethical attributes, markets by themselves inherently allow –for technical reasons– the expression of self-interest but not of goodness. Seen in this light, information of the type described in this article could help check in practice the extent to which the observed self-interested behavior of consumers must be attributed to dark aspects of the human psyche, rather than to the more down-to-earth practical reason that ethical attributes are unobservable. As mentioned in a previous section, there is at least some indirect market evidence pointing to the latter explanation. This evidence includes costs paid by firms to communicate socially responsible brand images (honest and not), security costs paid to prevent whistleblower access to factory farms and sweatshops, costs paid to lobby policy-makers against information disclosure, and costs paid for ethical improvements when unethical practices succeed to be revealed.

This theoretical research item connects to a more practical one. If the described type of information indeed incentivizes continuous improvement for, e.g., environmental,

[31]Some use attributes, for instance those relating to long-term health effects are unobservable.

socioeconomic, and animal welfare aspects of production, as discussed above, then this means no less than that this type of information decouples the liberal efficiency of market optimization from adverse effects that were since long considered to be inherent to markets. A research question that emerges then is whether, subject to the fine-tuning of several parameters,[32] this information approach could bring us closer to achieving through markets a Pareto optimal allocation that also includes environmental and distributive aspects. That is, closer to a Pareto optimal outcome that is not only efficient, but is also socially desirable.

4.3. Consumer democracy information costs

> "That [the East India Company] administration is necessarily composed of a council of merchants, a profession no doubt extremely respectable, but which in no country in the world carries along with it that sort of authority which naturally overawes the people, and without force commands their willing obedience. Such a council can command obedience only by the military force with which they are accompanied; and their government is, therefore, necessarily military and despotical." (A. Smith 1776, 519)

Cost is usually a decisive factor for the implementation of mandatory information schemes, while consumer choice on credence goods is not possible without information. Therefore, it serves the purpose of this article to close with a more general remark on the democratic function of information and its cost. The horizontal axis of Fig.4 depicts the only action options in market democracies for decision-making that is democratic at the level of the people. As mentioned also in the beginning of this article, and if indirect action is set for now aside, concerned members of the public that want to have a constructive impact on the management of real economy aspects can either vote or shop: People can either engage in political/ethical consumerism to reveal their preferences in the market as consumers (left hand side option), or they can vote in elections as citizens with the expectation that the political party that campaigns for their causes, if elected, will regulate the economy accordingly (right hand side option). Both these options have costs. On the one hand, voting requires for instance well-prepared nation-wide planning, employees, voting material, independent statistics and security. On the other hand, the availability of product information has its own substantial costs. None of the

[32] E.g. factors that determine whether assessment terms successfully capture collective societal concerns, and factors that determine whether information is successfully communicated to achieve its purpose.

democratic options is available unless its costs are paid for. Nevertheless, while there is no controversy about paying for the costs of elections, paying for the cost of information appears to be a controversial issue. Moreover, when legal or practical constraints limit the ability of the state to regulate the economy, elected governments regularly decide to abstain from command and control regulation and instead they rely on optimization through the market. Obviously, consumers cannot participate in that optimization if information is not available in the market. And if imperfect information is available, then optimization hardly works. Therefore, in these cases none of the democratic options is operational.

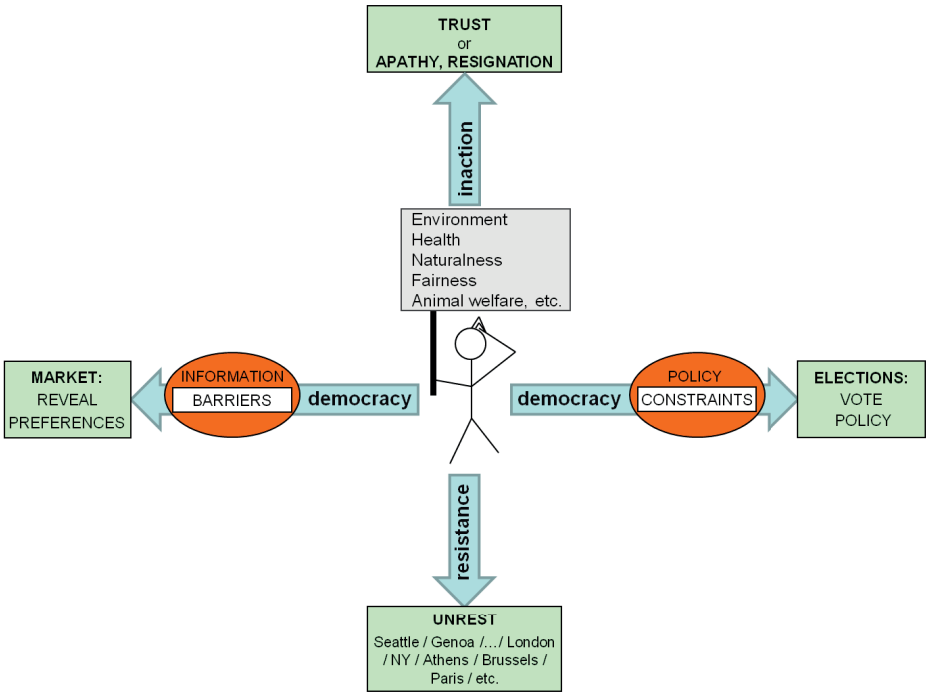

Figure 4: Outline of options for action available to citizens concerned about ethical unobservables in market democracies

What are then the remaining options for concerned members of society? These are presented on the vertical axis of Fig.4. The upper part of the axis depicts the option to take no action –at least not directly. This can be interpreted in two ways. The first way is that one becomes apathetic, resigns, and quits from trying to bring improvement on the issues at stake. Now this might be relatively easier to some, but

it is more difficult to others. And it is not a morally or politically defendable stand. The second way to interpret inaction is that the person trusts. One can trust in various things, like in the politico-economic system, or in the power of civil society organizations that one supports to fight together with some and against other stakeholders, a fight in which the balance of interests and of power is not proportional to that among members of society, for achieving one's cause. This is the option of indirect action by civil society proxy. There is not much wrong with the trust option except that, best intentions aside, stakeholder-level efforts have not delivered sufficient results so far. And the problems are pressing. Finally, the lower part of Fig.4 depicts the only option that remains. That is the option to bring change through protest, activism, unrest and other forms of social instability. This option is also undesirable in a well-ordered society.

Observation of the empirical world indicates that widely and consistently surveyed environmental, animal welfare and socioeconomic concerns among the international public are accompanied by repeated eruptions of civil unrest in world capitals and economic decision-making locales (Wikipedia 2016; 350.org 2016). At the same time, state policy is regularly subject to constraints that prevent elected governments from addressing these concerns to the extent desired by the citizenry through regulating the market. In such cases where the regulatory option is insufficiently available, the presented societal concerns-based labeling approach is designed to offer a way to preserve democracy, and democracy's long-known effects on willful societal stability, through consumer choice in the market. This functionality entails the understanding of costs for this type of information as the cost of preserving democracy when decision-making is forwarded to the market.

5. Conclusions

Information on ethical unobservable attributes is nowadays provided to consumers through endorsement labels. Endorsement labels share the following properties: They are (1) single-grade, (2) voluntary, (3) static, and (4) stakeholder-defined. These properties do not serve well the purpose of democratic (i.e. consumer-based) market optimization, which requires that unobservable product attributes should be treated, as much as possible, as observable ones. This article has outlined an alternative comparative labeling approach to ethical information, which is multi-grade, mandatory, dynamic, and society-defined. Such a system aspires to transform

markets into instruments that work to the direction willed by society, so as to bring market-driven and continuous improvement for unobservable production aspects of societal concern, such as environmental and socioeconomic aspects of the real economy.

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CHAPTER 3

Trading "Ethical Preferences" in the Market: Outline of a Politically Liberal Framework for the Ethical Characterization of foods

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This chapter is based[33] on:

Michalopoulos, T., Korthals, M., and Hogeveen, H. 2008. "Trading 'Ethical Preferences' in the Market: Outline of a Politically Liberal Framework for the Ethical Characterization of Foods." *Journal of Agricultural and Environmental Ethics* 21 (1): 3–27. doi:10.1007/s10806-007-9059-4.

[33] This version of the article corrects three instances of erroneous use of the incorrect term "minmax" instead of the correct term "maximin" in the published article.

ABSTRACT. The absence of appropriate information about imperceptible and ethical food characteristics limits the opportunities for concerned consumer/citizens to take ethical issues into account during their inescapable food consumption. It also fuels trust crises between producers and consumers, hinders the optimal embedment of innovative technologies, "punishes" in the market ethical producers, and limits the opportunities for politically liberal democratic governance. This paper outlines a framework for the ethical characterization and subsequent optimization of foods (ECHO). The framework applies to "imperceptible," "pragmatic," and "reasonable" food characteristics about which consumers/citizens maintain concerns. A political perspective is assumed in that valid information is taken to serve the politically liberal and democratic functions of the market by allowing concerned citizens to make informed choices in their role as food consumers. Information is aggregated by multi-attribute modeling. It takes the form of "maximized" ("utilitarian") to "most balanced" (maximin) non-binary aggregate comparative rankings of perceptibly substitutable food products. The model requires the description of characteristics by means of criteria and weights (structural input), and technical input on the performance of food for these criteria (product input). Structural input is grounded on relevantly concerned citizen/consumers' perceptions. It is culture and times dependent. Availability of product input is assumed. Uses for the amelioration of the aforementioned limitations are discussed. So long as, and to the extent that, certain ethical concerns are not addressed by public policy, the ECHO framework may facilitate offering members of society a necessary (though not a sufficient) condition for regulating the ethical aspects of food production in self-regulated markets as consumers, when they are constrained to do so through their government as citizens. In doing that, the framework may contribute to the development of the ethical dimension of food production and may bring rewards for food supply actors that take reasonable concerns of citizen/consumers into account.

KEYWORDS: Market democracy, political liberalism, consumer concerns, food labeling, ethical assessment.

1. Introduction

Following the introduction of "modern consumer theory" by Lancaster (1966; 1971), marketed products can be seen as "bundles" of technical characteristics over which people have subjective individual preferences. When consumers enter the market, they are seen to realize tradeoffs between characteristics, and to choose bundles that yield optimal utility or satisfaction of their preferences. For preferences to be considered during market choices it is necessary that consumers can distinguish marketed products in terms of the corresponding characteristics. For food products, this is possible for (a) readily perceptible characteristics (like food color, shape, selling location, price, etc.), and (b) for characteristics that have been perceived in past experience (e.g., taste, aroma, texture, cooking behavior, etc.). It so happens however, that consumers nowadays also appear to be concerned (or to have "preferences" in this sense) about food characteristics that cannot be assessed either on the basis of their appearance or of past experience. Herein, these characteristics are referred to as "*imperceptible*" (also referred to in the literature as "intrinsic" or "unobservable"). Preferences for imperceptible characteristics may refer, for example, to levels of environmental impact, health properties of food, fairness, or naturalness of production.[34] The consideration of this kind of preferences in the market requires the availability of appropriate information on imperceptible food characteristics.[35]

The purpose of this paper is the presentation of a conceptual framework for the ethical characterization and subsequent optimization of food products (ECHO, Fig.1). The direct purpose of the framework is to produce information that can be useful to

[34] Preferences for such characteristics are referred to in the literature as "ethical-" or "consumer concerns." Their expression in the market has been termed "ethical" or "political" consumerism. Consumer concerns relate to consumer trust crises in the food market (Brom, 2000). They "transcend the consumer vs. citizen dichotomy" (Korthals 2001a; 2001b).

[35] In local markets, certain information has always been available. Also, information on certain imperceptible characteristics has nowadays been legally enforced (e.g., origin of production, nutritional content, the existence of genetically engineered material above certain levels). For other characteristics information is generally available only for a limited range of foods. It takes the form of values-based (Barham, 2002) voluntary certification labels (e.g., EKO, Biological and FairTrade), or of voluntary commitment to certain "ethical standards" (codes of conduct) by so termed "socially responsible producers."

concerned citizens wishing to make informed choices as consumers in the market, and also beneficial to actors[36] in the supply side of the food chain that wish to take citizens/consumers' concerns into consideration. To be fit for communication to concerned citizens/consumers, generated information must be concise and meaningful.[37] The framework addresses these issues by producing aggregated information that refers to citizen/consumers' perceptions (herein referred to as "*characterization*"). Characterization takes the form of contextually valid comparative rankings of perceptibly substitutable food products. Rankings refer to qualified imperceptible food characteristics that correspond to citizen/consumer concerns. A multiple criteria modeling methodology is proposed for the generation of the rankings (ECHO Model). The extended mathematical presentation of the proposed model falls outside the focus of the present paper and relevant references are provided. The model aggregates technical information on product properties and its production history ("*product input*") to assess the performance of foods for each characteristic. The availability of product input is assumed.[38]

[36] Depending on the food product, the generated information might be relevant to a range of actors in the supply side of the food chain (like breeders, farmers and processors). Relevant actors will have to be identified on the basis of specific applications of the framework. For the purposes of this paper, all relevant actors in the supply side of the food chain will be collectively referred to as "producers."

[37] "[…T]he broad aim of the review [of the current EU labeling legislation] is to find a sensible and practical balance between the polarized positions: requests for more information on labels, and the need to have clear and meaningful labels, which are easily understood by consumers." Head of Cabinet for Health and Consumer Protection addressing conference on Ethical Traceability (Schinas, 2006).

[38] The purpose of this paper is to discuss a method for the generation of concise and meaningful information, and its uses, and not to provide a balanced argument for gathering information (or for communicating them to citizens/consumers). Therefore information costs are not discussed. Product input can be sought on an ad hoc basis from food experts and producers, or can be generated through a credible and trustworthy "ethical traceability" monitoring system. A European project on "ethical traceability" is currently in its culmination phase (EU, 2003). Traceability consists in ''being able to prove the history, the use and the localization of an entity by means of recorded identification'' (ISO 8402). To reduce requirements for product input, the model may be applied only for selected products (e.g., tomatoes, etc.), or only for selected characteristics of concern to citizens/consumers (e.g., animal welfare, etc.).

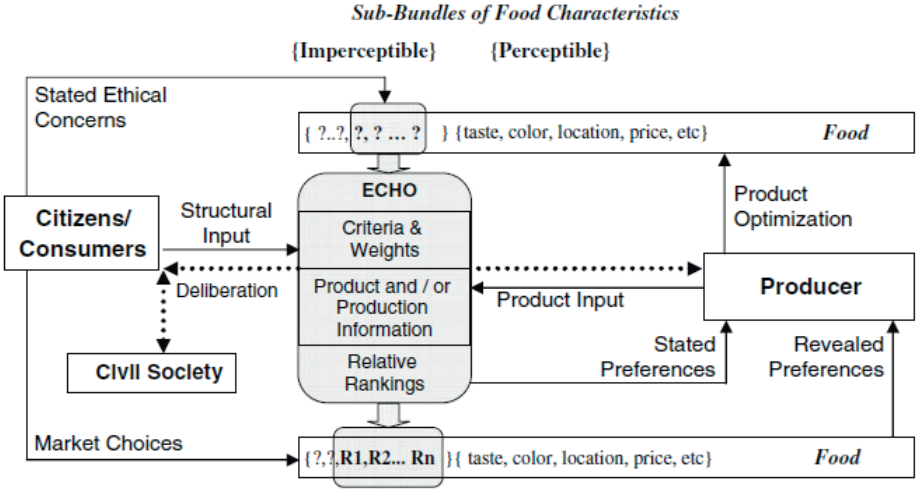

Figure 1: The ECHO Framework: *Food* is disaggregated in sub-bundles of characteristics. Arrows represent information flows. The ECHO model ranks product *Food* for n stated ethical consumers concerns about imperceptible characteristics (R1, R2 ... Rn). Rankings are relative to substitutes. Citizens/consumers provide structural input in deliberation with producers and civil society actors. Producer provides product input and receives feedback. (a) Rankings not available to citizens/consumers: Feedback is assessment of *Food* based on stated consumer preferences. (b) Rankings available to citizens/consumers: Feedback is revealed preferences based on market choices. Producer uses feedback to optimize production.

The framework produces information intended to facilitate the well-functioning of the market. The paper assumes a political viewpoint in that the well-functioning of the market is taken to require that the market performs the operations anticipated by the particular political context within which the market operates. A neoclassical food market operating within a model "politically liberal market democracy" is chosen for this purpose. To be both economically and politically consistent in our argument, the well-known distinctions between "consumers" and 'citizens,"[39] and

[39]. The distinction between "consumers" and "citizens" is not introduced because, in the assumed political environment, consumption activity can have a structural political function: to optimize the (allocation of resources for the) supply of goods that are not regulated by the state (see also footnote 34). Herein, "citizens/consumers" must be understood as citizens of contemporary politically liberal democracies who may expect to take reasonable "political" or "ethical" concerns into account during their inescapable food purchase for subsistence. Citizens/consumers may (or may not) consider these concerns in the market

between "values" and "preferences" (or "wants") are not introduced.[40] In a liberal environment, roughly, the market can be taken to operate as a dynamic mechanism for the optimization of the supply of goods about which citizens are concerned, when these goods are not regulated by the state. In the assumed political and economic environment, citizens/consumers can be understood as vectors of concerns about goods that are important to existing views of the good life. *Concerned* citizens/consumers are taken to represent those views of the good life

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alongside cultural and eudemonic motivations. The market choices of citizens/consumers are subject to "consumption constraints" (discussed at footnote 41). Throughout this paper, we refer to an optimization of production that considers the ethical preferences of citizens/consumers as "ethical optimization of production" (or, more precisely, as "CPR" optimization: see section 2.2).

[40] To preserve the economic clarity of the argument, the term "preference" is used in a neoclassical sense. The common (in ethics) distinction between sources of motivation based on "values," and on "mere preferences" or "wants" is not introduced. Although citizens may have "values," while consumers may simply have "wants," we take both to refer to, broadly perceived, "goods." We take citizens and consumers, owing to their own motivations, to have "preferences" about these goods. We take that in neoclassical markets citizens/consumers' preferences are accepted as they are "revealed," without further appraisal of the underlying motivations. Herein, appraisal of these motivations would be irrelevant either on political grounds (so long as e.g., hedonism is a reasonable view of the good life), or on market grounds (so long as purchases of goods motivated by "wants" do affect the allocation of scarce resources). Instead, when the aforementioned distinction must be referred to, then the term "ethical" is used to identify preferences that stem from desires which can be described as parts of "reasonable comprehensive doctrines of the good life" (Rawls, 1996, pp. 58–59; the term "ethical" is further discussed in section 2.2). It needs to be stressed, though, that to approach herein citizens' concerns as consumer preferences is not to suggest that citizens' concerns are appropriately to be addressed to the market (and that they should therefore absent from political debate or be irrelevant to public policy). To advocate this position would imply that one's ability to address some concerns is only to be relative to one's income (like when increased prices are implied), or that some concerns are not to be addressed at all (like calls for the proscription of animal production); and that is beside the point of this paper. Rather, to perceive herein citizens' concerns as consumer preferences is to assume that there are *prima facie* reasons to turn one's attention to the solutions that can be offered by the market when the state appears to be either unwilling (e.g. for normative reasons relating to a commitment to neutrality of intent) or unable (e.g. for practical reasons relating to international-agreements-bounded food policies, or to enforceability, to reduction of bureaucracy and to increase of efficiency) to effectuate policies that meet the democratic and the politically liberal expectations of the citizenry.

that are not served by the status quo of mainstream food production. Herein, information is regarded to be valid when it allows concerned citizens to make market choices on goods that they perceive to be important to their own private lives, and to their relation with others (i.e., people, animals, environment, future generations, nature, etc.). To establish a link between political and neoclassical economic terminology, it is possible to reformulate the previous statement by saying that valid information must allow "*consumers*" to optimize in the market the satisfaction of their "*ethical preferences.*"

It must be stressed that this work does not suggest the market as the appropriate (or as an inappropriate) arena for the regulation of the supply of any goods of concern to citizens. Therefore, advantages and limitations of optimizing ethical aspects of production through market self-regulation are not assessed in this paper. Rather, this work is concerned with the generation of information that is required if citizens are allowed to express concerns in the market when state regulation is, as a matter of fact or of norm, constrained (Michalopoulos, 2006). That is, this work aims to contribute[41] to allowing the members of society to regulate the ethical aspects of food production in real markets as consumers, when they are constrained to do so through their government as citizens.

In the sections that follow the function of the ECHO model is outlined. Differences to other approaches are highlighted. The function of the framework for product optimization that takes into account the ethical preferences of consumers is discussed. A range of uses for food producers, consumers, their relation, the optimal use of innovative technologies in food production, and for the liberal and democratic governance of market societies is presented. It is argued that the produced information may improve communication between the supply and the demand sides of the food chain. Improved communication on ethical issues may encourage actors in the supply side of the chain in considering the ethical aspects of their production. We refer to this as the development of the "ethical dimension" of the (food) market.

[41]This work targets a necessary though not sufficient condition for the justification of market self-regulation in politically liberal market democracies: that of the "information" part of "informed choice." We are aware that the communication of appropriate information does not suffice for achieving market democratization. Other necessary conditions (which are not addressed by the framework) will be collectively referred to as "consumption constraints." Consumption constraints may refer to income and purchasing power inequalities, to imperfect competition, to bounded rationality, etc.

2. The ECHO model

2.1. Function of the model

The ECHO model aggregates technical information to characterize foods' performance for imperceptible characteristics that refer to existing ethical citizen/consumers' concerns (Fig.2). Characterizations are comparative rankings of foods that can be considered as close substitutes in terms of perceptible characteristics (food "*options*"). Characterization happens on the basis of technical criteria that refer to stated citizen/consumer concerns, and according to weights that refer to citizen/consumer perceptions. First, the model is provided with a description of each characteristic in terms of measurable weighted criteria and preference scales (*structural input*). Next, the model is provided with technical information about the actual performance of food options for each of these criteria (*product input*). Product input is used to assess the performance of each option for each criterion on preference scales, and its availability is herein assumed. Structural input is used to aggregate product input and to rank food options for each characteristic. A multi-attribute method is referred to for this purpose.[42] Mathematically, a final step is possible for the overall aggregation of the performances of a food option for different characteristics.

The ethical characterization of food is approached as a multiple criteria problem. Multiple criteria approaches can facilitate "economic" decision making,[43] and are not unusual to assessments of ethical aspects of food production (e.g., Rigby *et al*, 2001; Diaz-Balteiro and Romero, 2004; van Calker*et al,* 2005). Reasons for this might range from the sheer complexity of such problems (e.g., different aspects of sustainability) to the lack of consensus on a single criterion (or a fixed weighted set of such criteria) for their description (see for example Verhoog, 2003, on the diversity in public perceptions of food naturalness).

[42] For an introduction to multiple criteria modeling see Dodgson et al. (2000), while for an application of the particular method in forestry see Diaz-Balteiro and Romero (2004).

[43] Friedman (1962), Zeleny, (1982, chap.1), and Romero and Rehman, (2003) distinguish "economic" from "technical" problems in that the former require decision makers to take into account multiple criteria. In that sense, it might also be stated that the ECHO framework approaches ethical optimization as an "economic" problem.

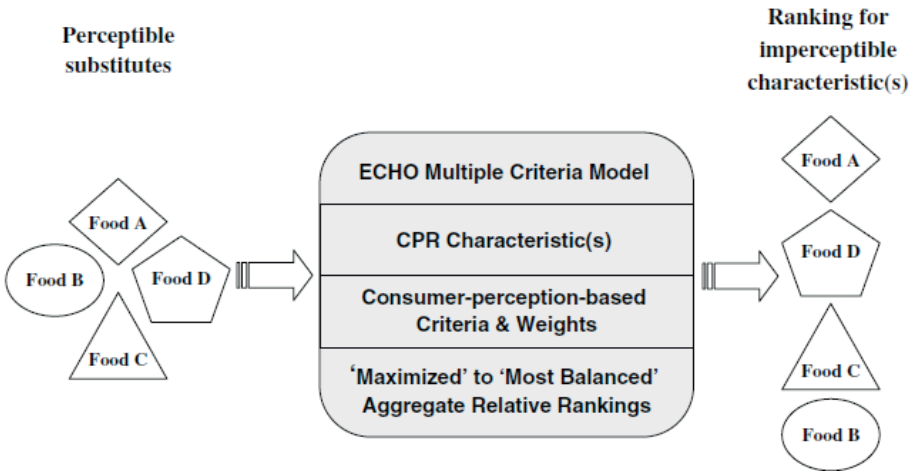

Figure 2: Function of the ECHO Model. The multiple-criteria model ranks seemingly (perceptibly) substitute products for 'credence', 'pragmatic', and 'reasonable' food characteristics (CPR). Criteria and relative weights used to describe characteristics are based on citizen/consumer perceptions. Produced rankings range from 'maximized' to 'most balanced'

The validity of the generated information crucially depends on product input and on the assumptions made for its process. The remaining of this section discusses the selection of characteristics for the application of the model and its sources of input (i.e., selection of decision-makers). The incommensurability of ethical values and the interpretation of the model's output are also discussed. Finally, differences to other approaches are highlighted.

2.2. Selection of characteristics

The framework only refers to qualified food characteristics. It is proposed that these characteristics must satisfy three conditions (*CPR* characteristics): to be imperceptible ("*credence"* condition), to be relevant to citizen/consumer concerns ("*pragmatic*" condition), and to be ethical ("*reasonableness*" condition). The credence condition restricts the application of the model to imperceptible characteristics. Perceptible characteristics are irrelevant to the framework because citizen/consumers may already consider them in their food purchase based on food appearance or prior consumption experience.

The pragmatic condition selects characteristics about which *the public* engages in debate. Thus, it protects recourses from being exhausted on assessing characteristics that live only in academic discussions.

The reasonableness condition reduces the number of eligible characteristics to those that correspond to "ethical" citizen/consumer concerns. For the purpose of this framework, citizen/consumers' concerns are regarded to be 'ethical' when they satisfy two criteria. It must be possible to describe the sources of motivation that underlie these preferences as parts of what Rawls calls 'comprehensive doctrines of the good life' (1996, pp. 58–59).[44] Also, these corresponding perceptions of the good life must be *reasonable* (Rawls, 1996, p. 193). In this sense, throughout this paper the term "ethical" is used in a fashion that is devoid of ontological connotations. To address herein (e.g.) environmental, health, naturalness, or humanitarian preferences as "ethical," does not contain a claim on the metaphysical or on the rational validity of the particular egalitarian, self-interest, or religious values behind these preferences. In other words, to say that "food naturalness" is an ethical issue *does not* imply that "food naturalness" is *in itself* something that possesses (or possesses not) objective value, or that it is *by itself* something that somehow ought (or ought not) to be pursued, or that it is (or that is not) something *in itself*, at all, indeed. Instead, it implies a descriptive acknowledgment that there exist members of the society that consider these issues to be important to their own lives, and a normative acknowledgement that in a politically liberal democratic environment this is permissible. Given this account of the term "ethical" in the present paper, the ethical "characterization" of foods refers to the ranking of foods in terms of imperceptible characteristics for which citizen/consumers maintain ethical preferences. The reasonableness condition rejects characteristics like, for example, "made by white people," and thus it does not enable the consideration of related concerns in the market.

2.3. Functional input

An overview of the information flow to and from the model is given in Fig.1. The selection of legitimate agents to make decisions about the criteria used for the description of characteristics, the importance weights attached to them, and the

[44]Similarly, Habermas (1993) referred to ethical issues as "constitutive to personal perceptions of goodness (life plans) of individual members of the society, [that are] therefore […] necessary for their existential self-understanding."

scales used for their measurement, are central for the validity of the generated information. For the market assumed by the framework, the role of information is to enable citizen/consumers to consider preferences for CPR characteristics in their market choices. To live up to this expectation, information must be relevant to the concerns of the consumers (Frewer *et al*., 1999). In other words, the weights, the criteria, and the scales used for scoring the performance of food options must refer to concerns stemming from citizen/consumers' own values, principles, and beliefs. We refer to this as the "*structural input validity*" condition.[45] This condition ideally requires that each individual citizen/consumer receives information that directly refers to her own perceptions. As such, the structural input validity condition points to concerned citizen/consumers as the legitimate source of input about "what (and how much) matters" in food production. This ideal situation seems difficult to achieve for at least two reasons. First, different people are likely to have different concerns stemming from different values, principles, and beliefs. A commitment to provide each and every citizen/consumer with personalized information might be technologically too complex to be feasible. Second, using citizens/consumers as the direct source of structural input seems to demand too much from individuals in terms of self-awareness and/or in terms of expertise (remember the regrettable "I don't want genes in my food" motto against genetic modification). The approximation to the structural input validity condition that can be proposed is that the description of characteristics happens through deliberative processes[46] with the

[45] The violation of this condition would run against the politically liberal assumption made in this study. The politically liberal assumption does not allow for further criticism of an existing view of the good life, once that view has been accepted to be reasonable (Rawls, 1996, pp. xxi–xxii; also Streiffer and Hedemann, 2005). For example, the structural input validity condition would reject as irrelevant to the decision-making process a view from an agrifood stakeholder that "genetically engineered food is natural" when this view disagrees with citizen/consumers' perceptions about what counts as "natural," even if reasonably based on the occurrence of inter-species gene transfer by bacteria and viruses in the wild. Within the ECHO framework a food supply actor must effect a change in citizen/consumers' perceptions to affect definitions of characteristics (Fig.1).

