Performance and optimization of farm certification systems as Private Institutions of Sustainability

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PERFORMANCE AND OPTIMIZATION OF FARM CERTIFICATION SYSTEMS AS PRIVATE INSTITUTIONS OF SUSTAINABILITY

Thesis submitted in fulfillment of the requirements
For the degree of Doctor (PhD) in Applied Biological Sciences:
Agriculture

Dutch translation of the title:
Performantie en optimalisatie van landbouwcertificatiesystemen als Private Instituties van Duurzaamheid

Please refer to this work as follows:
Mondelaers, K. (2010). Performance and optimization of farm certification systems as Private Institutions of Sustainability. PhD-thesis, Ghent University, Ghent, Belgium.

ISBN-number: 978-90-5989-363-4

Dankwoord

Nu het manuscript geschreven is en de weg ernaartoe afgelegd, nu de hoop en de verwachtingen zijn vertaald in concrete teksten, is het tijd om eens achterom en opzij te kijken naar iedereen die me doorheen deze tocht vergezeld en geholpen heeft.

Ik begin dit dankwoord met de ‘conditio sine qua non’. Mijn promotor sinds het eerste uur, Guido, gaf mij de kans om met dit boeiend vakgebied kennis te maken. Ik waardeer je scherpe analyses en je efficiënte sturing. Anderen hebben dit ook opgemerkt, getuige daarvan je verkiezing tot decaan. Daarnaast ben ik vooral blij dat je me de ruimte hebt gegeven om mijzelf op mijn manier te ontplooien.
Mijn tweede promotor en huidige baas, Ludwig, ook jou ben ik erkentelijk, voor het vertrouwen, de conceptuele aanwijzingen en de aangename discussies die meermaals uitmonden in filosofische gesprekken. Hopelijk kunnen we dit nog lang verder zetten.

Naast deze twee tenoren ben ik in de vakgroep rijk omringd geweest door fijne collega’s. A1.041 was steeds een leuke werkplek, waar ruimte was voor een babbel, grap, vraag, discussie of gezamenlijke activiteit. Ik denk met veel plezier aan die tijd terug. Een extra dikke merci voor Jeroen, Joris, Ann, Evy, Valerie, Bart, Anne, Stephan, Lies, Filiep, Mieke en Linde. Ook Tom wil ik hier speciaal bedanken en aanmoedigen tijdens zijn eindsprint.

Ook de leden van de examencommissie zou ik willen bedanken voor de interessante opmerkingen die het proefschrift ongetwijfeld ten goede gekomen zijn.

In mijn tijd aan de unief heb ik vier projecten uitgevoerd. Bij elk van deze projecten heb ik aangename mensen leren kennen die me uiteindelijk ook geïnspireerd hebben om tot dit finale werk te komen. Ik denk in het bijzonder aan Bénédicte, Floortje, Eva, Christine en Eline. Een speciaal plekje reserveer ik hier ook zeker voor Steven en Bert. De ene leerde me wat pragmatisme is terwijl de andere me bevestigde dat achter ieder simpel gegeven met enige goeie wil een diepgaand gesprek schuilgaat.

Ongetwijfeld vergeet ik veel mensen die mijn wegen gekruist en beïnvloed hebben. Allemaal hoe dan ook bedankt!

Ik evolueer stilaan richting de amusementssfeer. Nog steeds op de unief, denk ik aan ‘de Spanjaarden’, bij wie ik mijn culinair en humoristisch hart kon ophalen. Een speciale plaats hier ook voor Tineke en David die de laatste overlevers zijn op het Boerekot.

De Bende van Deinze gaat al wat verder terug. Aan hen dank ik mijn kritische zin en af en toe een opflakkering van non-conformisme, eigenschappen die goud waard zijn in de wetenschappelijk omgeving. Bedankt allemaal voor al die jaren van fijne vriendschap en ontspanning!

Dichter bij huis dan. Broers Bart en Jan, zus Veerle en schoonbroers en -zussen Stefaan, Nadia, Delphine, Karel, Marie, Beatrijs en Hendriek, ik heb het getroffen met zo’n toffe en samenhangende bende. Een speciale merci ook voor mijn schoonouders Louis en Martine die hun kinderen (en kleinkind) vertroetelen en op handen dragen.

Richting het oorsprongsgebied nu. Pa en ma, zonder jullie wederkerend geduld en steun had ik hier vandaag niet gestaan. Niet alleen bedankt voor die fijne mix van genenpools, een beetje ying en een beetje yang, maar vooral bedankt voor jullie niet aflatende onvoorwaardelijke vertrouwen en zelfwegcijfering. De warme nest die jullie hebben gecreëerd werkt inspirerend!

Tenslotte kom ik helemaal thuis, bij mijn muze, mijn levensgezellin en de mama van mijn spruiten. Katelijne, jij maakt het leven zo gemakkelijk, ongecompliceerd en zonder drukte. Wat moet gebeuren gebeurt, zodat genieten steeds centraal kan staan. Niet alleen ben je een fantastische moeder voor je ‘drie’ kinderen, je bent ook steeds mijn klankbord en referentiepunt. Na al die jaren ben je stilaan een beetje deel van mij.

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List of abbreviations

AB:	Accreditation Body
AE:	allocative efficiency
BELAC:	Belgian Organisation for Accreditation
BtoB:	Business to Business
BtoC:	Business to Consumer
CB:	Controlling Body
CE:	Choice Experiment
CI:	confidence interval
CRS:	constant returns to scale
CSR:	Corporate Social Responsibility
DD:	directional distance vector
DEA:	data envelopment analysis
DPSIR:	Driver-Pressure-State-Impact-Response framework
DSR:	Driver- State-Response framework
EFSA:	European Food Safety Agency
EMS:	Environmental Management System
EP:	economic performance
EnvP:	environmental performance
FA:	Food Agency (FAVV – AFSCA)
FADN:	Farm Accountancy Data Network
GSV:	Generalised Sustainable Value
HACCP:	Hazard Analysis and Critical Control Points
ICB:	Independent Control Body
ICQC:	Private Standard for Integral Chain Quality Control
IIA:	Independence for Irrelevant Alternatives
IoS:	Institutions of Sustainability
IPM:	Integrated Pest Management
IV:	Inclusive Value
LAVA:	Logistic and Administrative Auction association
LCA:	Life Cycle Analysis
LCL:	Latent Class Logit model
MAC:	Marginal Abatement Cost
MC:	Multi-criteria Analysis
MD:	Ministerial Decree
MD:	marginal damage
MNL:	Multinomial Logit
MQS:	Minimum Quality Standard
MRL:	Maximum Residue Limit
MSA:	Maximum Sustainable Abuse
MSU:	Maximum Sustainable Use
PIoS:	Private Institutions of Sustainability
PuIoS:	Public Institutions of Sustainability
Q&S:	Qualität und Sicherheit
RD:	Royal Decree
RDI:	Recommended Daily Intake

RtoC:	Return to Cost ratio
RUT:	Random Utility Theory
SAE:	sustainable allocative efficiency
SD:	sustainable development
SV:	Sustainable Value
SPE:	sustainable profit efficiency
SRC:	Service for Residue Control
STE:	sustainable technical efficiency
TE:	technical efficiency
TPC:	third party certification
VAT:	Value Added Tax
VC:	value contribution
VELT:	Association for Ecological Life and Production style
WTA:	willingness to accept
WTP:	willingness to pay

Introduction

Chapter 1. **Introduction and conceptual framework**

1.1 Introduction and outline of the dissertation

When purchasing a particular food product, the consumer has an endless choice between different brands and labels, leaving the customer with the complex task of choosing the product that most closely fits with his quality preferences and expectations. The product quality is signalled to the customer by means of labels and certificates on the packaging. A lot of the claims made do no longer relate to the product itself, but refer to hidden quality characteristics such as healthiness or environmental friendliness. The question we pose ourselves in this dissertation is whether such labels and certifications work and contribute to sustainability.

The objective of private market actors is private utility maximization, while the long term public interest is social welfare maximization. These two objectives do not necessarily coincide, especially for a series of ecological and social issues. Typically, market actors will try to evade costs and shift these to other parties. Examples are the emission of greenhouse gases or the pollution of aquifers. To counter this, public authorities dispose of a series of correction mechanisms such as a regulatory framework and economic instruments, of which taxes and subsidies are the two main examples. Public interference in the private market is, however, perceived as a market distortion. Furthermore, local governments have a decreasing influence on the globalizing economy. Promising is therefore the emergence of private mechanisms that specifically focus on the internalization of these social and ecological objectives into the firms' business objectives. Private standards and certification schemes are developed to guide producers to reach certain social and ecological objectives. These certification schemes can be termed **private institutions of sustainability (PIoS)**, which are *sets of rules that a private actor voluntary follows to reach a sustainability target.* A strong position on sustainability themes is thereby used as a mean to maximize private utility. Consequently, there is a potential win-win situation for both the private actor and the society.

Thus, Private Institutions of Sustainability, by their very own nature, seem to reduce the asymmetry between long term sustainability objectives and short term market objectives. As such, these instruments are selfregulating mechanisms for the sustainability mismatch**.** However, given that PIoS are private institutions, the involved actors still make a trade-off between their short term economic objectives and the long term sustainability targets. The two objectives of this research are therefore to analyze 1) **whether PIoS** indeed **reduce the mismatch between sustainability and private economic objectives** and 2) **whether further improvements in PIoS are possible.** Objective one will lead to positive research, answering the question how it is done, while objective two is normative, answering the question how it should be done preferably.

This PhD dissertation investigates whether certification schemes and labels as private institutions of sustainability are a promising tool to realize sustainable development. In the positive research part of this thesis, we analyze existing private institutions of sustainability. We first measure whether they improve ecosystem sustainability, as this is what they claim. Next, we calculate whether the use of these institutions creates more added value, by stimulating a more efficient resource use. We can call this sustainable value creation. The social performance is investigated by analyzing the social supply chain performance.

Due to their private nature, there will probably still be a mismatch with long term ecosystem sustainability targets. In part 3 of this thesis, the normative research part, we model changes in the Private Institutions of Sustainability, with the aim of reaching the ecosystem sustainability target. The proposed changes may affect the willingness to participate of both the supply and demand side. Furthermore, the institutional rules will have to be aligned with the proposed physical changes.

The remainder of this chapter introduces the conceptual framework that will be used as stepping stone for the following chapters. In this conceptual framework, which is based upon Hagedorn's Institutions of Sustainability framework (2002, 2005, 2008), we combine several theories to describe the existence of Private Institutions of Sustainability. First, we will show the close link between system sustainability and the absence of externalities. Externalities are uncompensated effects on other parties or on the ecosystem. Next, we introduce institutions as means to internalize externalities. We then make a distinction between public and private institutions of sustainability. Dynamic aspects of institutional change are also introduced. All the above elements are integrated in a conceptual framework. The hypotheses that will be tested in this doctoral thesis are then linked to the conceptual framework.

1.2 Building blocks of Private institutions of sustainability

"Private institutions of sustainability" are defined in three steps. First, section 2.1 explains the term "sustainability". In section 2.2 "institutions of sustainability" are introduced, while section 2.3 extends this to "private institutions of sustainability".

1.2.1 Sustainability of the ecosystem

There are many ways of defining sustainability, and many authors have devoted a considerable number of pages to this. The first question is to identify which sustainability we want to assess. The sustainability of a farm not necessarily coincides with the sustainability of the surrounding ecosystem. In this dissertation, focus rests upon the sustainability of the ecosystem. As Ostrom (2005) and others also noted, what is a 'whole' system at one level is a part of a system at another level. Neoclassical economics consider the macroeconomy to be the whole (Hagedorn, 2007). In that case the environment is part of the macroeconomy. For ecological economics the Earthsystem is the whole, with the macroeconomy a subsystem of the Earthsystem.

Following this system view, we can consider our Earthsystem as a nested system in which we find a supersystem and multiple subsystems, such as the natural and the social system. A sustainable lower level social system rests upon a sustainable supersystem. **Sustainability** is thereby defined as *the ability of a system to continue over a certain time span* (Hansen and Jones, 1996). Daly (1974) also sees our economy as a subsystem of the Earth, and the Earth apparently as a steady-state system. He adds that a subsystem cannot grow beyond the frontiers of the total system and that subsystems must at some point conform to the steady-state mode, otherwise it will disrupt the functioning of the total system. This is especially true for our macro economy. As explained by Hagedorn (2007), opportunity costs of economic growth in terms of demands on the Earth system exist. When the marginal cost of economic growth is higher than marginal benefits, "uneconomic growth" is realized. The problem of optimal scale therefore not only exists in microeconomics, but also in macroeconomics.

An interesting representation of the interrelation between the Earth system and its subsystems is given by Lawn (2007). In his “Linear throughput representation of the socio-economic process”, the macro economy is considered to be a subsystem of the social system, that is in turn a subsystem of the ecosystem. In line with the coevolutionary paradigm[1], it recognizes the ongoing exchange of matter, energy and information between these three major systems. Lawn (2007) distinguishes five elements that explain the dynamics of the linear throughput model. The first element, natural capital, is the original source of all human realizations, as it is the only source of low entropy resources; it is the ultimate waste assimilating sink; and it is the sole provider of the life-support services that maintain the habitability of the Earth. The second element is the throughput of matter-energy – that is, the input into macro economy of low entropy resources and the subsequent output of high entropy wastes. The throughput flow is the physical intermediary connecting natural and human-made capital. Human-made capital is the third element and is needed for human welfare to be greater than it would otherwise be if the socio-economic process did not take place. The fourth important element is net psychic income, which is the uncancelled benefit of socio-economic activity, originating from consumption of human made capital, being engaged in production activities, and non economic pursuits such as leisure time and enjoyment of the natural environment. Contrary to some opinions, human well-being in this representation depends not on the rate of production and consumption, but on the psychic enjoyment of life. The fifth and final element is the cost of lost natural capital services and arises because, in obtaining the throughput to produce and maintain human-made capital, natural capital must be manipulated and exploited both as a source of low entropy and as a high entropy waste absorbing sink.

Costanza and Daly (1992) discuss the link between natural capital and sustainable development. They consider constancy of total natural capital to be the key idea in sustainable development. Related to this is the distinction between **weak** and **strong sustainability**. The main difference between weak and strong sustainability is the degree to which substitutability between different forms of capital is allowed (Figge and Hahn, 2004). Weak sustainability implies that all forms of capital are substitutable by each other. Opponents to this view claim that at least some forms of capital have no substitutes or require a certain critical level which cannot be substituted (e.g. Costanza and Daly, 1992). The belief in non-substitutability of at least some forms of capital and, therefore, the need to conserve critical nonsubstitutable stocks are central features of strong sustainability (Figge and Hahn, 2004). The reason for this is that man-made and natural and/or social capital are (at least partly) complements. According to Figge and Hahn (2004), strong sustainability imposes, therefore, critical levels or safe minimum standards for—at least some—natural capital in order to avoid irreversible losses.

For more refined definitions of sustainability, we refer to the writtings of Costanza and Daly (1992) and the associated stream of literature. An excellent overview is also given by Van Passel (2007).

At the lower systemic levels externalities are created that might refrain the higher level system to attain its full life expectancy. **Externalities** are defined as *actions of one or more economic agents that give rise to uncompensated physical and/or real economic effects for others* (Vatn and Bromley, 1997). A positive effect is called an external benefit, while a negative effect is called an external cost. When the externality impacts on the ecosystem, its properties change and ecosystem sustainability is potentially endangered. The well known

[1] Coevolution is the term used to describe the evolving relationships and feedback responses typically associated with two or more interdependent systems (Lawn, 2007)

example of the Tragedy of the Commons (Hardin, 1968) is illustrative, as multiple individuals (shepherds) acting independently in their own self-interest ultimately destroy a shared limited resource (the common parcel of land, by overgrazing), even when it is clear that it is not in anyone's long term interest for this to happen. The shepherds do so in order to maximize their private utility while sharing the damage with the entire group. This is clearly at the expense of the local ecosystem. In this dissertation we consider the hierarchical supersystem (the ecosystem or the societal system, depending on the research issue) as the systemic level where the externalities have impact.

Externalities create a problem for the effective functioning of the market to maximize the total utility of the society. Externalities in fact indicate the existence of **market failure**. The "external" portions of the costs and benefits of producing a good are not factored into the supply and demand functions of market actors because rational profit-maximizing buyers and sellers do not take into account costs and benefits they do not have to bear. Hence a portion of the costs or benefits will not be reflected in determining the market equilibrium prices and quantities of the good involved. This is shown graphically in Figure 1.1. With every extra unit of commodity X produced, extra externalities are created. The price of the good or service producing the externality will tend toward equality with the marginal personal cost to the producer and the marginal personal utility to the purchaser (P_m), rather than toward equality with the marginal social cost of production and the marginal social utility of consumption (P_*). Thus, normal market incentives for the buyer and seller to maximize their personal utilities will lead to the over- or under-production (Q_m) of the commodity in question from the point of view of society as a whole, not the socially optimal level of production (Q_*). Goods involving a positive externality will be "underproduced" from the point of view of society as a whole, while goods involving a negative externality will be "overproduced" from the point of view of society as a whole (Johnson, 2005).