[46] These processes may, for example, take the form of appropriately adopted consensus conferences (see Nielsen et al., 2006). For a presentation of other possible candidate methods for this step of the framework see, for example, Beekman and Brom (2007). An alternative possibility would be to derive structural input from the opinion of actors that either "interpret" or "represent" concerned consumers/citizens (e.g., social scientists, consumer associations, NGO's). It should be noticed, however, that moving away from concerned consumers/citizens as decision-makers risks introducing bias and compromising the validity of structural input.

participation of focus groups of relevantly (e.g., environmentally) concerned citizens/consumers (peers). In these processes, stakeholders from the production sector, from the civil society, and social scientists should be invited to analyze and discuss the complexities of the issues at stake, and increase the chances for consensus. In the end of the day however, the produced descriptions must conform to the (deliberated) perceptions of citizen/consumers.[47]

To base descriptions of characteristics on citizen/consumers' perceptions does not exclude a role for science in the framework. Clear roles for scientists can be identified in informing deliberations and in the assessment of foods' performance for the selected criteria. Besides, science-based thresholds could be used as benchmarks for the further characterization of foods as surpassing (positive) or falling short of (negative) the minimal sufficient levels of the respective characteristic (e.g., ecological sustainability).

Finally, to ground the selection of characteristics and their description solely on citizen/consumer perceptions (and to avoid candidate absolutist descriptions of these characteristics) has the consequence that structural input is sensitive to shifts in citizen/consumer opinion. Possible reasons for such shifts can be technological change (which can challenge established norms by revealing new opportunities, Keulartz *et al*, 2004), the unexpected occurrence of disasters (which can lead to sudden changes in ethical priorities), as well as the development of conviction among the public that certain threats are becoming imminent (e.g., climate change). The ECHO framework can accommodate for such shifts in citizen/consumers' opinion by updating the model's structural input on a periodical or on an *ad hoc* basis. Such

[47] These processes could adopt a "common ground" approach to list these criteria only that are common across different concerned groups (sort of an overlapping consensus among concerned groups). Alternatively, it is also possible that these processes produce a full account of all criteria put forward by any concerned group. This alternative approach will reflect the pluralism in opinions among relevantly concerned citizen/consumers. Relative importance weights may refer to the number of participants that support each criterion. It would be perhaps desirable that weights also reflect the importance that different sub-groups of participants attribute to each criterion. The use of equal weights could also be considered. Criteria could be aggregated for the description of characteristics in a "maximized" or in a "most balanced" way (see section 2.4). Criteria may take the form of (e.g., environmental or health) risk factors for which concerned citizens/consumers wish foods to be assessed. Interval or ratio scales, and local or universal scales may be used for their measurement, depending on the nature of the criterion and the characteristic at stake, and on product input data availability (see Dodgson et al., 2000).

updates give to the ECHO framework a dynamic nature. Too frequent reassessments, however, should be avoided as they would compromise the operational value of the model as a heuristic tool to guide production.[48] Also, because consumers' perceptions differ between different cultures (Frewer *et al*., 2004), the description of characteristics on the basis of citizen/consumers' perceptions makes the framework context and culture-dependent. Overall, structural input expresses culture-and-times-dependent perceptions of citizen/consumers.

2.4. "Incommensurability" of ethical values and "additivity" of criteria.

The aggregation of performances for different criteria of each characteristic usually assumes that criteria are "additive." In "compensatory" models, lower performances of a food option for a particular criterion can be compensated by higher performances for another. Mathematically, the additivity assumption holds when the criteria are "independent." Independence roughly means that the performance of a food for one criterion is not affected by its performance on another. This condition is not always easy to prove (for example, see Dodgson et al, 2000). Besides, additivity of criteria also raises philosophical questions that relate to the incommensurability of ethical values; roughly that caring a bit more for one's family cannot compensate for caring a bit less for the neighbor. Views on incommensurability differ.[49] This issue might prove to be critical when criteria (or characteristics) represent different ethical values, and especially when these values are parts of different views of the good life that happen to overlap in raising concerns about the same food characteristic. Diaz-Balteiro and Romero (2004) introduced a multi-attribute variation that offers a way for tackling this issue. The proposed method ranks options for a range of different additivity levels[50] to produce

[48] Presumably, a periodic confirmation of characteristics, criteria, and weights every, say, 5-10 years could sound reasonable as on the one hand it would allow food supply actors to plan the ethical optimization of their production and services, while on the other hand it would allow the model not to lag too far behind the evolution of citizen/consumer perceptions. However, there may also appear reasons for ad hoc reassessments following food scares and crises.

[49] See Chang's (1997) analysis of incommensurability and Hardin's (1968) argument that scarcity of resources makes tradeoffs among ethical values inescapable in life.

[50] Levels range between zero ("no additivity") and one ("perfect additivity"). The in between values correspond to "different levels of additivity." Perfect additivity produces maximized "utilitarian" results. No additivity produces "most balanced" results, and it is interpreted as

a range of “maximized” to “most balanced” results. This variation allows one to take the decision about the appropriate additivity level in a subsequent phase, presumably in agreement with the opinion of the legitimate decision-makers. When compromises among different views seem untenable, then non-additivity can be assumed to produce most balanced results.

Essentially, the “most balanced” (“Rawlsian”; maximin) option assures that rankings will not reward the good performance of foods for some criteria (or characteristics) to the cost of its poor performance for others. In this way, the “most-balanced” option encourages that all identified criteria are paid attention to, and fits best with the politically liberal assumption of the framework. Nevertheless, this point is more relevant when criteria refer to different (that is, incommensurable) citizen/consumer values (concerns) rather than when they refer to different factors that co-contribute to the performance of foods for the same value. For example, while within a broad “environmental sustainability” characteristic one may identify criteria that refer to different values (e.g. the depletion of non-readily renewable resources, global warming, the preservation of biodiversity, etc.), it can also be the case that more than one criteria are relevant to certain values (e.g. impact on biodiversity may be affected by pesticide emissions and by the sort of fertilizer used). When the latter is true, then there may be cases where the politically liberal argument for balanced satisfaction of criteria loses its force. When different criteria refer to different citizen/consumer values, the Rawlsian demand for equity may guide the penalization of low performances for some criteria. However, when criteria are better seen as alternative ways for addressing the same value, reasons for penalization eclipse and the issue becomes merely to reward alternatives that work best.

2.5. Interpretation of output and its communicated form

Because the selection (section 2.2.) and the description (section 2.3.) of characteristics in the ECHO framework does not require any assumptions about the metaphysical or the objective validity of structural input, it logically follows that the outputs of the model are also unfit for such interpretations. Therefore, by producing a food that ranks high in terms of (e.g.) “naturalness,” one cannot file any other moral claim except that the product fits well with the perceptions of relevantly

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an “egalitarian” Rawlsian (maximin) solution with equilibrated achievements of different criteria (Zeleny, 1973; Romero, 1991 chap. 7; Ballestero and Romero, 1998; Diaz-Balteiro and Romero, 2004).

concerned citizen/consumers about "what it takes to be regarded natural." Whether these concerns and descriptions indeed enjoy in themselves a valid basis is an issue that is irrelevant to the politically liberal grounds of this framework, and it should better be deliberated upon during debates among relevantly concerned citizen/consumers. In this way it becomes clear that the function of the model is not to *assess* how much metaphysical or objective value rests with a food, but rather to *characterize* a food in terms of issues of concern to citizens/consumers, and on the basis of a set of criteria derived from citizens/consumers' perceptions. However, the precise interpretation of the produced rankings depends on the kind of preference scales used to score the considered food options for each criterion: i.e., on whether local or universal scales are employed.[51]

Similarly when a higher level of aggregation is attempted (a mathematically possible "overall" characterization), the numerical output of this process will not be valid as some teleological or perfectionist representation of the ethical value of a product. Instead, that numerical output would express a food's overall performance for CPR characteristics, on the basis of criteria that describe citizen/consumers concerns, according to weights that refer to citizen/consumer perceptions, and as compared to perceptibly equivalent (substitutable) food options. It should be noticed, however, that even a "most balanced" (see section 2.4.) overall ranking of foods would only be meaningful to citizens/consumers that maintain concerns for the whole range of qualified CPR characteristics. However, because the "most balanced" option ranks foods for their satisfaction of the least accommodated characteristic, such an overall

[51] For the proposed multi-attribute methodology, the produced comparative rankings depend on the "best" (referred to as "*ideal*") and on the 'worst' ("*anti-ideal*") product options considered. When "*local*" performance scales are used, then foods are compared to other *existing* marketed products. That is, the produced ranking will indicate that, for example, a tomato is, say, 50% natural as compared to the most and to the less natural tomato *available in the market* (what is the "most" and the "less" natural tomato is to be judged on the basis of the naturalness criteria suggested by citizens/consumers). Contrarily, when "*universal*" scales are used, then foods are compared to *technologically feasible* (though perhaps not yet realized) products. In that case, the ranking will indicate that a tomato is, say, 50% natural as compared to the most and to the less natural tomato that is technologically feasible. In the case of the naturalness example used here, technological change is perhaps more likely to affect the anti-ideal (i.e., the least natural) than the ideal (i.e., the most natural) tomato option referred to during the comparisons. For more detailed technical information on the use of such scales see Dodgson et al. (2000), while for the function of ideal and anti-ideal values for producing comparative rankings for the proposed methodology see Diaz-Balteiro and Romero (2004).

ranking could provide insight into the likelihood that a particular food option will be socially controversial.

Finally, it must be noticed that the form in which rankings will be communicated should not be confused with (and is not determined by) the, strictly speaking, output of the model. The model's output may be processed to take a form fit for effective communication, either as absolute numbers, or as percentages, geometrical shapes, color scales, etc. Besides, depending on the characteristic, it could be possible to combine rankings with other information to assess foods as "positive" or "negative" for the purpose of the respective characteristic. In that case, positive and negative rankings would not express comparative performances of possibly substitutable food options, but their performance as compared to scientifically or politically established benchmarks (e.g., one of ecological sustainability). The economic and normative consequences of such benchmarks can be far reaching, and their legitimacy will have to be carefully examined.

2.6. Differences to other approaches

The main distinguishing quality of the ECHO model is its dual political and economic perspective, able to produce information based on citizens' perceptions and on consumers' preferences. Other distinguishing qualities may include that the relation between criteria needs not be maximized (balanced rankings are possible, section 2.4). Also, that ethical aspects of production are not translated into monetary values (products are directly characterized on the basis of citizens/consumers' perceptions). Besides, the relation between "ethical" and other preferences is not addressed by the model. Instead, the generated information may allow concerned citizen/consumers to make tradeoffs themselves in the market, by weighing the levels of ethical characteristics against other preferences and product price: citizen/consumers' tradeoffs may in a subsequent stage guide production. Finally, the model requires the description of characteristics in terms of technical criteria, and it produces gradient (non-binary) results.

The use of technical measurable criteria makes the model operational as a heuristic tool for product development. As compared with non-technical proxies, technical criteria can be expected to be more useful to food supply actors that want operational standards for the optimization of their production and services. Besides, because these criteria must be based on citizens/consumers' perceptions, they can have strong argumentative value for producers that need to support their choices in

the public debate. Also, the reference to citizen/consumers' perceptions is likely to reduce discrepancies between citizen/consumers' understanding about what a label stands for and what the certification really guarantees, and therefore to serve better the purpose of facilitating informed consumption (for a relevant discussion of the organic label in the US see Sagoff, 2001).

Finally, the generation of graded output distinguishes ECHO from a number of popular ethical certification systems like the EKO, Biological, Organics, and FairTrade labels. Non-binary rankings enable a pragmatist understanding of food characteristics in terms of grades (or degrees, levels), rather than in terms of thresholds (Keulartz *et al*, 2004). They can replace vocabularies in which foods are either "fair" or "unfair" with more productive ones, in which foods are "more-" or "less fair" than other foods, subject to citizens/consumers' account of "fairness."[52] Moving from binary certifications to comparative rankings can allow producers to improve the ethical characterization of their products by means of relatively modest (and therefore less costly) changes in the ethical aspects of their production, instead of being forced to achieve the higher standards of binary labels.[53] Different levels of

[52] It is perhaps true that citizens/consumers perceive ethical issues in terms of dichotomies (we thank an anonymous referee for indicating the need to clarify this point). For example, a food can be either "100% natural," or else "unnatural." To argue against such dualistic understandings would require demonstrating that they are logically incoherent. It is true that if or when an acceptable and logically coherent definition (e.g., one of naturalness or of equality) would be referred to, then, indeed, foods could be categorized as either "natural" or else "unnatural," and as either "fair" or else "unfair." Even in this case however, one will still be likely to encounter within the "unnatural" or the "unfair" categories foods that are more unnatural or more unfair than other foods. That is, not all unnatural or unfair foods are equally unnatural or unfair. Different unnatural or unfair foods can be in stronger or in weaker contrast with the demands of the considered naturalness or fairness criterion and presumably be preferred in the absence of perfectly natural or fair foods. We hope (because we find them more productive; Keulartz *et al*., 2004), and we expect (because of the existing plurality of perceptions about what it means for food to be e.g., "natural'; Verhoog, 2003), that gradient descriptions of characteristics will be produced by the deliberative citizens/consumers' workshops (section 2.3). However, concerned citizens/consumers will have the possibility to insist on dichotomous characterizations of foods, either by identifying a single binary criterion that gets consensually acknowledged to capture all aspects of a characteristic, or by attaching a very high relative weight to some binary criterion that is perceived to capture its essence.

[53]Binary labels only reward major (and costly) changes required to achieve standardized certification levels. Consider for example a conventional apple producer that converts to biological production. The farmer must refrain from agrochemicals for two years so that

characteristics at different prices can provide to citizen/consumers opportunities for tradeoffs between ethical and price considerations even when the price premium of the "full" label cannot be afforded. In doing so, non-binary rankings may have the important consequence to relax affordability constraints for ethical consumption.[54] Besides, comparative ranking does not only provide information on how well do products fit with citizen/consumers' preferences, but also about how unsatisfactorily they may do so. Therefore, the concerned citizen/consumer can get informed not only about which products to choose, but also about which products to avoid. In these ways graded characterization serves better the purposes of the market mechanism, because it eases the reallocation of resources and increases the opportunities for citizen/consumers to reveal ethical preferences. Too many grades, however, might appear confusing to citizens/consumers. Additionally, large numbers of grades will demand high precision for product input and, consequently, increased costs.[55].A sensible balance between clarity and effectiveness must be sought when implementing the model.

3. Function of the ECHO Framework

The function of the ECHO framework depends on whether the generated information is made readily available to citizens/consumers (Fig.1 and Fig.3). When generated information is not made readily available to citizens/consumers, then characterizations can be used by food supply actors as a structured indication of concerned citizens/consumers' stated preferences. When information becomes

residuals are removed, before his production gets certified as biological (EEC, 1991). This means that the farmer might face two years of lower productivity without the financial compensation that "full" biological labeling provides. In this way binary certifications may obstruct conversion from conventional to biological agriculture in self-regulating markets.

[54]The high price premium associated to binary values-based certifications can have a severe impact on ethical consumption. According to a poll commissioned by Milieudefensie, price considerations result in that only 2 % of all the meat sold in the Netherlands is organic, while three-quarters of the Dutch population holds that animal husbandry must be more animal friendly and environmentally friendly. To increase the chances for ethical meat consumption, and to consequently improve the quality of life for production animals, an ongoing public debate in The Netherlands deliberates on the introduction of a pragmatist middle third way in meat production: the so called "compromise animal" or "compromise meat," meant to "fill the yawning gap between the ideal of organic animal husbandry and the existing practice of the meat industry. [translation ours]" (Snoeijen, 2007).

[55] We thank an anonymous referee for alerting us on this issue.

readily available so that concerned citizens/consumers can take it into account during their food consumption, then food supply actors can receive through the market mechanism feedback on the "actual" (i.e., the "revealed") CPR preferences of consumers. In the sections that follow a range of uses for the framework is discussed. The discussion includes applications that presuppose the availability of information to citizens/consumers. It must be stressed, however, that this discussion is not meant to provide a balanced argument for making information available to citizens/consumers. In such a discussion, countervailing arguments referring to, for example, information costs and producer rights should be addressed. Rather, this section aims to outline the uses of the framework in the case that information is indeed communicated, all other relevant issues elsewhere considered.

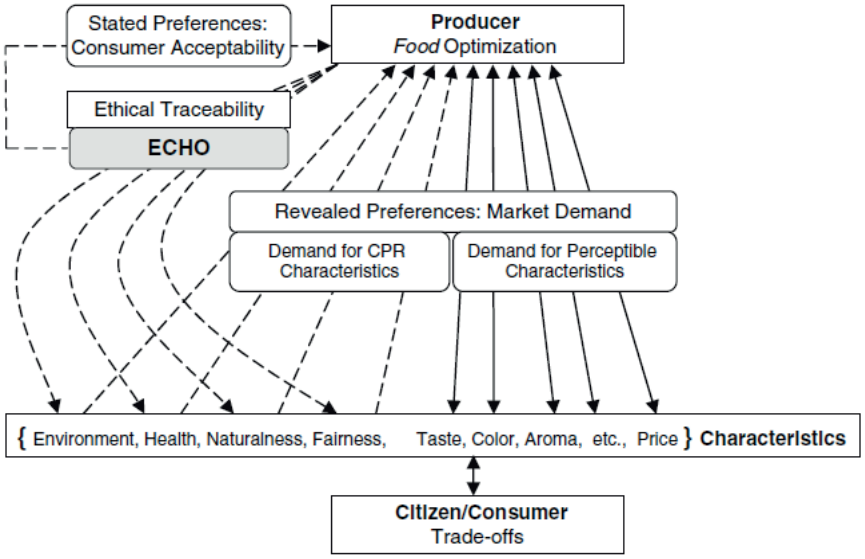

Figure 3: Function of the ECHO framework: *Food* is considered as a bundle of characteristics. Arrows represent information flow. Bold arrows represent perceptible and price information. Dotted arrows represent information on CPR characteristics. The framework provides feedback to producers (a) on *Food* acceptability based on stated citizen/consumer preferences, (b) on market demand for *Food* characteristics based on revealed preferences. Market trade-offs of citizens/consumers are used to calculate 'ethical elasticities' and to anticipate demand for *Food*.

3.1. Uses for actors in the supply side of the food chain

When information on the rankings of foods is not communicated to citizen/consumers (e.g., in the form of labels), then producers may use the model as an operational tool for the ethical optimization of their production. To perform this function, the model must be provided with structural input about citizen/consumers' perceptions, and then producers may apply the model on planned products so that they receive an early assessment of their ethical characteristics. This feedback can indicate the need to modify the qualities of planned products for the achievement of optimal levels for the preferred characteristics. The early assessment of citizen/consumer acceptability (and the subsequent optimization of production) can be valuable to producers who wish to minimize risks of suffering damages from investments in ethically controversial foods. In this way, the model may indicate the need for further research and/or for changes in research priorities, and can act as a heuristic tool to guide the optimal use of innovative technologies for the development of uncontroversial novel food products. Also, characterizations can be used by producers when they need to demonstrate a commitment in their production to the ethical convictions of citizen/consumers. In this function, the framework can help producers to defend their relationship with citizen/consumers and the long term profitability of their brand names. Additionally, the model could be used to illustrate the ethical aspects of their production for the attraction of ethical investors. Accordingly the model can facilitate long-term profit maximization for producers.

When the produced information is made available in the market, then additional uses for producers and citizen/consumers can be expected from the application of the framework. For producers, additional uses can be twofold. First, the feedback from the framework gets upgraded from "stated preferences" to "revealed preferences" based on actual market choices of citizen/consumers. This means that it becomes possible to estimate actual correlations[56] between different levels of ethical characteristics and market demand, and accordingly to optimize the ethical aspects of planned products. Moreover, market feedback can allow producers to assess the "ethical landscape" of the market and to identify opportunities for new products and for "ethical entrepreneurship" (Korthals, 2004a). Second, information will allow producers to illustrate in the market that their products are superior to

[56] That correlation could be expressed by an "Ethical Elasticity of Demand." Ethical Elasticities of Demand would express the change in market demand following a change in the levels of CPR characteristics.

perceptible substitutes in terms of CPR characteristics. The generated information may reveal that foods that are regarded to be substitutes for perceptible characteristics are not substitutes in terms of ethical characteristics (i.e., products that perform acceptably for CPR concerns of citizen/consumer, vs. products that do not). This "ethical differentiation" can help foods to disengage from price competition with ethically inferior products and claim added –ethical– price premium. In this way, information can allow producers who respect ethical constraints to gain advantage over those that do not comply with such constraints.[57] This might appear interesting to producers in western countries that must comply with strict regulations (e.g., labor, environmental, or animal welfare).[58] It can be particularly interesting when trading in markets that are bound by international agreements not to block entry to products from abroad that do not meet equivalent requirements.[59] Accordingly the framework can facilitate short-term profit maximization for producers.

[57] Essentially, in the short term, the absence of relevant information "punishes" in the market those food supply actors that acknowledge ethical constraints to their profit maximization goals, while the availability of credible information provides for them compensation in the market. Though current market demand indicates that this compensation can be expected to be low, the recent "GMO's" controversy has shown that the availability of information can increase the consistency between stated and revealed preferences of citizens/consumers (Scholderer and Frewer, 2003).

[58]"When applied to food and drink, the term "quality" [...] can certainly carry "ethical" connotations [...]. It's essential for us to know what qualities consumers are looking for in food, and which ones will persuade them to pay higher prices. This is because of the changing international environment in which the agrifood industry now operates. The barriers to international agricultural trade are falling fast, and there are many very powerful players out there who will fight tooth and claw for a larger share in world markets – especially bulk markets. […] I am confident that many farmers in the European Union will continue to compete effectively in bulk markets for the foreseeable future. But not all. Those that cannot win the battle on this ground must fight on different ground – and for many, that ground is high-quality production." Fischer-Boel, European Commissioner for Agriculture, 2006.

[59] One can refer to competition between products that have been subjected to environmental constraints (e.g., in signatory countries of the Kyoto Protocol) and products that have not been subjected to environmental constraints. For as long as corresponding environmental policies lack support from "scientifically sound risk assessment" (Kerr, 2003), the World Trade Organization (WTO) may object to devising national market barriers against products that fail environmental requirements. In the absence of relevant and citizen/consumer-perception-based information, environmentally "unconstrained" — and

3.2. Uses for Citizens/Consumers

In a straightforward way, citizens/consumers could use the generated characterizations to optimize food purchases for CPR characteristics (alongside the optimization for perceptible characteristics, subject to consumption constraints, and when relevantly concerned).

In economic terms, on the one hand citizens/consumers will be able to maximize the satisfaction of their preferences with the inclusion of CPR ones. On the other hand, by revealing CPR preferences citizens/consumers can present tangible incentives to producers for the optimization of the ethical aspects of their production. Normal market forces can be steered to develop the ethical dimension of food production by considering the satisfaction of CPR preferences for the optimal allocation of scarce resources. Accordingly the framework can facilitate the ethical optimization of food production.

Similarly in political terms, because the generated information refers to citizens/consumers concerns, on the one hand it can help citizen/consumers to consume foods that fit better with their own reasonable views of the good life. In this function the framework can help dissolve trust crises by enabling informed choices.[60] On the other hand, rankings can allow citizens/consumers to express in their food consumption reasonable values, principles, and beliefs that relate to their

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therefore presumably cheaper — products may engage in price competition with "constrained" ones. Other examples may refer to animal welfare, labor income, and working conditions.

[60] Trust crises often relate to the way risks are defined and managed by "others" (Slovic, 1999; Salaun-Bidarta and Salaun, 2002; Korthals, 2004 b). Frewer (2003) argued that when communication activity does not address the ethical issues consumers are concerned about, then "this information may have appeared, at best, irrelevant to consumers, and at worst may have seemed to be an attempt by the information source to hide from the public what the public perceived to be the 'real' risks of the technology." Because rankings refer to the perceptions of concerned citizens/consumers, the ECHO framework minimizes decision-making "by others" about what is important to know. Accordingly, it addresses the trust relation between citizens/consumers and food supply actors by shifting the focus of citizen/consumers' trust from the practices of food supply actors to the adequacy of the monitoring and auditing system used for the collection of technical information for product input (i.e., to the ethical traceability system in operation). For the successful implementation of the framework it is crucial that citizen/consumers will regard any institutionalized ethical traceability system as credible and trustworthy. A role for the government could be identified in monitoring and in supervising the overall good application of the framework.

effect on others (i.e., people, animals, environment, future generations, nature, etc.). Accordingly, the ECHO framework can facilitate the politically liberal and democratic allocation of scarce resources when citizens' concerns are not (or should not be) addressed by state regulation.

3.3. A basic theoretical illustration

A basic theoretical illustration of some of these functions is provided with the help of Fig. 3. Let us take the case of a food producer (breeder) that plans the development of the new competitive product *Food*. Let us also assume that the breeder sees opportunities for improved production in plant genomics research.[61] To realize her goals, the breeder must make choices about the desired characteristics of the new product (Should *Food* be tastier, or should it be cheaper?). Nurtured by the controversy about GMO's, the breeder decides to pay also attention to CPR aspects of her production (Will an "environmentally friendlier" but "unnatural" product raise controversy?). These choices will set the priorities in the research agenda for plant genomics (Should pest resistance or *Food* aroma be researched?) and will affect the method of application for its insights (Should genetic engineering or conventional breeding be used?). To optimize the levels of ethical characteristics the breeder may choose to use the ECHO model as a heuristic tool for guiding product development (If *Food* has, say, such and such characteristics, would it rank higher than existing products in citizen/consumers' perception?). When trust controversies arise, the breeder illustrates ethical production based on the comparative qualities of *Food* as assessed on the grounds of stated citizens/consumer preferences. However, the producer still needs to justify tradeoffs among levels for CPR characteristics, and also between levels of CPR characteristics and other producer choices (e.g., health risk tolerance levels against taste enhancement). Tradeoffs might not appear acceptable to citizen/consumers and trust controversies may still arise.

[61]There are reasons to believe that plant genomics bears a significant societal and economic potential because it can enable technological solutions to food-related problems (Nap et al, 2002; NWO, 2001). However, technological solutions can be assessed differently in the context of different concerns. Besides, the overall assessment of foods depends on a large range of criteria that concern the end product as well as its production history. Therefore, technological solutions cannot straightforwardly guarantee citizen/consumer acceptance for the resulting foods, and the "ethical assessment" of planned products remains important (Michalopoulos, submitted).

When CPR rankings are available in the market, then the focus of citizen/consumer trust shifts from the practices of producers to the credibility of the ethical traceability system in operation. When a citizen/consumer encounters *Food*, she will get informed on its performance for CPR characteristics, comparatively to perceptible substitutes and according to the deliberated perceptions of her peers (the relevantly concerned citizens/consumers). Information indicates how does *Food* perform for some characteristic (e.g., for naturalness) as compared to existing or to technologically feasible alternatives (other tomato options). The consumer chooses (or does not choose) *Food* over a possible substitute. Concerns are voiced and the satisfaction of CPR preferences gets optimized subject to consumption constraints (Should I buy a more "environmentally friendly" but less "natural" food? Is this price difference a sufficient reason to buy a product that ranks so low for "fairness of production"? Does this price difference refer to a characteristic that I am concerned with? Do I want to support this kind of food production?). The market choices of citizens/consumers reveal their preferences and allow the correlation of market demand with levels of CPR characteristics (How much does it actually pay to rank higher for environmental friendliness?). The producer can disengage from price competition with products that perform unacceptably for CPR characteristics, and claim a price premium for the ethical superiority of her production. Producers see tangible incentives for the ethical optimization of food production. The market becomes consumer-driven for ethical issues. The relation between CPR and perceptible characteristics of planned products can be optimized so as to better attune foods to the preferences of targeted markets. CPR optimization affects the practices of a range of actors in the production side of the food supply chain (Should biological pest management be applied? Should "closed" production systems be employed? Should air transportation be used? Should colorings be added? What packaging material should be chosen?). Research priorities for plant genomics get redefined. Resources get reallocated so as to regard ethical preferences of consumers. The ethical dimension of the market gets developed.

4. Conclusions

This paper has outlined a framework for the ethical characterization and subsequent optimization of foods (ECHO) in terms of characteristics about which consumers/citizens maintain concerns. The framework produces information on "credence," "pragmatic," and "reasonable" food characteristics, with the purpose to facilitate the well-functioning of the market. The paper assumes a political viewpoint

in that the well-functioning of the market is taken to require that the market performs the operations anticipated by the particular political context within which the market operates. A model politically liberal democracy and a neoclassical market were assumed for this purpose. Valid information was taken to allow concerned citizens in markets to make choices on goods that they perceive to be important to their own lives and to their relation with others (i.e., people, animals, environment, future generations, nature, etc.). The framework makes use of multi-attribute modeling. The proposed model produces "maximized" (utilitarian) to "most balanced" (maximin) non-binary aggregate rankings of food products. The model requires the description of characteristics by means of criteria and weights (structural input) and technical input on the performance of foods for these criteria (product input). Structural input is based on citizens/consumers' perceptions. Availability of product input has been assumed. Potential uses of the generated information have been identified for citizens/consumers, for producers, for their trust relation, for the use of innovative technologies, and for the optimization of the ethical aspects of production in self-regulated markets. So long as, and to the extent that, certain citizens' concerns are not addressed by state regulation, the ECHO framework has the potential to bring rewards for food supply actors that take citizen/consumer concerns into account, and to facilitate the politically liberal and democratic operation of the market.

This paper treats a controversial issue, loaded with ethical, epistemic, and practical difficulties. We have presented an effort to navigate among these difficulties in a politically and economically consistent way. The present paper does not suggest that the market is (or that it is not) the appropriate arena for the regulation of any particular good of concern to citizens. Rather, this work is concerned with the generation of information that is required if citizens' concerns are to be expressed in the market when state regulation is, as a matter of fact or of norm, constrained.

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CHAPTER 4

Relative importance of ethical concerns for different groups of fresh tomato consumers

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Submitted to a peer reviewed international journal

ABSTRACT. During the last decades ethical consumer concerns about food have become more prominent in industry, policy circles, and societal debates. Although there is a rapidly growing consumer behavior literature about ethical consumer concerns, insights in the relative weights of these concerns and the effect of socio-demographic parameters is limited. In this study we analyze the relative weight Dutch consumers in Wageningen attach to ethical concerns about food production. Four categories of concerns were considered: Healthfulness, Environmental impact, Naturalness and Fairness of food production. The relation of four socio-demographic parameters on these relative weights was examined: Preferred food outlet, gender, age, and educational level. Food outlet was found to have the strongest effect on the distribution of relative weights, as compared to the other parameters. Perceptions such as that healthfulness is the most important ethical concern about food, and also that consumers of organic/biological shops care relatively more about the environmental aspects of production are confirmed by the results. Results also indicated that consumers of low cost retailers are relatively more concerned about the healthfulness of food. Furthermore, we observed indifference in preferences between health risks and health benefits in food, while impact on global hunger was the major fairness concern, and labor wages the major wealth distribution concern. The generated insights may be used to optimize food production, supply and promotion for ethical aspects of food production.

HIGHLIGHTS:>Impact of socio-demographic parameters on stated consumer preferences for ethical food production > Correlations in relative importance of Environmental, Healthfulness, Naturalness, Fairness aspects> Food outlet has the strongest effect on relative ethical preferences >Healthfulness most important, indifference between risk aversion and benefits > Global hunger the major fairness concern.

KEYWORDS: stated ethical preferences, food consumer concerns, environmental impact, food healthfulness, food naturalness, fairness of food production.

1. Introduction

The societal acceptability and market demand for food products mainly depends on traditionally acknowledged attributes like product price, taste, healthfulness, aroma, cooking functionality and purchase location convenience. Recent food controversies however, and most notably those relating to genetic modification, illustrated that market demand for food products can also be significantly affected by attributes like the quality of life of farmed animals, perceived food naturalness, and impact on the environment, on future generations and on 'others': distant people which the consumer does not expect to ever meet. The latter group of attributes, together with food healthfulness, is collectively known as 'ethical' consumer concerns (Brom, 2000).

The ethical behavior of consumers has been extensively researched in the consumer behavior literature. A major part of that literature focuses on the effect of price-changes on consumer demand for ethically-labeled (like organic or fair trade) products. Another body of literature examines consumer attitudes towards ethically labeled products. In these studies data on socio-demographic, economic, psychological and ethical factors affecting relevant consumer behavior are collected and analyzed, while, in general, prices in monetary terms are not taken into account. Finally, there are studies that examine what factors affect consumer willingness to pay for ethically-labeled products, especially socio-demographic, economic, but also ethical and psychological factors (e.g. Vermeir and Verbeke, 2006; Vitell and Muncy, 1992; Gracia and Magistris, 2008; Yiridoe et al. 2005).

However, most studies focus on consumer preferences about individual food attributes, and do not examine interrelations between consumer preferences for different ethical product attributes. Moreover, the socio-demographic factors that are usually included in the analyses are consumer age, income, education and gender, while likely relations of relevant consumer preferences with other socio-demographic parameters, like preferred food outlets, are usually not taken into account. To address these shortcomings in the scientific literature, in this study we examine the relative weight of four general categories of ethical concerns: Healthfulness, Environmental impact, Naturalness and Fairness of food production (Fig.1). The effect of four socio-demographic consumer parameters, namely preferred food outlet, gender, age, and educational level on the relative importance attributed to these four categories of ethical concerns is also examined. The analysis is based on data collected by means of a consumer survey of Dutch consumers in

Wageningen for ethical concerns of food production, in 2007. In the sections that follow, first the theoretical framework section describes a short overview of consumer ethics, our hypotheses, and the analytical framework used, and then the methodology section describes the questionnaire and the statistical tools used. Next, the analyzed results are presented and discussed.

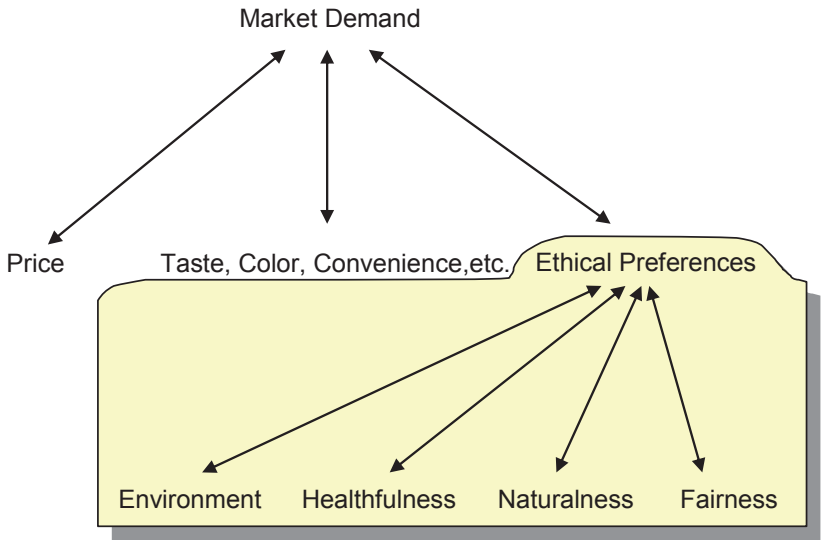

Figure 1: Scope of the present analysis of consumer preferences. Animal welfare concerns were excluded from the scope of this research as irrelevant to tomato production. Producer uses feedback to optimize production.

2. Theoretical Framework

2.1. Consumer Ethics

Ethical issues in business have dramatically increased during the last decades. Part of the research on business ethics has been about marketing and marketing related activities (Ferrell and Gresham, 1985; Hunt and Vitell, 1986; Ferrell *et al.,* 1989). However, until fifteen years ago only a handful of articles examined consumer ethics (Vitell et al., 2001). Bagozzi (1995) stressed that consumers are important participants in the business process and not considering them in ethics research will likely result in an incomplete understanding of business ethics. This led to the

emergence of consumer ethics as a field of studies of ethical issues in the marketplace from the consumer perspective. According to Belk et al. (2005), among the most important issues of consumer ethics are consumer reaction to ethical transgressions by suppliers, and the emergence of consumer boycotts and buycotts of business organizations. Several studies on consumer ethics focus on responsible consumer behaviour (Roberts 1996) and decision-making-process models (Brinkmann, 2004). According to Brinkmann (2004) the introduction of ''moral awareness'' can benefit from the study of consumer focus on different moral criteria when evaluating and choosing alternatives. Honkanen et al. (2006) stresses that to evaluate the moral behaviour of consumers we need to have a profound understanding of the moral attitudes of consumers. In general, attitude towards consuming a product has been found to be one of the most important antecedents for predicting and explaining consumers' choices across products and services, including food products (Bredahl, 2001; Cook et al., 2002; Conner et al., 2003). In order to understand differences in attitudes, we need to study their antecedents. We propose that ethical concerns (Brom, 2000) are such antecedents. In this paper we will use a framework of four general ethical concerns as an overview of 'what matters' in public perception among the ethical issues involved in plant (food) production. In the next section we will present the analytical framework used to evaluate the relative weight of these general categories of ethical concerns.

2.2. Overview of our hypotheses

Our first hypothesis considers the relation between socio-demographic parameters and the importance attached by consumers to different ethical concerns. Roberts (1996) used a simple eighteen-item scale and concluded that very little of the variance on his scale is related to demographic variables. Also Diamantopoulos et al. (2003) concluded that demographics are not very significant in defining the socially responsible consumer because ethical concern and awareness have become widespread. Auger et al. (2003) showed that is difficult to predict the effects of socio-demographic characteristics such as age, gender, ethnicity, and education. Price, quality, convenience, and brand familiarity are still the most important decision criteria (Carrigan and Attalla, 2001; Weatherell et al., 2003). Based on these sources, our first hypothesis is that consumer preference for ethical attributes is not related to socio-demographic parameters. Our second hypothesis concerns ethical consumerism that is situational; i.e., specific to the purchase environment (Belk et al., 2005). Codron et al. (2006) believes that supermarket chains are an important

factor in the rise of the "responsible" consumer because they quickly spotted the opportunity in this trend, and this, in turn, gave further impetus to the development of markets for relevant products. Supermarket chains' merchandising systems have a much greater capacity to reach mass markets than the small shops that had been selling ethical products to niche markets (Codron et al., 2006). In line with these sources, our second hypothesis is that relative weights of ethical concerns differ between groups of consumers with different preferred food outlets. Finally, although consumer ethics is focusing on consumer preferences on individual food attributes, the interrelations between the relative importance that consumers attach to different ethical attributes of foods are not examined in the literature. Our third hypothesis is that consumer preferences for certain ethical attributes are correlated.

3. Analytical Framework

The ethical concerns of consumers that are relevant to plant production (fresh tomato) were quantified using the framework presented at Fig. 2. To develop the framework, first, an inclusive list of relevant consumer concerns was created with the help of a scientific literature review of recent food debates. In a second step these were complemented with input from an interdisciplinary food expert workshop, where a wide variety of experts from social and natural sciences, the production sector, and the civil society were invited to brainstorm on concerns relevant to plant genomics and tomato production. The generated set of concerns was structured, complemented and refined using semi-qualitative interviews with disciplinary food experts from the Biological, Organic and Biodynamic, Food Safety and Nutrition, and from the Fair-trade food sector. The resulting framework of concerns is meant to identify 'what matters' in public perception among the ethical issues involved in plant (food) production (Michalopoulos et al, 2008)

The resulting framework consists of four general categories of ethical concerns: *Environmental* impact, *Naturalness* and *Fairness* of production, as well as *Healthfulness* of food for the consumer. Environmental impact and Fairness refer, respectively, to ecological and socioeconomic impacts of production and can be understood as 'altruistic' concerns in the sense that they refer to one's impact on others or on society at large. Contrarily, Naturalness and Healthfulness refer to intrinsic characteristics of the edible end-product, and can also be understood as 'individualistic' concerns because they mainly have to do with one's own personal

life interests. The *Environmental* impact category includes concerns about greenhouse gasses emissions, the production of non-biodegradable in the mid-term wastes, unsustainable water consumption, and impact on biodiversity. Impact on biodiversity includes the emission of pesticides and nutrients (toxicities), deforestation and the destruction of natural habitats, and the disturbance of natural ecosystems with the introduction of new species. The *Healthfulness* category considers added consumer health benefits from the consumption of enhanced, improved, or functional foods ('novel' foods), like protection from cancers and cardiovascular diseases, and also possible risks to consumer health. Risks include the existence of toxic substances above safety levels, pathogenic microbes, and uncertainty about possible negative effects from novel foods in the long term. *Naturalness* considers whether the method of plant breeding was traditional or high-tech, using for example genetic modification, and the method of production. The method of production considers the use of agrochemicals, artificial infrastructure like heating, lighting, and greenhouses, and whether plant cultivars have been grown on soil or on artificial substrate. The *Fairness* category regards how food production affects the management of the common natural environment, wealth distribution, and global hunger. Impact on the commons includes the introduction of non-socially-agreeable irreversible changes in the natural environment, and the non-socially-agreeable commercial use of natural community resources like the biodiversity of local ecosystems. Wealth distribution regards the impact of production to wealth 'trickling down' to the poor, and specifically the relative poverty of the country from which foods are imported and the livability of the wages of the 'weakest link' in the food supply chain. Impact on global hunger regards the production method used for its impact on the total volume of food produced (yield), the good distribution of production (rights of small and subsistence farmers to save seed), and the long-term production safety (risk of resistant pests being developed in the future).

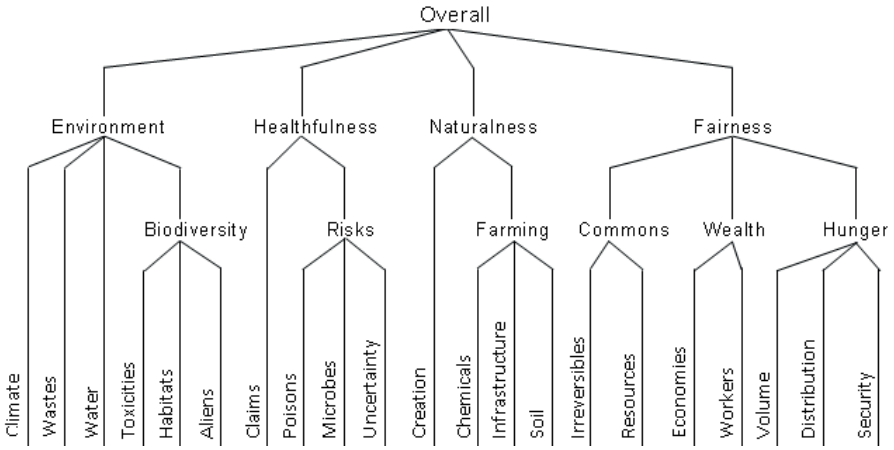

Figure 2: Developed tree of ethical concerns relevant to fresh tomato production, which shows their branching into sub-categories of different aggregation levels.

4. Materials and Methods

4.1. Questionnaire

On the basis of the developed framework, a consumer survey with written questionnaires was used to collect data on the stated relative importance of these concerns for consumers in Wageningen, The Netherlands. The questionnaires were distributed randomly to consumers at the exits of four food retailers in Wageningen and the weekly local open market. Each questionnaire was in a closed envelope that contained a second stamped envelope addressed to the University department. Consumers were informed that they participate at a university research project, and they were asked to study and fill-out the questionnaires at home, and then return them by post to the university. Upon reception of a completed questionnaire, a gift coupon of 15 Euro would be sent to each participant. Out of a total of 172 distributed questionnaires, 105 valid replies were received, four of which did not contain the socio-demographic participant information.

The analysis of respondent sample is presented at Table 1. We aimed for a sample of about 20% respondents from each local retailer: B&K (*organic*& biological specialist shop), C1000 (full service &*convenience* supermarket), AH (full service &*luxury* supermarket), ALDI (*low cost* supermarket), and Market (twice weekly open-air

market with small specialized retailers and high level of personal contact). Female respondents outnumbered male respondents by 11%. Respondents were generally well educated, with more than half of the sample having received higher education. This is not surprising because of the small size of Wageningen, the relatively large size of the local 'Wageningen University and Research Center' (WUR), and the high number of former students remaining in the area after their studies.

Each questionnaire was divided in sections that correspond to the different aggregation levels of concerns presented at Fig.2. For each concern a brief description was given, and participants were asked to divide 100 points among the concerns of each level according to their importance in their opinion[62].

Table 1: Overview of socio-demographic statistics of consumer sample (N=101)

Socio-demographic Analysis															
	Total	Retailer					Gender		Age			Education			
		B&K	C1000	AH	ALDI	Open Market	Male	Female	<30	31-44	>45	Primary (LS+LBO)	Secondary (MS+MBO)	Higher (HBO+Un)	
N	101	17	24	19	21	20	45	56	22	25	54	4	41	56	
%	100%	16	23	18	20	19	43	53	21	24	51	4	39	53	

4.2. Statistical analyses

The consumer questionnaires were divided into sections that corresponded to the divisions of the concerns tree of Fig.2. For each section, participants were asked to divide 100 points among the concerns of each branched group, according to their relative importance. A section with Likert scales was also included in order to give an indication how the stated relative importance of concerns compared to their perceived absolute importance. This section referred only to the overall group of concerns (1st level branching), and asked consumers to mark the importance of the four main categories of concerns on a scale from 0 ('Not at all Important') to 10 ('Very Important'). The data collected from the survey were analyzed using commercially available statistical software (SPSS). The analyses proceeded in three steps.

[62] The questionnaires (in Dutch) are available upon request from the corresponding author.

The first step included descriptive statistics, and a statistical evaluation of differences between the importance of concerns within each group was made. In this step the mean, lowest (Min) and highest (Max) relative importance attributed by any participant to each concern, and also the standard deviation of these responses were calculated. Because participants were asked to divide 100 points between the concerns of each group, the mean values within each group of concerns always add up to 100. However, because the number of concerns in each group varied, the mean values attributed to concerns of different categories were not directly comparable. This is exemplified by a zero preference hypothesis: if respondents would attribute equal relative importance to all concerns, then the mean value for each concern would still vary from 50.0 for groups with two concerns, to 33.3 for groups with three concerns, and to 25.0 for groups with four concerns (these groups are presented analytically in Fig.2). To correct for these differences in group membership, the mean values were normalized as follows:

(Normalized Mean) = (Mean) * (Number of concerns in the respective group)

Therefore, in case a respondent would not have any preferences for the relative importance of different concerns the statistically expected Normalized Mean value for every concern would be 100. Although these (normalized) mean values give an indication for the attitudes of the respondents' sample, the projection of these values to the general population requires cautiousness because of the relatively small, stratified, and local sample used. The second step used univariate analyses of variance (ANOVA) to study the differences between socio-demographic characteristics of consumers and their stated preferences for ethical issues. In the first part of this step, pair-wise comparisons of the mean stated consumer preferences for concerns within each group were performed. The second part focused on pair-wise comparisons of preferences from consumers that belong to different socio-demographic groups. For each concern, the effect of four socio-demographic parameters on stated consumer preferences was examined: preferred food outlet (AH, ALDI, B&K, C1000, and Market), gender (Female, Male), age group (<30, 30-45, and >45), and education (LS+LBO, MS, MBO, and HBO+University[63]). In the third step the mean stated consumer preferences for the full set of concerns were cross-analyzed using Spearman's correlation test.

[63] These refer to different categories of the Dutch educational system. LS+LBO would be described as 'primary' education, MS together with MBO could be understood as 'secondary' education, while HBO+University as 'higher' education.

5. Results and discussion

Table 2: Descriptive statistics of perceived relative importance of ethical aspects of food production: mean, minimum maximum and standard deviation. Superscripts a, b, c, d indicate significantly different (p<0,05) pairwise comparisons (ANOVA), where 'a' is different from 'a'; 'b' from 'b', etc., within each vertical group of concerns. The 'Mean Normalized' indicates the % of the equal importance attributed to a concern (Mean Normalized = Mean * Number of concerns in the group).

Concern			Relative Importance					
			Mean		Norm. Mean	Min	Max	Std. dev.
Overall								
Environment			21	a	84	0	50	10
Healthfulness			38	a, b, d	151	10	100	15
Naturalness			19	c, d	75	0	50	10
Fairness			22	b, c	90	0	60	10
	Environment							
	Climate		22	a, b, c	87	0	60	10
	Wastes		25	c, d	98	10	50	9
	Water		26	b	104	0	50	9
	Biodiversity		28	a, d	111	5	70	9
		Biodiversity						
		Toxicities	34	a, b	101	10	70	12
		Habitats	37	b, c	111	0	80	13
		Aliens	29	a, c	88	0	60	12
	Health							
	Claims		50		101	0	100	19
	Risks		50		99	0	100	19
		Risks						
		Poisons	39	a, b	117	13	85	14
		Microbes	34	a, c	101	0	70	13
		Uncertainty	27	b, c	82	0	80	18
	Naturalness							
	Creation		49		99	0	100	19
	Farming		51		101	0	100	19
		Farming						
		Chemicals	49	a, b	147	0	100	20
		Infrastructure	28	a, c	85	0	100	17
		Soil	23	b, c	69	0	60	14
	Fairness							
	Commons		29	a	87	0	70	14
	Wealth		29	b	86	0	70	12
	Hunger		42	a, b	127	5	100	16
		Commons						
		Irreversibles	49		98	0	100	18
		Resources	51		102	0	100	18
		Wealth						
		Economies	41	a	83	0	70	14
		Workers	59	a	117	30	100	14
		Hunger						
		Volume	22	a, b	67	0	60	13
		Distribution	39	a	116	0	90	16
		Security	39	b	117	0	100	17

Table 3: Effect of preferred retailer, gender, age group and education level on perceived *relative* importance of ethical aspects of food production. Superscripts a, b, c, d indicate significantly different results ($p < 0,05$), obtained with pairwise comparisons (ANOVA): 'a' is different from 'a', 'b' from 'b', etc., within each vertical group of concerns.

	Concern	Mean	Full Service & Luxury (AH)	Full Service & Convenience	Low Cost (ALDI)	Biological & Organic (B&K)	Open Market	Female	Male	<30	30-45	>45	LS+LBO	MS	MBO	HBO+Univ.
Overall	Environm.	21	21 [a]	21 [c]	19 [b]	27 [a, b, c, d]	18 [d]	20	22	23	19	21	21	22	18	22
	Healthful.	38	38	36 [b]	46 [a, b]	31 [a]	39	38	38	37	40	38	38	38	40	38
	Naturaln.	19	17	18	16	22	20	19	17	16	21	18	23	14	19	19
	Fairness	22	24	25 [a]	19 [a]	21	23	23	22	24	20	23	19	26	24	21
Environm.	Climate	22	21	20	22	25	20	24 [a]	19 [a]	22	22	22	27	23	25 [a]	20 [a]
	Wastes	24	24	26	23	21 [a]	27 [a]	25	24	23	26	24	30	25	25	24
	Water	26	26	25	27	25	27	26	27	29	27	24	23	28	24	27
	Biodivers.	28	29	29	27	30	25	26 [a]	30 [a]	26	25	29	20	24 [a]	26	30 [a]
Biodiv.	Toxicities	34	35	34	31	33	36	33	34	33	34	34	30	35	33	34
	Habitats	37	34	39	34	40	38	38	36	37	37	37	45	34 [a]	43 [a, b]	35 [b]
	Aliens	29	31	27 [b]	35 [a, b, c]	27 [a]	27 [c]	28	30	30	28	29	25	31	25 [a]	31 [a]
Health	Claims	50	49	48	54	55	45	52	49	48	46	54	44	53	56	48
	Risks	50	51	52	46	45	55	48	51	52	54	46	56	47	44	52
Risks	Poisons	39	42 [a]	41 [b]	31 [a, b, c]	39	40 [c]	36 [a]	43 [a]	38	40	39	37	40	37	40
	Microbes	34	34	34	38	30	35	32 [a]	38 [a]	30 [a]	34	37 [a]	37	32	34	35
	Uncertaint.	27	25	26	31	31	25	32 [a]	20 [a]	32	26	25	26	28	29	25
Natur.	Creation	49	48	51 [b]	50	58 [a]	39 [a, b]	51	46	53	45	50	43	53	53	47
	Farming	51	52	49 [b]	50	42 [a]	61 [a, b]	49	54	47	55	50	58	47	47	53
Farming	Chemicals	49	58 [a, b]	50	46 [a]	48	42 [b]	50	48	49	52	48	51	46	49	50
	Infrastruct.	28	27	29	28	27	31	26	31	30	23	30	23	33	25	28
	Soil	23	15 [a, b, c]	21	27 [a]	25 [b]	27 [c]	24	21	20	25	23	26	20	26	22
Fairness	Commons	29	30	30	28	31	26	28	29	31	29	27	23	26	28	30
	Wealth	29	31	29	25	29	30	31 [a]	25 [a]	32	27	28	36	31	31	27
	Hunger	42	39	42	47	40	44	41	45	37	44	45	41	43	42	43
Comm.	Irreversibl.	49	56 [a]	46	51	49	44 [a]	49	48	49	51	47	38	52	47	49
	Resources	51	44	54	49	51	56	51	52	51	49	53	63	48	53	51
Wealth	Econom.	42	38 [a]	39 [b]	41	41	48 [a, b]	41	43	43	42	42	50	42	41	42
	Workers	58	62 [a]	61 [b]	59	59	52 [a, b]	59	57	57	58	58	50	58	59	58
Hunger	Volume	22	24	24	21	17	22	24	21	24	22	22	21	26	24	21
	Distribut.	39	39	41	37	41	34	39	40	38	35	42	32	43	40	38
	Security	39	36	34 [a]	42	41	43 [a]	38	39	38	43	37	47	31 [a]	36	41 [a]

The statistical differences in consumer responses within each group of concerns are presented in Table 2. The horizontal sections of the table correspond to the different groups of concerns (see Fig.2). Among the four general concerns (first section) food healthfulness was identified as far the most important concern coupled to food production, being attributed an average relative importance of 38%. This result confirms the importance of health aspects in food consumption, and it is significantly higher than the average relative importance attributed to environmental impact, food naturalness and fairness of production. Notably, healthfulness also scored the highest Normalized Mean value among concerns of all categories (52% higher than what would be expected if respondents had equal preference for all concerns in this group). Additionally, food healthfulness was attributed the highest minimum value in the overall group (no respondent attributed to healthfulness less than 10% of the total importance points to be distributed within this group of concerns), while it also scored the highest maximum value (healthfulness was the only concern to which some respondents granted all 100 relative importance points). Contrarily, no respondent attributed to environmental impact and food naturalness more than 50 importance points (50% of the maximum points available).

Impact on biodiversity was considered the most important Environmental concern, and effects on climate were the least important –behind the generation of wastes and sustainable water use. Although agriculture is a major source of greenhouse gasses, the low relative importance that consumers attached to GHG emissions probably indicates either lack of public awareness about the importance of climate change, about the relevance of greenhouse gasses emissions from food production, or lack of concern for global warming at the time of the survey. The destruction of natural habitats through conversion to agricultural land was considered the most important threat to biodiversity, and the introduction of new organisms into natural (existing) ecosystems was the least important. Health risks and added benefits were considered to be equally important, while the presence of toxic residues and ingredients in food was seen as the major food risk. High consumer awareness about health risks in that period could be explained because of a number of food safety incidents on the Dutch market (de Jonge, 2010), however most of these incidents concerned microbial contamination and not presence of toxic residues (EVMI, 2007). Uncertainty about possible, though yet unidentified, health risks was the least important concern, likely indicating respondents' high level of trust to science and the Dutch food safety system. For food naturalness, the way that plant varieties are created (breeding) was equally important to the farming method used for growing the cultivars. The major concern regarding the naturalness of the farming method

was the use of agrochemicals (pesticides and fertilizers), followed by the use of infrastructure like glasshouses and lighting, leaving plant growth on natural soil in the last place. Impact on world hunger was by far the most important fairness concern. The socially agreeable introduction of irreversible modifications was seen as equally important to the commercial use of resources from the common natural environment. Regarding wealth distribution concerns in food production, support for needy individuals (through livable wages) was regarded as more important than support for weak economies (through importing products from such economies). Respondents attributed the lowest importance within the fairness category, to increases in the volume of food production in order to combat global hunger. Supporting food production by the needy (distribution of production) and securing food production in the long term were the major global hunger concerns.

As measured by their mean normalized scores, the concerns that were attributed the highest importance were food healthfulness (overall group), use of agrochemicals (farming naturalness), global hunger (fairness), toxic residues and ingredients (health risks), income of small farmers and workers (wealth distribution), production distribution and long-term security (global hunger). The exceptionally high minimum value attributed to worker wages by any respondent indicates the high receptiveness of the respondent sample to fair trade issues.