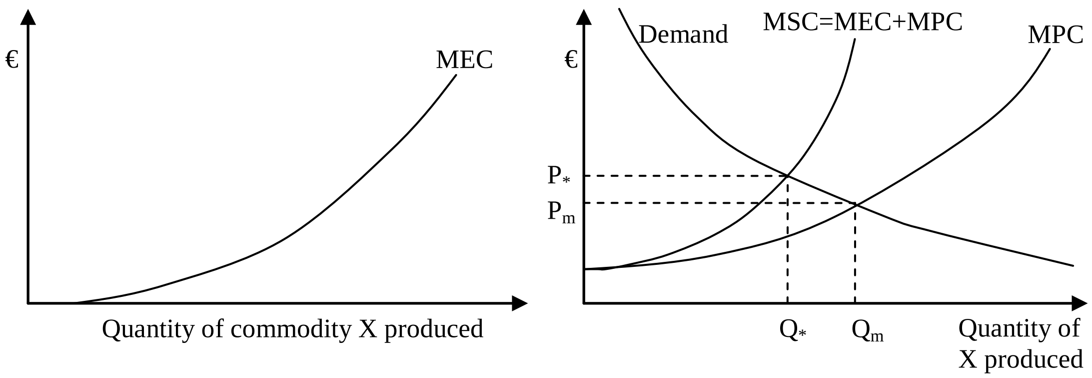


Figure 1.1. External costs and market outcomes when commodity X is produced. MEC=Marginal external cost; MPC=Marginal private cost; MSC=Marginal social cost. Based upon Field (1994).

There is an intimate link between the creation of externalities and **public goods**. To define public goods, we first introduce the main characteristics for the classification of goods, which are ‘rivalry’ and ‘excludability’. Rivalry is present when use by one person prevents someone else from using it. Excludability occurs when someone can prevent others from using the good or resource. Based upon these two characteristics, we can distinguish between 4 cases (Devlin and Grafton,1998): private goods, club goods, common pool resources and public goods. For a private good, such as a house, rivalry and excludability are high. For a club good, rivalry is low and excludability is high. A typical example is a satellite television. For a common pool resource, rivalry is high and excludability low. Fish in the sea used to be a good example. Everybody wanted to catch these fish and nobody could be excluded from it. Public goods exhibit low rivalry and low excludability. Everybody can enjoy the air without necessary preventing other people from enjoying it. In the case of common pool resources and public goods, externalities can be easily created, as there is no excludability and property rights are ill defined.

According to Demsetz (1967), **property rights** specify *how persons may be benefited and harmed, and, therefore, who must pay whom to modify the actions taken by persons*. The recognition of this leads easily to the close relationship between ill defined property rights and externalities. Hagedorn (2007) identifies following categories of property rights: (a) the right to use the asset (usus); (b) the right to appropriate the returns from the asset (usus fructus) and (c) the right to change its form, substance and location (abusus). When it is unclear who has the property rights, persons can use and abuse an asset without compensating the rightful owner. Also according to Demsetz (1967), the primary function of property rights is that of guiding incentives to achieve a greater internalization of externalities. Every cost and benefit associated with social interdependencies is a potential externality. One condition is necessary to make costs and benefits externalities: the cost of a transaction in the rights between the parties (internalization) must exceed the gains from internalization.

The first systematic analysis of pollution as an externality can be found in Pigou (1920). Pigou's most famous contribution is that of internalizing externalities associated with environmental damages (Van Passel, 2007). Pigou (1920) proposed to impose taxes on polluting firms in proportion to the output of the pollution, known as the Pigouvian tax. An important aspect of the Pigouvian solution to pollution was the ability of the polluter to get away with pollution because there are no defined property rights to environmental resources (Edwards-Jones et al., 2000). Ronald Coase (1937) argued that the distribution of private property rights is irrelevant for economic efficiency since negotiations between the parties will always result in the same Pareto-efficient level of the externality. This result, often known as the **Coase Theorem**, requires that:

- Property rights are well defined
- People act rationally
- Transaction costs are minimal

If all of these conditions apply, the private parties can bargain to solve the problem of externalities. Coase (1960) later noted that transaction costs, however, could not be neglected, and therefore, the initial allocation of property rights often matters. A normative conclusion is that institutions which minimize transaction costs should be created, so as to allow misallocations of resources to be corrected as cheaply as possible.

In this chapter we go a step further. We focus on private entities that identify existing (or potential) externalities and internalize these in order to create private utility from it. They therefore appeal to other private entities’ interest in removing these externalities. A practical example is organic farming, a production method that renounces amongst others the use of chemical pesticides. This restriction comes at a cost, because alternative and more expensive pest control measures have to be used and a lower yield is obtained. In order to guarantee farmer profitability, organic food prices are higher than the conventional counterpart. Only those consumers that are sufficiently susceptible to the externalities created by the pesticide use will be willing to pay for the organic product. Of course, different reasons might exist why private entities want to internalize externalities. We identify these reasons further in the text.

1.2.2 Institutions of sustainability

As discussed above, the natural and social system are in a permanent process of interaction. The social system changes due to economic and technological reasons and natural impact, while the ecological system changes due to natural reasons and human impact. Therefore, both systems co-evolve by mutual co-adaptation. Due to new technologies, increasing population and economic growth, human impact on eco-systems threatens to destroy our resource base. As Hagedorn (2005) amongst others argues, this should draw our attention to "sets of rules" (or constraints) that we can, and actually do, impose on our interaction with nature. These sets of rules are called "**Institutions of Sustainability (IoS)**". Institutions of Sustainability regulate the co-adaptation between the socio-economic and the natural system.

In order to analyze the role of institutions with respect to sustainability, Hagedorn et al. (2002) formulated the 'Institutions of Sustainability'-framework. When developing a framework for analysing or even designing institutions of sustainability, focus rests upon those transactions which are related to natural resources and ecological systems. This distinguishes the IoS framework from conventional transaction cost economics (Williamson) which has been developed against the background of transferring "commodities" (goods mostly produced by means of engineered processes). In the IoS-framework, "non-commodities" are at stake; that means goods, services and resources which are received through those processes of self-organisation which are typical for ecosystems and only to a limited extent influenced by humans. The IoS framework relates four key elements that interact with each other to come to sustainable change:

- the actors, characterized by values and beliefs, reputation and trustworthiness, power, information and knowledge, social environment and embeddedness;
- the institutions, as formal and informal rules, property rights and duties;
- the transaction, characterized by properties such as excludability and rivalry, assets specificity, separability, frequency, uncertainty, complexity, heterogeneity;
- the governance structures, such as markets, hybrids and hierarchies, making the rules effective

Depending on the type of transaction, the actors involved, the prevailing institutions and the associated governance structure, the outcome with respect to sustainability will be different. In what follows we will define each of these four elements further.

According to Hagedorn (2005), institutional change depends on the characteristics and objectives of the **actors** involved in those transactions. This is not only true for individual actors whose values, interests and resources to exert influence (power) are very different, but also for groups of individuals like communities using organisations and networks to shape institutions according to their interest and to solve their conflicts.

North (1990) defines **institutions**[2] as *the rules of the game* in a society or, more formally, the humanly devised constraints that shape human interaction. They reduce uncertainty by providing a structure to everyday life. Institutions can be both formal constraints, such as rules devised by human beings, and informal constraints, such as conventions and codes of behaviour. An essential part of the functioning of institutions is the costliness of ascertaining violations and the severity of punishment.

[2] In this dissertation the term 'institution' encompasses both the defining set of rules and the chosen organisational structure aligned with these rules.

The neo-classical economic theory pictures the decision-making unit or firm as a black box, a production function, wherein inputs are transformed into outputs according to laws of technology (Williamson, 2003). A firm's level of capital and labour is related to its productive output (Leiblein, 2003), whereby market pricing coordinates the use of resources (Demsetz, 1983 cited in Williamson, 2003). This, however, will explain little on the inner workings, nor on the firms' reaction on uncertainty or potential opportunism in contracting. It is therefore that Williamson (2003) proposes to look at agriculture through a "new lens". It focuses on the "the costs of doing business, and the social rights and obligations (institutions) which people devise to reduce them".

Davis and North (1971) proposed to distinguish between institutional environment and institutional arrangements (this was later also used by North and Williamson). The institutional environment refers to the "set of fundamental political, social and legal ground rules that establishes the basis for production and distribution" (Davis and North, 1971); it is the broader set of institutions within which transactions occur. The institutional arrangements are "the arrangements between economic units that govern the ways in which these units can cooperate and/or compete" (Davis and North, 1971); they are the contracts or arrangements set up for particular transactions, also referred to as governance structure. North, as others, therefore distinguishes between institutions as rules and governance structures as the organisational solutions for making rules effective. Ménard (1995) reasons that institutions establish and delineate the conditions under which goods are produced and exchanged. Organisations, on the other hand, are "the players of the game" and include firms, community groups and agencies (North, 1990).

The institutional environment consists of institutions that are in itself the result of institutional arrangements. Within the institutional environment, new institutional arrangements are set up. Each level of the institutional environment is a support for new negotiations and sets of arrangements. Williamson (2000) developed a framework in which he distinguishes between four levels of institutions. The top level is the socially embedded level and refers to the norms, customs, traditions and codes of conducts, i.e. informal constraints and social capital. The institutions at this level change very slowly. The institutional environment forms the second level and includes the formal rule of the game, i.e. constitution laws and property rights. The rules of the game are partly the product of evolutionary processes and partly the results of political action, and change in a period of 10 to 100 years. The third level accommodates the governance structures or institutional arrangements. The key question on this third level is "how to get the governance structures right" and therefore involves the study of the effectiveness and efficiency of different governance structures. These governance structures can change in a period of 1 to 10 years. The fourth level is the level at which the neo-classical economic theory applies. The firm is described by a production function, and its objective is to maximize utility by "getting the marginal conditions right". Prices and quantities change continuously.

Given the rules of the game (the institutions), the players of the game (the actors) engage or not in a transaction. A **transaction,** the third element of Hagedorn's framework**,** can be defined as *a transfer of property rights*. According to Williamson (1985), transactions differ in the degree to which relation-specific assets are involved, the amount of uncertainty about the future and about other parties involved, the complexity of trading arrangements and the frequency with which transactions occur (Van Huylenbroeck et al., 2009). In the neo-classical economic theory transaction costs are assumed to be zero. In this framework, resource allocation will not be influenced by the form of the governance structure. Yet, transaction costs do matter. The risk of opportunistic behaviour of the trading partner and the bounded rationality result in high costs in time and resources to search for information on the contracting environment and the firm. McCann (1997) defines transaction costs as the resources used to define, establish, maintain, and transfer property rights. According to Hobbs (2003) transaction costs can be subdivided into search (information) costs, negotiation costs and monitoring and enforcement costs. Search costs arise prior to the contracting, as the partners collect information on the contract itself, on the economic and financial consequences, the possible work load and so on. Negotiation costs are the costs of drawing the contracts, while monitoring costs are ex-post to the transaction. They result from monitoring on the way the contract is complied with and include an assessment of the product quality, timely deliverance and efforts ensuring that the contract agreements are adhered to (Hobbs, 2003). Transaction cost economics predicts that simple transactions are matched with a simple governance structure, while more complex exchanges are associated with more complex forms of organisations. Deviations are less efficient, and will incur high transaction costs (Leiblein, 2003).

Depending on the characteristics of the transaction, different types of **governance structures** exist that guarantee transaction cost minimization. According to Van Huylenbroeck et al. (2009), there is a continuum of governance structures ranging from pure anonymous spot markets, in which market prices provide all relevant information and competition is the main safeguard, to hierarchies (firms), that mitigate risk but only provide weak incentives to maximize profits, while bearing additional bureaucratic costs. Ménard (2004) introduced the concept of **hybrids** as an intermediate form, which is a governance structure where actors have transferred part of their autonomous property rights to others, in order to allow for some coordination between partners. According to Menard (2004), hybrids share 3 fundamental characteristics:

1. Pooling Resource. Whatever the form hybrid arrangements take, they are systematically oriented towards organizing activities through interfirm coordination and cooperation, so that key investment decisions must be made jointly.
2. Contracting. Some more or less formal contracts exist, but they are reduced to a framework, to mitigate costs and rigidity. In this situation the choice of governance structure that can adequately complement contracts and contribute to their implementation becomes crucial. Mechanisms must be designed that are aligned with the characteristics of the transactions they support, filling blanks left in contracts, monitoring the arrangement, and solving problems without repeated renegotiation.
3. Competing. In hybrids partners remain independent residual claimants with full capacity to make autonomous decisions as a last resort. Competitive pressures in hybrids operate in two directions. First, with the possible exception of bilateral contracts, partners to a hybrid agreement compete against each other. Second, hybrids usually compete with other arrangements, including other hybrids.

Currently more advanced governance structures such as polycentricity, co-production, multifunctionality and cooperation are identified and analyzed (Hagedorn, 2005). Some sustainability issues require decentralised governance (f.e. protected areas), others highly centralised governance (f.e. plant genetic resources), and often we see combinations. The result is that governance structures are characterized by polycentricity and diversity.

Hagedorn (2005, 2008) introduces the dichotomy of **Integrative and Segregative Institutions**[3] as basic concept underlying his theory of Institutions of Sustainability.

[3] The terms integrative and segregative differ in meaning from the terms internalisation and externalisation used in conventional economics: 1) they do not just refer to the capacity of market mechanisms but to any type of

Integrative institutions allow actors, who make decisions on transactions, not only to profit from beneficial effects, but they also hold them fully responsible for adverse effects. Similarly, they not only force them to internalise the transaction costs they cause, but also protect them against transaction costs resulting from the activities of other agents. A good example is the avoidance of reputation damage for certification schemes (a form of PIoS) when a food scare occurs in the unregulated spot market. Segregative institutions force actors who make decisions on transactions to focus and refrain from receiving some beneficial effects, but also allow them to shift some of the burdens resulting from adverse effects to others. They may externalize transaction costs within limits, but can also not avoid bearing transaction costs which should rather be attributed to other agents. Hagedorn (2005) mentions that both integrative and segregative institutions cause private costs for the decision makers and social costs. He associates integration and segregation with two categories of costs: transaction costs and opportunity costs. The latter refer to the benefits foregone from additional integration when the rules and governance structures are seggregative (and vice versa). Given that PIoS are the set of rules designed to voluntary internalize externalities, they can be seen as an example of integrative institutions.

1.2.3 Private institutions of sustainability

Private Institutions of Sustainability (PIoS) can now be defined as a *nonlegislative voluntary commitment to undertake additional efforts to reduce the production of negative - and increase the production of positive - externalities*. Two main characteristics make these PIoS a special type of Hagedorn's Institutions of Sustainability: the central position of the private actor and the voluntary nature of his participation in (and often the initiation of) the PIoS.

Furthermore a strong parallel exists between PIoS and the process of 'self-organisation', as identified by Ostrom (2009). She found through research in multiple disciplines that, opposite to accepted theory, some government policies accelerate resource destruction, whereas opposite to this, some resource users have successfully invested time and energy to achieve sustainability. She calls this latter process 'self-organisation'[4].

1.2.3.1 Public versus private institutions

To maintain and even improve the current level of environmental sustainability, initiatives can originate at public or private level. Basically, all measures aiming to do so can be subdivided into three distinctive categories. Two categories principally reside under public authority, while the third is situated in the private sphere.

When the market is deficient in regulating the externalities caused by production processes, public authorities are there to intervene. Policy makers dispose of two different options to implement public regulations. The first one, the **Command-and-Control** option, is based on the coercive power of the State, in which the public authorities change the structure of property rights and impose regulations aimed at preventing the occurrence of negative

institution and governance structure; 2) they do not only focus on the responsibility of actors for physical effects they caused but at the same time on the nature of the social/political process associated with regularizing actors' interdependencies (Hagedorn, 2005)

[4] Ostrom introduces a framework that helps to describe the probability of self organisation when socio-ecosystem sustainability is under threat. In this framework, she identifies four key elements that interact and will determine the outcome: the users of the socio-ecosystem (SES), the resource types, the resource systems and the governance structures in place. For each of these elements, and for the interactions and the outcomes, the key determining features for self organisation are also identified. Given the focus on 'self-organisation', Ostrom's framework is also applicable to our case of private institutions of sustainability.

externalities or at inciting the production of positive externalities. Although it certainly has its merits, the Command and Control instrument has been heavily criticised, mainly due to its environmental ineffectiveness with respect to certain types of pollution, its weak economic efficiency, the lack of flexibility, the absence of stimulations to innovate and the risks to be trapped in suboptimal technological solutions. The second category resides under the **market mechanisms** that, by integrating price mechanisms, push the regulated agents to internalize the environmental externalities. These economic instruments (taxes, retributions, subsidies, trading in property rights) make it possible to attribute prices to environmental goods, enabling agents to integrate these in their cost calculations.
The third (and most recent) category corresponds to a more diverse set of options, with as principal and common characteristic its **voluntary nature**. This voluntary character mainly refers to the absence of the use of the State's coercive power, implying that the adoption of the approaches depends on the good-will of the involved actors. These instruments play on the moral responsibility of the actors involved and on the social sanctions to which the latter will be exposed in case of non compliance.