Results of the analysis of participant perceptions in relation to their socio-demographic parameters are given in Table 3. Within the overall group, the strongest environmental concerns were expectedly stated by consumers of the biological and *organic* food specialist shop (B&K), and differences between the perceptions of consumers from other food outlets were not observed. Consumers of the *low-cost* supermarket (ALDI) attributed the highest relative importance to food healthfulness, which was significantly higher than the importance attached to this concern by consumers from the organic shop and the *full-service* & *convenience* supermarket (C1000). Contrarily, customers of the convenience supermarket expressed the strongest fairness concerns. This was significantly higher than the responses from low-cost retailer customers, which attributed to fairness the lowest importance among consumers of all food outlets. No significant effect of food outlet on the importance attributed to food naturalness was observed. Consumer perceptions for the overall group of concerns were also not significantly affected by gender, age group, and educational background. The absence of observed effects from these parameters could be attributed to the nature of the respondent sample: Specifically, owing to the predominant role of WUR as a local employer, the respondent sample was highly educated.

Per food outlet, consumers from the *full-service* & *luxury* supermarket considered the use of agrochemicals as the most important food naturalness concern, and growth on natural soil as the least important. They also expressed the relatively strongest fairness concern regarding socially disagreeable irreversible changes in the natural environment (commons), and also regarding livable wages for food production workers. *Low cost* retailer consumers attributed significantly higher relative importance than other respondents to the introduction of new species (aliens) as a biodiversity risk, and the lowest relative importance to toxic ingredients and residues (poisons) in food: their stronger healthfulness concern was the presence of microbes in food. Consumers of the *organic* retailer attached the highest relative importance to the way that plant varieties are bred (creation) as a naturalness concern. That was expected because creation is a rather esoteric concern that could be used to distinguish merely environmentally-minded biological product consumers from holistic worldview-driven organic consumers, and can direct the latter to specialist shops that offer a wider variety of organic products. Consumers of the *convenience* supermarket attached significantly higher relative importance to fairness of production. The explanation of this might be that the *convenience* retailer lacked the traditionally 'elite' image of the other full service food outlet (AH), and also that it is situated in a working and student area. Respondents that were approached at the *open market* attributed the lowest overall relative importance to environmental issues and viewed food naturalness significantly more relevant to the way of farming, especially plant growth on natural soil, than to the method of plant variety breeding. Respondents from the *open market* were also the only ones that regarded food imports from weak economies as relatively more important than the wages paid to labor, with respect to fairness of production and wealth distribution.

Regarding the effect of socio-demographic parameters, gender was less likely to affect participant responses than food outlet. Females expressed significantly higher concerns about impact on climate change, uncertainty about health effects of novel foods, and the fair distribution of wealth in food production. Males expressed significantly higher concerns for adverse effects on biodiversity, and for the existence of toxic residues and microbes in food. The only statistically significant effect of respondent age that was observed referred to food healthfulness Respondents above 45 attributed significantly higher importance to the existence of microbes in food than respondents below 30 years old. This age effect could be attributed either to the higher vulnerability of elderly population fractions to microbial outbreaks, or to the relatively recent food safety emphasis on long-term

effects of toxins in food. Secondary education respondents (MBO) were significantly more concerned about impact on climate and loss of natural habitats due to the destruction of natural ecosystems for agriculture. Participants with higher education (HBO or University) were more concerned about biodiversity in general, and about the long-term security of production.

Table 4. Effect of preferred retailer, gender, age group and education level on perceived *absolute* importance of ethical aspects of food production. Superscripts a, b, c, d (read horizontally), and also 1, 2, 3 (read vertically) indicate significantly different results (p<0,05), identified with pairwise comparisons (ANOVA): 'a' is different from 'a', 'b' from 'b', etc.

	Mean	AH	ALDI	B&K	C1000	Market
Environment	24 [1]	23 [a]	24 [b]	26 [a, b, c, d]	23 [c]	22 [d]
Healthfulness	30 [1, 2, 3]	30	31	27	29	31
Naturalness	22 [2]	22	22	23	22	22
Fairness	24 [3]	24	23 [a]	24	26 [a]	25

Results from Likert scales indicate that within the overall category the differences in the *relative* importance of different concerns corresponded well to differences in *absolute* importance (Table 4). Healthfulness was the most important food concern in absolute terms, and consumers from the organic retailer were more concerned about the environment than consumers from other retailers. Also, consumers from the convenience supermarket attributed significantly higher (the highest) importance to fairness of production than consumers from the low cost retailer (which attributed the lowest). It is noteworthy that even when the differences were not significant, the *absolute* importance results obtained by Likert scales (Table 4) fit almost perfectly the *relative* importance results obtained by dividing 100 points within each group of concerns (Table 3), in nominal order. In this way the absolute importance results from Likert scales confirm the reliability of the method used to obtain the relative importance of different concerns.

Spearman's rho correlation coefficient analysis of the results showed that statistically significant correlations appeared mainly between concerns belonging to the same group (Table 5). Significant correlations generally indicate some underlying connection between concerns. Accordingly, when concerns are positively correlated higher (or lower) values for one concern are associated with higher (or lower) values for the other. Contrarily, negative correlations mean that higher values for one concern are associated with lower values for the other, and can also be referred to

as ‘tradeoffs’. Such tradeoffs between concerns of the same group were expected because of the nature of the questionnaire (respondents were asked to divide 100 points among the concerns included in each group). However, they become less likely as the number of concerns within a group increases.

Table 5. Spearman’s rho (spearman correlation coefficient, p<0.05). Bold values refer to correlations between concerns of the same group. All lines and columns on this table that did not include significant correlations, and also all non-significant correlations, were removed to reduce table size and improve display. The full table is available at Appendix A (Table A.1).

Spearman's rho	Health	Naturalness	Fairness	Wastes	Water	Biodiversity	Toxicities	Habitats	Aliens	Microbes	Uncertainty	Chemicals	Infrastructure	Soil	Commons	Hunger	Volume	Distribution	Security
Environment	**1.00**	**-0.45**	**-0.53**											0.27					
Health		**1.00**																	-0.30
Naturalness			**1.00**																
Fairness				**1.00**	**-0.27**	**-0.31**	0.28												
Climate				**-0.34**	**-0.43**	**-0.30**													
Wastes				**1.00**	**-0.27**	**-0.31**	0.28												
Toxicities							**1.00**	**-0.47**	**-0.35**						0.28				
Habitats								**1.00**	**-0.56**	-0.26									
Aliens									**1.00**	-0.26									
Poisons										**1.00**	**-0.62**	**-0.73**							
Microbes										**1.00**	**-0.62**	**-0.73**							
Creation												0.32							
Farming												-0.32	0.32						
Chemicals												**1.00**	**-0.72**	**-0.54**					
Commons															**1.00**	**-0.56**			
Wealth																**-0.56**	**-0.56**		
Economies																	0.27		
Workers																	0.27		
Volume																	**1.00**	**-0.34**	**-0.42**
Distribution																		**1.00**	**-0.63**
																			-0.42

For the overall category, healthfulness was negatively correlated to every one of the other three concerns within the category. These tradeoffs were stronger between healthfulness and environmental impact or fairness of production, than between food healthfulness and naturalness. This result indicates that naturalness was perceived as a stronger concern on its own by respondents that valued healthfulness. The explanation of this result can be that healthfulness and naturalness are more individualistic concerns (having to do more with one's own personal life interests), than the altruistic environmental impact and fairness concerns (which have to do more with one's impact on others). This possibility is also supported by the small (and statistically insignificant) positive correlation found between environmental impact and fairness, hinting to a possible distinction of respondents into 'individualists' and 'altruists'.

Within the environmental category, the relative importance that respondents attached to the production of wastes was positively correlated to emissions of agrochemicals as a threat to biodiversity. Within food healthfulness there were no tradeoffs between concerns for residues/toxins (poisons) and for microbes in food. Concerns about microbes were less correlated to concerns about uncertainty than concerns about residues/toxins were. Respondents that were concerned for food naturalness also cared about the use of natural soil for food production. The relative importance attached to creation (breeding method) as an issue of naturalness was positively correlated to concerns about the use of agrochemicals in farming. Within the naturalness of farming group, respondent tradeoffs were primarily between use of agrochemicals and infrastructure (glasshouses, heating, and lighting) and less between agrochemicals and growth on natural soil. Respondents that were mostly concerned about the macroeconomic support to weak economies as a wealth distribution issue also tended to adopt a macroscopic view on world hunger, by regarding the total volume of food production as the relatively most important global food hunger issue. Within the global food hunger group, the smallest tradeoffs were between concerns on the total volume and on the distribution of food production. Finally, the importance that respondents attached to emissions of agrochemicals as a threat to biodiversity was positively correlated to the management of the commons as an issue of fairness (socially undesirable irreversible changes to the natural environment and use of natural resources). That was also the only significant correlation that was observed across completely different categories of concerns. However, although the management of the (environmental/natural) commons was framed as a fairness issue in the

questionnaire, it still has a clear environmental dimension which could be underlying the observed correlation.

While the generalization of these results to the Dutch population should happen with cautiousness due to the relatively small, segregated, and local sample used, they do however give an indication of the general relations between ethical consumer preferences. The generated insights could be useful to actors in the food supply chain, especially to food producers that seek to optimize their production, and retailers concerned to optimize the availability of food products that and fit best the ethical preferences of consumers. Available instruments relevant to this purpose include the so-termed E.CH.O framework (Michalopoulos et al. 2008). Further uses of the generated insights could include the optimization of food promotion through advertising that would better fit the ethical preferences profiles of consumers from different retailers.

6. Conclusions

In this study we analyzed the stated preferences of Dutch consumers in Wageningen for ethical aspects of food production. A consumer survey was used, in which participants were asked to divide 100 points within groups of concerns according to their relative importance. These results regarding the relative importance of different concerns were also confirmed in absolute terms with the use of Likert scales. Four categories of aspects were considered: Healthfulness, Environmental impact, Naturalness and Fairness of food production. The effect of four socio-demographic parameters on these preferences was examined: Preferred food outlet, gender, age, and educational level. Our first hypothesis, that consumer preference for ethical attributes is not related to demographic parameters, was generally rejected because results show that some of the variation in participant responses can be attributed to socio-demographic parameters. However, food outlet was found to have the strongest effect on consumer preferences, as compared to the other parameters. In particular, consumers from the organic and biological specialist shop stated the highest relative concern for environmental impact. Consumers from the low cost retailer stated the highest relative concern for food healthfulness and the lowest relative concern for fairness of production. Fairness was considered relatively more important by consumers of the full service and convenience supermarket. Based on these results, we do not rejected our second hypothesis; that

the relative weights of ethical concerns differ between groups of consumers with different preferred food outlets. Finally, the results do not reject our third hypothesis that consumer preferences for certain ethical attributes are correlated. Overall, healthfulness was regarded as the most important ethical concern about food. We observed indifference in preferences between health risks and health benefits in food. Impact on global hunger was the major fairness concern, and the liveability of labor wages was the major wealth distribution concern. Uses of the generated insights include food production, supply, and promotion optimization for ethical aspects of food production.

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Appendix A

Table A.1: Full results Spearmans' rho (full version of Table 5)

Spearman's rho	Health	Naturalness	Fairness	Climate	Wastes	Water	Biodiversity	Toxicities	Habitats	Aliens	Claims	Risks	Poisons	Microbes	Uncertainty
Environment	-.531*[1]	-0.10	0.05	0.00	-0.15	0.04	0.18	0.01	-0.13	0.18	-0.07	0.07	0.17	0.07	-.201*
Health	1	-.449*[1]	-.530*[1]	-0.09	0.06	-0.09	0.06	0.02	0.09	-0.14	-0.09	0.09	-0.13	0.14	-0.04
Naturalness		1	-0.10	0.01	0.14	0.05	-0.11	0.14	-0.05	-0.04	0.15	-0.15	-0.10	-0.07	0.17
Fairness			1	0.14	-0.06	0.08	-0.17	-0.03	0.01	-0.02	0.06	-0.06	.234*	-0.15	0.01
Climate				1	-.338*[1]	-.430*[1]	-.295*[1]	-0.07	0.00	0.07	0.08	-0.08	-0.08	-0.10	0.14
Wastes					1	-.268*[1]	-.309*[1]	.280**	-0.07	-0.17	0.07	-0.07	-0.06	0.01	0.06
Water						1	-0.09	-0.02	-0.03	0.06	-0.06	0.06	0.04	0.07	-0.04
Biodiversity							1	-0.10	-0.03	0.17	-0.01	0.01	0.07	-0.05	-0.08
Toxicities								1	-.473*[1]	-.346*[1]	0.13	-0.13	0.07	0.14	-0.16
Habitats									1	-.562*[1]	-0.14	0.14	-0.07	0.18	0.07
Aliens										1	0.08	-0.08	-0.02	-.256*[1]	0.08
Claims											1	-1**	-0.01	-0.06	0.06
Risks												1	0.01	0.06	-0.06
Poisons													1	0.09	-.734**
Microbes														1	-.620**
Uncertainty															1
Creation															
Farming															
Chemicals															
Infrastructure															
Soil															
Commons															
Wealth															
Hunger															
Irreversibles															
Resources															
Economies															
Workers															
Volume															
Distribution															
Security															

	Creation	Farming	Chemicals	Infrastructure	Soil	Commons	Wealth	Hunger	Irreversibles	Resources	Economies	Workers	Volume	Distribution	Security
Environment	0.02	-0.02	0.01	.224*	-.249*	0.10	-0.09	0.10	-0.09	0.09	-0.06	0.06	-0.08	0.03	0.06
Health	0.04	-0.04	0.12	-0.13	-0.06	0.09	-0.13	-0.04	-0.02	0.02	0.02	-0.02	-0.04	-0.08	0.09
Naturalness	-0.12	0.12	-0.07	-0.11	.268**	0.01	0.07	-0.11	0.11	-0.11	0.04	-0.04	-0.11	-0.02	0.13
Fairness	-0.07	0.07	-0.10	0.10	0.00	-.236*	.215*	0.03	-0.01	0.01	-0.04	0.04	0.13	.216*	-.301**
Climate	0.14	-0.14	-0.02	0.04	0.06	-0.17	.207*	0.01	0.04	-0.04	-0.07	0.07	0.06	0.14	-0.15
Wastes	-0.12	0.12	-0.06	-0.12	.202*	0.15	0.07	-0.15	-0.02	0.02	0.03	-0.03	-0.04	0.12	-0.10
Water	-0.13	0.13	-0.03	0.07	-0.12	-0.08	-0.08	0.10	-0.03	0.03	0.09	-0.09	0.15	-.216*	0.09
Biodiversity	0.14	-0.14	.196*	-0.08	-0.18	0.10	-0.14	-0.04	0.13	-0.13	0.05	-0.05	-.209*	-0.02	0.17
Toxicities	-0.19	0.19	0.18	-.212*	-0.03	.282**	-0.06	-.202*	0.15	-0.15	-0.18	0.18	-0.04	0.01	0.01
Habitats	0.08	-0.08	-0.02	-0.01	0.06	-0.17	0.06	0.07	-0.03	0.03	0.02	-0.02	-0.09	0.02	0.05
Aliens	0.00	0.00	-0.11	0.19	-0.03	-0.04	-0.01	0.10	-0.02	0.02	0.10	-0.10	0.11	-0.05	-0.04
Claims	0.03	-0.03	0.01	-0.12	.192*	-.249*	-0.04	.239*	0.08	-0.08	-0.08	0.08	0.04	0.11	-0.14
Risks	-0.03	0.03	-0.01	0.12	-.192*	.249*	0.04	-.239*	-0.08	0.08	0.08	-0.08	-0.04	-0.11	0.14
Poisons	-.240*	.240*	0.01	.227*	-.218*	-0.10	0.09	0.05	-0.16	0.16	0.00	0.00	0.09	0.04	-0.09
Microbes	-0.14	0.14	-0.01	0.00	-0.04	0.01	-0.14	0.15	-0.01	0.01	.233*	-.233*	0.03	-0.13	0.17
Uncertainty	.244*	-.244*	0.02	-.212*	.245*	0.01	0.10	-0.16	0.14	-0.14	-0.06	0.06	-0.05	0.07	-0.09
Creation	1	-1**	.320**	-.206*	-.216*	0.05	0.05	-0.17	0.16	-0.16	-0.02	0.02	0.00	0.10	-0.10
Farming		1	-.320*[1]	.206*	.216*	-0.05	-0.05	0.17	-0.16	0.16	0.02	-0.02	0.00	-0.10	0.10
Chemicals			1	-.721*[1]	-.544*[1]	-0.11	-0.05	0.03	0.07	-0.07	-0.09	0.09	-0.07	0.10	-0.13
Infrastructure				1	-0.10	0.09	0.07	-0.04	-.207*	.207*	0.01	-0.01	-0.02	-0.10	0.18
Soil					1	0.04	0.07	-0.07	0.12	-0.12	0.13	-0.13	0.13	-0.05	0.00
Commons						1	-.225*	-.561*[1]	0.13	-0.13	-0.05	0.05	-0.10	-0.09	0.19
Wealth							1	-.563*[1]	0.05	-0.05	0.17	-0.17	0.16	-0.01	-0.08
Hunger								1	-0.16	0.16	-0.05	0.05	0.02	0.06	-0.11
Irreversibles									1	-1**	-0.13	0.13	-0.05	0.01	0.01
Resources										1	0.13	-0.13	0.05	-0.01	-0.01
Economies											1	-1**	.268**	-0.10	-0.11
Workers												1	-.268*[1]	0.10	0.11
Volume													1	-.335*[1]	-.424**
Distribution														1	-.634**
Security															1

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CHAPTER 5

Public multi-criteria assessment for societal concerns and gradual labeling

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This chapter is based[64] on:

Michalopoulos, T., H. Hogeveen, E. Heuvelink, and A.G.J.M. Oude Lansink. 2013. "Public Multi-Criteria Assessment for Societal Concerns and Gradual Labelling." *Food Policy* 40 (June): 97–108. doi:10.1016/j.foodpol.2012.12.010. http://www.sciencedirect.com/science/article/pii/S0306919212001352

[64] This version of the article corrects an erroneous reference to the voluntary TLS nutritional labeling system of the FSA (UK) as 'mandatory'.

ABSTRACT–We present a multicriteria product assessment framework that can be used to rank existing products against hypothetical product scenarios. Products are ranked for Environmental Impact, Healthfulness, Naturalness and Fairness. Assessment criteria and relative importance weights are sourced from the public. The framework has been demonstrated for fresh tomato production scenarios. Results are valid because they correspond to public concerns, gradient to reward small production improvements, and relative to available product alternatives. Their interpretation can be normative with reference to existing production averages: without agreement on absolute acceptability thresholds. Data improvement agrees with rational stakeholder behavior. Results identify technological applications of higher and lower public acceptability potential, for production and research agenda optimization. Other producer uses include labeling and brand name protection. Civil society uses include the critical assessment of production. Public uses include labeling in consumer-driven markets, and smooth production sector restructuring by incentivizing a race-to-the-top for production externalities of public concern, like the environmental sustainability or the fairness of production.

KEYWORDS – Product assessment, Societal and consumer concerns, Technological innovation, Production externalities, Labeling, Corporate societal responsibility, Market optimization, race-to-the-top

1. Introduction

Two shortcomings limit the effectiveness of certification schemes, such as values-based product labels and codes of ethical conduct, to achieve the management of innovative technologies and the regulation of externalities of food production according to ethical concerns of the public.[65]

The first shortcoming is that when they are used as production optimization ~~instrum~~ents, certification schemes face a problem of validity. The content of the ethical claims stated, namely the ethical issues that are considered and the risk levels that are accepted, do not always match public concerns. The communication of ethical claims that do not match public concerns can be perceived by the public as ''at best, irrelevant [. . .] and at worst may have seemed to be an attempt by the information source to hide from the public what the public perceived to be the 'real' risks of the technology'', damaging trust in brand names and certification schemes (Frewer, 2003).[66]

The second shortcoming has to do with their effectiveness as a means to enable public involvement in production optimization through ethical consumption in consumer-driven markets, and to motivate subsequent adjustment of production practices and technology use to revealed consumer preferences. This problem relates to the number of grades used to score certified products. As a rule, certification schemes are communicated to consumers in the form of two-grade' binary' labels. This means that products are usually either fully certified or not certified at all (e.g. either 'organic' or 'conventional'). Conversion to full certification for conventional producers however usually implies high costs, which lead to higher product prices. Higher prices, in their turn, lower consumer demand for labeled products, which consequently de-motivates the certification of more conventional producers, and eventually the restructuring of the food supply sector according to relevant public preferences. In particular, the lower the number of available

[65] We use the term 'public' to collectively refer to 'citizens' and 'consumers' (this issue is clarified at section Potential Uses, under Discussion). We refer to citizen and consumer concerns about food healthfulness and naturalness, and also about production externalities like environmental and socioeconomic impact as 'ethical' concerns (Andersen and Philipsen, 1998; Brom, 2000). Ethical concerns increasingly affect consumption patterns of concerned consumers, transcending the traditional 'consumer vs. citizen' dichotomy (Korthals, 2001a,b).

[66] Slovic (1999), Frewer (2003), Korthals (2004), Wynne (2006) discuss different production stakeholders' attitude to public and consumer concerns.

certification grades around which rational production aggregates, the more ethically distorted is the market: While the distribution of consumer preferences for ethical product characteristics is expectedly continuous, producers offer only a small number of discrete product choices (like 'conventional', 'organic', etc.). Therefore there is a discrepancy between ethical preferences of consumers and supply of products that satisfy these preferences, and, consequently, the distribution of production practices does not match the distribution of the corresponding ethical preferences among consumers.[67]

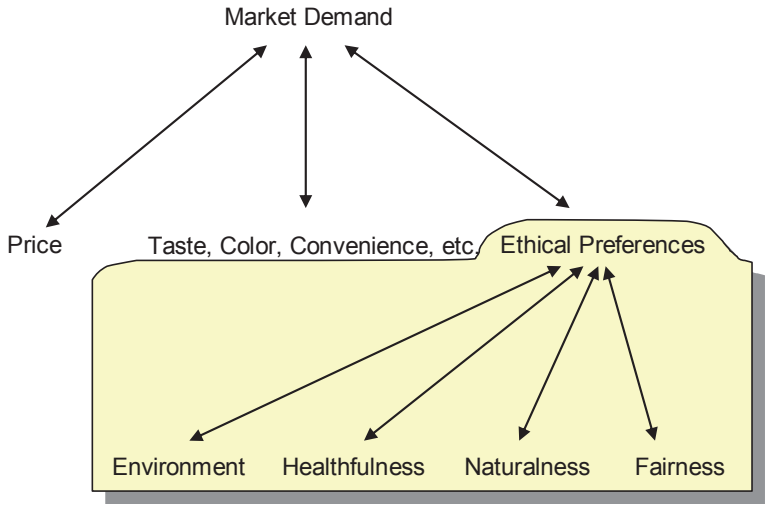

Figure 1: Scope of the present assessment application.

[67] Studies show consumer willingness to pay higher prices for improved environmental, animal welfare, or fairness impact, but not the full 'organic' or 'fairtrade' price premiums. For instance, a poll commissioned by Milieudefensie (Netherlands-based NGO), indicated that only 2% of the meat sold in the Netherlands is organic due to high prices, while about 75% of the Dutch population responds that animal husbandry must be more animal and environmental friendly. To increase ethical meat consumption and consumer impact on animal welfare and the environment, The Netherlands debated the introduction of a pragmatic middle road in meat production: the so-called 'compromise animal' or 'compromise meat', meant to ''fill the yawning gap between the ideal of organic animal husbandry and the existing practice of the meat industry. [translation ours, the term 'comfort' has also been used instead of 'compromise']'' (NRC, 2007). See also de Pelsmacker (2005) for the case of FairTrade coffee.

In this paper we demonstrate a simplified application of the 'ECHO' assessment framework (Michalopoulos et al., 2008) meant to address these shortcomings. Substitutable product alternatives, in this case fresh tomatoes, are ranked according to their performance for public concerns and in terms of public perceptions. We use a public-sourced, inclusive list of assessment criteria identified from recent public food debates, which were subsequently completed and structured using qualitative interviews with disciplinary experts. These criteria are meant to represent 'what matters' among the ethical issues involved in food production. The criteria are weighted using stated consumer perceptions about their relative importance. These weights were obtained using written questionnaires and are meant to represent 'how much' the corresponding ethical issues matter.

Four existing and seven hypothetical fresh tomato options are assessed for 21 product and production attributes. The existing products are taken from the Dutch market. The hypothetical products were defined using expert judgment and are meant to represent scenarios of technologically reasonable product conjectures. Simplifications and expert assumptions were used to complete unavailable data on products' performance for the assessment criteria. The hypothetical tomato options include plant-genomics-enabled applications that have been developed using techniques such as marker-assisted-breeding (MAB), and also genetic modification (GM) techniques like cisgenesis and transgenesis (see e.g. Mahalakshmi and Ortiz, 2001; Nap et al,2002; Buckler IV and Thornsberry, 2002; Crusak and Cakmak,2005; Gremmen, 2005; Brookes and Barfoot, 2005; Rommenset al., 2007; Lammerts Van Bueren, et al, 2007). This enables us to discuss producer uses for the optimization of the public acceptability of technologically innovative products during the phases of product design and research agenda setting, and also to demonstrate the relevance of this approach to socially optimal technological innovation in production. The tomato options are assessed for four categories of consumer concerns: Ecological Impact, Healthfulness, Naturalness, and Fairness (Fig. 1). This allows us to discuss producer uses for product promotion and also state policy uses for research agenda setting and for food production optimization in consumer-driven markets.

In the remainder of this paper, the Methodology section starts with a brief introduction of the ECHO product assessment framework, and then describes the selection of the assessment criteria, indicators and relative importance weights. Next, the rationale behind the assessed tomato options is explained, and the empirical model used for the assessment is presented. In Results section the results are interpreted and analyzed. The Discussion section identifies potential stakeholder

uses, and also suggests methodological improvements and possible extensions of the presented product assessment approach.

2. Materials and methods

2.1. The ECHO product assessment framework

The ECHO[68] product assessment framework (Michalopoulos et al., 2008) is an integrated approach for product characterization on the basis of public concerns (criteria) and in terms of public perceptions (weights). Depending on the purpose of the application, this input may be derived either from 'citizens' (stated preferences), or from 'consumers' (revealed preferences). The framework essentially identifies conditions for input validity, and subsequently ranks substitutable products using a multiple criteria indexing model by Diaz-Balteiro and Romero (2004), based on the established Lancaster consumer demand model (Lancaster, 1966).

Among the characteristics of the ECHO framework are:

- The terms of product assessment are deliberated public concerns and perceptions, supporting justification of results and policies within a liberal–democratic political context. The incommensurability of values-based public concerns can be taken into account for the interpretation of results, helping to identify products with high likelihood for public controversy.
- The generated results are gradient (i.e. non-binary) product rankings. Gradient assessments can be used to incentivize and reward relatively modest production improvements, and can consequently facilitate and catalyze the re-allocation of production resources. This is especially relevant to periods of (e.g. environmental) restructuring of the production sector.
- The results can be interpreted to support normative claims that refer to dynamic production averages as thresholds. Reference to fixed and controversial values-based, e.g. fair trade or organic, thresholds can be avoided. The dynamic nature of these thresholds means that the generated normative claims can incentivize a 'race to the top' for production externalities of public concern.
- The implementation of the framework can generally rely on existing statistical data (national or sector production averages) and data improvement goes with the grain of market actor behavior (rational producer motivations, consumer organizations and NGO mission statements).

[68] The 'E.CH.O.' acronym stands for 'Ethical CHaracterization and Optimization'

These are discussed in more detail in the remaining sections.

2.2. Assessment criteria, relative importance weights, and indicators

The criteria used in this assessment correspond to public concerns relevant to fresh tomato production. An inclusive list of criteria was first identified from the public food debate through literature research. The identified criteria were qualified using input from an interdisciplinary food expert workshop, where experts from social and natural sciences, the production sector, and the civil society were invited to brainstorm on the relevance of societal concerns to genomical tomato production. The resulting set of criteria was completed and structured using semi-qualitative interviews with food experts. In an effort to remain close to public perceptions for the selection of criteria, disciplinary experts were used (namely, organic sector experts were consulted on Naturalness, fair trade sector experts on Fairness, etc.).

The qualified assessment criteria fall into four broad categories or 'product characteristics': Environmental Impact, Healthfulness, Naturalness, and Fairness of production. These characteristics were selected because (a) they refer to unobservable food attributes. Unobservable or 'credence' attributes are attributes that consumers cannot assess by their senses, and therefore the availability of information is necessary if consumers are to reveal relevant preferences in the market (Giannakas, 2002). Also, (b) consumer concerns about these characteristics are generally regarded to be reasonable.[69] Finally, (c) the selected characteristics are pragmatic in the sense that they enjoy sufficient consumer demand, as demonstrated by the survival of organic, biological, fairness, and health labels at non-competitive prices in the food market. In particular, the 'healthfulness', 'environmental impact' and 'fairness' characteristics were conceived so as to correspond to the aspiration kernels of typical 'healthy' (or 'functional', 'fortified'), 'biological', and 'fair trade' production, respectively, while 'naturalness' was meant

[69] 'Reasonableness' is a condition for the selection of assessment characteristics within the ECHO framework (Michalopoulos et al., 2008). Reasonableness demands that considered issues are 'in agreement with the principles of justice and able to be described as parts of scientifically irrefutable views of the good life'. These terms refer to the work of Rawls (1999). Because of the absence of principled public opposition to the goals of e.g. organic or fair food production, the corresponding concerns are assumed here to be 'reasonable'. An obvious counterexample is that the reasonableness condition would reject product assessments on the basis of, say, whether they are 'made by white people'. This normative element of the ECHO framework does not permit consumer choices and market optimization in terms of such concerns.

to capture those aspirations of 'organic' and 'biological' food consumers that do not refer to 'health', 'environmental friendliness', and 'fair trade' concerns.

Each characteristic is described using criteria that are relevant to tomato production in general and to the product options included in this assessment in particular. The Environmental assessment regards common environmental issues like the release of greenhouse gasses (GHGs), impact on biodiversity, water use, and the generation of wastes. Impact on biodiversity includes impact on non-target organisms, referring to the 'silent spring' effect (Carson, 1962), conversion of natural habitats to agricultural land, and perceived uncertainty about the environmental impact of (certified) GMO's. The Health category considers added (certified) benefits to consumer health (one can imagine positive claims about common serious health conditions such as cancers and cardiovascular diseases), health threats like pesticide residuals and pathogenic microbes, and also perceived uncertainties regarding the impact of (certified) GMO's on consumer health. Food Naturalness considers the breeding technology, the use of agrochemicals and artificial infrastructure during farming, and the use of artificial substrate as the rooting environment of production plants. To assess Fairness, wealth distribution was considered alongside other publicly debated issues like the socially acceptable management of the commons and impact on global hunger. Wealth distribution regards the relative weakness of the national economy at the place of production and the relative income of the 'weakest link' in the supply chain (farm labor, in this application). The socially acceptable management of the commons includes the introduction of irreversible environmental changes and the non-consented commercial use of local natural resources (both assumed to be socially undesirable). Impact on global hunger is assessed in terms of changes in the volume, the distribution, and the security of food production (mid-term resistance to food production pests risk).

The indicators used in this application to measure the performance of options for the selected criteria were either straightforward, were taken from other studies, or, for the purpose of this demonstration, were improvised. Environmental and Health risks were modeled in a simple way using binary indicators. A binary indicator was defined to become 0 (risky) for all genetically modified products, and 1 (not risky) for all non-genetically modified products. Although these might suffice for this demonstration, policy applications of the presented product assessment framework would require improved indicators and risk modeling. The criteria were weighted for their relative importance according to stated consumer preferences using a stratified consumer survey in Wageningen, The Netherlands, in 2007. Out of 172 written questionnaires distributed at the exits of different food retailers, 101 valid replies

were returned by post. An overview of the terms of product assessment are presented at Fig. 2 and explained in Table 1.

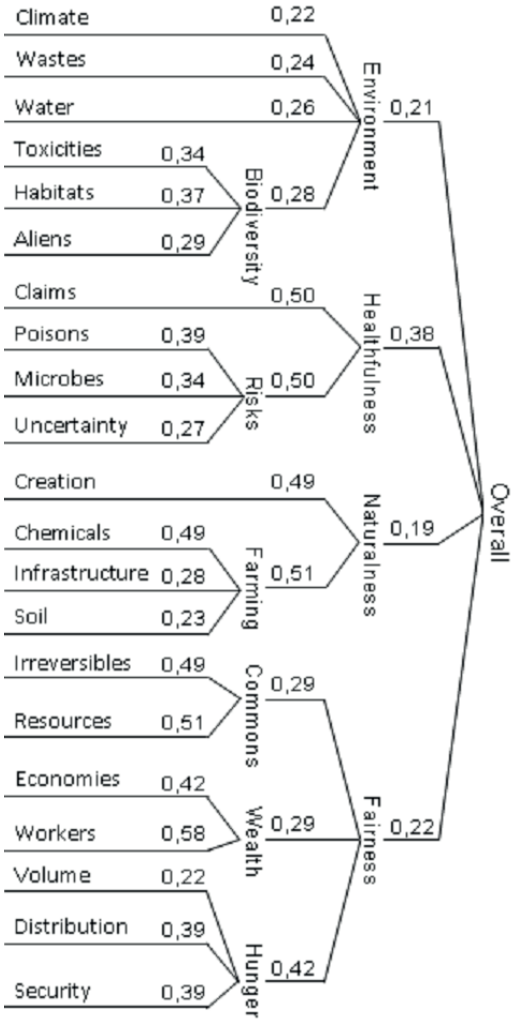

Figure 2: Assessment criteria and relative importance weights tree

Table 1: Criteria and indicators used in this assessment.

	Name	Criterion (Concern)	Indicator
a. Environment	Climate	Impact on global warming	GHG emissions for farming, transportation, & agrochemical production (1st ord. emiss.)
	Wastes	Production of non-readily biodegradable wastes	Solid wastes produced: substrate (rockwool) and plastics
	Water	Water Depletion (efficiency of water use as a function of scarcity)	If RF<WR, then WD= IE*(RF/WR), else WD=1 (WR=withdrawal rate, RF=refill rate, WD=water depletion, IE= irrigation efficiency)
	Biodiversity	(hazards to non-targeted biodiversity)	
	Toxicities	Toxicities to non-target organisms (including eutrophication)	Mean of normalized active substance pesticide & nutrient emissions
	Habitats	Food security pressure for convertion of natural habitats to agricultural land	Yield to land: tn tom/ ha
	Aliens	Increased uncertainty about effects on traditional ecosystems	If GMO cross pollination is possible then 0, else 1
b. Healthfulness	Claims	Added medicinal function against serious diseases	EFSA approved claim= 1, otherwise 0
	Risks	(consumer health risk tolerance)	
	Poisons	Consumer exposure to toxic substances risk	Pesticide residues detection rate (0,01% samples with detected residues)
	Microbes	Consumer exposure to pathogenic microbes risk	Colony forming units (cfu)
	Uncertainty	Safety uncertainty	Genetically modified=0, otherwise 1
c. Naturalness	Creation	Naturalness of the breeding technology	direct disciplinary expert rating
	Farming	(naturalness of the farming processes)	
	Agrochemicals	Use of artificial pesticides and fertilizers	direct disciplinary expert rating
	Infrastructure	Use of greenhouses, lighting, heating and irrigation	direct disciplinary expert rating
	Soil	Use of artificial material (substrate) instead of soil	direct disciplinary expert rating
d. Fairness	Commons	(democratic management of commons)	
	Irreversibles	Social acceptability of irreversible externalities	GMO cross pollination possible=0, else 1
	Resources	Informed consent of local communities for the commercial use of indigenous natural resources	Informed community consent for using local common resources (genetic biodiversity)=1, otherwise 0
	Wealth	(discrepancies reduction: "wealth trickling down")	
	Economies	Relative poverty of country of production (relative sizes of economy)	0 if GDP of production country is greater than that of production, otherwise 1- (PPPcorrected GDP per capita at country of production / […] of consumption)
	Workers	Relative livability of incomes at place of production and consumption (relative power of incomes of workers at the worst paid production stage)	Purchasing power parity (PPP)- corrected incomes (I) of weakest link (glasshouse) at countries of production (p) and consumption (c): 1-((Ip/PPPp) / (Ic/PPPc)). If Workers <0, then Workers=0
	Hunger	(relief of world hunger)	
	Volume	Effect on global food production	Yield to scarce resources (land): tn tom/ ha
	Distribution	Food security of subsistence farmers	Subsistence farmers save seed=1, else 0
	Security	Evolutionary pressure on pests to develop resistance to pesticides	Pesticide Use: kg wzs /ton tom (continuous emission by 'bt' varieties=0)

2.3. Tomato options and performance matrix

The four existing and seven hypothetical fresh tomatoes ('tomato options') included in this assessment are presented at Table 2. The options are composed of unobservable product and production attributes that are relevant to the selected criteria. Existing options were taken from the Dutch tomato market, while hypothetical options must be understood as product scenarios at product design or R&D stage. The inclusion of existing options is meant to map tomatoes' performance for public concerns in the Dutch market. The selected options were chosen because their performance differs substantially for at least one of the assessment criteria. Additionally, the existing options serve as references for the interpretation of the performance of the hypothetical options. The hypothetical options have also been intentionally defined to differ substantially for at least one of the assessment criteria. Differences in observable tomato attributes like price, color, taste, etc. were outside the scope of this exercise and were not considered (see Fig. 1, for the scope of this exercise).

Table 2: Definition of Tomato Options included in the assessment

Tomato Option		Definition
O1	Standard NL	Typical (average bulk) greenhouse tomato from The Netherlands
O2	Organic NL	Typical (average) organic tomato from The Netherlands
O3	Standard ES	Typical (average bulk) tomato from Murcia, Spain
O4	Organic ES	Typical (average) organic tomato in Murcia, Spain
O5	Advanced NL	O1 grown in hi-tech semi-closed glasshouse
O6	Fair-Basic Ma	Minimal Fair trade tomato scenario, with Spanish and Moroccan properties
O7	MAB-Envir. NL	O1 improved for environmental traits by MAB
O8	MAB-Health NL	O1 improved for health traits by MAB
O9	MAB-Fair NL	O1 improved for fairness traits by MAB
O10	GM-A NL	O1 improved for selected overall traits by same-species gene insertion (GM cisgenic)
O11	GM-B NL	O1 worsened for selected overall traits by other-realm gene insertion (GM transgenic)

The first category of options (O1–O4) includes existing Dutch and Spanish tomatoes from the Dutch market. Existing options can be described with different degree of detail, depending on the purpose of the study, and also depending on data availability. For this exercise a high level of abstraction was used. Four broad existing options are specified: 'standard' and 'organic' tomatoes produced in The Netherlands and in Spain[70] (Table 2). The standard options refer to (for all relevant

[70] Spanish tomatoes in the Dutch Market are usually produced in Almeria and Murcia (Costa and Heuvelink, 2005). Dutch tomatoes originate mainly from Westland.

purposes[71]) stereotypic, mainstream, or bulk tomatoes. The organic options refer to representative tomatoes with nationally recognized organic certifications. Input on the performance of the existing options for each criterion refers to sector and national averages, and was sourced from publicly available sources (Bos et al., 2007; van der Velden et al., 2004; van Kootenet al., 2006; Costa and Heuvelink, 2000; Pluimers, 2001; Muñozet al., 2003; EC, 2004; IBRD, 2008), personal communication with experts, and with consumer organizations. Considered expert assumptions were made when data was not available. All product input is presented at the Performance Matrix (Table 3).

Table 3: Matrix with the performances of the considered tomato options for the assessment criteria

	Environment						Healthfulness			Naturalness						Fairness				
Criterion	GHG	Wastes	Water	Toxicities	Habitats	Competition	Claims	Poisons	Microbes Uncertainty	Creation	Agrochemicals	Infrastructure	Soil	Irreversibles	Resources	Economies	Workers	Volume	Distribution	Security
Indicator Units	CO2eq/ 1000kg	kg waste /kg tom	m3 water/ tn tom	Mean emissions kg a.i./ tn tom.	kg tom /m^2	Binary	Binary	Detectable residues (*0,01%)	c.f.u. Binary	Direct rating	Direct rating	Direct rating	Direct rating	Binary	Binary	Composite indicator (Table 1)	Composite indicator (Table 1)	kg tom /m^2	Binary	kg wzs /ton tom
StandardNL	1950	0.023	40	0.04	55	1	0	0.008	1 1	0.88	0	0.5	0.0	1	1	0.00	0.00	55	1	0.015
OrganicNL	2222	0.000	40	0.20	43	1	0	0.000	1 1	1.00	1	0.5	1.0	1	1	0.00	0.00	43	1	0.000
StandardES	1105	0.019	9	0.96	9	1	0	0.057	1 1	0.88	0	1.0	0.5	1	1	0.21	0.18	9	1	0.289
OrganicES	959	0.019	9	0.50	7	1	0	0.000	1 1	1.00	1	1.0	0.5	1	1	0.21	0.18	7	1	0.000
AdvancedNL	1365	0.023	40	0.02	66	1	0	0.004	1 1	0.88	0	0.3	0.0	1	1	0.00	0.00	66	1	0.008
Fair-BasicMa	1216	0.019	8	0.96	9	1	0	0.029	1 1	0.44	0	0.5	0.5	1	1	0.90	0.87	9	1	0.289
MAB-Envir.NL	1638	0.023	40	0.03	66	1	0	0.007	1 1	0.44	0	0.5	0.0	1	1	0.00	0.00	66	1	0.013
MAB-HealthNL	1950	0.023	40	0.03	55	1	1	0.007	1 1	0.44	0	0.5	0.0	1	1	0.00	0.00	55	1	0.013
MAB-FairNL	1950	0.023	40	0.03	66	1	0	0.007	1 1	0.44	0	0.5	0.0	1	1	0.00	0.00	66	1	0.013
GM-A NL	1541	0.023	40	0.03	69	0	1	0.007	1 0	0.13	0	0.5	0.0	0	1	0.00	0.00	69	1	0.012
GM-B NL	1950	0.023	40	0.04	50	0	0	0.008	1 0	0.00	0	0.5	0.0	0	0	0.00	0.00	50	0	0.015

[71] The relevant purpose is to be distinguishable. Properly, a product may be regarded as 'standard' when it does not perform significantly differently from bulk or stereotypic products available at the country of consumption. However, it may also be the case that a product's performance in reality differs from the bulk, but due to the absence of a credible traceability system it cannot, for all useful purposes, be distinguished from the bulk. In other words, an option is assessed on the basis of the information that is available.

The second category includes imaginary hypothetical options, meant to represent potential product scenarios (O5–O11). The performances of these options for the assessment criteria have been scored on the basis of considered expert assumptions about technologically reasonable product conjectures. Analytically:

Option O5 (Advanced-NL) represents the fraction of Dutch tomatoes that are produced in technologically advanced ('semi-closed') glasshouses, characterized by energy savings and reduced emissions (Van der Knijff et al., 2004; van der Ploeg et al., 2007). The FairBasic-Ma option (O6) serves as reference point for Fairness and has been defined to satisfy only the minimal Fair-Trade certification requirement for 'a fair price'. For the rest of the criteria, the scoring of O9 relied on data about Spanish and Moroccan climate and production practices. Morocco was chosen as the land of production so that the system satisfies the Fair-Trade focus on developing countries, and because Moroccan tomatoes exist in the Dutch market. It is assumed that O6 is a traditional variety, neither MAB nor genetically modified, and its Environmental and Healthfulness performance was assumed to follow regional norms. Unavailable data for Moroccan tomato production were complemented using data from Spanish production (StandardES).

Options O7, O8, and O9 refer to hypothetical 'genomical' products (MAB technology-enabled, non-GM). They represent reasonably realistic scenarios of MAB technology applications to improve tomato options' Environmental (O7), Healthfulness (O8), and Fairness (O9) attributes. Scoring the performance of these hypothetical options at the performance matrix was based on expert opinion. Specifically, MAB-enabled options were assumed to deliver about 15% improvement for each genetic trait relevant to the assessment criteria. Each of these options was conceived as a modification of O1, which means that when their performance for some relevant criterion would not be affected by MAB, then the options' scores would remain the same as for O1.

Options O10 and O11 are hypothetical GM varieties. Their inclusion is meant to give an impression about the potential performance of GM products for public concerns. Options O10 and O11 have been intentionally defined with in-built positive and negative, respectively, biases: Option GM-A-NL (O10) is defined to represent an overall positive and reasonably realistic in the mid-term technological scenario, in which genetic modification is used for the improvement of product performance for all relevant criteria. It features the most desirable or the least controversial attributes for each category of concerns. It is cisgenic so as to raise the mildest Naturalness objections for a genetically modified product. Contrarily, option GM-B-

NL (O11) represents a technological scenario where genetic modification negatively affects product assessment. Option O11 features the least desirable, or the most controversial, attributes for all relevant criteria. No improvements were assumed as compared to O1, and worse performances were assumed when thought realistic,[72]presumably as a side-effect of using genetic modification to improve some attribute that is irrelevant to the scope of the present assessment, like taste or color. It is transgenic with genes sourced from organisms that belong to a different biological taxonomy realm so as to raise the strongest Naturalness objections for a genetically modified product. Scoring the hypothetical options O10 and O11 at the performance matrix was based on expert opinion and O1 was used as a reference. Both GM options were assumed to be fertile. Possible use of e.g. 'terminator technology' for the production of infertile GM varieties that would reduce environmental risks was here ignored.

Because all options are assumed to be legally fit for the Dutch food market, they are assumed to satisfy Dutch safety requirements. For this reason it was assumed that Healthfulness and Environmental risk for cisgenic and transgenic options is the same, which is perhaps unfair to cisgenic products in public perception (Russell and Sparrow, 2008).

2.4. Empirical model

Multiple-criteria modeling provides a pragmatic solution to economic problems where there is no consent on a single criterion to assess different options for complex multidimensional characteristics. For this, multiple-criteria models require the description of characteristics by means of a set of criteria, which are measured by indicators, and are related through coefficients that indicate their relative importance ('weights'). A timely example of such a multidimensional characteristic is sustainability ('sustainability' has environmental and societal aspects , which in their turn can be further analyzed to sub -aspects, etc. See Díaz -Balteiro and Romero (2003), Rennings and Wiggering (1997), Pannell and Glenn (2000)). When mathematical requirements concerning hidden nonlinearities and interaction between indicators (independence) are satisfied, and also when tradeoffs between

[72] A 10% yield decrease was assumed. A tomato's taste depends, among others, on the concentration of certain ingredients in the fruit and, in principle, decreasing the 'dilution' of such substances enhances the taste of the product. Also, see Morris and Sands (2006) for the case of lowering nutritional value as an unintended side-effect (externality) of improving yield.

societal values represented by different criteria are philosophically or politically allowed, multiple criteria modeling can be appropriate for the assessment of alternative product options. This is because it is theoretically sound (Keeney and Raiffa, 1976), it can incorporate objective as well as subjective indicators, it can rank an unrestricted number of alternatives, it is simple to use, and it is transparent (van Calker, 2005). A valuable feature of the particular multiple-criteria method used within the ECHO framework is that it can index (rank) the overall performance of different options both in the case that trade-offs between the performance for different indicators are allowed and not allowed (Diaz-Balteiro and Romero, 2004).

The indexing application starts with a normalization step to account for differences in measurement units. In the case of indicators of the type ''more is better'',[73] performances for different indicators were normalized as follows (ibid.):

$$\overline{R}_{ij} = 1 - \frac{R^*_j - R_{ij}}{R^*_j - R_{*j}} = \frac{R_{ij} - R_{*j}}{R^*_j - R_{*j}} \forall i.j \qquad (1)$$

Where for each characteristic in (1): *i* = 1, 2,…,n are different options evaluated according to *j* = 1,2,…,m indicators, and $\overline{R}_{ij}$ is the normalized value achieved by the ith system with respect to the jth indicator. R^*_j is the 'ideal' value of the jth indicator (best or optimum value), and R_{*j} is the 'anti-ideal' value achieved by the jth indicator (worst or nadir value). The ideal value represents a maximum value if the indicator is of the type ''more is better'' or a minimum value when the indicator is of the type ''less is better'', while the opposite is true for the anti-ideal value. Using the above normalization system the indicators have no dimension and are bounded between 0 and 1. The resulting normalized ideal vector is $\overline{R}^*$= (1,. . .,1) and the anti-

[73] Indicators were assumed to be either of the kind 'more is better' or 'less is better'. Indicators were also assumed to be linear, meaning that product performance for the assessment indicators was assumed to be linearly correlated to the public acceptability of products (Dodgson et al., 2000). For example, it was assumed that acceptability of the GHG emissions attribute increases linearly as emissions reduce (that is because GHG emissions is type 'less is better'; the opposite was true for indicators type 'more is better'). For subjectively measured non-binary criteria like 'naturalness of creation' (the relative naturalness of different breeding methods) preference scales were constructed using direct expert rating (value functions). In these cases, expert consultation was sourced from within the field that voices relevant public concerns. For Naturalness concerns that was taken to be the organic / bio-dynamic movement (http://www.louisbolk.org/).

ideal vector is $\overline{R}_*$ = (0,. . .,0). The ideal and anti-ideal vectors were introduced in the assessment as 12th and 13th system options, serving as controls that scored consistently 1 and 0 for the aggregated assessment (when λ =1, explained below).

For binary indicators the best and worst values were defined as 1 and 0, respectively. To limit data requirements and reduce the need for assumptions, in this exercise we used local scales to normalize non-binary indicators (Dodgson et al, 2000). This means that in this model ideal and anti-ideal values refer to the best and worst performances that are achieved within the particular group of assessed options, and not to technologically or pragmatically feasible, 'universally' ideal and anti-ideal performances.

After normalisation, the different options are ranked for each characteristic according to the function (Diaz-Balteiro and Romero 2004):[74]

$$S_i = (1-\lambda)[\underset{j}{Min}(W_j \overline{R}_{ij})] + \lambda \sum_{j=1}^{m} W_j \overline{R}_{ij} \qquad (2)$$

wherein (2): S_i is the generic ith food option; *ij* is the generic jth indicator of the characteristic; *Wj* is the weight or relative importance attached to the jth indicator; and λ is a control parameter that takes values $0 \leq \lambda \leq 1$. The control parameter λ measures the tradeoffs between the 'aggregated' and 'most balanced' rankings. Overall, 11 sets of rankings were produced (i.e. for λ = 0.0, 0.1, 0.2, …, 0.9, 1.0), two of which are presented in this paper: λ = 1.0, and λ = 0.0.

When λ= 1, then the model assumes independence among the indicators, and additive aggregate rankings are produced. In this case the options are ranked for their aggregated performance (according to the weighted sum of their normalized performances for all indicators).

When λ= 0, additivity is *not* assumed and tradeoffs between performances for different indicators are not accepted. This produces the so-termed 'most-balanced' rankings. In this case the options are ranked according to their performance for the single indicator for which they show the worst normalized performance ('for the

[74] Diaz-Balteiro and Romero (2004) argue that function (2) is mathematically similar to the augmented Tchebycheff function, which has been widely researched in the MCDM literature (Steuer, 1989, chapters 14 and 15; Tamiz et al, 1998).

minimization of the maximum deviation of the most displaced indicator from the ideal').

Essentially, the most-balanced ranking ignores the performance of products for other, besides the 'worst', indicator, and the options are ranked for their performance for the indicator for which they perform the worst. However, because in this exercise we use local scales for the normalization step, the worst comparative performances among the assessed options are defined to be anti-ideal, and are assigned the normalized value 0. As a consequence, if an option has the worst available score as compared to the other assessed options for any indicator of a lower assessment level (sub-indicator), then this value will be used as input and it will be reproduced in all subsequent assessments. Therefore, when an option scores the worst value for any indicator then its most-balanced ranking shall always be 0 for all higher levels of assessment. In complex assessments involving large numbers of indicators, it becomes likely that any option will score worst for at least one indicator. In that case the most-balanced index mainly consists of zeros and product differentiation is not achieved. This is the case in this exercise. To differentiate among zero-scoring options we compare here the part of the total importance weight for which options do not score the worst available, anti-ideal, values. This ranking is presented at the 'more-is-better'-type index 'NotWorst' of Table 4. For instance, when Not-Worst = 0.1 then this means that the option does not have the worst comparative performance for 10% of the total importance weight assigned to the assessment indicators used (it has the worst performance for 90%). Differentiation in the most-balanced index can be also achieved by using 'universal' instead of local measurement scales in the normalization step. The use of universal scales reduces the chances that many options will score anti-ideal values for some indicator because in that case the anti-ideal will be the technologically or pragmatically worst performance universally possible, in-stead of the worst performance among the assessed options.

Table 4: (a and b) Results: (a) aggregated (compensatory, λ = 1) and (b) most-balanced (non-compensatory, λ = 0) sorted normalised indices. In brackets: NotWorst indices: Total weight of criteria for which the system does not perform worst when compared to the alternatives (*0.01%). 1 and 0 are attributed to the best and worst performances observed among the considered tomato options for the assessment criteria, respectively. StandardNL is consistently marked with bold because in this exercise it serves as a possible interpretation benchmark.

Environment			Healthfulness			Naturalness			Fairness			Overall		
a. Aggregated Indices														
	0.72	Organic NL		0.98	MAB-HealthNL		0.94	Organic ES		0.74	Fair-Basic Ma		0.69	MAB-HealthNL
	0.68	Advanced NL		0.84	GM-A NL		0.90	Organic NL		0.70	Advanced NL		0.66	Organic NL
	0.63	MAB-Env. NL		0.50	Organic NL		0.63	Standard ES		0.70	MAB-Env. NL		0.60	Organic ES
	0.58	MAB-Fair NL		0.50	Organic ES		**0.48**	**Standard NL**		0.70	MAB-Fair NL		0.59	GM-A NL
	0.57	GM-A NL		0.49	Advanced NL		0.43	Advanced NL		0.69	MAB-HealthNL		0.57	Advanced NL
	0.56	MAB-HealthNL		0.48	MAB-Env. NL		0.32	Fair-Basic Ma		0.68	Organic ES		**0.54**	**Standard NL**
	0.56	**Standard NL**		0.48	MAB-Fair NL		0.26	MAB-Env. NL		**0.68**	**Standard NL**		0.52	MAB-Env. NL
	0.47	GM-B NL		**0.47**	**Standard NL**		0.26	MAB-HealthNL		0.67	Organic NL		0.51	MAB-Fair NL
	0.39	Organic ES		0.40	Fair-Basic Ma		0.26	MAB-Fair NL		0.57	GM-A NL		0.44	Fair-Basic Ma
	0.32	Standard ES		0.34	GM-B NL		0.11	GM-A NL		0.52	Standard ES		0.42	Standard ES
	0.30	Fair-Basic Ma		0.31	Standard ES		0.05	GM-B NL		0.22	GM-B NL		0.28	GM-B NL
b. Most Balanced, and NotWorst Indices (within brackets)														
(0.91)	0.00	Standard ES	(1.00)	1.00	MAB-HealthNL	(1.00)	0.51	Organic ES	(0.91)	0.00	Organic ES	(0.82)	0.00	MAB-HealthNL
(0.90)	0.00	Organic ES	(0.86)	0.00	GM-A NL	(1.00)	0.42	Organic NL	(0.83)	0.00	Standard ES	(0.77)	0.00	Organic ES
(0.78)	0.00	Organic NL	(0.50)	0.00	Organic NL	(0.75)	0.00	Standard ES	(0.83)	0.00	Fair-Basic Ma	(0.72)	0.00	GM-A NL
(0.76)	0.00	Advanced NL	(0.50)	0.00	Organic ES	(0.75)	0.00	Fair-Basic Ma	(0.71)	0.00	Organic NL	(0.70)	0.00	Organic NL
(0.76)	0.00	MAB-Env. NL	(0.50)	0.00	Advanced NL	(0.64)	0.00	MAB-Env. NL	(0.71)	0.00	Advanced NL	(0.65)	0.00	Fair-Basic Ma
(0.76)	0.00	MAB-HealthNL	(0.50)	0.00	Fair-Basic Ma	(0.64)	0.00	MAB-HealthNL	(0.71)	0.00	MAB-Env. NL	(0.63)	0.00	Standard ES
(0.76)	0.00	MAB-Fair NL	(0.50)	0.00	MAB-Env. NL	(0.64)	0.00	MAB-Fair NL	(0.71)	0.00	MAB-HealthNL	(0.63)	0.00	MAB-Env. NL
(0.76)	**0.00**	**Standard NL**	(0.50)	0.00	MAB-Fair NL	(0.64)	0.00	GM-A NL	(0.71)	0.00	MAB-Fair NL	(0.63)	0.00	MAB-Fair NL
(0.67)	0.00	GM-A NL	**(0.50)**	**0.00**	**Standard NL**	**(0.64)**	**0.00**	**Standard NL**	**(0.71)**	**0.00**	**Standard NL**	**(0.63)**	**0.00**	**Standard NL**
(0.67)	0.00	GM-B NL	(0.36)	0.00	GM-B NL	(0.49)	0.00	Advanced NL	(0.57)	0.00	GM-A NL	(0.60)	0.00	Advanced NL
(0.65)	0.00	Fair-Basic Ma	(0.31)	0.00	Standard ES	(0.14)	0.00	GM-B NL	(0.26)	0.00	GM-B NL	(0.36)	0.00	GM-B NL

3.1. Interpretation

The assessment results take the form of comparative rankings, as presented at the indices of Table 4. The first four columns present results for each category of concerns, while the fifth column presents a mathematically possible overall assessment. As discussed in the methodology section, each value on the indices denotes an option's performance as compared to the best and worst values observed among the assessed options (these best and worst values function as upper and lower boundaries, and are assigned a normalized value of 0 and 1 for each indicator, respectively). The horizontal section 'a' presents 'aggregated' option rankings where low performances for a criterion are allowed to be compensated by high performances for another (λ = 1,0). The horizontal section 'b' presents most-balanced rankings where such trade-offs are not allowed (λ = 0,0).