There is an intimate link between PIoS and **Corporate Social Responsibility** (CSR). The EU definition of CSR is: *"a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis."* (COM, 2001). While CSR mainly refers to intra firm processes, PIoS often refers to inter firm arrangements, and more specifically to hybrids, which are organisational structures where multiple actors cooperate and contract together, while still remaining competitors. Burke and Logsdon (1996) describe how CSR can actually create value for the firm, when it is applied strategically.

1.2.3.2 Motives for participation in private institutions of sustainability

Despite the variety of their types and subtypes, all voluntary approaches contain a common element: they are nonlegislative commitments to undertake additional efforts in reaching sustainability targets. In essence, a firm is not required by law to develop or adhere to a voluntary approach. As a consequence, in contrast to other instruments, voluntary approaches do not apply to all firms belonging to the same industry, contributing to the same adverse effect, or submitted to the same jurisdiction. Motivations for participation in PIoS can be found both in and outside the economic sphere. Often voluntary approaches are initiated in response to consumer and community pressure; competitive pressure; or a threat of a new regulation or tax (Börkey et al. 1999). The motives for participation can however also be purely ideological, as a response to the current overexploitation of the ecosystem.

Going beyond legal compliance is counterintuitive because a firm is supposed to make money and internalizing externalities is costly. These expenditures will increase the production cost and as a result there will be either a decrease in demand due to increasing product prices, or a decrease in profit if the firm decides not to raise its product price. However, various economic motivations for adoption of voluntary strategies can be identified. Henriques and Sadorsky (2008) describe a variety of potential benefits to firms such as relief from existing environmental regulation (like a burdensome tax), the pre-emption of regulatory threats, or the influencing of future regulations; cost-efficiency; improved stakeholder relations; and the possibility of receiving technical assistance in kind or via some kind of incentive mechanism. Hence, organizations are motivated to increase their internal efficiency and external legitimacy, which can lead to competitive advantage and shareholder value creation. Khanna (2001) also provides an excellent overview of firms' motives to participate in environmental management programs. A commonly expected gain associated with voluntary internalizing an externality is avoiding the costs of public regulations. The government may plan to introduce a new standard or a new tax. In behaving proactively and deciding to reduce its emissions, a firm may expect to pre-empt public regulation (Maxwell et al., 2000). Benefits from voluntary internalization of externalities are not limited to regulatory gains. Internalization may result in a better use of, and access to, inputs. Such a case is called ‘no regret action’ and the classic example is that of energy savings. Environmental improvement of a process may be associated with a lower consumption of fuel or gas, and, therefore, may result in a reduction of energy costs. Another expected gain for firms’ voluntarily internalization is provided by product differentiation on environmental performances and their signalling to consumers via advertisement and labeling. Once the environmental performances are known, green consumers can express their willingness to pay for the environment in purchasing goods. High quality products will then be sold at higher prices. Even if consumers do not want to pay more for greener products, there may still be an advantage of differentiation. At the same price consumers opt for greener products and therefore the greener firm is rewarded by an increase in its market share. Finally, as a rule, product differentiation relaxes price competition. A third benefit which may outweigh the abatement costs is reputation gains vis-à-vis stakeholders (its employees and local communities).

Motivation can also be found outside the economic sphere. Vatn (2009) explains that the human motivation is much more complex than that described by the standard model of rational choice, which aims at maximizing individual utility. Schlüter (2009) argues that, as many environmental goods cannot, and in the eyes of many citizens should not, be regulated by the market, we can expect that in the field of the environment many other forms of rationality than the *homo economicus* prevail. Gintis (2000) also distinguishes between different types of people, depending on their rationality. The homo economicus’s rationality is to maximize individual utility. The economic motivations outlined in the previous paragraph relate to this type of people. The *homo egualis* on his turn prefers equality and the *homo parochius* distinguishes between insiders and outsiders. The *homo reciprocans* on his turn exhibits a propensity to cooperate and share with others that are similarly disposed, even at personal cost, and a willingness to punish those who violate cooperative and other social norms, even when punishing is personally costly. The reasons for voluntary participating in PIoS are therefore not necessarily economically inspired. Some degree of altruism, inspired by a genuine concern for the Earth and its future inhabitants can be part of the rationality of the participants. Related to this is the ‘warm glow’ effect (Andreoni, 1989), which refers to actors’ engagement in philanthropy ‘to feel the glow’ that comes with altruistic behaviour.

1.2.3.3 Dual objective of Private Institutions of Sustainability

PIoS have the dual objective of simultaneously improving ecological sustainability and maximizing private utility of the actors implementing the PIoS. These systems therefore contribute to ‘sustainable development’, as the commodities that result from the PIoS simultaneously create added value for the firm and contribute to the sustainability of the Earth system.

With this dual objective a possible contradiction is associated, as the institutions implemented to attain the sustainability objective might constrain the actor in attaining his private utility maximization objective. The actors involved in PIoS than have to make a trade off between the long term sustainability goal and the short term private utility maximization objective. As the primary objective of private economic actors is to reap economic rents from the creation of added value, the long term sustainability goal is often made subordinate to the short term private utility maximization objective. This is in conflict with the ecological economist view

of the Earth as supersystem and the micro-economic agent as a dependent subsystem, as explained earlier in the text. We can go one step further in this. As the long term sustainability objective of PIoS is reflected in the end product as a credence attribute, it is difficult to evaluate by economic actors, enabling free riders to make an environmental claim that is in reality not met. To avoid this, extra institutions need to be created for monitoring and enforcing the institutional rules that actually guarantee the claim.
Conversely, some of the institutions defining the PIoS can be designed as such that both objectives are met simultaneously, and work mutually reinforcing. By implementing new resource saving technologies, economic rents can be created while contributing to ecological sustainability.

Schaltegger and Synnestvedt (2002) explain the above relation between environmental performance and economic success more formally, as displayed graphically in figure 1.2. Either there is a negative relationship between better environmental performance and economic performance (lower curve), when the corporate environmental protection conflicts with the other business objectives, or there is a parabolic relationship (upper curve), where economic results are increasingly improved by environmental protection practices, up to a point where marginal benefits from environmental protection are decreasing. The type of relation depends on the type of environmental problem and the applied technology.

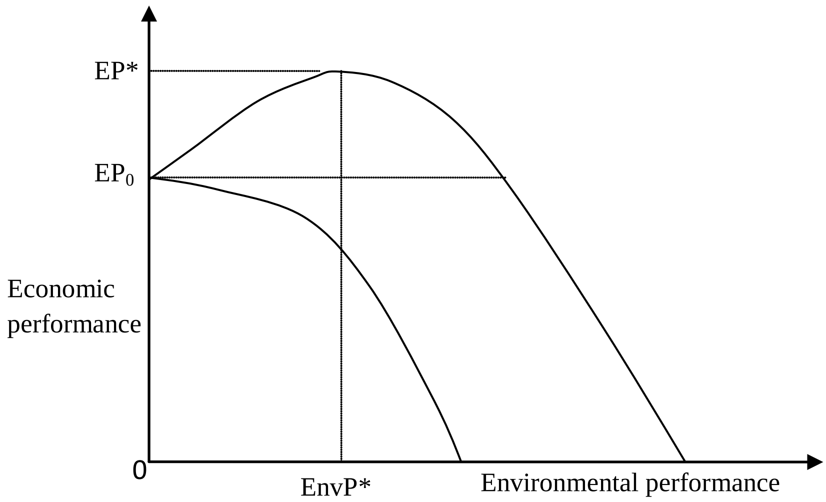


Figure 1.2. Relation between firm environmental performance (EnvP) and firm economic performance (EP). Source: Schaltegger and Synnestvedt (2002)

1.2.3.4 Types of private institutions of sustainability

Four main types of voluntary approaches can be distinguished depending on the parties involved (Börkey et al. 1999, Khanna, 2001):
1. unilateral commitments made by (groups of) private actors (f.e. polluters);
2. agreements achieved through direct bargaining between private parties (f.e. polluters and pollutes);
3. environmental agreements negotiated between industry and public authorities;
4. voluntary programmes developed by public authorities (e.g., environmental agencies) to which individual firms are invited to participate.
The latter two imply an important role played by public authorities, the former two fully reside in the private sphere (private voluntary mechanisms).

Unilateral commitments consist of environmental improvement programmes set up by firms and communicated to their stakeholders (employees, shareholders, clients, etc.). The definition of the environmental targets as well as of the provisions governing compliance, are determined by the firms themselves. Nevertheless, firms may delegate monitoring and dispute resolution to a third party in order to strengthen the credibility and the environmental effectiveness of their commitments (Croci & Pesaro, 1996).

Private agreements are contracts between a firm (or sometimes a group of firms) and those who are harmed by its emissions (workers, local inhabitants, neighbouring firms, etc.) or their representatives (community organizations, environmental associations, trade unions, business associations). The contract stipulates the undertaking of an environmental management programme and/or the setting of a pollution abatement device.

Contracts between the public (local, national, federal or regional) authorities and industry are known as **negotiated agreements**. They contain a target (i.e., a pollution abatement objective) and a time schedule to achieve it. The public authority commitment generally consists of not introducing a new piece of legislation (e.g., a compulsory environmental standard or an environmental tax) unless the voluntary action fails to meet the agreed target.

Within **public voluntary programmes**, participating firms agree to standards (related to their performance, their technology or their management) which have been developed by public bodies such as environmental agencies. The scheme defines the conditions of individual membership, the provisions to be complied with by the firms, the monitoring criteria and the evaluation of the results. Economic benefits in the form of R&D subsidies, technical assistance, and reputation (for example by being permitted to use an environmental logo) can be provided by the public body.

1.2.3.5 Key features of private institutions of sustainability

Some key features can be identified that make voluntary approaches differ from each other. An excellent overview is given by Börkey et al. (1999).

We can distinguish between **individual** or **collective** voluntary approaches. Voluntary approaches may be developed by single firms (hierarchy) or by coalitions of firms (hybrids). Whether voluntary approaches are collective or individual is a key distinction, for the former involve inter firm cooperation whereas the latter do not. This directly influences the costs of voluntary approaches, in particular the costs of monitoring and sanctioning non compliance to limit free riding (free riding occurs when it is in the interest of economic agents not to contribute to an action because they will benefit from it without paying its costs). We can distinguish between horizontal and vertical alliances within PIoS in the food chain. In this dissertation our attention will be focused on collective voluntary approaches as primary food production is characterized by many suppliers (farmers).

Voluntary approaches cover the whole spectrum of **geographic** delimitations. They may take place at a local, national, federal or regional level.

Agreements can be **binding or non-binding**. The legal form of voluntary approaches is an important element of their success. Agreements are binding for both parties when they include sanctions in the case of non compliance and are enforceable through a court’s decision. Binding agreements, as opposed to nonbinding agreements, or gentlemen’s agreements, are more likely to be effective.

As they operate outside the regular legislative process, voluntary approaches are not necessarily **transparent** and open to all vested interests. However, the involvement of additional parties is possible. Third parties, like community organizations and green groups, play an increasing role in unilateral commitments as well as in negotiated agreements.

Voluntary approaches may concern setting pollution abatement objectives and/or the implementation of measures to achieve them. Where the environmental objective is set by the party(ies) involved in the voluntary approach, the voluntary approach is called **target based**. Where the target is set within the framework of the regular legislative process by government, and the voluntary approach only consists of selecting and implementing the measures to achieve it, the voluntary approach is termed **implementation based**.

PIoS result into credence attributes of food products and therefore need to be **signalled** to the buyer or consumer. A useful classification of quality dimensions for food, based on the theory of the economics of information, is into search, experience, and credence dimensions. While search and experience attributes can be verified before or during consumption, credence attributes are not revealed even after consuming the product. Typical examples are environmental impact or animal welfare (Marette et al.,1999; Nelson, 1970, 1974; Darby & Karni, 1973). Credence attributes mainly focus on the quality of the production process, and less on the core product itself. Therefore, quality-of-life issues, such as food ethics, environment and health cannot be verified upon purchase or consumption. In recent years however, these attributes have become crucial as components of buyer and consumer value (Teisl et al., 1999; Schröder and McEachern, 2004; Bernués et al.,2003; Miles and Frewer, 2001; Wandel and Bugge, 1997). Grunert (2002) puts quality labels as a possible solution, giving buyers/consumers information about credence characteristics of food products. A typical process-related quality trait, and consequently a credence attribute, is organic agriculture (Grunert et al., 2000).

Moreover, to check the legitimacy of the environmental claim a **monitoring and control** system is put in place. As explained by Tanner (2000), one can distinguish between first, second and third party certification. Third-party certifiers are independent from buyers and sellers in agrifood commodity chains. In case of first party certification suppliers audit themselves, while in case of second party certification retailers' paid technicians audit the suppliers. The third party certification is considered to be more reliable as third party certifiers are thought to have no stake in the outcome of the transaction (Golan et al., 2001).

1.3 Institutional change in PIoS

Social and economic conditions in a society change continuously as new things become scarce, as prices change, as tastes and preferences change, as population increases and as technology opens up new possibilities and problems (Bromley, 1989). These changes are normally treated as exogenous. The theory of institutional change attempts to explain and predict the probable response of economic actors to these changes. One of these responses are PIoS.

When making an institutional choice, Denzau and North (1994) argue that we need our mental models, our beliefs, and our filters, in order to interpret data (such as prices, and other information about an outcome of a choice) and choose the solution the individual considers to be the wisest at a particular moment in time (Schlüter in Beckmann p322). North (1990) notes that it is usually some mixture of external change and internal learning that triggers the choices that lead to institutional change. The actor will assess the gains to be derived from recontracting within the existing institutional framework compared to the gains from devoting resources to altering that framework. According to North (1990) the process of change is mostly incremental as economies of scope, complementarities[5] and the network externalities arising from a given institutional environment bias costs and benefits in favour of choices consistent with the existing framework. Institutional change will occur at the margins most pliable in the context of the bargaining power of the interested parties. The direction of change is therefore determined by path dependency.

Bromley (2006) questions North and others' idea of rational and utility maximizing behavior as the driver for institutional change. According to him, institutional change results from a process of changing our beliefs, our cognitive and normative models, when the current institutional arrangements cannot satisfactory explain a particular phenomenon. In this process we search for 'sufficient reasons' that support a new institutional choice. The accepted view of institutional change is that such a change is either directed towards improving the 'efficiency' of the economy, in which one party is made better off and no other party is made worse off, or it is merely 'redistributional' in nature such that the gain to one party is offset by a loss to others (Bromley, 1989). Bromley adds to these categories of institutional change the category of 'reallocating economic opportunity', and that of 'redistributing economic advantage'. The latter consists in the creation of institutional arrangements that find no support in the social welfare function. These arrangements redistribute economic advantage in favour of some economic agents who are able to use their special position at the expense of others. The 'reallocation of economic opportunity' is an ongoing process of modifying institutional arrangements in response to the changing nature of attitudes and preferences in society as a whole. According to Bromley, it is not something driven by the relentless pursuit of productive efficiency as for any given structure of institutions there are infinitely many productively efficient points along production possibilities frontiers and there are infinitely many institutional possibilities as well.

In the introduction to this paragraph we noted that institutional change is the economic response to exogenous changes. This view however ignores the possibility of endogenous institutional change. Aoki (2005), who explains institutional change from a game theoretic perspective, notices that institutions, as rules of the game, are treated in two different ways: either they are considered exogenously predetermined outside the domain of economic transactions (as in the institutional environment of North, 1990 or Williamson, 2000), or they are treated as endogenously shaped and sustained in the repeated operational plays of the game itself. While the exogenous view takes a dichotomy approach to separate the rule making game and the operational game, the endogenous view takes an integrative approach. Following the endogenous view, Aoki (2005) states that, as the patterns of play structured by institutions repeat themselves, the cumulative consequences of repeated plays may start to generate internal inconsistencies and/or endanger the sustained compatibility with the environments. In such situations, mutant strategies that have been suboptimal thereto may exhibit an increasing viability. The transitional process to new institutions converges when a new pattern of plays of game emerges and is collectively recognized as the way how the game is now being played. Additionally, agents' new action choices given this new pattern of play should generate satisfactory pay-offs to them to make the institutional change successful.