Allowing performance trade-offs means that options with high aggregated rankings may sometimes score very (or even unacceptably) low for certain criteria. Although performance tradeoffs might be, in some cases, inevitable in practice (Hardin, 1968), they are however often regarded as ethically unacceptable by the public (e.g. see Chang, 1997 on the commensurability of ethical values that underline the assessment criteria). This abstract philosophical issue can have tangible real-life consequences when ethical concerns about certain aspects of production trigger activist disobedience, or legitimize such activity in public perception. In this sense, most-balanced indices are interesting because they express the factual grounds for public controversy about otherwise beneficial product options and technologies. The mathematically possible overall aggregated index presented at the last column of Table 4 is an example of a likely controversial aggregation, because it assumes that one may compare and substitute (compensate) achievements of quite distinct values –that one can make for example tradeoffs between achievements of environmental impact and fairness.[75]

Aggregated assessments are common to widely-used policy decision-support tools, like cost–benefit analysis. However, when can trade-offs be legitimate essentially

[75] The overall aggregated assessment also increases demands for independence of criteria from within a certain category, to across all categories. For attributes that are relevant to different categories of concerns (like genetic modification) overall aggregations may face independency problems. In the current exercise, one possible example of dependency among indicators across different categories is 'Yield to land', which affects both the Environmental assessment (increase of food production volume reduces pressure to convert natural habitats into agricultural land) and the Fairness assessment (increased food yields contribute to reduce world hunger).

remains a political question. As such, it is not addressed directly in this paper. Indirectly, aggregated indices may be usefully complemented by most-balanced indices to provide a more realistic picture of prospect product public acceptability. Specifically, most-balanced rankings bring into attention exceptionally poor (worst) performances for issues of public concern that are invisible (compensated) at the aggregated indices. Options that score the worst value 0 on the most-balanced index can be differentiated on the NotWorst index. The NotWorst index indicates the percentage of the total relative importance weight attached (by the public) to the assessment criteria for which an option does not perform the worst as compared to the other assessed options (see methodology section). Namely, a low NotWorst score means that for a large part of public concerns the considered product is the worst, and perhaps unacceptable, option –regardless how well it might perform for other concerns (the NotWorst index is of the type 'more is better').

The indices can be interpreted in a normative way to provide support for relevant policies, aiming for instance the improvement of the environmental externalities of production. The most straightforward normative interpretation simply regards products that rank higher as better (more publicly acceptable) than lower-ranking products. This interpretation however is rather weak because it does not contain substantial information about 'how good' a product actually is: That a product ranks close to the top of the, say, Environmental index does not mean that its environmental performance is actually satisfactory ('good enough'), and the reverse. As such, the straightforward normative interpretation of the indices does not support substantially strong characterizations of products options as –somehow– 'acceptable' or 'unacceptable'. There are at least two ways to tackle this problem within the ECHO framework: 'absolute benchmarking' and 'average benchmarking'.

Absolute benchmarking, whenever possible, enables the strongest normative claims: the characterization of products as 'environmentally friendly vs. unfriendly', 'healthful vs. unhealthful', 'natural vs. unnatural', 'fair vs. unfair', etc. This approach can be used when objective ('absolute') acceptability thresholds can be identified (or agreed upon) for a particular category of public concerns: For example, an Environmental Sustainability threshold. To implement this, an 'absolute benchmark option', purposefully defined to perform exactly at the acceptability threshold can be added in the assessment. At the resulting index, all options that rank above the absolute benchmark option may be interpreted as acceptable for the particular category of concerns, and all options that score below as unacceptable. In practice however, agreement on such absolute acceptability benchmarks is rare and difficult

to achieve, while efforts to that direction tend to result in counterproductive polarizations (Keulartz et al., 2004).

Average benchmarking interprets product options relatively to 'what is the norm' of substitutable products in the domestic market. It technically characterizes assessed options as 'above' or 'below' average production, whilst it externalizes the judgment whether average production in itself is acceptable or not. Therefore, its normative force depends on the perceived (public) acceptability of average production. This approach can be used when objective acceptability thresholds are not available. To implement this, an 'average benchmark option' is purposely defined to perform exactly at the average threshold and is added in the assessment. At the resulting index, options that score above the average may be regarded as 'above the norm' (improvements, superior to the norm), while options that score below would be described as 'below the norm' (worsening, inferior to the norm). To illustrate this, in the present application the StandardNL option serves as an average benchmark. For this purpose StandardNL has been defined to represent the typical tomato in the Dutch market).[76]

3.2. Analysis

The rankings of the assessed tomato options for the four categories of concerns (Fig. 1) are presented at the indices of Table 4. These rankings are based on the performance (Table 3) of the tomato options (Table 2) for the selected indicators (Table 1), weighted according to stated consumer perceptions for the relative importance of the corresponding criteria (Fig. 2). These criteria were sourced from the public food debate and have been structured with the help of disciplinary experts. The weights were sourced using a consumer survey in Wageningen, The Netherlands. Because Wageningen, the locality of a University of life sciences, has an

[76] 'NL' at e.g. 'StandardNL' refers to country of production, not consumption (here, country of consumption is always The Netherlands). However, because domestic fresh tomato dominates the Dutch market, the bulk produce StandardNL is assumed to represent the average of domestic consumption. Note that this 'average' interpretation threshold is quantitative, in the sense that it refers to consumption volumes. However, the average interpretation threshold can also be qualitative: In that case it can refer to the middle of the distance between the performances of the Best and Worst options included in the assessment for each criterion, regardless the consumed volumes of the corresponding product options. Such an interpretation threshold would be more sensitive to technological change and probably more effective in stimulating and rewarding socially desirable innovation.

above average population with regards to educational level and also consumer awareness, as shown by the large variety of values-labeled products available at mainstream retailers (organic, fair-trade, etc.), the rankings may not be representative of The Netherlands. The rankings refer to the performance of tomato options as compared to vectors of best and worst performances observed in the assessment (best and worst performances consistently score 1 and 0, respectively).

The rankings of the four existing tomato options (StandardNL, OrganicNL, StandardES, and OrganicES) are mostly intuitive. Organic Dutch production ranks the highest for Environmental friendliness, achieving an overall 72% of the ideal performance. That is significantly superior to the norm of bulk (standard) Dutch production, which achieves 56% of the ideal Environmental score. In spite of its lower greenhouse gasses emissions due to lack of heating, standard Spanish production ranks lower than Dutch production because of water scarcity at the site of production (Almeria), higher agrochemical emissions, and lower yields. Organic tomatoes also score higher than conventional (standard) for Healthfulness concerns. Standard Spanish production ranks far below the standard Dutch norm, due to the higher probability of traceable pesticide residues. Expectedly, organic options also achieve the highest score for Naturalness, with the technologically advanced standard Dutch production being assessed as the least natural. Dutch production together with organic Spanish production perform the best for overall Fairness concerns, while standard Spanish production ranks below the norm because of its lower yield per hectare and its higher use of pesticides (lower contribution to combat hunger and higher evolutionary pressure on pests to develop resistance and threaten food security, respectively).

The rankings of the hypothetical product scenarios AdvancedNL, MAB-Env.NL, MAB-HealthNL, and MAB-FairNL are interpreted with reference to the performances of existing tomato options. The results for AdvancedNL and for all MAB-enabled options, as defined in this exercise, indicate the potential of genomics technology to improve the Environmental, Healthfulness and Fairness aspects of food production, while reducing its perceived Naturalness. The technological improvements in greenhouse efficiency assumed for AdvancedNL rank it second best for environmental performance, closely next to the leading OrganicNL. MAB-Health gives the most promising results for the Healthfulness category, indicating a potential for products with added health functions to outperform organic production for health concerns.

The performance of the two genetically modified tomato option scenarios, GM-A-NL and GM-B-NL, indicates that the acceptability of genetically modified products may vary significantly per application of genetic modification technology. Results suggest that, according to stated consumer perceptions, GM systems can be superior to the norm as compared to existing products for Environmental and Healthfulness concerns. This result confirms the need for a case-by-case examination of the acceptability of different GM product designs. However, GM varieties often achieved the lowest rankings at the NotWorst indices. This result indicates that GM products had the worst performance for a large part of public concerns. This result suggests the possibility for public controversy, and possibly a substantial public support base for production boycotts and civil activism, in the sense that the public appears to at least partly sympathize with activist concerns.

The FairBasic-Ma option narrowly led the aggregated index for Fairness, and it scored lower than StandardEs at the most-balanced NotWorst index. This is because of the more inclusive understanding of fairness externalities of production in this exercise, as compared to the minimal requirements set by the Fair-Trade certification. Namely, in addition to wealth distribution, public concerns about the socially agreeable management of the commons (irreversible release of GMOs) and impact on world hunger (yield) were also regarded to be aspects of fairness that are relevant to food production. Besides, tomatoes' performance for Fairness was taken to depend both on the genetic properties of the cultivar and on farming practices. The incorporation of 'fair use of natural resources' requirements at the FairTrade certification would improve its fairness ranking. Relevant improvements of the minimal FairTrade certification standard would help improve its low environmental performance (the environmental performance of FairBasic-Ma was assumed to be like that of StandardES, but with higher GHG emissions due to increased transportation distance).

4. Discussion

4.1. Potential use

The presented product assessment approach provides pragmatic operational insight that widens current decision-makers' understanding of the public acceptability of products and technologies. As such, it has the potential to help technological change management. In state policy it can facilitate the optimal allocation of research funds by allowing direct comparisons of the public acceptability of different research

trajectories, as represented by middle- or long-term expert conjectures about technologically reasonable product scenarios. Moreover, the presented product assessment framework has the potential to help policy goals like production sector restructuring towards the socially optimal management of production externalities of public concern, like environmental sustainability. There are three distinct aspects of the ECHO framework that suggest its effectiveness in these respects: the generated indices are valid, gradient, and normative.

a. *Valid*: If the relative importance weights are sourced from a representative sample of the population in a market (e.g., the Dutch consumers), then rankings generated by the ECHO framework can be defended as valid to the public because they refer to public concerns, and to public perceptions about the relative importance of the concrete corresponding issues of concern. The validity of the claims supported by the generated indices depends on the nature of the terms of the assessment: When the assessment criteria and relative importance weights refer to deliberated stated preferences of concerned citizens, then the resulting indices express the relative public acceptability of the accessed product options. When they refer to revealed preferences of consumer focus groups, then the resulting indices express expected market demand (Fig. 3, also see Michalopoulos et al., 2008). The communication of valid product assessments to consumers enables the public regulation of unobservable production externalities of public concern, like environmental sustainability, in consumer-driven markets.
b. *Gradient*: The gradient nature of the assessments (rankings) enables state policies that reward small improvements in food production. Rewards for small improvements can lower investment loss risk for producers, enabling the gradient (smoother) transition of the production sector towards a, for instance, more environmentally friendly or fairer food production paradigm. These rewards can either be provided by the state, or by the market through the use of a labeling scheme. Such a scheme would add 'ethical' value to products by informing consumers about their comparatively good performance for public concerns. Gradient labels could, for instance, take the form of the so termed 'food flower' labels (Fig. 4, also called 'omni-label', Tim Lang at BBC, 2008a,b). Different sizes of petals at the flower label can correspond to product's performance for a different category of concerns. Alternatively, they can also take the form of the Traffic Light System (TLS). TSL is considered as the most effective front-of-pack nutrition labeling approach (Lobstein and Davies, 2008,

Balcombe et al., 2010, Roberto et al., 2012), and has been adopted by the British Food Safety Agency in nutritional labeling.

c. *Normative*: The relative interpretation of product acceptability with reference to average benchmarks tackles the cumbersome issue of interdisciplinary agreement on absolute acceptability standards. Characterizing products as 'positive' or 'negative' with reference to average production for issues of public concern, incentivizes producers that perform below average to improve production so as to rank at the middle-upper part of the assessment index (average or above-average products).

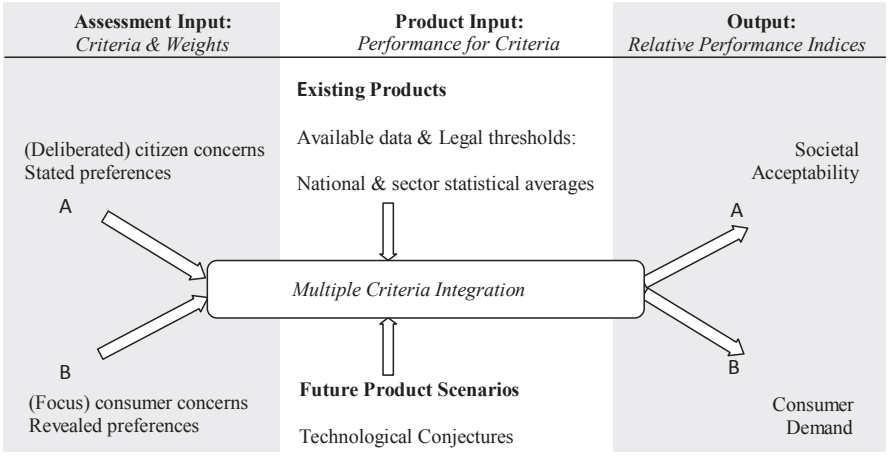

Figure 3: Input information flows and interpretation of output. Assessment input A produces output A and assessment input B produces output B

Crucially, the improvement of the below-average part of production causes the average production benchmark to improve as well, with the consequence that a new group of producers will soon find themselves producing below average. This practically means that relative-to-average benchmarking effectuates a positive (according to public perceptions) competition spiral, a race-to-the-top, for technological innovation and production externalities of public concern, like the environmental sustainability or the fairness of production. In the case of the labeling example shown at Fig. 4, different petal colors could correspond to 'above average', 'average', and 'below average' performances for each category of concerns.

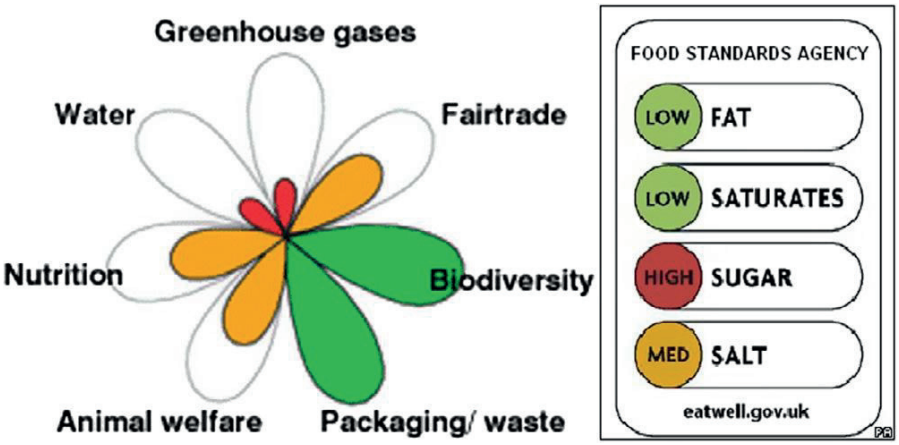

Figure 4: Labeling examples suitable for the communication of non-aggregated indices. Food flower (BBC, 2008a) and Traffic Light System (BBC, 2007).

Food supply actors can use the generated indices for production optimization for public concerns, aiming profit maximization. The presented approach can compare potential product scenarios toexisting and expected competitors at early development stages (product design) facilitating the strategic allocation of research funds. Also, the generated rankings can be incorporated as production constraints into economic models to improve estimation of future product demand. Favorable rankings could be used to defend from public criticism, to protect consumer trust, and to increase product demand through labeling. Sourcing input on assessment criteria and relative importance weights from the public enables promotion claims that products perform well according to public perception about 'what matters' and 'how much' in food production. Civil society actors can use the indices to criticize supply actors and to motivate the improvement of product performance for unobservable attributes of public concern, like the environmental sustainability or the fairness of production. Overall, the implementation of the ECHO framework can be beneficial to all actors across the supply chain that wish to consider, assess, and communicate the performance of their production for concrete issues of societal concern from the perspective of the public. This makes ECHO especially relevant to socially responsible production and to corporate social responsibility (CSR).

The practical aspects of a potential market-scale implementation in product labeling require further elaboration. It can complement and meta-assess existing labels from the perspective of the public, as illustrated in this exercise. Attention must be paid

on its transparent institutionalization and its compatibility with trade law issued by national and also international institutions, such as the World Trade Organization. Possible institutional implementers include the state, major retailers and NGO's, consumer organizations, or alliances between these actors. The more elaborate analysis deserved by these issues is the subject of forthcoming publications (Michalopoulos, forthcoming, in preparation).

4.2. Improvements

Improved data quality about product performance for the assessment criteria is necessary for the generation of credible indices. Expert judgment about reasonable technological conjectures is the only source of input on the performance of hypothetical product scenarios. Lack of data and producer unwillingness to provide relevant information may hurdle product assessments of existing options. Data availability in particular depends on the traceability of production, meaning whether particular products can be traced throughout the supply chain (on 'ethical traceability' see e.g. Coff et al., 2008). As a rule of thumb, when more detailed data does not exist, assessments can rely on national production averages (for 'bulk' products) and average national sector statistics (for e.g. 'organic', or 'fair' products), which are usually publicly available for a large number of relevant indicators. For the performance of less general product options, the economically rational and practical assumption can be made that production happens at the minimal legally allowed standards (for example, that labor wages paid are the lowest that national law allows at the site of production). Operating this assumption has the practical benefit that it creates an incentive for producers to voluntarily report relevant data about products that perform above national or sector averages. In this way, when the assumed data underestimate reality, rational producer behavior can be expected to facilitate improvement of data quality by correcting data upwards in order to claim higher relative rankings for their products. Additionally, this assumption creates a motivation for well-performing producers to improve the traceability of their products so as to enable their favorable differentiation. In the opposite case, like when producers report favorably incorrect data, or the case that production happens below legal standard, input for downwards corrections can be expected from actors like NGO's, consumer organizations, and whistle-blowers.

The application of ECHO in product design by supply chain actors requires attention to the so-termed 'value-action gap', namely the gap between the stated and the revealed preferences of consumers. Available methods can be used to retrieve the

relative weights of assessment criteria from consumers with a limited value-action gap. Conjoint methods can be useful for this purpose. Conjoint analysis is widely used in marketing to measure relative contributions of different product attributes (e.g. flavor versus flavor vs. size) to the overall preference of a product (Rao, 2008). Common conjoint applications outside of marketing include the evaluation of farmers' preferences for different characteristics of modern crop varieties (Baidu-Forson and Waliyar, 1997) and factors influencing smallholder farmers' adoption of dairy technologies (Makokha et al., 2007).

Improvements of the multiple criteria assessment methodology can include the incorporation of lexicographic ranking at the non-aggregated most-balanced index, so as to also take into account product performance for other than the worst criteria. Indicators in general (and risk modeling in particular) should be improved, preferably with the integration of established methodologies to calculate production impact on issues of public concern (for instance carbon footprint of production). Finally, when the linear value functions used in this application are not realistic the indexing model should be modified so as to incorporate non-linear functions, or thresholds of achievement should be identified above which further increments give diminishing returns. Finally, practical applications of the illustrated framework should pay ample attention to the process used to structure the assessment criteria and to retrieve relative importance weights. This is especially relevant to multiple criteria context because it can directly determine the results (Simon, 1976). A variety of appropriate methods are identified in the literature, and can be used during the deliberation step anticipated by the ECHO framework (Michalopoulos et al., 2008)

4.3. Extensions

Model extensions could include trend analysis of the relative importance weights in order to extrapolate results into the future, for the purpose to facilitate strategic business planning (for example, the importance attached to GHG emissions and Environmental impact could be expected to increase). Producer applications could include the operational incorporation of product rankings into economic optimization models in the form of goals or constraints.

Food policy applications would demand the development of generic models that will be able to compare broad categories of substitutable foods (e.g. the broad product category 'vegetables' instead of the narrow category 'tomatoes'), and which will be fit to also assess multi-ingredient processed products. For certification policy uses

like labeling, the use of global scaling for the assessment of product performance (i.e. referring to universal 'best' and 'worst' performances instead of those observed among the assessed options, as we did in the present demonstration) offers the advantage that when novel products with better performances are introduced in the market the existing rankings will not need recalculation (not as often). Finally, it is possible to enable personalized assessments, adjusted to the personal perceptions of individuals about assessment criteria and relative importance weights, either on-line or on-site using mobile product scanning gadgets to be developed. However, personalized assessments may conflict with the public deliberation step anticipated by the ECHO framework.

5. Conclusions

In this paper we illustrate a multicriteria product assessment framework, based on a simplification of the ECHO product assessment framework. We rank existing fresh tomato options alongside hypothetical future product scenarios. A valuable feature of the model in use is that it produces both aggregated and non-aggregated results, where trade-offs in product performance for different criteria are allowed and not allowed, respectively, and which inform on a product's overall performance and also on its potential for public controversy. The terms of the product assessment are sourced from the public. We assess products for four categories of existing societal concerns: Environmental impact, Healthfulness, Naturalness, and Fairness of production. Within each category, the products are ranked for an inclusive list of criteria that refer to unobservable (credence) product and production attributes, and which were identified from recent public food debates. These criteria were weighted according to stated consumer preferences in a consumer survey. The results indicate that the public acceptability of novel products developed with the use of innovative technology may vary significantly with the purpose of the technological application. Mid-term expert conjectures for plant genomics technology application scenarios meant to improve product performance for societal concerns resulted in products that ranked at the highest positions of all generated indices –apart for Naturalness. The expected acceptability of hypothetical genetically modified product scenarios strongly depended on the application, confirming the need for a case-by-case examination of technology use. However, genetically modified products consistently showed the highest potential for public controversy. Among existing bulk fresh tomato options, Dutch production was assessed as more environmentally friendly,

healthful and fair, while Spanish production as more natural. Organic products performed overall better than bulk. The credibility of these results is limited by the simple indicators, data availability and risk modeling method used in this demonstration. Their generalization is contingent upon the representativeness of the consumer sample that provided the relative importance weights, which may not be representative of the Dutch population. Nevertheless, the generated indices address the issue of validity of certification schemes by referring to public concerns as the terms of product assessment. They are also gradient so as to support small production improvements to the direction of citizen or consumer preferences. Besides, the produced rankings are relative to the performance of substitute products and their interpretation can be normative with reference to the existing production norm –without reference to absolute acceptability thresholds. Data improvement goes with the grain of rational stakeholder behavior. Producer uses include research fund allocation, profit optimization in the short term through labeling, and in the long-term through the protection of consumer trust in brands. Civil society uses include the critical assessment of production. Public uses include research funds allocation, labeling in consumer-driven markets, and smooth production sector re-structuring, by incentivizing a race-to-the-top for production externalities of public concern, like the environmental sustainability and the fairness of production.

The assessment methodology described in this work is self-standing and can be used by interested actors independently from the broader framework. It is relevant to food and also non-food products. The final proof of the usefulness of the integrated ECHO framework will be whether its prospect implementation by private, civil, or public actors can effect change on corporate social responsibility regarding concrete issues of public concern, such as production externalities. Specifically, when this change can be described as positive from the deliberated perspective of the broader public.

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CHAPTER 6

General Discussion

1. Introduction

The overall objective of this thesis was to develop an approach to generate information that addresses some of the limitations of currently available information schemes for the consumer-based optimization of production practices and technologies of concern to society. Four studies were conducted as steps to reach this objective. Chapter 2 offered a critical analysis of product information available to consumers through product labels. This analysis focused on a number of properties that are common among available ethical labeling schemes and have a negative impact on the ability of labels to facilitate consumer-based optimization. Based on this analysis, Chapter 2 also examined conceptually the function of a label that facilitates consumer-based optimization. Chapter 3 presented the conceptual outline of a framework designed to generate information on ethical aspects of production. This outline focused mainly on information flows for the selection of assessment criteria and weights, on conditions that must be met by assessment criteria, and on the description of a multicriteria model that can be used to rank the performance of different product options for different categories of criteria. Chapters 4 and 5 applied a simplified variation of this assessment frame work to fresh tomato production. Chapter 4 presented the collection and analysis of data on the relative importance of ethical concerns relevant to tomato production. Based on this input, the fourth study illustrated the generation of the desired type of information by ranking several fresh tomato options that differed in terms of their use of genomics technology and production practices.

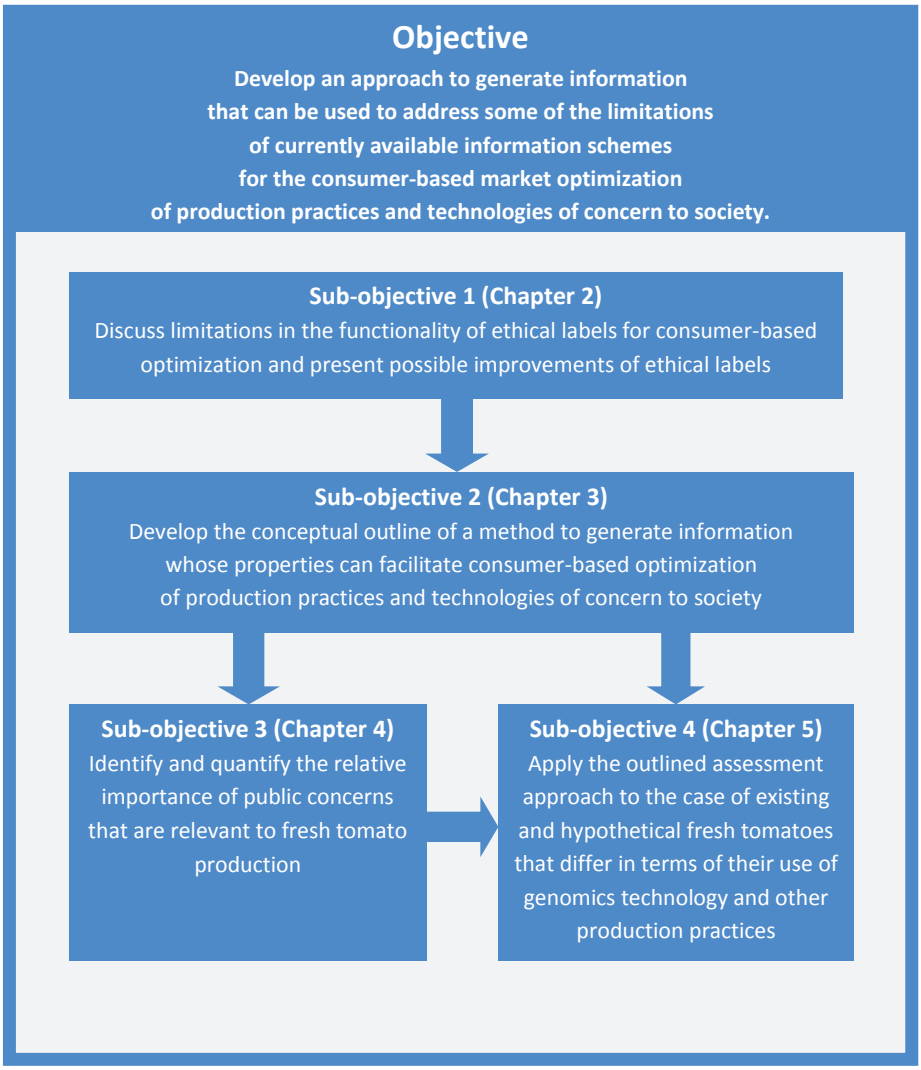
The current chapter proceeds with a synthesis of these results. It also discusses the contributions of the thesis to the literature, identifies limitations of the data and methods used in this research and outlines business, policy and research implications.

2. Synthesis of Results

An overview of how results from investigating the different sub-objectives contribute to other sub-objectives and to the overall objective of this thesis is presented in Figure 1. These contributions are discussed in more detail in the remainder of this section. This section also discusses contributions of this thesis to the literature. The overall contribution of this thesis is that it fills in a gap in the literature by developing a method to generate information on comparative product performance for unobservable ethical attributes, and which information is fit for

optimizing these attributes based on the law of supply and demand through product labeling. The investigation of the sub-objectives also resulted in contributions to the literature. These are discussed in the remainder of this section.