[5] in institutions (see Aoki, 2005 also)

Whether we follow the endogenous or exogenous view to institutional change, depends on the institutional level we analyse. Ostrom (1990) distinguishes between multiple levels of nested institutions. According to her, institutional change is a continuous process of adjustments across these nested levels. At the lowest level we find 'operational rules', which directly affect day to day decisions made by participants in any setting. Changes in these rules will lead to changes in physical variables. Here participants interact in light of internal and external incentives they face to generate outcomes directly in the world. At the second level, 'collective choice rules' are situated. These rules determine who is eligible to be participant and the specific rules to be used at the operational rule level. Participants at this level not necessarily are the same as those at the operational level. At the deepest level, we find 'constitutional choice rules'. They first affect collective choice activities by determining who is eligible to be a participant and the rules to be used in crafting the set of collective choice rules that, in turn, affect the set of operational rules.

Hagedorn (2002) describes institutional change in the area of environmental coordination as a response to technological, biological and economic factors on the one hand and societal and political influences on the other hand. In his IoS-framework (see figure 1.3 below), the interaction between nature and actors depends upon the properties of the transactions and the characteristics of the actors. Changes in both will determine which institutional arrangements emerge. These arrangements define the appropriate changes in property rights to nature components as well as the accompanied changes in governance structures that enforce these property rights.

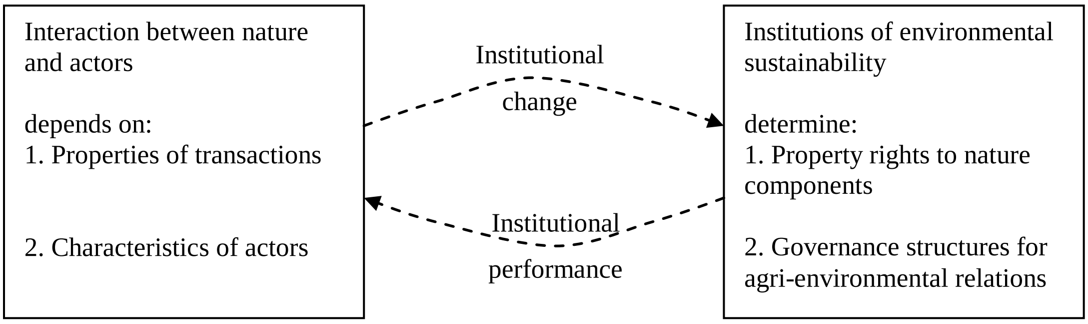


Figure 1.3. Institutions of sustainability framework (Hagedorn, 2002)

PIoS can be seen as the result of economic actors' dissatisfaction with the current institutions that regulate private actors' interaction with nature. This dissatisfaction emerged due to external changes and associated changes in private actors' mental models. All four of Bromley's arguments for institutional change can be associated with PIoS. But maybe the most prominent is the argument 'reallocation of economic opportunity' referring to the modification of institutional arrangements in response to the changing nature of attitudes and preferences in society as a whole. Given the increased knowledge, awareness and sensitivity about the human impact on the ecosystem, the societal voice for a change in behaviour sounds louder. PIoS is the private answer to this voice. Following Aoki (2005), PIoS are recognized by a group of private actors as the way the game should be played now. They are convinced that these PIoS will generate satisfactory payoffs. The latter are not necessarily restricted to economic payoffs.

PIoS are not only a response to changes, they themselves are also subject to change due to continuous processes of external changes and internal learning.

1.4 *Conceptual framework and hypotheses*

1.4.1 The conceptual framework

Institutions are created and changed by economic actors with the objective of attaining a desired outcome. As explained in the previous paragraph, Bromley (1989) identifies different intended 'outcomes' of institutional change, such as efficiency improvement, redistribution and reallocation (or herorientation). In Ostrom's framework for analyzing social-ecological systems (SES), the interaction between resource systems, users, resource units and governance systems leads to certain outcomes. Ostrom (2009) makes a distinction between the social performance of a SES, the ecological performance and externalities created to other SES's. With social performance she associates social performance measures such as efficiency, equity, accountability and social sustainability. Ecological performance measures are ecological sustainability, biodiversity, resilience, overharvesting etc. Also PIoS are devised to attain a certain outcome. In Hagedorn's Institutions of Sustainability framework, the interaction between actors, institutions, governance structures and transactions in an action arena will define the outcome, which he terms the **institutional performance**. When the institutional performance is satisfactory, there is no need for institutional change (see figure 1.3).

In this dissertation we intend to measure the **performance** of PIoS. As explained, PIoS claim to have a dual objective, to simultaneously contribute to sustainability and economic development. PIoS' endogenously shaped institutions and governance structures are aimed at reaching this dual objective. As our measure for the performance of PIoS, we distinguish between the institutional effectiveness, the institutional efficiency and the institutional equity of PIoS. **Institutional effectiveness** indicates *to what extend the desired effect is reached given the set of endogenously and exogenously determined institutions*, while **institutional efficiency** indicates *whether this is done in the most economic way*. **Institutional equity** on its turn refers here to *the fair division of value among actors participating in the PIoS.*

As PIoS have a dual objective, institutional effectiveness can relate to both. Do these systems contribute to sustainability and to economic development? When defining sustainability we introduced the system view, with the economic system subordinate to the social and the ecosystem. In this dissertation, the institutional effectiveness of PIoS is primarily related to their claimed objective of contributing to ecosystem sustainability. As mentioned by Lepoutre (2008), remarkably little studies actually assess whether firms with a proactive environmental strategy (PES) are successful in achieving improved environmental performance. Most studies seem to assume, however, that the adoption of proactive environmental practices automatically generates good environmental performance. The few existing studies that do investigate the PES - environmental performance relationship come to opposing conclusions. Majority of authors find a positive connection (see Lepoutre, 2008 for an overview). However, the paper of Hertin et al. (2008) shows that there is currently no evidence that environmental management systems (EMS) have a consistent and significant positive impact on environmental performance. They conclude that policy action based on the simple assumption that companies with an EMS perform better than those without therefore seems inappropriate. Rivera et al. (2006) focus on two main questions: 1) Are voluntary programs effective in promoting higher environmental performance by participant firms? 2) If so, which distinct areas of environmental performance are more likely to be improved by firms joining a voluntary environmental program? They found hardly no evidence that firms following an EMS are performing greener than their counterpart.

The institutional efficiency indicates whether the ecosystem sustainability target is reached in the most efficient way, i.e. with the highest economic rent for the employed resources. The effect of an environmental management system on economic performance is more widely studied in the literature. The relationship between environmental and economic performance is explained earlier in paragraph 1.2.3.3.

Institutional equity of PIoS focuses on the value distribution among participants in the PIoS and can be seen as a measure for the social performance of PIoS. When multiple actors are involved in PIoS, a hybrid governance structure emerges. Particular is that partners to a hybrid agreement remain to some extent competitors. In food production all kinds of hybrids exist. Codron *et al*. (2005) classified these partnerships into three main groups: (1) farmer-driven initiatives, (2) retail driven vertical alliances between producers, manufacturers and retailers and (3) generic standards common to several retailers. When one partner to the hybrid has a dominant position, bargaining power can be exhibited. Evidence of retailers' dominant position in the food chain is given by McCorriston (2001 and 2002), Gohin and Guyomard (2000), Giraud-Héraud et al. (2003 and 2005). According to Bunte (2003), social welfare – in this case social supply-chain performance – depends on two elements: (1) efficiency (profit) and (2) equity (people). Efficiency is concerned with the creation of value added; equity is concerned with the division of value added over the respective stakeholders. One of the most heavily studied equity issues related to pricing studied in industrial organization is price transmission. It refers to the way prices at one level in the product chain react to changes at another level.

The measurement of effectiveness, efficiency and equity require the definition of a benchmark, a point of comparison. The benchmark reflects the opportunity costs of the employment of resources. Opportunity costs refer to the value that the best available alternative would have generated with the employed resources. Value not necessarily needs to refer to the economic value created. This can also be the ecosystem services provided, environmental degradation avoided etc. The benchmark can either be normative, representing an ideal use of the resources, or positive, based upon existing options in the market. The logical benchmark when the effectiveness is measured is the target effect itself. The concrete target measure for PIoS is the contribution of the PIoS to the actual ecosystem sustainability of the Earth system. To measure the efficiency, the appropriate benchmark is, in the spirit of opportunity cost thinking, the best available economic alternative. Currently, the best available alternative to the PIoS for the production of commodities is the market itself. Equity on its turn can be measured as the proximity of the PIoS to the ideal configuration according to the different stakeholders. Configuration here refers to the rights and duties of the different partners in the scheme. In an ideal configuration where inequity is zero, we find a correct division of costs and benefits across partners according to their contribution in the PIoS.

The current endogenous institutional structure of a PIoS will determine the sustainability outcome and the socio-economic performance, or the institutional effectiveness, efficiency and equity as defined above. Benchmarks (firms, hybrids, markets not participating in PIoS) operating in the same exogenously determined institutional environment, but with a different set of endogenously determined institutions, will have a different institutional effectiveness, efficiency and equity. By comparing PIoS with these benchmarks changes can be proposed that improve the effectiveness, efficiency and equity of the PIoS. These changes will alter the institutional structure, which will, on its turn, alter the effectiveness, efficiency and equity ones more. This is the dynamics of PIoS. The graphical representation of this cycle is shown in figure 1.4 below.

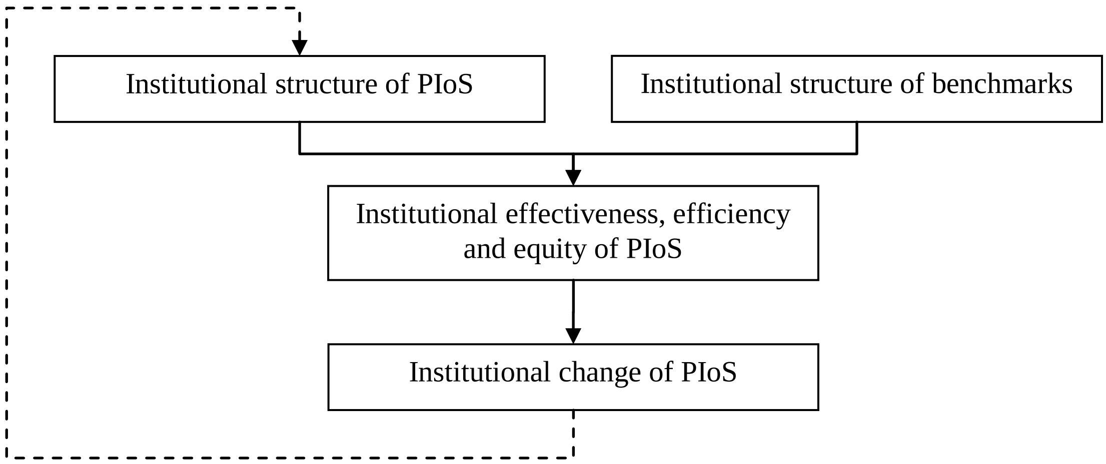


Figure 1.4. Framework of analysis

1.4.2 Hypotheses

Given this framework, the following research questions (RQs) are of interest:

with respect to the actual performance of PIoS:
Research question 1. Do Private Institutions of Sustainability lead to more ecosystem sustainability?

Research question 2. Do Private Institutions of Sustainability lead to more economic value creation?

Research question 3. Do Private Institutions of Sustainability lead to more equity among participants?

with respect to institutional change and further improvement of the performance of PIoS:
Research question 4. What is the cost of improving the environmental performance of PIoS?

Research question 5. What is the desired compensation for endogenous changes in the institutions underlying PIoS ?

Research question 6. How does the sustainable efficiency of farms participating in the PIoS system change when new sustainability targets are introduced?

The first three research questions analyse the situation as it is and therefore lead to positive research. The last three research questions are more normative, as they focus on improvements of the current system and consequences of these improvements.

The link between environmental, social and economic performance and these research questions is indicated in figure 1.5, which extends figure 1.2. The figure shows the interrelation between environmental and economic performance for the market (market curve), the PIoS (PIoS curve) and an optimized PIoS (Optimized PIoS curve). Many different PIoS-systems can exist in the market. Accordingly, different PIoS-curves can be drawn. Of these curves, one outperforms the rest, which is the optimal PIoS-curve in figure 1.5. The figure also shows the potential relationship between the environmental and social performance. Suppose that a farm participating in the PIoS system is currently situated in point A on the PIoS curve, characterized by an economic performance EP_{PIoS} and an environmental performance $EnvP_{PIoS}$. In this part of the curve economic and environmental performance reinforce each other. Another farm participating in the regular market is on its turn situated in point F, as this point guarantees maximum economic performance given the market curve. We can also distinguish between unsustainable and sustainable resource use, depending on whether the sustainability threshold is surpassed or not.

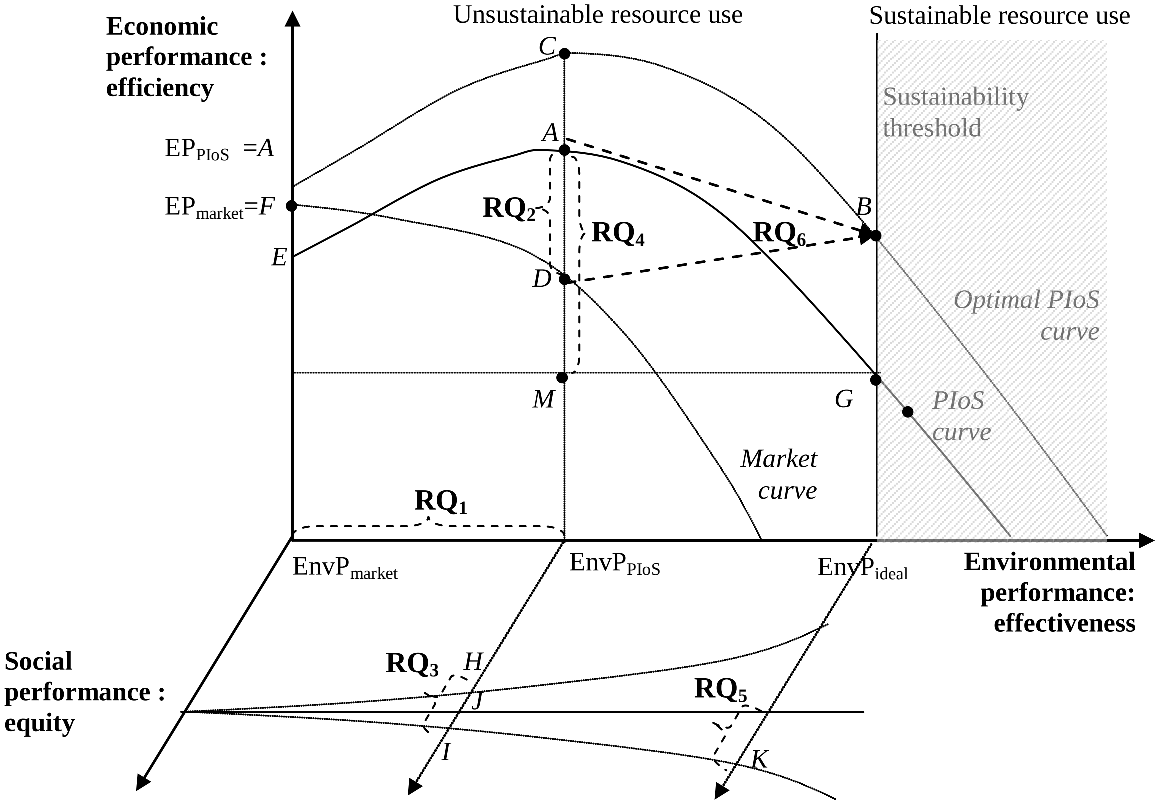


Figure 1.5. Link between research questions and environmental (EnvP) and economic (EP) performance of PIoS. The dotted line shows the technology of the market, while the full line shows the technology of the PIoS. The sustainability threshold is also indicated

RQ_1 investigates the environmental effectiveness of PIoS. PIoS claim to be better for the environment. As this claim cannot be verified upon sale, it is a credence attribute, that is signalled to the buyers by means of a certification book or a label. Both from the buyers and societal point of view it is interesting to know whether this claim is actually met. In figure 1.5, if the farm participating in the PIoS is situated in point A and the farm participating in the market in point F, a different environmental performance should be noticeable (RQ_1) between these farms ($EnvP_{PIoS}$ - $EnvP_{market}$).