Figure 1: Outline of objectives and sub-objectives. Arrows indicate the flow of output from addressing each sub-objective.



2.1. Sub-objective 1: Limitations of available information

The first sub-objective of this thesis was to discuss limitations in the functionality of ethical labels for consumer-based optimization and to present possible improvements of ethical labels. This sub-objective was addressed in Chapter 2. That chapter focused mainly on information provided to consumers through product labels, and especially through the most credible third-party issued and monitored ones. The perspective adopted for the analysis of this information differed from that usually met in relevant literature: Ethical labels were not approached as instruments that inform consumers on whether products meet a certain level (standard) of ethical performance with the aim to achieve the corresponding level of incremental improvement in production practices. Instead, Chapter 2 contributed to the literature through an investigation of the functionality of label information for the optimization of ethical aspects of production based on the law of supply and demand. This investigation focused on four properties that are widely common among "endorsement labels", which is the type of labels that dominates ethical labeling. These properties are that endorsement labels are usually binary (i.e. they offer a single certification grade); static (i.e. they have fixed values that are not a function of market dynamics); defined by stakeholders (i.e. rather than being defined by the broad society); and are also voluntary. The presented analysis suggested that these properties have a negative effect on the efficiency of the outcome of consumer-based optimization of the production aspects at stake. Next, Chapter 2 identified examples of labels that do not share these features, most common of which are 'comparative' labels that indicate product performance for the unobservable use attribute energy consumption. Based on this example, the chapter identified difficulties in the development of a hypothetical ethical equivalent to energy labels and discussed its potential optimization functionality. Overall, the analysis presented in Chapter 2 suggested that consumer-based optimization is better served by labels that are continuous or multi-grade; that inform on product performance as compared to the evolution of the market; that inform on what matters to the public; and, finally, that are compulsory. These requirements are summarized in Table 1, and the extent to which they are addressed by the results of this thesis is discussed in the remainder of this chapter.

Table 1: Typically available versus recommended properties of product labels that inform on unobservable 'ethical' attributes and aim in consumer-based optimization

Typical Properties	Recommended Properties
Single-grade	Continuous or multi-grade
Static	Dynamic
Stakeholder-defined	Public-defined
Voluntary	Compulsory

2.2. Sub-objective 2: Method outline

The second sub-objective of this thesis was to develop the conceptual outline of a method to generate information whose properties can facilitate consumer-based optimization of production practices and technologies of concern to society. This implied that the properties of the generated information should be consistent with the requirements identified in Chapter 2 (Table 1). This sub-objective is addressed mainly in Chapter 3, the output of which was complemented and partly revised in Chapters 4 and 5.[77] The method that was developed in Chapter 3 was fully termed: "a framework for the **E**thical **CH**aracterization and **O**ptimization of production from the perspective of the public" (ECHO).This abbreviation was unfortunate.[78] Therefore, consistently to the title of Chapter 5, the term 'public assessment' framework or 'PA' framework is used hereinafter (instead of 'ECHO') to refer the developed framework. In this term, as in the entirety of this thesis, the word 'public'

[77] Specifically, Chapter 3 anticipates that assessment terms are defined by 'concerned members of society'. This was revised in Chapter 4, which referred to a 'representative sample of society'. Chapter 3 suggested that equal weights could be used to aggregate product performances for different criteria. This was revised in Chapter 4, which referred to the opinion of the general public for deriving the relative importance of assessment criteria. Finally, Chapter 3 relied upon an ethical traceability scheme for the sourcing of product data. Chapter 5 suggested an alternative approach to product data mining to be used in the absence of such a scheme.

[78] The acronym 'ECHO' has been an unfortunate choice of title for the framework because it does not specify the public perspective of the framework, and it is confusing because it sounds too similar to EKO, or ECO and more generally to the excessive variety of ecological labels presently available. Therefore the title should be revised.

simply means 'members of society', or 'the people', and therefore these terms are used interchangeably.[79]

The ambiguity of the terms 'public' and 'members of society' captures the twofold role of members of society (i.e. as citizens and as consumers) within the overall framework that was presented in Chapter 3: As citizens, members of the general public define collectively the terms of ethical assessments. As consumers, they reveal their individual preferences in the market for different levels of observable and unobservable attributes. Namely, citizens are involved in the 'characterization' part of the framework: they decide what production aspects the generated information informs on. Consumers are involved in the 'optimization' part of the framework: informed by the generated information on product performance, consumers make choices in the market.[80]

Table 2. Elements of the developed framework

Characterization (generation of information)
Sourcing assessment criteria and weights
Sourcing product data
Integration into category indices (ranking)
Optimization (use of generated information)
Inform consumer choices
Alternatively
Inform policy measures
Inform producer R&D

[79] This use of the term 'public' is consistent with its common use in expressions like 'public opinion', 'public company', 'publicly available', 'public attitudes', and 'public preferences', and does not necessarily refer to its more restricted use in political philosophy. Nevertheless, insofar lay members of society share widespread concern regarding certain aspects of production, the use of the term 'public' in the context of decision-making on assessment terms is also consistent to Dewey's (1927) claim that "Indirect, extensive, enduring and serious consequences of conjoint and interacting behaviour call a public into existence having a common interest in controlling these consequences".

[80] The described allocation of roles between citizens and consumers is consistent to the intended use of the framework in market optimization from the perspective of the public. Other applications may introduce variations.

Accordingly, the overall framework as outlined in Chapter 3 consists of two parts: a "characterization" and an "optimization" part. These refer, respectively, to the assessment of products and to the use of these assessments. The 'characterization' part addresses the objectives of this thesis. It is concerned with the generation of information that indicates the performance of products as compared to their substitutes. This is achieved by ranking substitutable product options in terms of their performance for specified assessment terms. The "characterization" part includes three elements. The first element refers to guidelines for sourcing assessment criteria and weights. These were presented in Chapter 3. The second element refers to suggestions for the sourcing of data on product performance for the assessment criteria. Chapter 3 introduced an 'ideal approach' to accomplishing this task. This suggestion was revised in Chapter 5, which introduced and applied a more efficient approach to data mining. Finally, the third element refers to a multiple-criteria ranking model that integrates product performances for these criteria into category indices.

The "optimization" part exceeds the objectives of this thesis. However, it was regarded to be meaningful to also describe in more detail the intended function of the generated information in consumer-based optimization; as well as to outline other possible supplier and policy uses that can be relevant to this purpose. The intended function of the generated information in consumer-based optimization was described in Chapter 2. Since a detailed description of market optimization did not strictly fall under the objective and the sub-objectives, these uses are outlined in Section 4 of this chapter. These elements of the framework are summarized in Table 2.

The remainder of this section describes how selected results connect to the literature, and identifies contributions made to the literature from the investigation of the second sub-objective. These concern the public approach in sourcing assessment terms (which is also the feature that distinguishes the developed PA framework from available assessment instruments), and the suggested approach in sourcing product data.

a. Sourcing of assessment terms (criteria and weights)

A distinguishing aspect of the developed assessment framework is its 'public perspective'. The key feature of this perspective is that the subjective aspects of ethical assessments reflect what ethical issues matter (assessment criteria) and to what extent (relative importance weights; note that fixed performance thresholds are not defined) according to public opinion. Namely, production is assessed for what matters to members of society. Contrarily, available instruments assess production for the part of public concerns that is agreed to by stakeholder panels, and according to the relative importance attached to these concerns by these panels. This public perspective positions the framework squarely within the democratic tradition, and enables it to claim a democratic optimization functionality that is exceptional among available ethical assessment and labeling schemes.

– *Identified obstacles to the public perspective*

The shift from stakeholder-based to public-based assessments was suggested in Chapter 2. This implied that the conceptual model developed in Chapter 3 has to address well-identified quality and reliability shortcomings of public opinion. These shortcomings include scientific illiteracy, vulnerability to unjustified scares, hypes, populism, propaganda, non-objective media coverage (Boykoff and Boykoff 2007), and also "psychological bias" among the public that leads to selective sourcing or processing of information (Frewer 2003). Scientific illiteracy is a much-discussed issue in technology governance literature, and has been especially relevant to the development of biotechnologies. It is the subject matter of the so termed 'public deficit model' (Wynne 2006), according to which the public often exhibits crucial ignorance in scientific matters (Bodmer 1985). Indeed, according to a recent Oklahoma State University survey, 80.44% of US citizens characteristically stated that they support "mandatory labels on foods containing DNA" (Lusk and Murray 2015). Observation of such cases incentivized support for the view that scientific illiteracy prevents the general public from making rational decisions on science-dependent issues, which advocated limiting the relationship between scientific experts and the public to one in which the former inform and educate the latter. This included political decisions regarding 'upstream' aspects of technology R&D that concerned the types of technologies to be researched and developed.

The deficit model was criticized mainly by scholars within the field of Science and Technology Studies (STS), who challenged "[t]he embedded assumption [...] that no

rational and properly informed person could possibly disagree with the desirability of whatever science endorsed" (Wynne 2006). The above resulted in a proliferation of public education, and also public participation and consultation processes on ethical or social aspects of innovative technologies(Rowe and Frewer 2000; Kaiser 2005). These processes had questionable success in the case of bio-technologies (Frewer 2003). Brian Wynne, who largely spearheaded the criticism of the public deficit model, also criticized sharply these participatory approaches for not going far enough. This was because, among other reasons, "they impose their own definitions of what counts as an ethical issue" (2001), and because they were leaving out of the scope of public debate legitimate public concerns about production aspects that "relate to the science […] but are not scientific issues" (2007). Along these lines Wynne described the emerged participatory approaches as "hitting the notes, but missing the music" of public participation (2006), and called upon scholars to seek input from work in political theory and philosophy (2007).

– ***Political philosophy input used to overcome public opinion deficits***

Chapter 3 relied upon input stemming from two major branches in contemporary political philosophy of the democratic tradition in order to cope with the above-mentioned deficits of public opinion. These are the "Deliberative Democracy" branch (Elster 1998), which became widely known through the works of Jurgen Habermas(e.g. 1984), and the "Political Liberalism" branch that was developed by John Rawls (1993).

Deliberative democracy theory "emphasizes the importance of the design of the actual decision-making procedure – ensuring fair and inclusive fora in which each participant has equal standing and equal speaking time – for the transformation of individual *interests* into collective *reasons* (Elster 1998; Bohman 1998)" (Engelen, Keulartz, and Leistra 2008). Accordingly, the presented PA framework anticipated a structured public deliberation process for the collection of input on assessment terms. The purpose of this process is to help the public arrive to decision-making that is "well-considered": That is, to let the best arguments win in a controlled, structured and inclusive discussion setting, in which deliberating members of the public can benefit from, experts and stakeholders, from an inclusive range of relevant fields and sectors, that perform a valuable educative, informatory and consultative function. (The precise structure of this process remains to be detailed by experts in that field.) At the same time, insofar subjective aspects are concerned, the role of experts and stakeholders is strictly informatory and the decision-making

power rests entirely with representatives of society. Deliberative methods of public participation have been implemented in a variety of real-life applications (Abelson et al. 2003; Beekman and Brom 2007) with demonstrated ability to shift participant opinion towards more considered decisions (Fishkin and Luskin 2005; Cabrera and Cavatorto 2009). By ensuring that assessments inform on what matters according to a well-considered public opinion, the anticipated deliberative step protects the "throughput legitimacy" (references to Elster 1998; and Bohman 1998; in Engelen, Keulartz, and Leistra 2008) of decision-making on assessment terms, and therefore the validity of product assessments. Moreover, the design of the deliberative step protects the "input legitimacy" of the broader framework as an instrument for direct participatory democracy (references to Scharpf 1970; and Scharpf 1999; in Engelen, Keulartz, and Leistra 2008) through consumer-driven markets: By reserving for the public the decision-making power to set the agenda of ethical assessments (i.e. to define assessment terms), it ensures the demand-side of market optimization expresses revealed consumer preferences for what society at large (of all stakeholders) believes is at stake.

Another relevant concern raised in the literature is that public concerns "change over time, as does their relative weight vis-à-vis each other", which requires that "[t]he dynamic character of consumer concerns is something to be reckoned with in a serious and structural way" (Korthals 2008). This is addressed by anticipating the update of assessment terms through repetitions of the deliberative step at reasonable time intervals. In this respect, the function of these public deliberation events, or more precisely the function of their repetition in reasonable time intervals, is to "at least temporarily stabilise [the] collective meaning" (Felt and Wynne 2007) of the ever-changing set of public concerns.

Input from the political philosophy branch of Political Liberalism refers to the concept of "reasonableness". Rawlsian reasonableness (Rawls 1993, 54–58; Streiffer and Hedemann 2005) is incorporated in the framework in the form of a normative requirement that qualifies whether particular concerns identified during the deliberation process can serve as assessment criteria. As developed by John Rawls, reasonableness requires among others that the concerns behind the terms of the assessments must be scientifically irrefutable. Besides scientific irrefutability, reasonableness also requires that the societal ends (e.g. a harmonious relation with nature; a just society) that underlie societal concerns (e.g. environmental impact; income inequalities), and which incentivize assessment criteria (e.g. greenhouse gasses emissions; employees pay ratios) must be parts of "comprehensive doctrines of the good" (which approximately means worldviews) that are in agreement with

the basic principles of Justice. This minimal, yet crucial qualification of reasonableness serves a twofold purpose. First, it precludes framework applications in support of irrational causes by disqualifying assessment criteria based on refutable concerns that stem from scientific illiteracy, such as those identified in the survey referred to in the previous section (e.g. a concern about whether food contains DNA). At the same time, irrefutable concerns such as religious or metaphysical ones can be qualified as "epistemically reasonable" given our "burdens of judgment", because the burden of proof is placed on science to refute a concern (Streiffer and Hedemann 2005). This type of irrefutable concerns is represented by the 'Naturalness' category in the assessment illustration presented in Chapter 5. Second, it precludes framework applications in support of unfair, such as discriminatory, causes. Chapter 3 also identifies an additional "pragmatic" requirement for the qualification of societal concerns as assessment criteria. This requires that qualified criteria should receive a relatively high weight, which means that low-weight criteria can be omitted. This is a logistical efficiency requirement. It should be respected only to the extent that the inclusion of lower-weight assessment criteria burdens logistics to the effect that implementation becomes infeasible or ineffective, by demanding to collect or to communicate too much information. From a politically liberal perspective, this pragmatic requirement is certainly non-ideal (ideally all concerns of members of society should be considered) because it violates "neutrality of effect": concerns shared only by few members of society will be omitted from market optimization. Nevertheless, it respects "neutrality of aim" (i.e. neutrality of intent), which is the minimal condition for policy legitimacy in a politically liberal context, because it is justified on non-partisan grounds (Rawls 1993, 192–194; Streiffer and Hedemann 2005). Accordingly, the overall qualification of valid assessment criteria as outlined in Chapter 3 consists of the following steps:[81]

1. Extract *Deliberated Public Concerns*: Concerns that the public considers to be relevant.
2. Subtract *Non-Reasonable Concerns*: Concerns that are scientifically refutable, or are not in agreement with the basic principles of justice.
3. Subtract *Non-Popular Concerns*: Minor concerns or concerns presently shared by a small fraction of the public as indicated by their relative importance weight.
4. The remainder is the *Valid Qualified Criteria* to be used in the assessment.

[81]I.e.: Receive the criteria proposed by the public, remove unreasonable ones, remove low weight ones, and the remainder is the qualified set of assessment criteria.

Box 1. Example outline of event designed to define assessments terms per concern category

1. Opening. Topic: Event Purpose and Process
2. Presentations to representatives of the public (Public) by experts and stakeholders (E&S)
   Topic: Proposed lists of measurable criteria
3. Deliberation session for the Public
4. Questions to E&S by the Public
5. Deliberation session for the Public

(Sufficient repetitions of steps 4 and 5 until the Public present a preliminary list of criteria)

6. Presentation of criteria decided by the Public (preliminary)
7. Reactions by E&S
8. Check of the Rawlsian reasonableness of preliminary criteria if challenged
9. Deliberation session for the Public

(Sufficient repetitions of steps 6, 7, 8 and 9 until the Public ends amending the criteria list)

10. Announcement of criteria decided by the Public (provisional)
11. The relative importance of provisional criteria is derived from the Public.
    Omission of criteria attributed insignificant weights
12. The weighted set of provisional criteria is considered to be final.

An example outline of a hypothetical event that complies with the requirements set in Chapter 3 is given in Box 1. In combination, these political philosophy contributions can help extract from the public well-considered, collective, inter-subjective, and reasonably-qualified assessment terms designed to withstand criticism of being arbitrary, subjective, poorly-considered, scientifically refutable, or unfair within a politically liberal context. In this way, the framework outlined in Chapter 3 acknowledges and addresses legitimate concerns in the literature regarding deficits of public opinion that were identified in Chapter 2, while at the same time aspires to 'play the music' of public participation: It reserves for representatives of the general public the power to define the terms of assessments that produce information on the ethical performance of products, consequently the terms on the basis of which suppliers must compete in order to be assessed favorably, and consequently the terms with regards to which the market will optimize.

b. Sourcing of product data

The feasibility of collecting data on product performance for assessment criteria can be crucial for the implementation of the framework, and can determine the range of possible implementers (e.g. only the state can command data disclosure). Consistently to relevant literature (e.g. Coff et al. 2008), Chapter 3 anticipates the installation of an "ethical traceability scheme" for marketed products, which is meant to facilitate data collection. Although a traceability scheme would be valuable if already available, the requirement to establish one when it does not exist can be problematic for a number of reasons: it points to the state or to quite powerful suppliers as the only possible implementers; it implicates top-down changes in supply chains; and it requires burdensome implementation logistics. The requirement for an ethical traceability scheme reflects an intuitive approach to ethical labeling. According to this approach, each and every labeled product should be granted a label that informs accurately on product performance for the selected assessment criteria. Chapter 5 attempts to address these shortcomings of the intuitive approach by contributing to the literature the outline of an alternative, 'lighter', cost-effective, and bottom-up approach to the collection of product data. In this approach, implementers must focus on the more modest and pragmatic task to improve the currently imperfect situation from the viewpoint of consumers. This approach is discussed in more detail at section 4.1 in this chapter.

c. Limitations of available assessment labels that are addressed

Along these lines, the framework outlined in Chapter 3 addresses directly one of the four limitations of available ethical information schemes that were identified in Chapter 2 (see Table 1): The outlined PA framework is designed to generate information that is defined by representatives of the general public rather than stakeholder-defined. In addition to this, Chapter 3 also addresses indirectly three more limitations: It identifies conditions meant to protect the democratic legitimacy of the generated information. This supports the use of the generated information within a mandatory labeling context that aims in democratic (i.e. consumer-based) market optimization. Furthermore, as discussed in the next sub-sections, it anticipates the use of a product ranking method that can produce information fit for multi-grade and dynamic labeling.

2.3. Sub-objective 3: Fresh tomato-related concerns and relative importance

The third sub-objective of this thesis was to identify and quantify the relative importance of public concerns that are relevant to fresh tomato production. This sub-objective was addressed in Chapter 4 of this thesis. The purpose of this sub-objective was to support the application of the selected assessment approach that was provided in Chapter 5.

In order to limit the methodological scope of this interdisciplinary work and because of resource and time constraints, it was decided not to make a full-blown application of the framework. Therefore, the methods employed for the definition of assessment terms did not satisfy the public deliberation standard set by the framework. Instead, simplifications and less elaborate methods that are more common in the literature were used. Therefore the validity, credibility and generalizability of the obtained results must not be overstated (see section Data and Methods). Consequently, while Chapter 4 produced some insight on the relative importance of different concerns in society and served the purpose to illustrate the applicability of the framework, it does not set a methodological example on the sourcing of input on assessment terms within the PA framework. Nevertheless, the methods employed to define assessment terms respected the societal perspective of the framework, as requested in Chapter 2 and anticipated in Chapter 3: relative importance weights were derived by citizens (i.e. stated consumer preferences), after presenting them with a rather inclusive list of candidate criteria. More analytically, an inclusive list of 21 concerns relevant to fresh tomato products and their production was composed and structured within four broad categories of ethical concerns: Healthfulness, Environmental impact, Naturalness and Fairness of food production. These assessment categories corresponded to production aspects that are unobservable as product characteristics and were considered to evidently meet the 'reasonableness' and 'pragmatic' conditions set by the framework (see previous section). The survey results and the survival of certified products at non-competitive prices in the market were assumed to indicate that a sufficiently large segment of the public is concerned. The reasonableness of these categories of concerns was assumed to be evident by the absence of established principled opposition to the corresponding labels. The generation of the inclusive and structured inventory of criteria was based on the analysis of input collected from scientific literature, reviews of recent food debates, an expert workshop, and interviews with disciplinary experts that study or express relevant concerns from within the perspective of the concerns (i.e. Organic and Biodynamic agriculture expertise was consulted on Naturalness, Fair Trade expertise for Fairness). The mean

relative importance attached to these concerns was derived from a local small-scale consumer survey at the exit of different retailer shops.

The analysis of results from the consumer survey showed Healthfulness to be the most important concern. It indicated no statistically significant difference among the relative importance of' Environmental and Fairness concerns. Notably, consumers were indifferent between reduction of health risks and increase of health benefits. Impact on global hunger was identified as the major concern in the Fairness category, and labor wages was the most important aspect of wealth distribution. Additional analysis identified correlations among concerns and indicated that socio-demographic parameters of the consumer sample were significant in explaining some of the variation in responses.

The conceptual contribution of Chapter 4 to the overall framework developed in this thesis consists of two progressive insights that revised the outline of the PA framework as presented in Chapter 3: While Chapter 3 anticipated the participation of 'concerned' citizens in the public deliberation events, Chapter 4 gathered this input from a sample of the general public (thus, not only from concerned members of society), so that the democratic legitimacy of the framework is preserved. Second, in Chapter 3 it was suggested that "equal weights" could be used to aggregate product performances for different assessment criteria. Chapter 4 dismissed this possibility because it was arbitrary and inconsistent with the broader intention to manage subjectivity in assessment terms by referring to the opinion of the public.

2.4. Sub-objective 4: application of ranking model

The fourth sub-objective of this thesis was to apply the outlined assessment approach to the case of existing and hypothetical fresh tomatoes that differ in terms of their use of genomics technology and other production practices. This sub-objective was addressed in Chapter 5. This chapter demonstrated the properties of the selected ranking method, and discussed the interpretation and usefulness of the generated product indices.

In order to avoid dwelling too deep into the technical details of different assessment options or into a quest for valid indicators, sourcing of product data for this application often relied on considered expert assumptions (see section Data and Methods). Therefore the validity and credibility of obtained results should be seen in the light of the restrictions of the data collection process, and also in the light of the

simplifications that were made during the sourcing of assessment terms; as described in Chapter 4 (see previous section). The demonstrated ranking method is based on a multi-criteria model that was developed by Díaz-Balteiro and Romero (2004). A notable feature of this ranking model is that it generates "compensatory" and "non-compensatory" indices (as the opposite end-points of a continuum of 'different degrees of compensation'). In addition, as a member of the Multiple Criteria Decision Analyses family, the model requires determining the normative direction of indicators: namely, whether they are of the type "More is Better", or "Less is Better". The choices implied by these options have philosophical connotations the explanation of which helps the interpretation of results.

– ***Political philosophy aspects of the ranking model***

Compensatory aggregated indices rank different product options according to the maximum mean ('maximean') score that a product option achieves for different assessment criteria. Thus, they accept 'tradeoffs' (compensations) between the achievement of different assessment criteria: for example, a high score for climate protection can compensate for a low score on biodiversity protection. This type of tradeoffs is standard practice among assessment methods that use more than one criterion, and also among contemporary policy-support tools such as Cost-Benefit Analysis. However, by paying attention to the maximum mean performance, compensatory indices are 'blind' for low performances for criteria that might correspond to issues that society holds dear. In these cases, this abstract philosophical issue can have tangible real-life consequences when ethical concerns about unacceptably low performances for certain production aspects lead to, or legitimize in public perception, activism and social instability.

The non-compensatory "most-balanced" indices that are produced by the ranking model address this point.[82] These indices are 'non-compensatory', which means that they do not allow tradeoffs among product performance for different criteria. Instead, they rank alternative product options according to their worst performance. This corresponds to Rawls' maxi-min aggregation function (Rawls 1999, 132–139;

[82]Hybrids between compensatory and non-compensatory approaches are also possible. The MSC certification requires an aggregated average (compensatory) score of 80% for assessed indicators, and at the same time requires that the score for all indicators is at least 60% (Tlusty 2012). This ensures that scores below 60% are not compensated. See also goal programming (Romero and Rehman 2003).

Pogge 2007, 68). According to the maxi-min function, best is the product that has the least bad performance across all individual criteria.[83] The broader potential usefulness of most-balanced indices in optimization should be examined further in future research. In this adaptation, the ranking model was modified by adding an indicator that also ranks options according to the sum relative importance of criteria for which they exhibited the worst performance among alternative product options. This indicator is meant to provide additional input on the factual grounds for public controversy raised by otherwise (i.e. according to their performance for other criteria) beneficial product scenarios. If a product scores low for this indicator, then this means that society attaches much total importance to the criteria for which the product performs worst among alternative products. Therefore, (all other parameters being equal,) this author expects that a product which scores low on this indicator has higher likelihood for public controversy than alternative products. Also, society will be more sympathetic to relevant concerns referred to by activists. Although robust evidence that validates this interpretation of the introduced index is lacking because the index was developed in the context of this research, the obtained results offer some empirical support to this interpretation (see next paragraph).

The modeling requirement to define the normative direction of the indicators used (i.e. whether each indicator is of the type "More is Better", or "Less is Better") also has political philosophy connotations that affect the interpretation and use of results. The obvious problem here is that opinions differ among members of society. This is especially (but not exclusively) true at the level of worldviews or ideologies. For instance, some people consider animal suffering and the use of animals merely as means to human ends to be morally unacceptable, while others take a more anthropocentric view that allows for such treatment; analogous differences of opinion exist regarding the relation of humankind to pristine nature and also in socioeconomic issues. Despite these differences at ideological or worldview level, it seems uncontroversial to observe that a remarkable analytic consensus exists in society regarding the normative direction of the specific issues at stake: Analytically,

[83] "The maximin rule tells us to rank alternatives by their worst possible outcomes: we are to adopt the alternative the worst outcome of which is superior to the worst outcomes of the others" (Rawls 1999, 133). E.g., if options A and B are assessed for 3 criteria, the normalized scores achieved by A are 9,9,3 and those achieved by B are 7,6,4, then A is inferior to B because A offers a combination that includes the worst performance for one of the criteria ('3'). Contrarily, according to their aggregated compensatory scores A (score 7,00) is superior to B (score 5,67).

(i.e. 'everything else being equal',) members of society seem to generally agree that, for instance, less environmental pollution is better than more, more preservation of pristine ecosystems is better than less, less animal suffering is better than more, and more equal distribution of profits is better than less equal distribution of profits. And so on. This type of consensus is termed "overlapping" (Rawls 1999, 340), as opposed to "strict consensus", because it is supported by members of the public that may refer to different reasonable[84] worldviews to justify their normative position.[85] Observation of such a consensus allows the framework to adopt a pertinent issue-based approach that bypasses the ideological minefield of worldview-level differences of opinion among members of society. Methodologically, this enables the framework to define the normative direction of assessment criteria from 'worst' to 'best' without siding with any other worldview except from the democratic. Moreover, it enables the framework to support normative judgments regarding 'better' and 'worse' products based on their performance for assessment criteria, normatively-charged communication techniques, such as normative color-coding, and normative policy uses for its results on the basis of what is the desired direction of the issues at stake according to the overlapping opinion of society.

Interpretation of ranking indices

The functionality of the ranking model was demonstrated through the choice of fresh tomato options that were included in the assessment in Chapter 5. Eleven product options were ranked for four categories of concern (Environment,

[84] Even though the idea of an overlapping consensus, as applied to this framework, refers to overlap of 'reasonable' worldviews, the type of "overlapping consensus" mentioned herein remains "an idea of an overlap that is already present or latent" in society. Therefore, this must not be confused with the different and more elaborate idea of "reasonable overlapping consensus". See Rawls' (2005, 389) "Reply to Habermas".