RQ_2 focuses on the economic performance of the PIoS. Are these systems the most efficient way to attain the environmental performance level of the PIoS? How much value would farms in the regular market create when they have to meet this environmental performance? This RQ can be related to the opportunity cost of using capital (or capital forms). Do policy makers better invest their resources in these PIoS systems or in other systems? In Figure 1.5, the difference between point A and point D can be interpreted as the difference in value created by the PIoS and the market system at the environmental performance level of the PIoS.

RQ_3 focuses on the institutional equity of PIoS and refers to the distribution of value among participants in PIoS. Do these systems contribute to equity in the supply chain or do they facilitate exhibition of market power? In figure 1.5 the level of equity in the market is indicated by point J, while PIoS potentially reside in point I to H.

To guarantee sustainability, firms will have to become more environmentally friendly. PIoS seem promising vehicles as they are especially designed for this. When the sustainability targets of PIoS are changed the underlying institutions of PIoS have to change to guarantee that these targets are met. This will have implications for the participants of PIoS. Assuming that these participants optimize the environmental and economic performance of their PIoS (point A in Figure 1.5), introducing extra sustainability constraints will affect the economic performance. In Figure 1.5, firms move from point A on the PIoS-curve in the direction of point G. Economic performance then deteriorates from point A to point M in figure 1.5. Private actors will only accept this economic performance deterioration when an appropriate compensation is given. RQ_4 focuses on the actors desired compensation for changes in the institutions underlying PIoS in the direction of more sustainable production.

The previous research question considers the members of the PIoS to be homogenous and does not take the differential stakes between members into account. RQ_5 wants to investigate which compensation value-chain members expect for changes made by other value-chain members in the institutions underlying PIoS. The right compensation can result into more equity among the PIoS value chain members. Graphically this would mean that the equity in the PIoS moves in the direction of point K.

Current resource use is probably still unsustainable, even within PIoS systems. As explained earlier, some critical stocks of natural capital need to be maintained to guarantee strong sustainability, which assumes only limited substitution between capital forms. These critical stocks can be regarded as the sustainability thresholds for these resources. Resource consumption has to remain below these ‘sustainability thresholds’ to guarantee sustainable resource use. Although PIoS might (or might not, see RQ_2) be the more efficient system at their environmental performance level, the question is how efficient they are when these absolute sustainability thresholds are imposed. RQ_6 wants to analyze this. In Figure 1.5 point B reflects the point where environmental performance is in line with the earth’s sustainability threshold and economic performance is optimal given the possible technologies (the curves in the figure). This point thus creates highest ‘sustainable value’. To know whether firms participating in PIoS (f.e. firm A in figure 1.5) perform better than firms who do not (firm D in figure 1.5) with respect to absolute sustainability targets, these firms could be compared with this ideal point.

The above research questions can now also be translated into following hypotheses:
Hypothesis 1. Firms participating in Private Institutions of Sustainability contribute more to ecosystem sustainability than firms who do not
(figure 1.5, shift from $EnvP_{pios}$ to $EnvP_{market}$)

Hypothesis 2. Firms participating in Private Institutions of Sustainability create more ‘sustainable value’ than firms who do not
(figure 1.5, shift from point D to A)

Hypothesis 3. Private institutions of Sustainability can lead to more equity among value chain members

(figure 1.5, shift from point J to I)

Hypothesis 4. Improving the environmental performance of PIoS will change the private actors' desired pay-off structure
(figure 1.5, shift from point A to G)

Hypothesis 5. Institutional changes in PIoS can simultaneously improve the equity among value chain members
(figure 1.5, shift from point J to K)

Hypothesis 6. Farms participating in PIoS are more sustainable efficient than farms who do not when new sustainability targets are introduced
(figure 1.5, shift from point A to B versus shift from D to B)

1.5 Cases analysed

To test the above hypotheses and related issues different case studies are used. PIoS in agriculture can be divided in two distinctive groups, based upon the motivation for participation and the associated impact towards environmental sustainability.
In Figure 1.5, PIoS to the left of point A use improvements in their ecological performance to improve the economic performance, leading to a win-win for both. In the spirit of Bromley (1989), this optimization refers to efficiency improvement. In Ostrom's nested institutions framework, main differences compared to conventional production systems will relate to the operational rules, i.e. the lowest level of institutions. This first type of PIoS systems, of which the Belgian vegetable certification standard Flandria/FlandriaGAP is a good example, are market oriented systems which integrate environmentally sound techniques up to the point that economic performance starts degrading. Their principal motivation for integrating environmentally sound techniques can be found in the economic sphere, and often has to do with safeguarding 'reputation'. But, given the high numbers of participants in these schemes, their contribution to overall environmental sustainability might be more substantial compared to the second group, as explained next.

The firms situated to the right of point A on the PIoS-curve in Figure 1.5 make a trade-off between economic and ecological performance. Drivers are, apart from 'efficiency improvement', also the 'reallocation of economic opportunity' as a response to changing attitudes in society and 'redistribution' between economic and ecological performance. Changes are more fundamental and require adaptation of rules at the constitutional level. This second group, of which organic farming is the main example, predominantly acts as facilitator of the introduction of more environmentally sound production methods. This group can be regarded as the innovators in the field of environmental sustainability, those who pave the way for the remaining majority of farmers. Participation often takes place for ideological reasons, and motivation is not necessarily economic. The real environmental performance, expressed as the contribution to an overall reduction in ecological degradation, remains marginal, due to the limited number of participants. These systems are niches in the market and they primarily have a signalling function, both towards private parties and policy makers.

In this dissertation both the organic system and the integrated Flandria/FlandriaGAP farming system will be used as examples of PIoS. Both systems are briefly introduced below. The institutional context is explained in the next chapter. The benchmark for these systems is the conventional market system regulated by the public framework.

As for the type of voluntary approach, both cases are examples of unilateral commitments taken by private actors. Organic farming, as its principles are since 1992 framed in a European legislation, shares some similarities with public voluntary programmes, but the initiative comes from the private sector and its preconditions change under private agreement. Flandria/FlandriaGAP receives some governmental support for adhering to certain environmental standards and therefore also partly resembles to public voluntary programmes.

As for the key features, both PIoS are collective voluntary approaches. In agriculture, single farmer initiatives for mainstream sales channels are rare, given that single farmers cannot guarantee sufficient supply for these channels. Given their collective nature, and the close relationship between farmers and their suppliers (especially in the case of FlandriaGAP, see chapter 7), both PIoS give rise to hybrid organisations. Via these hybrids, resources are pooled. An important contractual arrangement of the hybrid is the certification standard, consisting of a standards manual stipulating the rules and a monitoring and enforcement system. Given this, farmers participating in hybrids remain competitors of those participating in the PIoS as well as of rival PIoSes. Agreements made within both the organic and integrated farming system are binding, and non compliance is monitored by an independent controlling body. Transparency is largely limited to those participating in the PIoS. Both organic farming and Flandria-participation is signalled to the end consumer.

Organic agriculture limits the use of external inputs and integrates several practices which are considered more environment friendly than conventional agriculture. The organic production system strives at a minimal disruption of the natural equilibrium, and at the same time, high-quality food production by banning residues harmful for human and animal health. Therefore the use of chemical fertilizers, pesticides and genetically modified organisms are prohibited. The organic principles of regulation also stimulate processes of recycling, closed loop systems, and the use of production techniques which allow domestic animals to exhibit species specific behaviour. For countries in the EU the regulation is stipulated in EEC regulation 2092/91 and subsequent.

The Flandria quality vegetable label guarantees a high quality product, cultivated in an environmentally friendly way and perfectly traceable. Today there are more than thirty Flandria vegetable products offered at Belgian auctions. Environmentally friendly cultivation implies that for each type of cultivation particular specifications should be respected. For example, the use of organic resources is preferred over the use of synthetic resources and ‘observe and alert’[6] messages must form the basis of crop protection. The use of fertilisers must be based on the results of soil analyses and considerable attention has to be paid to hygiene aspects. Strict requirements are also imposed to residue monitoring. In order to meet additional requirements from buyers and public authorities, the content of the quality label Flandria was extended by adding the FlandriaGAP Specifications. As a result of these specifications, the strict standards applying to Flandria for hygiene, planet-friendly planting and sustainable horticulture are now set even higher. Extra attention is paid to food safety, care for the environment and the work force. The auctions "Mechelse Veilingen" and "Veiling Hoogstraten" switched over completely to the FlandriaGAP Specifications in 2004. The first control of the products takes place at the auctions. An external control body is responsible for second-line control: it monitors the automatic control system within LAVA (Logistic and Administrative Auction association) and is responsible for the control of alien substances.

[6] Pest development on crops is monitored in special field trials. When the economic damage threshold is nearly reached, warning messages are given to farmers with these crops

For each of the hypotheses defined above, one of these two PIoS will be used to illustrate the mechanisms at work.

1.6 Structure of the thesis

Part 1 of this dissertation, consisting of three different chapters, investigates the market interest in PIoS. It can be considered as the part of the thesis that is setting the scene. In part 1 the private nature of PIoS is investigated, while in part 2 and 3 we focus on the sustainability contribution of PIoS and changes therein. As opposed to public institutions of sustainability, PIoS are voluntarily initiated by market actors. This part 1 explains why market actors are interested in organizing or participating in these institutions. This knowledge is of interest for the research questions investigated in part 2 and part 3, as the motivation of private actors might differ from those of public actors.
Chapter 2 compares PIoS with other strategies to achieve more sustainable production and consumption. After a literature review on different approaches to secure environmental sustainability, the results of a focus group session with representatives from the different stakeholder groups are discussed. This chapter will already qualitatively assess the first research question that PIoS reduce the asymmetry between private and social objectives. It will show that PIoS are considered one of the most promising tools to come to a successful increase in both environmental and economic sustainability.
Chapter 3 explores by means of a choice experiment whether there is a consumer interest in the marketing of public goods and PIoS. It is investigated whether consumers are susceptible to the environmental claims made in PIoS systems and whether they are willing to engage in these systems, as this is an important precondition for the success of PIoS. This knowledge will be important when investigating research question 2, the economic performance of PIoS, as market based systems cannot be succesful without consumer interest.
The farmer is not the only involved actor in the PIoS value-chain. An important driving force for private certification is the retail sector. In chapter 4 we discuss how PIoS are of strategic importance for retailers to strengthen their market positioning. This chapter will already show that market actors' interest in PIoS not necessarily coincide. Equity issues within the PIoS value chain are further investigated in research question 3.

From part 2 onwards the research questions outlined in the conceptual framework are investigated. This part, consisting of three chapters, focuses on the environmental, economic and social performance of PIoS.
In Chapter 5 we present a quantitative assessment of the differences in ecological sustainability between a non-certified and a certified system (the PIoS), the conventional and organic farming system, respectively. Ecological sustainability is evaluated at a disaggregate level, i.e. it is decomposed into several ecological indicators which are all evaluated separately. The data in this chapter originate from an extensive literature review, and the difference between the two systems is calculated by means of a technique called meta-analysis.
From the former chapter we learn that the environmental performance (which is achieved by PIoS) may well come at an economic cost (lower output). To make the tradeoff between ecologic sustainability and private value maximization we need an evaluation tool that can assess both simultaneously. To do so, chapter 6 further improves the Sustainable Value method as developed by Figge and Hahn (2004) by redefining the opportunity costs. Furthermore, a practical application is presented and discussed in which the sustainable value creation of a PIoS system is compared with the conventional market system.

In the subsequent chapter 7 we discuss how PIoS are continuously evolving due to both market forces and changes in understanding of the concept of sustainability. This chapter focuses on the social performance of PIoS and discusses equity-related issues. This is done by analyzing the effects of the emergence of a premium private spot market, where the certification manual is only a license to enter. We also discuss the differential effects on the involved market parties.

The previous parts show that we need a mix of ingredients from different systems to come to more sustainable and value maximizing systems. Taken PIoS as given, we can use them as mechanisms to further close the gap between private and public objectives. To that end the prescription rules have to be adapted. Changing the rules of production will create market effects. In Part 3, consisting of three chapters, we explore how changes in the rules of prescription of PIoS result into changes in the underlying institutional setting of PIoS and in the private utilities of the involved actors. We also investigate how value creation and environmental sustainability can be optimized jointly.
From the introductory chapter we know that PIoS intend to internalize external costs. By changing the certification rules for the environmental better, more external costs are internalized. As these changes need to be implemented at the micro level, the farmer is confronted with higher costs and/or lower outputs. To do this without losing income he will need a price premium. In chapter 8 we design an experiment in which we test certified farmers' willingness to accept changes in the certification rules. The ecologic contribution of these rules is obtained from a multicriteria analysis. By comparing the desired private pay-off structure with the ecological gains, the most favorable pathways can be determined.
Changes in the certification rules can only be implemented successfully when other elements of the institutional setting of the PIoS also change. In the following chapter 9 we describe how changing the rules of prescription is a 2-stage-2-level game. The first stage is a negotiation between players at the rule making level, while the second stage takes place at the rule dependent (farm) level. In a choice experiment the farmer reaction to changes in the PIoS's governance structure, the stakeholders' bargaining position and the purpose of the PIoS are tested and discussed. Chapter 9 explains under which conditions institutional change can lead to more equity among the value chain members.
The sustainable value method discussed in chapter 6 allows for analyzing the sustainable value creation of PIoS given the current resource consumption. For a number of resources our current consumption exceeds the maximum sustainable use. Chapter 10 introduces an efficiency based method that allows for estimating the improvement path for an industry when resource use needs to be further reduced. This improvement path simultaneously reduces resource use and optimizes value creation. In a practical application firms operating in PIoS are compared with conventional firms. In this chapter we also show that there is still room for improvement in sustainable efficiency of PIoS.

Chapter 11 is the concluding chapter. It revisits the hypotheses and brings together the lessons that may be derived for policy makers, practitioners and researchers. In this chapter we also explain the limits of this research and identify alleys for future research.

PART I: Market interest in farm certification systems

In this dissertation private voluntary farm certification systems are studied, as examples of PIoS. In this first part we further position PIoS versus other sustainability oriented strategies and investigate the motivation of private actors to participate in these systems. PIoS differ from other IoS due to their private nature and market orientation. Private market actors engage in these demanding systems in order to create added value. The question is of course whether the market also perceives this added value and is interested in it, as this is a precondition for the success of these systems. In Part 1 this question is investigated. Part 1 consists of three chapters:

- Chapter 2: A qualitative assessment of stakeholders' interest in PIoS – the case of pesticide reduction
- Chapter 3: Consumer interest in PIoS
- Chapter 4: Strategic importance of PIoS for retailers

Chapter 2 indicates why PIoS contribute to environmental and economic sustainability, according to stakeholders. The real environmental performance is investigated in part 2, research question 1. Chapter 3 explains the consumer interest in PIoS, which is an important precondition for value creation within PIoS, futher investigated in part 2, research question 2. Chapter 4 explains the retailers' interest in PIoS, which will be important when investigating equity issues within PIoS (part2, research question 3).

Chapter 2. **A qualitative assessment of stakeholders' interest in PIoS – the case of pesticide reduction**

2.1 Introduction to the chapter

This chapter places PIoS between other strategies to make our production more environmentally friendly. As explained in chapter 1, PIoS differ from IoS due to their private and voluntary nature. We can term the institutions originating at the public level as Public Institutions of Sustainability (PuIoS). The main aim of this chapter is to reveal the mental models of the main stakeholders with respect to PIoS versus PuIoS. This chapter contributes to the discussion on the institutional effectiveness and efficiency of PIoS. In the following chapters 'objective' measures based upon quantitative data are constructed, while this chapter, which is based upon qualitative data, has a more subjective nature, as it discusses the perception of stakeholders with regard to the environmental and economic performance of PIoS compared to other strategies. In chapter 1 the motives of private actors to participate in PIoS are explained. According to Henriques and Sadorsky (2008) these can be brought back to relief from existing environmental regulation (like a burdensome tax), preemption of regulatory threats, or influencing of future regulations; cost-efficiency; improved stakeholder relations; and the possibility of receiving technical assistance in kind or via some kind of incentive mechanism. This chapter will relate the stakeholders' attitude to these motives.

To illustrate the discussion, this chapter focuses on measures aimed at reducing pesticide use in agriculture. In the first section, the research methodology is briefly explained. Secondly, pesticide reduction is associated with enhanced ecosystem sustainability. In a third section, different approaches to secure sustainable production are introduced and the possible role of private initiatives is explained. The chapter ends with a stakeholders' assessment of the contribution of the different strategies to economic and ecologic sustainability.

2.2 Research methodology

The main source of information in this chapter is, apart from the consulted literature and in depth interviews, a series of focus group sessions with stakeholders of public and private institutions of sustainability. From March, 2005 to June, 2005, six focus groups were conducted with the principal stakeholders including the vegetable growers, representatives from the auctions, pressure groups, retail and government. Each focus group covered a different subject and consisted of a different stakeholder group composition, in line with the subject. Table 2.1. reflects the structure of the focus group sessions. Throughout the chapter, wherever relevant, remarkable positions and points of view will be amplified. In general, focus groups are discussion sessions between several stakeholders under supervision of a moderator. The main subject of the discussion is fixed but, within this subject, the discussion topics evolve depending on the stakeholder group composition. The technique is particularly interesting for the exploration of the reasoning behind certain points of view.

In addition private and governmental experts in the field of standards and labelling were consulted and their comments further strengthened (or challenged) the results from the focus groups cycle. These interviews included three meetings with representatives of the Auction of Mechelen, one with a representative of the Brava Auction and one with government officials from the Food Agency. During four user group meetings, the results of this (and related) research were presented to and discussed with a total of 24 representatives from the auctions, retail sector, consumer groups, the farmers' union, government officials and pressure groups.

Table 2.1. Structure of focus group sessions

	Stakeholder type	Subject
Focus group 1	Vegetable growers aligned to 3 different certification schemes * (9)	- motivation for participation in the initiatives - (dis)advantages
Focus group 2	Vegetable growers in FLANDRIAGAP and EUREPGAP (13)	Consequences of participation at farm level
Focus group 3a and Focus group 3b	Certification representatives, auctioneers, retail, consumers and producer organizations (5+4)	- producers' stakes versus other stakeholders' stakes - certification initiatives versus other measures aimed at reducing pesticide use
Focus group 4	Vegetable growers, initiators, auctioneers, retail (6)	driving forces and evolution within the initiative
Focus group 5	All involved stakeholders (13)	feed back and discussion

Number of participants in parentheses
* Biogarantie, FLANDRIA and GlobalGAP

In this chapter we mainly use the information from focus group sessions 3a and 3b relating to the discussion topic PIoS versus other strategies to reduce pesticide pressure. An extensive report describing the focus group processes, constellation, dynamics and contents is available (Mondelaers et al., 2005).

The use of two focus groups discussing the same question allowed triangulation. The objective of these focus group sessions was explorative research focusing on the associations participants make w.r.t. economic and ecological sustainability of alternative strategies for reduced pesticide use. The participants were representatives from certification organisations, the auctions, retail, producer organisations, consumer organisation and a government agency. A moderator from a professional bureau guided the focus groups along a semi-structured predefined scenario. A secretary indicated main findings on flip charts to structure the discussion. Two different observers made notes, while the process was also video taped. This procedure again allowed triangulation. Although social sustainability was also scheduled, it was only discussed for PIoS, due to time lack.

The different strategies to improve sustainability were identified prior to the focus group, based upon a literature review. The focus group then started with the identification of missing or redundant strategies. In a next step, participants were asked to position the strategies on an axis indicating the contribution to (economic or ecological) sustainability. The group discussions resulted in a final position and a nuanced motivation for this position. In the second part of this chapter both the positions and the participants' argumentation are reflected.

2.3 Sustainable development and pesticide reduction

In this section we briefly recapitulate the concept of sustainable development and relate it to pesticide reduction. Since the beginning of the 1990s a large number of publications have defined and discussed sustainable development (SD). Many of these start from the initial definition by the so-called Bruntland commission, namely that SD is "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (from the World Commission on Environment and Development's report Our

Common Future – Oxford University Press, Oxford, 1987). This definition contains huge challenges as it comprises well-balanced strategies to achieve social, environmental and economic goals. The Belgian Federal Plan for Sustainable Development 2000-2004 indicates that the goals for SD can be divided into the following three groups:

1. **economic goals** for SD should enable to meet the present needs without endangering the needs of the next generations. This implies the adoption of production and consumption patterns which comply with the human needs and which decrease the burden on the environment. This process should search for a balance between production and consumption that overcomes problems of over- or underproduction and over- or underconsumption of certain goods and services;
2. **social goals** for SD should be pursued within and amongst communities, and include an equitable distribution of financial means, natural resources and cultural integration. These social goals urge for strategies to be developed and programmes to be implemented that aim at the decrease and eradication of poverty, the creation of jobs and income (stimulated by a dynamic labour market, promoted by an active labour market policy) and the provision of means and resources for all less/least developed areas over the world;
3. **environmental goals** of SD are defined to ascertain the boundaries of natural resources in its management by taking technological development and institutional structures into account. These goals imply the recognition and respect for ecological norms, priorities for rational use of the environment and the development of national and international laws stipulating the responsibilities for pollution, environmental damage and the compensation for victims of both.

A booming economy producing increasing numbers of goods and services puts a high stress on the environment. Obviously the objectives of economic growth conflict with environmental concerns, with externalities in particular being the major problem. Often, the polluters do not bear the full cost of their actions. The challenge for policy makers is therefore to *"rectify market failures without losing the benefits that the market also brings"* (cf. Cairncross, 2000). Government interference is considered important in the case of environmental sustainability, because external products of agriculture have a collective nature (non-exclusiveness and non-rivalry; everyone enjoys cleaner water, more biodiversity, cleaner air etc.). Private parties will not bear the transaction costs related to reducing the negative external effects of agriculture if other parties can enjoy freely from their efforts (free riders). Every one prefers a cleaner environment, but who will pay for it?

Pesticides have become merely indispensable to maintain the current level of high productivity in conventional agri- and horticulture. The current intensive form of agricultural production is in fact partly realized due to the use of chemical pesticides. Advantages concerning pesticide use include harvest protection (quantity); high-quality production; efficient management (same production each year); stable price-making and production; employment (35.000 employees in EU) and reduction of certain risks (mycotoxins). The intensive production process, however, results into crops being more sensitive to diseases and plagues, creating techno-economic dependency on pesticides. Excessive use of pesticides can lead to undesired side effects because substances are assimilated by non targeted organisms or remain in the environment as residues. The main problems related to the use of pesticides are human toxicity, for the applicator, field worker, bystander and for the consumer (pesticide residues on/in food) on the one hand and environmental problems, such as drift (pollution of surface water, toxicity for aquatic organisms); leaching (pollution of ground water, toxicity for soil organisms); reduction of biodiversity and pseudo-estrogenic effects on the other hand.

The contradiction in case of pesticide usage is the fact that the ones that gain advantage (farmer, industry, consumer) differ from the ones that are at a disadvantage (civilians, consumers, environment, and bystanders). However, pesticide users continue to adapt their practices in response to market and pest pressures. The current drivers include:

- public concerns over the health effects of pesticides including the cocktail effect and bystander exposure;
- consumer sensitivity about pesticide residue levels in food, leading to action by supermarkets and the Food Agency;
- public concern over the impact of pesticides on the environment;
- costs of removing pesticides from water to meet EU drinking water standards;
- legislative measures and proposals including the Water Framework Directive, proposals for new EU laws on pesticide approval, on Maximum Residue Levels and for the EU thematic strategy for sustainable use of pesticides;
- continuing financial pressure on farming;
- pesticide industry consolidation, coupled with the programme of reviewers under Directive 91/414, leading to reduced range of products. This creates particular problems for growers of minor crops in niche markets;
- need to encourage innovation, for example the development of new chemical pesticides with improved safety/efficacy profiles or the development of alternative products and techniques.

The literature review in the next sections gives an overview of the different mechanisms available to guarantee an increase in environmental sustainability. These mechanisms are illustrated on the case of pesticide reduction.

2.4 Institutional context of pesticide use in the fresh vegetable sector

2.4.1 The regulatory framework

On 26 June 2003, EU farm ministers adopted a fundamental reform of the **Common Agricultural Policy** (CAP). The vast majority of subsidies are now paid independently from the volume of production. These new "single farm payments" are linked to the respect of environmental, food safety and animal welfare standards ("cross-compliance"). The reformed CAP aims at a strengthened rural development policy with more EU money, new measures to promote the environment, quality and animal welfare and to help farmers to meet EU production standards starting in 2005.

The European Community has developed a very comprehensive regulatory framework, **Directive 91/414/EEC** defining strict rules for the authorisation of plant protection products (PPPs). The Directive requires very extensive risk assessments for effects on health and environment to be carried out, before a PPP can be placed on the market and used. Community rules also exist that define maximum residue limits (MRLs) on food- and feedstuffs. These regulations focus particularly on the beginning and the end-of-life stages of such products. The actual phase in the life-cycle of plant protection products, which is a central key element for the determination of the risks they pose, is not sufficiently addressed by the existing regulatory framework. With respect to the quality of surface water and ground water, respectively Directive 75/440/EEC and, Directive 80/68/EEC outline the strategy and regulatory framework.

As a complement to the full implementation and review of the effectiveness of the existing legal framework, the concept of thematic strategies was introduced in the 6th Environment Action Programme. In its Communication 'Towards a **Thematic Strategy** on the Sustainable Use of Pesticides' of July 2002, the European Commission launched a broad consultation of all stakeholders and institutions. With the adoption of the Council and the Parliament called for the elaboration of this Thematic Strategy and determined the goalposts and objectives of such a new tool. In particular, the objectives of the thematic strategy are the following:

1. to minimise the hazards and risks to health and environment from the use of pesticides;
2. to improve controls on the use and distribution of pesticides;
3. to reduce the levels of harmful active substances, in particular by replacing the most dangerous by safer (including non-chemical) alternatives;
4. to encourage the use of low-input or pesticide-free crop farming;
5. to establish a transparent system for reporting and monitoring progress including the development of appropriate indicators.

The Thematic Strategy on the sustainable use of pesticides was adopted in 2006 by the European Commission, together with a proposal for a **Framework Directive on the sustainable use of pesticides**. It aims to fill the above mentioned current legislative gap regarding the use-phase of pesticides at EU level through setting minimum rules for the use of pesticides in the Community, so as to reduce risks to human health and the environment from the use of pesticides. Discussions on the Framework Directive on the sustainable use of pesticides (2009/128/EG) started in the European Parliament and the Council in 2006. The Framework Directive 2009/128/EG was accepted in the 2nd semester of 2009. According to this directive, member states have to design national action plans for the reduction of pesticides before 2012. These action plans have to contain target figures.

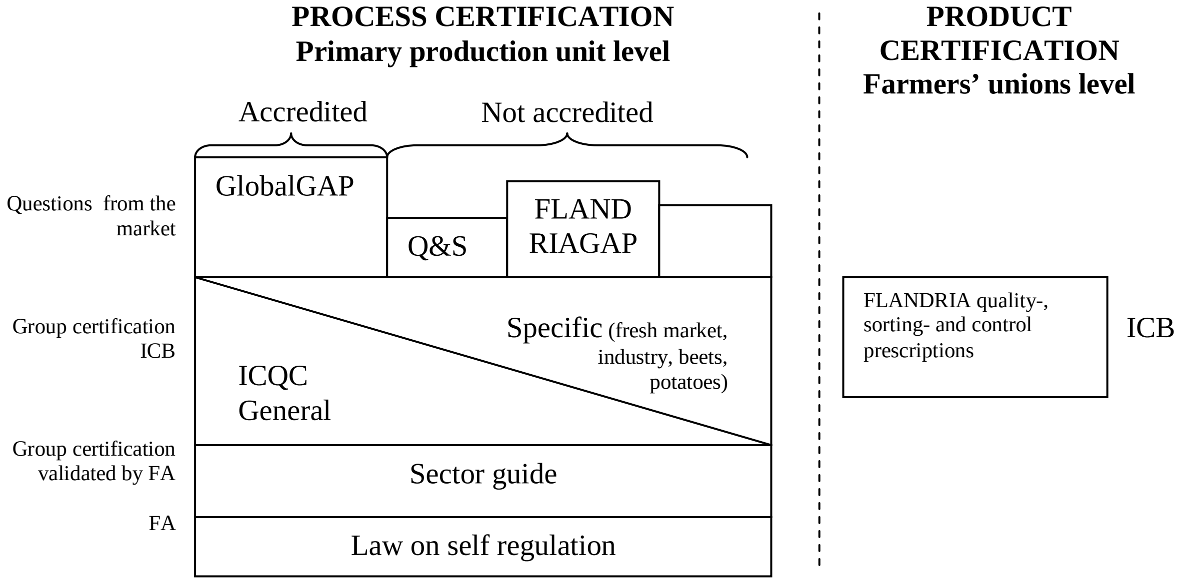
To implement the Directive 91/414/EEG **at the Belgian level**, the following decrees were put in place (see www. phytoweb.fgov.be for a more detailed description):

- RD 28/02/1994 with reference to Plant Protection Products;
- MD 07/04/1995 with reference to Plant Protection Products, amended in 2002;
- RD 08/11/1998 with reference to Protection Certificates;
- RD 13/03/2000 on Maximum Residues

More recently, the RD 22/02/2005 has been approved, outlining the first Belgian reduction programme for plant protection products in agriculture and the use of biocides. The federal reduction programme aims at achieving a more sustainable use of pesticides and a significant general decrease in the risks associated with the use of pesticides, in balance with the necessary plant protection. The programme wants to reduce the negative impact of pesticide use in agriculture with 25% at 2010. To this end several measures are proposed, such as legislative reform, total traceability, improvement of technical measures and additional measures to reduce the presence of pesticide residues. The first actualisation (2007 – 2008) improved the earlier version and defined priority actions for the coming periods.

2.4.2 PIoS in the fresh vegetable sector

Contrary to the meat sector, where control of the public standards is quite straightforward due to the presence of a single regulation in Europe and the capacity of governments to put in place credible monitoring systems (via slaughterhouses), the definition and monitoring of a safety Minimum Quality Standard (MQS) in the fresh vegetable sector, mainly relating to pesticide residues, is more complex. Rather than increased monitoring by increasing public expenditure, European governments prefer to depend on the private sector, increasing their legal responsibility and promoting the emergence of private standards and monitoring of these standards by independent certification bodies (Codron et al., 2005). Figure 2.2 (based upon De Blaiser, 2005) illustrates the institutional context of certification in the Belgian produce sector.



* ICB: Independent Control Body (private)
* FA: the Food Agency (FAVV – AFSCA)
* ICQC: Private Standard for Integral Chain Quality Control
* Q&S: Quality and Certainty: German fresh fruit and vegetable standard

Source: Baised upon De Blaiser (2005)

Figure 2.1: Institutional context of private and public certification initiatives in the produce sector

Process certification standards aim at steering the production process towards better agriculture practices. Product certification standards outline the minimum characteristics to which the end product has to comply. Both on product and process level, the law can be considered as the base line, the minimum product and process requirements. In accordance to the General Food Law (Regulation (EC) 178/2002), Belgium has promulgated a law on self regulation, traceability and notification for the Belgian food and farm sector (RD14/11/2003), valid since 01/01/2005. This law focuses on the preservation of food safety at all stages in the food chain. The primary sector has to comply with a 'light version' of this law, with regulations concerning registration and good hygienic practices, because HACCP-like systems are too demanding for implementation at farm level. Control of this minimum standard is governed by the Food Agency (FA), through an auditing system. The audits are complemented with unannounced controls. Different mechanisms have been put in place to facilitate compliance with the law on self regulation. The most common option for a farmer is to comply with a sector guide, which is (usually) proposed by his sector federation and approved by the FA. Currently, 43 agricultural sectors are preparing sector guides and 20 will be approved before 2011 (www.favv.be). These privately initiated certification books stipulate all the legal demands that have to be met considering food safety, by introducing regulations concerning traceability and registration.

To enhance the general process quality throughout the vegetable chain, major players (from production and processing level in various sectors) have proposed a common production and processing standard (the ICQC – standard; Integral Chain Quality Control). This standard integrates the specifications of the Sector Guide as well as other legal and supralegal prescriptions at stake in the agricultural sector. In the future this standard will be used to cover the production conditions of Flandria (i.e. it will become their process standard), the major certification system for vegetables in Flanders. The past decade, several more restrictive certification standards have been initiated, to comply with the extra demands from market players downstream the food chain, as is the case for GlobalGAP, or for diversification purposes, as is the case for Flandria/FlandriaGAP.

Thus, contemporary agri-food systems are increasingly governed by an array of inter-related public and private standards, both of which are becoming an a priori mandatory part of doing business in supply chains for agricultural and food products, beyond the most basic bulk commodities (Henson and Reardon, 2005).

2.5 Different approaches to secure environmental sustainability

As already explained in the previous chapter, one can distinguish between public and private institutions of sustainability, to address the adverse effects of excessive pesticide usage. Basically, all measures aimed at reducing these effects can be subdivided into four distinctive categories. Two categories principally reside under public authority, while the third is situated in the private sphere. The fourth category, as outlined further in the text, encompasses strategies aimed at increasing knowledge and information dissemination (see Figure 2.1 also).

Policy makers dispose of two different options to implement public regulations. The first one, the Command-and-Control option, is based on the coercive power of the State, in which the public authorities change the structure of property rights and impose regulations aimed at preventing the occurrence of negative externalities or at stimulating the production of positive externalities. Although it certainly has its merits, the Command-and-Control instrument has been heavily criticised, mainly due to its environmental ineffectiveness with respect to certain types of pollution, its weak economic efficiency, the lack of flexibility, the absence of stimulations to innovate and the risks to be trapped in suboptimal technological solutions.