[85] One might explain one's normative position from different ideological perspectives, by referring for instance to broader economic consequences, or to fairness, or to respect for religious codes of morality. (e.g. A normative position against tuna extinction can be rationalized as economically damaging, as unfair treatment of the species, or as disrespect for God's creation.) While these explanations appear to overlap in supporting societal consensus at the level of the normative direction of concrete production aspects at stake, disagreement is possible:"Rawls himself (2005, 240–241)says that restricting justifications to an overlapping consensus will often allow more than one reasonable answer. In these cases, a resort to majoritarian voting procedures will be the way to decide among the reasonable answers." (Streiffer and Hedemann 2005)

Healthfulness, Naturalness, Fairness), and according to their performance for twenty one criteria that reflected different combinations of end-product and production process attributes. The list of assessed options included presently available and also hypothetical product options meant to signify product scenarios at R&D stage, products of different countries of origin, certified and uncertified products, and products whose production used a range of practices and technologies for different purposes.

The analysis of results illustrated the usefulness of the employed ranking model for examining the effects of these production parameters on the performance of products for production aspects of public concern. It was demonstrated that the absence of specified compliance thresholds on the generated indices can be overcome by using the performance of substitute products, of certified product options or of average production as benchmarks, in order to claim for instance that product A is X% better for the environment than product B, or than certified product C, or than the average or median performance met among marketed products. The dynamic grading of products as 'above average' vs. 'average' vs. 'below average' can happen in a straightforward way once the number of grades has been decided, by using the ranking method described in Chapter 2.

Overall, and notwithstanding the methodologically suboptimal process followed to derive assessment terms and product input, results appear to be to a considerable extent intuitive: The public acceptability of products that were developed using innovative technology varied significantly with the type and purpose of the technological application. Product scenarios that relied on non-GM plant genomics technology to improve performance for societal concerns resulted in options that ranked at the highest positions of all category indices apart for the Naturalness index. The performance of hypothetical GM product scenarios strongly depended on the application, confirming the need for a case-by-case examination of technology use. At the same time, GM products consistently ranked at the lowest positions of the non-compensatory indices regardless of the purpose of the GM technology used. This is consistent to the public controversy about such products and also to the suggested use of the non-compensatory indices as indicators of likely controversy. Among the assessed bulk tomato options, Dutch production was suggested to be more environmentally friendly, healthful and fair, while Spanish production was suggested to be more natural. Organic products performed consistently better than their bulk national counterparts. These results suggest the potential usefulness of the presented public assessment approach for investigating the effect of innovation

on the societal acceptability of products at R&D stage, through comparing their expected performance to presently available substitutes.

– ***Contributions to the literature***

During the investigation of this sub-objective this thesis contributed to the literature in the following ways. It demonstrated the PA model and illustrated that the type of information it produces is consistent with the requirements that were identified in Chapter 2: The generated indices have the form of continuous rankings, which however can be divided into the desirable number of grades using dynamic statistical thresholds. For instance, each grade could represent 20%, or 25%, or 33.3% of product performances. Also, in Chapter 2 it was remarked that multi-grade labeling schemes can be composed by a number of single-grade ones that are assessed for a common dimension of societal concerns. Chapter 5 contributed to the literature by demonstrating how this assessment can be accomplished in a relatively simple way, by assessing product option scenarios that were purposefully defined to just meet the minimal certification requirements of existing labels.

3. Data and methods

The primary objective of the application was to demonstrate how an adapted version of a multi-criteria method by Díaz-Balteiro and Romero (2004) can be applied to the comparative ranking of product options for unobservable attributes. For this reason, the assessment of tomato options presented in Chapters 4 and 5 does not fully satisfy the requirements set by the framework as outlined in Chapter 3. Moreover, logistical constraints and the need to limit the methodological scope of this interdisciplinary work advocated against the display of a full-blown application of the framework. Instead, the considered set of assessment criteria was identified and structured based on an expert workshop and disciplinary expert opinion, and was completed using literature review. Data on the relative importance weights of these criteria was generated using a small scale consumer survey. On the contrary, the assessment approach outlined in Chapter 3, required that criteria and relative importance weights should be obtained using appropriately designed public deliberation events (e.g. Abelson et al. 2003; Fishkin and Luskin 2005) and by using suitable methods for structuring criteria and eliciting weights (e.g. Hämäläinen et al.

2002). Nevertheless, the method adopted in Chapter 4 respected the guiding principle of the 'societal approach' that permeates this assessment framework insofar members of society provided input on the relative importance of a rather inclusive list of criteria that captured a broad range of societal concerns.

Methodological limitations include the use of non-validated intuitive indicators when more suitable indicators were unavailable or difficult to calculate. Simple dummy variables were used to indicate the presence or absence of environmental or health risks and uncertainties. Future applications should rely on externally validated indicators and risk-modeling approaches. Product input relied on expert assessments when data on the performance of existing tomato options were not available and when hypothetical product scenarios were considered, so as to protect this research from having to dwell too deep into the technical specifics of different fresh tomato production scenarios. Following Pluimers (2001), second-order environmental emissions from tomato production were considered; future applications should determine the appropriate systems boundaries (e.g. see Matthews, Hendrickson, and Weber 2008). The generalizability of results to the Dutch population depends on the representativeness of the consumer sample used in the application in Chapters 4 and 5.

During the generation of non-compensatory 'most balanced' indices (Chapter 5), it was observed that the ranking method by Díaz-Balteiro and Romero (2004) did not differentiate among options that had the lowest (worst) score for even one of the assessment criteria. Because of the relatively large number of criteria used (21 criteria), most options scored the worst observed performance on at least one criterion. Therefore the most-balanced indices appeared to be largely non-operational. To address this shortcoming, the model was supplemented with an additional improvised index that ranks such options according to the sum relative importance of the criteria for which they exhibited the worst performance. Future research could examine the incorporation of lexicographic ranking at the most-balanced index (Romero and Rehman 2003), to enable differentiation of products that exhibit worst performances according to their performance for remaining ones.

4. Business and policy implications

As defined by the main research objective, the intended function of the presented assessment framework is to generate information that can facilitate the consumer-based market optimization of production practices and technologies of concern to society. Table 3, rows 1 to 4, present an overview of the main implementation steps required for this purpose as discussed earlier in this Thesis.

Table 3 also presents an overview of other relevant applications for the generated information. Uses for the state include advisory or justification applications. Society-based assessments of appropriately defined hypothetical product options can generate input on the expected societal acceptability of different technological scenarios. Such input can be useful in assessing the social desirability of policy measures such as the allocation of research funding. In the context of democratic governance, society-based assessments can support the introduction of regulatory measures like the allocation of incentives and disincentives aiming at enhancing the ethical performance products or firms. Socially responsible stakeholders on the supply side of the market can use society-based product assessments to advertise superior product performance 'for what matters to society'. Market research can calculate the ethical elasticity of demand (i.e. how demand is affected when the ethical performance of products increases or decreases). Production stakeholders can reverse-engineer the assessments so as to determine optimal levels of production parameters for their targeted consumer segment. Since the framework is designed to produce information that is in line with the functionality requirements defined in Chapter 2, using the generated information in consumer-based optimization would ideally proceed along the lines described in Chapter 2.

Table 3. Outline of implementation steps and uses.

Step		Method	Example
CHARACTERIZATION			
1	Define the criteria of assessments and their relative importance.	Deliberation of representative sample of members of society. Consultative participation of experts and stakeholders, including NGOs.	What issues determine, ideally, whether production is 'fair' or 'environmentally friendly'? What is their relative importance?
2	Source product data.	Focus on already differentiated supply chains: Adopt the perspective of present-day consumer, not of the product.	Is a traceability scheme available? Does the supplier provide data? What are the average sector levels of aspect X in production country? What is demanded by local law?
3	Generate Information.	Integrate performances for assessment criteria into category indices (i.e. product rankings).	Multi-criteria method by Díaz-Balteiro& Romero (chapter 5).
OPTIMIZATION			
4	Communicate Information to consumers. Let the market optimize.	Communicate results through comparative, dynamic, front-of-pack, multi-grade, normatively color-coded, compulsory labeling. Update labels regularly.	See chapter 2.
5	Inform policy measures.	Inform strategic planning. Justify command and control regulations, and/or incentives and disincentives	Tax reduction for top-grade suppliers (as judged by society).
6	Inform producer R&D.	Reverse-engineer assessments to determine optimal levels of production parameters (and potentially advertise results). Calculate the ethical elasticity of demand.	How much should labor aspects improve to rank in the same fairness grade as 'Fair Trade' substitutes? Is investment in technology X likely to improve product ranking?

The remainder of this section gives an overview of main conditions relevant to an implementation of the developed framework in consumer-based optimization. These conditions include the relative political power of affected parties, as well as the benefits at stake (Bonroy and Constantatos 2015).[86] Although power struggles of this type shall undoubtedly affect chances for implementation and might prevent harvesting possible environmental and social benefits at stake, they are outside the scope of this overview of implementation aspects. This section outlines possible implementers, minimization of implementation costs, cost assessment, WTO-compliance, and research implications.

4.1. Implementers, costs minimization, and costs

Ideally, the implementation of the overall ethical characterization and optimization framework requires actors to perform the following tasks:

(a) to derive the assessment terms through appropriately organized public deliberation events,

(b) to enforce product data collection,

(c) to enforce product labeling,

(d) to monitor the correct application of the labels and

(e) to issue updates.

Each of these activities can be performed by different actors. In line with the current practice of third-party issued and monitored certifications, activities a, d and e can be performed by credible and independent organizations, while state enrolment is also possible. Activities b and c ideally require state support. This is because the state has the authority to command both data disclosure and enforcement of labeling. Major retailers are also well-positioned to perform activities b and c, insofar they can command data disclosure from products available in-store, as well as to apply labels on products. The ability of major civil society organizations to collect data and to communicate results through labeling is less apparent. This type of actors could rely

[86] "The introduction of a label or a modification of its standard creates gainers and losers, who stand on opposite sides with respect to implementing such regulatory intervention. […] The relative political power of such groups, as well as the benefits at stake, will most likely shape the type of regulation finally observed." (Bonroy and Constantatos 2015)

on more efficient approaches to data collection (see next paragraph), and could communicate results to consumers through alternative methods such as smart apps that indicate product grades by scanning products on-self when product labeling is not possible.

To achieve cost minimization and logistical feasibility when an ethical traceability scheme is not available, product data collection must discard the intuitive idea that grades ought to make justice to the actual performance of each marketed product. Instead, a 'lighter' and bottom-up approach for the collection of product data can be examined. In this approach implementers adopt the more modest and pragmatic task to improve upon the present situation from the viewpoint of consumers: Product differentiations presently visible to consumers are limited to few broad categories. There are third-party certified products, and there are conventional products from various places of origin. When more precise data is not provided, products can be assigned grades that reflect the general performance of products in these categories. Third-party certified products, and especially those awarded prestigious certifications, must meet known standards. Remaining products must respect legislation that is applicable at the location of a product's (or a component's) origin. An economically rational assumption to be considered in the absence of more precise data include that production is cost-effective, namely that product options perform for each criterion exactly at the performance thresholds set by relevant legislation or certification when this is available. Moreover, when appropriate, (i.e. e.g. when expertise-constrained and cost-constrained developing country producers and small medium enterprises are not involved,) suppliers that withhold data on issues of public concern can be assumed to market products of the lowest grade. Data corrections by suppliers, consumer organizations, NGOs, whistleblowers, and competitors can be welcome.

Instead of requiring the top-down enforcement of product traceability schemes, this data retrieval strategy creates incentives for suppliers that perform better than assumed to willingly improve the traceability and the differentiation of their production if and when they find it profitable. Until and unless that happens, implementers can consider only already-differentiated product options in presently differentiated supply chains. To give an example, this product data mining approach does not try to identify whether the tomatoes of organic supplier A indeed perform the same as the tomatoes of organic supplier B. Instead, and unless a supplier has further differentiated his product at consumer level, all organic tomatoes of a certain country of origin can be regarded as indistinguishable within the organic category because this is the level of product differentiation perceived by the consumer. Profit-

maximizing producers or groups thereof, domestically or abroad, whether with state support or not, are free to decide whether it is worth to further differentiate their supply chain so as to be assessed and graded separately. Otherwise, supply chains remain as differentiated as they presently are, and in the absence of more detailed data product labels can reflect category averages. This approach allows avoiding the logistically gargantuan task to collect verifiable data on the performance of every marketed product for each assessment indicator. Implementers can reduce drastically the number of product options to be investigated, can rely on national legislations and on generally available statistical data such as sectoral or national production averages, on market shares of component suppliers, can avoid top-down changes in supply chains and can work synergistically with existing certifications. Finally, to avoid fragmenting the market in case of horizontally differentiated attributes the assessment terms of which must be sourced from geographically different publics, sticker labels can be used as it happens with in-shop labeling of electrical appliances, so that the correct results are communicated at different localities.

Notwithstanding efforts for cost reduction, the cost of a full-blown and full-scale implementation of the framework can be considerable. Obvious implementation costs include costs for organizing the public deliberation process, and costs for applying, monitoring, and updating product labels. The analysis of costs and benefits must also consider effects on consumer welfare (e.g. Van Tongeren, Beghin, and Marette 2009), information asymmetry costs of driving legitimate ethically responsible business out of the market (Akerlof 1970), and also the expected effects on the environmental and social production aspects at stake. Besides and beyond cost-benefit calculations, it must also be considered that the type of information developed in this thesis is designed to enable democratic –i.e. consumer-based– market optimization of unobservable production attributes of concern to society. From this perspective, the cost of enabling this type of information can be regarded as the market equivalent of the costs of elections in democracies that forward the optimization of credence goods to markets.

4.2. WTO-compliance

Implementation of the PA framework developed in this thesis by the state or non-state implementers that enjoy the support of the state requires compliance with international trade law (Aaronson 2005) and with relevant bilateral trade agreements. Bilateral agreements are contingent upon the implementation location

and need to be considered on a case-by-case basis by future implementers. With regards to WTO compliance, the first thing to notice is the high degree of uncertainty about what is and what is not WTO-compliant. Therefore this section does not repeat in-depth and yet inconclusive analyses of related cases made by more qualified authors. Instead, it only maps a number of relevant issues and does not remove the need for more qualified expert analysis.

Uncertainty exists because it has been and largely remains unclear (Zadek, Lingayah, and Forstater 1998; Kolben 2010) how signed agreements shall be interpreted and applied to new cases by the Dispute Settlement Body (DSB) and the Appellate Body (AB) of the organization. This is especially the case with regards to ethical aspects of production, because they mostly refer to 'non-product related production process methods' (NPR-PPMs). The WTO compliance of NPR-PPMs-related measures is generally regarded to be particularly unclear. Recent developments, among which the US–Tuna II case (WTO 2016), suggest that the Agreement on Technical Barriers to Trade ("TBT": WTO 1994)covers all labeling-related measures, including NPR-PPM-related ones (Duran 2015). The WTO compliance of mandatory public-opinion-based comparative labeling of NPR-PPMs-related aspects of production depends upon several factors. Chief among them are the WTO principles of "non-discrimination" and of avoiding measures "prepared, adopted, or applied with a view to or with the effect of creating unnecessary obstacles to international trade" (Duran 2015). Non-discrimination requires that "like products" of domestic origin are not treated differently to imported ones. The crucial term "like products" is not defined (Aaronson 2005; Bernasconi-Osterwalder and Norpoth 2009). Therefore a judgment whether two products are like "can only be formed on a case by case basis, and in respect of the actual consumer market being examined" (Holmes et al. 2008). The factors that determine whether products are "like" include "end-uses" and "consumer tastes and habits" (Bernasconi-Osterwalder and Norpoth 2009). Kolben (2010) explains that a WTO concern underlying 'likeness' is arbitrariness. Nevertheless, even when products are like, "detrimental [i.e. discriminatory] impact is only prohibited in cases where it does not stem exclusively from a legitimate regulatory distinction. (AB Report in *US-Clove Cigarettes*, paras. 173-175 and 182)" (WTO 2014; Duran 2015). Assessing whether obstacles to trade are unnecessary involves "a weighing and balancing process of a number of factors, namely: (i) the degree of contribution made by the measure to the legitimate objective at issue; (ii) the trade-restrictiveness of the measure; and in most cases (iii) whether a less trade-restrictive alternative measure is reasonably available that would make an equivalent contribution to the relevant legitimate objective, taking into account the

risks non-fulfilment would create. (AB Report in *US-Tuna II*, paras. 318-322)" (Duran 2015; WTO 2016). The "legitimate objectives" are identified at TBT, para.2.2, and are: national security requirements; the prevention of deceptive practices; protection of human health or safety, animal or plant life or health, or the environment. Finally, as Mathis (2011) observes, TBT, para.2.4, requires that WTO Members "shall use ["relevant international standards"], or the relevant parts of them, as a basis for their technical regulations" when these are available, while para.2.5 grants that technical regulations which are "in accordance with relevant international standards" will be "rebuttably [sic] presumed not to create an unnecessary obstacle to international trade", provided that they meet "one of the legitimate objectives explicitly mentioned in paragraph 2".

The above factors suggest that WTO compliance is more obvious in the case of environmental attributes because these fall under an explicitly mentioned legitimate objective. Moreover, Duran (2015) argues that the factors "trade-restrictiveness" and "availability of a less trade-restrictive measure" (factors ii and iii in previous paragraph) might not be unnecessary obstacles to trade in the case of voluntary labeling. As compared to other forms of government regulation, labels are generally viewed as one of the least trade-restrictive instruments available (Ankersmit and Lawrence 2012). However, "the degree of contribution made by the measure to the legitimate objective at issue" (factor i), i.e. the effectiveness of the measure, might prove problematic for voluntary labeling (Duran 2015). Comparatively, the type of compulsory labeling presented in this thesis is likely to be more effective because it also utilizes the force of supplier incentives to avoid bad reputation, and also it is more suitable for capturing preferences of moderately concerned consumers (see Chapter 2). At the same time, the presented labeling scheme is more trade-restrictive than voluntary labeling because it is mandatory.

Labeling for social attributes is more problematic because these are not explicitly mentioned as a legitimate objective.[87] This increases the risk that labeling for social attributes might be considered to create an unnecessary obstacle to international trade. Relevant is a report to DG Trade on "'Qualified Market Access' (QMA) or - the possibility of 'qualifying' imported products to ensure that they meet specific standards in terms of environmental protection and human rights" (Holmes et al. 2008). The authors advocate that efforts to justify QMA should adopt a consumer

[87] The most relevant legitimate objective might be the "prevention of deceptive practices": As discussed in Chapter 2, the proposed labeling approach relates to the prevention of "bluffs" (Carr 1968) and "cloaks" of social responsibility (Friedman 1970) by "dishonest sellers" (Akerlof 1970) that trade in information asymmetry.

welfare approach that relies on consumer "tastes and habits"[88] and conclude: "If these consumer preferences represent a truly 'collective preference', widely shared by most consumers rather than reflecting the norms of a limited group, mandatory standards can be justified" (Holmes et al. 2008). Since mandatory labeling is far less restrictive than QMA, and since the presented PA framework is especially designed to avoid subjectivity and arbitrariness by referring precisely to collective societal opinion, the conclusions by Holmes et al. suggest that WTO-compliance might be feasible for the labeling approach developed in this thesis.

Finally, WTO-compliance might require to use "as a basis" for the assessments existing relevant international standards (Mathis 2011). Relevant international standards for the category of social concerns could be those developed by organizations such as the FLO and the ISO (Mathis 2011). Meeting this requirement, while also satisfying the guiding principle of the PA framework to generate society-based assessments, will probably need an adaptation of the presented PA framework. A possibility the feasibility of which must be studied by qualified experts, might involve the composition of an inclusive list of criteria "based" on international standards, which however will be weighted by members of society domestically. This adjustment comes close to the approach used in Chapter 4 for deriving the relative importance weights used in the application presented in Chapter 5. Nevertheless, as necessary as they might prove to be, relevant adjustments of the presented PA framework will be sub-optimal to the extent that certain criteria of concern to society are not covered by any international stakeholder-defined standard (Chapter 2).

4.3. Research implications

This thesis identified several items for future research. These include investigations of:

- the detailed structure of public deliberation events that are suitable for the definition of assessment terms. This description should articulate the processes, steps and actors that are necessary in order for representatives of the general public to arrive at well-considered decisions
- the optimal number of assessment grades and the optimal color-coding to be depicted on labels, in order to maximize the effectiveness of the presented

[88] Relevantly, the EU-wide animal welfare labeling of table eggs is justified on the grounds of informing consumer choice (EC 2016 accessed).

labeling approach in bringing change in production practices and technologies towards the direction desired by society

- the effects and effectiveness of labels based on most-balanced rather than on aggregated ethical assessments in bringing socially desirable change. Moreover, investigation of the possible usefulness of these indices as predictors of social controversy regarding production practices and technologies (see Chapter 5)
- the effects of label implementation on production aspects of concern to society: Namely, the effectiveness of the presented approach to ethical labeling for bringing positive change
- the compliance of the presented labeling approach to international trade law (e.g. WTO) and to relevant bilateral trade agreements, as well as the investigation of the remaining effectiveness of adaptations that might be necessary to achieve that compliance
- the formal analysis of microeconomic and macroeconomic effects from market-scale implementation, including effects to developing countries and to small farmers, as well as the investigation of ways to alleviate or to compensate for potentially negative effect.

5. Conclusions

This thesis presented an approach to generate information on the comparative ethical performance of products, and made suggestions for its use in consumer-based optimization. This information approach addresses a number of limitations that reduce the functionality of currently operating labels which are voluntary, single-grade, static and stakeholder-defined 'endorsement' labels. Specifically in the approach developed in this thesis:

- The generated information is citizens-defined: members of society define collectively the assessment criteria and weights. Consequently, the generated information informs precisely on product performance for the collective concerns of the general public.

- The format of the information that is generated by product assessments (product rankings) can support multi-grade labeling and 'dynamic' grade thresholds that evolve following the evolution of the market.

- Political philosophy instruments and concepts ('public deliberation', 'reasonableness', 'overlapping consensus') are anticipated to protect the democratic legitimacy of the generated information, so as to support its communication through compulsory labeling, and to support related normative uses (e.g. normative color-coding of labels and tax incentives) within the context of democratic governance.

These suggest that the investigation performed in this thesis achieved its main objective, to describe a method to generate information that addresses limitations of presently available labels, for the consumer-based optimization of unobservable 'ethical' aspects of production, about which members of society are concerned.

The environmental and social issues at stake, their current state, and the results obtained so far from various governance efforts to bring sufficient improvement are well documented. This thesis presents an effort to outline an information approach designed to correct imperfections in the dominant information paradigm, with the ambition to bring tangible, market-driven and continuous improvement for the issues at stake, by transforming markets into instruments that work to the direction willed by society. Nevertheless, the analysis of the information approach presented in this thesis is conceptual, evidence offered for its potential effectiveness is not conclusive, and a formal analysis of microeconomic and macroeconomic effects from market-scale implementation is not provided. Pragmatically assessed, and if proven conceptually robust, this thesis hopes to contribute a different view to the ongoing public and governance-level debate about the social and environmental functionality of markets, and about ways to improve it.

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Summary

The current state of several environmental, social, and other aspects of production that create concern in society is well documented. Well-known is also the need to improve upon results obtained so far from relevant governance efforts. A force that can have direct impact on the performance of the supply sector for these issues is consumer choice. Despite initial optimism that ethical consumerism could provide the motivation for socially responsible production, and in spite of consistent survey results that suggest increased ethical concern among the international public, ethical consumption has failed so far to develop into a market force of a magnitude sufficient to incentivize much needed improvements in the socially responsible conduct of businesses. At the same time, ethical consumption is constrained by information asymmetry because it requires consumer choice on aspects of production that are unobservable.

Chapter 2 of this thesis identifies a number of limitations in the functionality of currently available information schemes for the consumer-based market optimization of production practices and technologies of concern to society. These relate to four properties that are common among 'endorsement' labels. Specifically, ethical labels 1) typically offer one certification grade; 2) they are voluntary; 3) they use 'static' thresholds that are not a function of market dynamics; and 4) they are defined by stakeholders. An analysis of these properties suggests that the common type of endorsement labels leads to suboptimal market allocation as compared to that which would be achieved if ethical attributes were observable. Moreover, it does not utilize the incentivizing power of information regarding low ethical performances, and it is particularly problematic in capturing the preferences of moderately-concerned consumers. Overall, the common type of endorsement labels fails to unleash normal market forces on unobservable ethical aspects of production so as to enable their optimization based on the law of supply and demand. On the basis of these results, this thesis proposes the development of a 'comparative' type of ethical label that is 1) continuous or multi-grade; 2) mandatory; 3) dynamic; and 4) defined by society.

Chapter 3 of this thesis outlines a "Public Assessment" (PA) framework for the generation of this type of information. The developed "ethical characterization and

optimization" framework focuses on "unobservable", "reasonable" and "pragmatic" attributes that relate to production practices and technologies of concern to society. A political perspective is assumed in that valid information is taken to serve the politically liberal and democratic functions of the market by allowing concerned citizens to make informed choices in their role as consumers. The framework anticipates the use of public deliberation processes for the definition of assessment criteria and their relative importance weights. Ethical performance thresholds need not be defined. Comparative information on product performance for assessment criteria is aggregated using multiple-criteria modeling. The generated information takes the form of "maximized" (compensatory) to "most balanced" (maximin) comparative rankings of substitutable food products.

A simplified variation of the presented method was applied to the ethical assessment of fresh tomato products. In Chapter 4, stated consumer preferences were used to put weights on an inclusive list of 21 product and production process criteria relevant to four categories of concern: Healthfulness, Environmental impact, Naturalness and Fairness of food production. These weights were used in Chapter 5 to assess eleven existing and hypothetical products, including certified and uncertified ones, which were produced at different locations using different practices and technologies. Special attention was given to applications of plant genomics technology. The discussion of results illustrated that the generated product rankings can be interpreted to support product optimization and promotional claims by suppliers regarding the ethical superiority of products for issues defined by society, as compared to the performance of competitors, relevant certifications, and the mean or average performance of production. Possible policy uses include the allocation of incentives and disincentives to best and worst performing products, as well as the allocation of funding to technologies that are assessed as desirable by society. Last but not least, the generated type of information supports the development of compulsory comparative ethical labels that aspire to facilitate continuous consumer-based improvement of the environmental and social aspects of production, to the direction that society at large regards as positive.

In conclusion, this thesis presents an assessment approach that generates information with the following characteristics:

- The generated information is citizens-defined: members of society define collectively the assessment criteria and weights. Consequently, the generated

information informs precisely on product performance for the collective concerns of the general public.

- The format of the information that is generated by product assessments (product rankings) can support multi-grade labeling and 'dynamic' grade thresholds that evolve following the evolution of the market.

- Political philosophy instruments and concepts ('public deliberation', 'reasonableness', 'overlapping consensus') are anticipated to protect the democratic legitimacy of the generated information, so as to support its communication through compulsory labeling, and to support related normative uses (e.g. normative color-coding of labels and tax incentives) within the context of democratic governance.

These suggest that the investigation performed in this thesis achieved its main objective, to describe a method to generate information that addresses limitations of presently available labels, for the consumer-based optimization of unobservable 'ethical' aspects of production, about which members of society are concerned.

Anastasios (Tassos) Michalopoulos

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Completed Training and Supervision Plan

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Advanced Agriculture Business Economics	FMA, MSc course, WUR	2003	6
Economics of Agribusiness	AEP, MSc course, WUR	2003	6
The Work of John Rawls	OZSE Utrecht University	2008	6
B) General research related competences			
Mansholt Introduction course	Mansholt graduate School	2003	1.5
'ECHO: a politically liberal framework for "ethical characterization" of foods'	Multidisciplinary seminar, Mansholt Graduate School	2003	1
Research Methodology: Designing and conducting a PhD research project	Mansholt Graduate School	2003	3
Techniques for Writing and Presenting a Scientific Paper	Mansholt Graduate School	2003	1.5
Ethics for life scientists	Mansholt Graduate School	2003	3
C) Career related competences/personal development			
Teaching "Food Ethics"	Applied Philosophy Group, WUR	2004,2006	2
"Economics and Ethics: A Bridge Between the Two: Modelling societal concerns in tomato and potato genomics"	2nd Cesagen & CSG conference, London	2005	1
"The Citizen Goes Shopping: What do the peers have to say about it?"	6th EurSafe Congress on Ethics and Politics of Food. Oslo	2006	1
"Plant-genomics-enabled food: A multi-criteria model for the societal assessment of novel foods"	3rd Cesagen & CSG Conference, Amsterdam	2006	1
"'Ethical characterization' of foods and opportunities for plant genomics"	4th Cesagen & CSG Conference, London	2007	1

'ECHO: A politically liberal framework for the ethical optimization of unregulated food markets'	7th EurSafe Congress on Sustainable Food Production and Ethics, Vienna	2007	1
Nederlands Taal	James Boswell Institute, Utrecht University	2006	2
Managing FP7 EU funding	Europa Media Trainings	2009	2
Advanced Course on Public Communication & Applied Ethics of Nanotechnology	St. Edmund Hall, University of Oxford	2009	3
Total			**42**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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