Public authorities can also influence market behaviour through market mechanisms that push the regulated agents to internalise the environmental externalities. These economic instruments (taxes, retributions, subsidies, trading in property rights) make it possible to attribute prices to environmental goods, enabling agents to integrate these in their cost calculations.

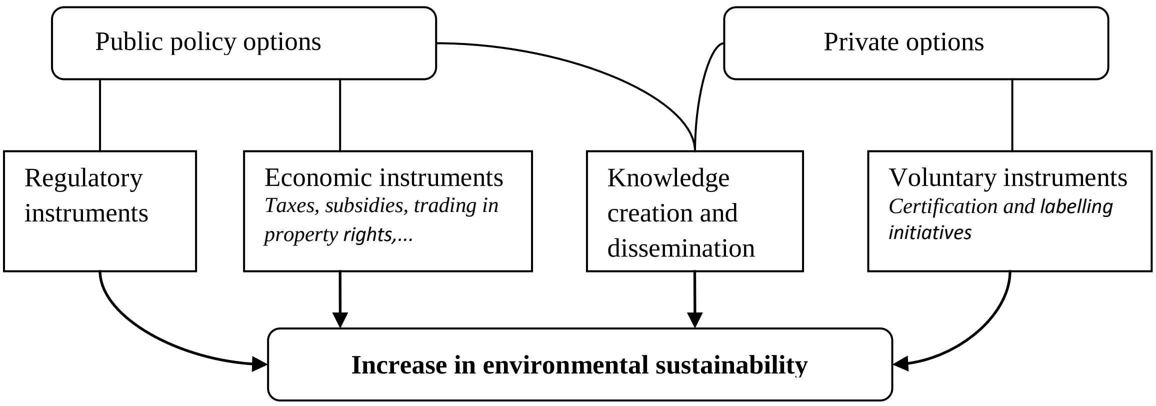


Figure 2.2. Public and private options for an increase in environmental sustainability

The third category corresponds with a more diverse set of options, with as principal and common characteristic its private and voluntary nature. This voluntary character mainly refers to the absence of the use of the State's coercive power, implying that the adoption of the approaches depends on the good-will of the involved actors. These instruments play on the moral responsibility of the actors involved and on the social sanctions to which the latter will be exposed in case of non compliance.

A fourth category focuses on the creation of knowledge and on the reduction of information asymmetry currently present in the market. By stimulating and diffusing technological progress, environmental gains can be realized at low economic costs. These initiatives can be stimulated both by private or public actors.

The next sections outline the different instruments both at the public and private level now (or potentially) applied in the field of pesticide use regulation. We start with explaining the specific institutional context of private voluntary certification in the Belgian fruit and vegetable sector.

2.5.1 Command-and-control measures

In the case of environmental policy, the command-and-control approach consists of relying on public standards to bring about improvements in environmental quality (Field, 1994). One can distinguish between ambient standards, referring to a maximum level for some pollutant in the ambient environment; emission standards, which are maximum levels of emissions directly originating from the pollution resource; and technology standards, which specify the technologies or practices that polluters have to adopt. The former two types are performance standards which regulate the output. Each farmer can, in function of his personal preferences, individually determine how to remain below the prescribed output. The technology standard is a design standard, which prescribes the path the farmers have to take. These standards are more easily controllable for the official bodies, but flexibility is lost for the individual farmers. Under this scenario the incentives for finding cheaper ways of reducing emissions are effectively zero. Additionally, uniform design standards across all farmers impose high costs to farmers due to differences in farm structure.

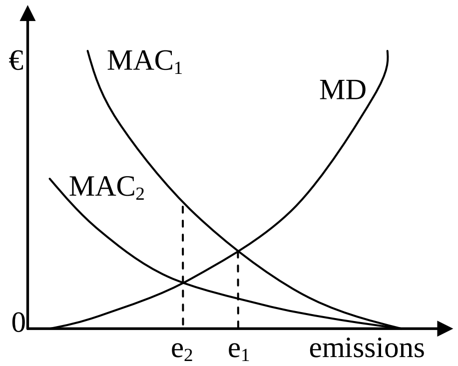


Figure 2.3. Emission standard e_1 and e_2. In case of an efficient emission standard e_1, marginal damage (MD) equals marginal abatement cost (MAC). MAC_2 shows how technological progress can be cost saving

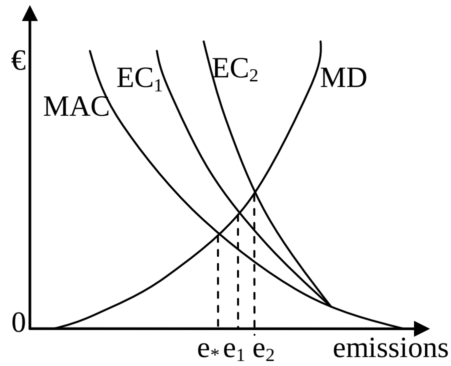


Figure 2.4. Emission standard e in the presence of low (EC_1) and high (EC_2) enforcement costs. Based upon Fields (1994).

When setting standards the question is whether only damages should be taken into account or also abatement costs. Figure 2.3 shows the setting of an efficient emission standard at emission level e_1, the level where marginal abatement costs of firm 1 (MAC_1) equal marginal environmental damage. When the emission level is set to e_2, firm 1 faces higher costs than the cost of the damage. Progress in technology can further reduce firm 1's abatement costs (curve

MAC_2). To identify free riders, public authorities need to monitor and control the standards, which brings about associated costs. Figure 2.4 shows the impact of enforcement costs on the optimal emission level. Higher enforcement costs increase the tolerable emission level.

Future legislative options for the Belgian policy makers to further regulate the use of plant protection products, comprise of adding new measures to the current regulatory framework and adapting the current measures. Additional constraints can be imposed to producers based on type of pesticides, equipment, time of application and regional zones. Adherence should than be checked using an efficient and effective control system.

To regulate the availability of chemical pesticides, several options can be pointed out:

1. ***Pesticides*** could be obtained ***on prescription***. This system is considered fairly bureaucratic and too time-consuming for the farmer (hence costly).
2. ***Pesticide input quotas***. At national level, an upper boundary on each group of active ingredients could be imposed. Based upon current and historical data, farmers obtain a quota per active ingredient group: restrictions can be imposed on company or field level.
3. ***Transferable quotas*** (although this can be considered as a market mechanism) from year to year and between different farmers are an option, because application of pesticide doses is function of the climate, the pest population etc. In sales centres, farmers' purchases have to be administered.
4. ***Credit system***: farmers receive a total of for example 10 credits per crop. When using a pesticide classified as dangerous, some points are deducted. Fewer points are lost when using less harmful pesticides. A negative score is permitted, as long as the farmer remains below the prescribed level of active ingredients. Compensatory measures, such as an extended buffer zone, the use of green electricity and habitat management should then be integrated. This system is considered as rather complex due to the compensation measures. This system is applied in AMK (Agro-Environmental Label, The Netherlands), as documented by Manhoudt et al. (2002).

The current system starts from approval and registration. As the construction of standards is dominated by eco-scientists, who focus on risk minimization, the economic consequences are largely neglected. A danger exists of overuse of the approved pesticides, leading to pest resistance. A more restrictive legislation is considered harmful for the agricultural sector, which is already under high pressure. A combination of a more restrictive legislation with a legislation more adapted to producers' wishes and possibilities could be a better solution.

2.5.2 Economic instruments for public policy makers

Up to now, the negative external effects of agriculture are only to a limited extend incorporated in the product prices. In the case of environmental goods, government intervention could influence market actors' behaviour. Different policy measures influencing market mechanisms, both compulsory and non compulsory, can be identified.

At producers' level, ***subsidies*** can be used to correct for the economic loss caused by measures aimed at increasing environmental sustainability. Agri-environmental measures (EU's sixth environment action programme) for example offer support for commitments on keeping records of actual use of pesticides, lower use of pesticides to protect soil, water, air and biodiversity, the use of integrated pest management techniques and conversion to organic farming. The problem with this kind of subsidies is that those who participate are not the biggest polluters. Craincross (2000) argues that subsidies in agriculture, while increasing production of a limited number of crops, decrease biodiversity and can become harmful for the environment. An environmental policy for sustainable development could therefore better aim at reducing the subsidies which endanger the environment. This would reduce incentives to overuse natural resources, as well as increase the efficiency of the economy because the market would not be distorted anymore and market prices would reflect the true value of goods and services. At sector level, the State can reduce the price difference between environmentally sound products and conventional products, by subsidizing the sales of the environmentally sound products. These subsidies can be appointed to the processors of these products, because this is easily administrable (due to the relatively small number of processors). The problem in this case is whether and to what extent the decrease in prices will be visible at consumers' level. Another possibility is a direct cut in consumer prices at retail level. A financially and administratively less demanding option is the sponsoring of advertisement campaigns.

Taxes and charges aim at forcing the polluters to pay, and thereby overcoming externalities. Polluters are charged for the use of natural resources. The Belgian Federal Plan for Sustainable Development includes a number of tax measures to reduce the environmental burden of some industries, i.e. (1) taxes on unwanted social or ecological ways of producing and consuming and/or tax reductions on desirable production and consumption patterns; and (2) shifting the base on which taxes are calculated from labour to the level of use of environmental resources. Regulating taxes can be based upon the number of pollution units per hectare or farm (for example quantity of pesticides in water). The underlying idea is that external effects are valorised and integrated in the company costs, according to the 'polluter pays' principle. This relates back to the famous Pigouvian tax. Pigou (1920) stated that the negative externalities caused by pollution would be internalized by the market if polluters paid a tax equal to the marginal social cost of polluting emissions.

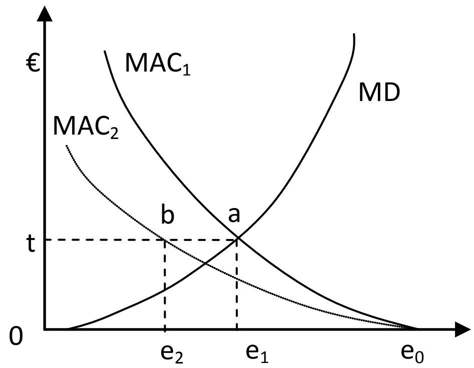


Figure 2.5. Tax t on emission level e_1. A firm's total costs for emission control are abatement costs from e_0 up to point e_1 (triangle e_0-e_1-a) and total tax payment (rectangle e_1-0-t-a) for firm with MAC_1

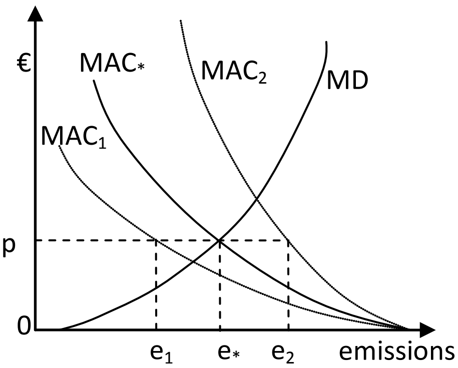


Figure 2.6. Tradable permits. Firm 1 resp. 2 have marginal abatement cost curve 1 (MAC1) and 2 (MAC2). p is the price for a tradable permit, i.e. where supply and demand of permits meet. Firm 1 buys permits up to point e_1. It is cheaper to remove the remainder of costs by abatement. Firm 2 buys permits up to level e_2 and abates the rest of the emissions.

Figure 2.5 depicts this graphically. Opposite to figure 2.3, polluters now not only have to pay the abatement cost up to point e_1 (i.e. triangle e_0-e_1-a), they also pay a tax (rectangle e_1-0-t-a). Farmers who can easily adapt their production process, will do so by investing in pollution reduction measures, to reduce the tax amount they have to pay. The rest will pay the full tax amount. In figure 2.5, firm 2 with technologically superior marginal abatement cost curve 2 (MAC_2) will pay less than firm 1 with MAC_1 (0-t-b-e_2 + e_2-b-e_0 versus 0-t-a-e_1 + e_1-a-e_0). This system offers the farmers a choice between changing the production process and paying the tax. This system also stimulates innovation. One of the main difficulties with the regulating tax is the correct definition of the relationship between tax level and pollution level. When it is too difficult to calculate the exact amount of pollution units per farm, the inputs (pesticides), the production process (conventional versus integrated versus organic) or the output (f.e. number of conventionally produced potatoes) can be taxed. These measures aim at generating tax incomes, which can be refunded to the market.

Vat-differentiation at consumer level is another, similar, policy option influencing market behaviour. According to the degree of ecological efforts, the different production process strategies (f.e. conventional versus integrated versus organic farming) could be administered a different VAT-level. This strategy causes a major shift in the administration procedures.

Permits, property rights and user rights aim at creating a price for negative effects. The government can administer property rights or user rights to the environment. Hence, a purely collective good becomes a purely individual good. The market actor obtains the exclusive right to use the environment. The government determines the price for the external effect and market actors enter into a contract to regulate the external effects. They are held responsible for the pollution. Permits are to a certain extent comparable with quotas. Permits primarily focus on the output, while the quota system measures the level of active ingredient input. Users of the environment (farmers) are given the possibility to reach a certain level of pollution (confer Manure Action Plan, MAP). A maximum pollution level is determined for the sector as a whole. These permits can also be made transferable. Defining property rights can be a powerful strategy for sustainable development because of the following two reasons: first, people will take more care of an asset which he or she owns compared to one which is communally owned. Communal property can easily lead to a tragedy of the commons. The concept was introduced by Hardin (1986) and is defined as the process where the "*sink capacity is tampered by human contributors without having to pay for such a destruction*" (in Rao, 2000). And second, property rights can be enforced by courts, so that polluters can be imposed a cost for their pollution. Figure 2.6 shows the optimal mix between buying permits and abatement in function of the firm's abatement cost curve.

Producers are risk averse, hence they might exaggerate their use of pesticides to reduce the risk on crop failure. ***Crop insurance*** could be the solution to this. The insurance premium should be lower than the cost for a standard pesticide application. This system is rather difficult because crop damage levels (as well as the causes) are difficult to estimate.

Mandatory labelling as a tool is mainly used when a political consensus is absent concerning the negative effects of a strategy. Good examples are genetically modified crops. The government asks for mandatory labelling in case of asymmetric information (when one party is more informed than another), because consumers have the right to be informed of the product's content. This tool is very efficient in case of a difference in consumer preferences.

2.5.3 Know how and information dissemination

The stimulation of research and the dissemination of knowledge can be regarded as one of the most promising and feasible solutions for the increased use of sustainable practices. The strategy can increase the use of sustainable practices significantly, at a relatively low cost for society. The most important condition should however be that the newly introduced methods and techniques imply a significant (economic) improvement for the implementers.

Organizing ***advice and training for farm managers*** can be successful in case of lack of information or misperception. The starting point should be to get farm managers acquainted with alternative production methods. The strategy could or could not be compulsory, with non-compulsory implicating that only a selective (interested) public will be reached. Problematic is also that alternative production methods, in most cases, impose higher costs to the producers. Implementation will therefore only be achieved when the alternative becomes compulsory or financially attractive. Some examples of alternative methods with a lower environmental pressure do exist. The use of bumblebees for fertilisation purposes is very cost-effective compared to use of man labour, but some pesticides are extremely harmful for the bee population, hence alternative, less environmentally harmful strategies are introduced in horticulture. By financially supporting demonstration projects and after school education (courses, presentations and traineeships), the government tries to fill in the current knowledge gap.

Consumer awareness campaigns can be an appropriate tool to alter consumption patterns in the long run. The recent trend towards ‘green consumerism’ confirms the validity of this approach. The problem is that many consumers are fairly uninterested in making these kinds of choices. They prefer other bodies to take the appropriate measures. Hence, awareness campaigns will demand an elaborated financial (government) investment plan and a long term vision.

Stimulation of research and development is a third promising possibility. New pesticides should be developed with a low level of (harmful) active ingredients and suitable for spot application and new machinery should co-evolve with the pesticide types. To this end, some governmental efforts are essential. Because of the concentration in the pesticide industry, only a few multinational companies are important players in the field. For approval of new kinds of pesticides in the EU member states, the products of these companies have to be evaluated and approved in every country, which makes the process extremely costly. These companies hence don’t invest in economically less important crops, leading to limited options for the farmers. The farmers associations propose an approval system on EU level, based upon climate zones, instead of the country-specific approach. Extra budget should also be released for research concerning alternative production methods (for example new type of crops etc.).

2.5.4 Private Institutions of Sustainability

As this chapter concentrates on pesticide use reduction in the fresh vegetable sector, we introduced some particularities of this sector when describing the institutional context. The PIoS present in this sector are examples of hybrid governance structures (see chapter 1 for a definition), as the market is characterized by multiple relatively small suppliers and some large buyers. The majority of vegetables are traded in one of the six Belgian vegetable auctions. The hybrid governance structures allow intense coordination of the production process and product characteristics of the supplying farms for various reasons (see chapter 7 also). Ménard (2004) describes different examples of hybrid configurations. The PIoS discussed here as multi-actor arrangements share a lot of similarity with the ‘**collective trademarks**’ identified by Ménard. Collective trademarks usually involve backward coordination and are principally initiated by suppliers. Because of the large number of partners involved, the risk of opportunism is high, while monitoring and control are difficult. This is opposite to franchising, where the existence of a franchisor makes the arrangement particularly well fitted to a principal–agent approach. In collective trademarks, the arrangement is most of the time developed by a group of peers, making enforcement particularly challenging. Different types of hybrid PIoS are explained below.

2.5.4.1 Types of hybrid PIoS

All sector members can participate in a single PIoS, by jointly adhering to a ***Minimum Quality Standard (MQS) at sector level*** surpassing the legal requirements. Main reasons are retaining consumer trust and avoiding an impact on the sector due to an isolated crisis. The sector can also impose measures on the sector players to avoid governmental interference, when considered less optimal. This tool is typically used for products difficult to diversify in the market place (such as vegetables and fruits). The MQS in the fruit and vegetable sector is faced with difficulties concerning definition and control (Giraud-Heraud et al., 2003). The risks are only visible in the long run and difficult to identify. Government policy homologated a ban on dangerous active ingredients at EU-level. They also imposed Maximum Residue Levels (MRLs). However, due to the intensification in crop production, the globalisation and the decrease of consumer trust, government control is considered insufficient. Therefore sector players prefer private standards with independent control bodies (integrated in Good Agriculture Practises, GAPs). In the fruit and vegetable sector, the GAPs are privately initiated.

Some sector players can jointly agree on extra product characteristics and standards or ‘impose’ extra standards on their suppliers, as a diversification strategy or as a safety measure. This type of PIoS can be termed ***private voluntary certification.*** The measures are integrated in certification books and in most cases monitored by a third party. After a positive evaluation, producers receive a certificate, which enables them to sell their produce under the specific conditions of the certification initiative. When the certification strategy is accompanied with a label, we speak of Business to Consumer (BtoC) communication, if not, the certification standard is meant for Business to Business (BtoB) communication purposes.

Both ***voluntary labels***, developed by an individual or group of firms with a private objective, and mandatory labelling, issued by the government, with a social objective, try to target the consumers’ behaviour by attracting attention to certain product attributes. A consumer buys a product after clearly evaluating all attributes including search, experience and credence attributes. Search attributes are considered before the actual purchase of the product and are e.g. colour, price, size. Experience attributes are those which consumers perceive after the purchase and use of the product. Consumers attach experience attributes to the product after purchase, while credence attributes are not accurately evaluated. They are better known by the producers than by the consumers, as is the case for environmental or ethical attributes. Grunert (2002) identifies quality labels as a possible solution, giving consumers information about credence characteristics of food products. A third-party assessment is commonly put in place to add to the credibility. The label acts as a proxy for more direct contact between consumer and producer (Golan, Kuchler et al. 2000; Bougherara and Grolleau, 2002). A consumer of labelled products is prepared to pay a premium for the extra attributes of these products. Labelling then increases economic efficiency by helping consumers to target expenditures towards products they most want (Golan et al., 2000). From the producer-firm or government side, the labelling decision is not an easy one because many attributes can be labelled, and it is not easy to know what the many and very different consumers find important. The effectiveness will depend on the type of information involved and the level of distribution of the costs and benefits of proving that information (Golan et al. 2000).

Figure 2.7 shows the PIoS labelling strategy. A polluting firm 1 without private voluntary certification emits e_1 and voluntary abates e_0-e_1. Firm 2 with a private voluntary certification standard emits e*. In order to signal this to buyers a fixed signalling cost of (p_2-p*-b-c) is faced. Avoided societal costs are (e_1-e*-b-d). The economic rent from this strategy must accrue to the signalling and extra abatement cost (p_2-p*-b-c) + (e1-e*-b-a), otherwise firm 2 better follows the strategy of firm 1. Society is better off when the extra fee charged by firm 2 is lower than the avoided marginal damages MD, i.e. when (p2-p*-b-c)+(e1-e*-b-a) < (e1-e*-b-d).

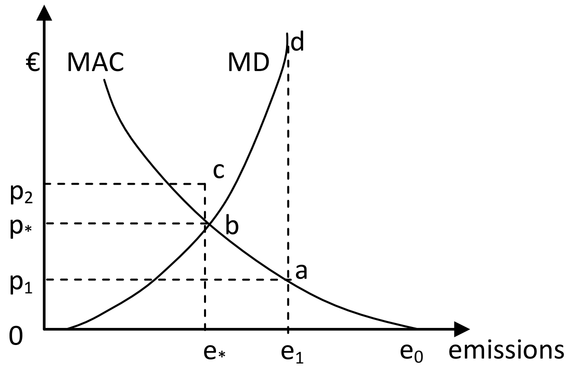


Figure 2.7. PIoS with labelling. Desired emission is e*. Firm 1 without private voluntary certification emits e_1 and voluntary abates e_0-e_1 at a cost of triangle e_0-e_1-a . Firm 2 with a private voluntary certification emits e*. In order to signal this to buyers a fixed extra signalling cost of p*-p_2-b-c is faced .

Possible ***additional strategies*** at the point of sales could be internal cross subsidies on sustainable products in combination with higher margins on non sustainable products; saving and rewarding systems mainly focussing on sustainably produced goods; extra shelf space for sustainable goods (creating a positive retail image); advertisement for sustainably produced goods, financed through a 'tax' on food; no price stunting, except for commodities produced in a sustainable manner.

2.5.4.2 Stakeholders participating in PIoS

Different types of stakeholders are directly and indirectly involved in the hybrid PIoS. We will use the Flandria-initiative as an example for the PIoS-stakeholder configuration. The principal stakeholders in this PIoS are the participating farmers and six Belgian vegetable (and fruit) auctions, united in LAVA (Administrative and Logistic Association of Auctions), and independent controlling bodies (f.e. Certagro). Another closely involved stakeholder is the fruit and vegetable retail and distribution sector. Government, farm suppliers, pressure groups and consumers are more indirectly involved in/influenced by the initiative. The auctions and retailers both fulfil the same role, which is facilitating the transaction between producers and consumers by reducing transaction costs and adding surplus value to the product.

The **producers** implement the certification standards at farm level. On individual level, they have a modest impact on the adaptations in the certification books.

The **auctions**' core business is to ensure that demand matches supply. As promoters of the Flandria certification initiative, they are the main actors in the construction and adaptation process of the certification book. Also part of their duties is motivating farmers to participate in the initiative. Furthermore, they have a consultancy role towards the farmers, amongst other with regard to the certification. They also participate in the communication efforts associated with the initiative. With respect to their customers, they have to guarantee choice, uniformity and quantity. To this end, grading, monitoring and control (both at farm and auction level) are also part of their core businesses.

With respect to certification books, the **retail** initiates and/or subscribes to certification initiatives. Based upon the type of initiative, they formulate extra demands in line with the firm policy and perform additional controls. As final actor in the chain, they have an important role in communicating the advantages of the certified produce towards the end consumer.

The **media**, as a more indirect (i.e. a secondary) stakeholder, plays a vital role with respect to the way the food chain is presented to the general public, taking into account that they have become the primal source of information concerning food (and food scares) for the general public.

Pressure groups (consumer, producer and environmental associations) try to influence the equilibrium in the certification books in a sense that their supporters' stakes are defended the most.

Whether the initiative will survive or not largely depends on the end **consumers**' willingness to buy. This partly depends on factors internal to the initiative, but to the same extend on the attitude of consumers themselves towards more sustainable production practises.

The **governmental bodies** mainly influence the lower boundaries of certification initiatives. With legislation in continuous evolution, certification initiatives on their turn have to evolve in order to at least encompass the base legal level. The FA (Food Agency) checks whether these legal requirements within the food chain are met, irrespective of the type of private certificate already administered to the product or producer. Furthermore, sustainable production practises are financially supported at EU and country level, with a major influence on the persistence of the initiative as such.

2.5.4.3 PIoS and transaction costs

The many stakeholders have complex interrelations of pooling resources and contracting together while simultaneously competing against each other. The pooling of resources creates mutual dependency. Given the possibility of opportunistic behaviour, mechanisms are put in place to reduce uncertainty. The design and implementation of institutions that allow simultaneous coordination and competition creates transaction costs.

As explained earlier, transactions differ in the degree to which relation-specific assets are involved, the amount of uncertainty about the future and about other parties involved, the complexity of trading arrangements and the frequency with which transactions occur. The risk of opportunistic behaviour of the trading partner and the bounded rationality result in high costs in time and resources to search for information on the contracting environment and the firm. In chapter 1 transaction costs are defined as the resources used to define, establish, maintain, and transfer property rights. Main categories of transaction costs relating to PIoS as sets of rules are: costs of information on potential PIoS-partners, costs of preparing and formulating the PIoS-rules, costs of negotiating the terms of the PIoS, costs of monitoring the fulfillment of the PIoS-rules, costs of enforcement of the PIoS-rules, costs of adjusting the PIoS-rules to new conditions.

When designing and implementing PIoS, property right transfers take place at different levels. In the introductory chapter we explained that institutions constitute of different nested levels of rules. We distinguished between 'constitutional choice rules', defining who is eligible to be a participant in crafting the 'collective choice rules' and what rules should be used in crafting these collective choice rules. ‘Collective choice rules’ determine who is eligible at the ‘operational rules’-level and which rules govern the operational rules level. The ‘operational rules’ on its turn are the day to day rules. Ostrom (2005) distinguishes between different types of rules that we can associate with each of these levels. First, ‘boundary rules’ define the attributes and conditions required of those who enter a position in the action arena. These boundary rules define the general position of appropriators from the PIoS. Additional to the position of appropriator, the position of monitor can be created, when outlined in the ‘position rules’. ‘Choice rules’ on their turn determine which assets are under consideration and how these are allocated across appropriators. ‘Pay-off rules’ outlines the incentive mechanism to redirect the appropriations made from the PIoS, with rewards and penalties, such as fines, loss of appropriation rights, legal pursuits etc. ‘Information rules’ define what should be reported. Finally, ‘aggregation rules’ define whose interests are taken into account to what extend when designing and changing the rules. An example could be an equal weight for each appropriator.

At each nested level the different transaction costs identified in the first paragraph can be associated with the different types of rules outlined in paragraph 2. We can first distinguish transaction costs relating to the **design** of the PIoS governance system. For example, when designing the ‘boundary rules’ for the ‘collective choice rule’-level, which is the level where the PIoS-standard is constructed, the actors at the ‘constitutional choice rule’-level will experience different costs. First they experience costs of information on potential appropriators, to determine which stakeholders should be considered for the design of the PIoS-rules. They also experience costs of preparing and formulating the boundary rules, i.e. the time and effort to craft the design rules. Other costs are costs of negotiating the terms of the boundary rules, i.e. which rules will be accepted under which condition, costs of monitoring the fulfillment of the boundary rules, i.e. how to guarantee that the designers remain within the boundary rules, costs of enforcement of the boundary rules, i.e. what to do if the designers neglect the rules, and finally costs of adjusting the boundary rules to new conditions, for example when new exogenous institutions require a new design process.

In the case of the farmer driven Flandria-standard, for the ‘collective choice rule level’ a Redaction Committee is installed. It is composed of technicians from the auctions, and has received the authority from the ‘constitutional choice rule level’ to adapt the Flandria/FlandriaGAP certification standard, after analyzing existing certification books in the market place. At the constitutional choice rule level we find LAVA, as manager of the Flandria standard, who decides upon approval. At this level we also find government officials. These are not involved at redaction level, but they do play a role during accreditation, by checking whether the standards surpass the law and the correct procedures have been taken into account. For the accreditation procedure, an advisory committee is founded, consisting of representatives from environmental movements, the Farmers Union, consumers (Test Aankoop), two universities and the Belgian Federation of Distribution enterprises (FEDIS). The committee’s advice is not binding, but repeated denial will result into non accreditation from the Belgian Organisation for Accreditation (BELAC). The Flandria standard covers both product and process certification, which are independently certified. The process certification is based upon the ICQM-standard (Integral Chain Quality Management), supervised by VegaPlan vzw. The product quality is independently certified. The average producer has no direct impact on the rules and formulations in the cahier de charge. To avoid unrealistic instruction books, groups of 10 to 20 farmers, together with 2 technicians from the auctions, discuss the practical feasibility and consequences of new rules. Other complaints are normally communicated towards the samplers at auction level. Based upon statistics from these complaints and the control results, adaptations to certain bottleneck rules are made, normally discussed at a monthly reunion of the Redaction Committee.

Transaction costs can also be associated with the **implementation** of the PIoS-rules by the appropriators. As an example, for the farmers subject to the PIoS operational rules transaction costs relate to the information costs to get acquainted with the standard, administrative costs to report adherence to the rules, and investment costs to guarantee that the standard can be met.

Free riding as an important transaction cost

In section 2.5.4.1. we explained that PIoS mainly relate to credence attributes, which are difficult to verify. This opens the possibility for opportunistic behaviour, which is taking selfish advantage of this lack of certainty, by claiming that an attribute is present or absent. A special case of opportunistic behaviour is free riding. Free riding is enjoying the benefits from an action while not bearing the costs. It typically occurs when multiple actors are involved in a collective action. In theory, free riding is likely to occur when compliance costs are high relative to the penalty and when control mechanisms are weak and easy to evade. A trade-off has to be made between the cost of free riding versus the cost of increased monitoring and control.

The (potentially very high) cost of free riding is the loss of credibility and reputation of the PIoS. The very aim of the PIoS is to distinguish itself from non certified production. The product from a free rider claims to be different from non certified products while it is not. Hence there is no validity for setting this claim and accordingly, no legitimate ground for accruing associated benefits. To avoid this cost, a monitoring and control system is put in place. Many options exist and depending on the option, (the different types of) free riding can be avoided more effectively, while costs will also differ.

Free riding can occur external and internal to the certification institution and can be exerted by the institution itself. Internal to the institution we can identify free riding within a stakeholder group versus free riding between groups of stakeholders.

First, we should remember that a PIoS is in fact designed with the very aim to internalize external costs and thus to reduce free riding on public goods. As explained in chapter 1, the PIoS has different incentives to do so. It is however possible that a PIoS claims a non existing internalization and hence is exerting free riding. Note that this is exactly the first hypothesis that we want to test in this dissertation. There are different institutions put in place to counter this. A legal framework identifies the type of claims that can be made and how these have to be documented and proved. Second, a certification scheme normally has some kind of monitoring and control procedure (see further), as a guarantee towards stakeholders for the claims made.

Under external free riding we can understand market parties external to the PIoS costless profiting from the efforts of the PIoS. As explained more into depth in chapter 7 and 9, one of the main reasons to install certification schemes is to avoid that averse behaviour of one private actor results into a negative image for all participants in a sector. The dioxin-crisis in Belgium was exemplary. Actors external to the certification scheme cannot use the certification manual as a proof of good conduct. Thus, the certification initiative here acts as safeguard for all those who participate in the scheme. Those who do not can sometimes profit from reputation related spill over effects, when the certification initiatives has a positive influence on the sector's image, but during times of crisis (such as a food scare), the non participants cannot use the certification manual as proof of trust.

Most typical is the internal type of free riding where a producer claims to follow the certification rules but in fact does not. A less obvious type of internal free riding occurs between different stakeholder groups, when one group, f.e. the farmers, bears all the costs for a reputational claim, while another party, f.e. the retailers, free rides on these farmers' efforts to attain this reputation.

Private institutions to avoid free riding

In order to avoid free riding at these different levels, different monitoring and controlling mechanisms are set in place. Verification of the authenticity of a claim made by a PIoS (for example on absence of residues) is performed by the European Food Safety Agency (EFSA) and the Belgian Federal Public Service for Health, Food Chain Safety and Environment.

To reduce internal free riding, as explained earlier, one can distinguish between first, second and third party certification (TPC) (Tanner, 2000). Third-party certifiers are independent from buyers and sellers in agrifood commodity chains. In case of first party certification suppliers audit themselves, while in case of second party certification retailers' paid technicians audit the suppliers. The third party certification is considered to be more reliable as third party certifiers are thought to have no stake in the outcome of the transaction (Golan et al., 2001).

As Hatanaka and Busch (2008) indicate, certifiers or controlling bodies (CBs) offer a combination of services, ranging from establishing standards, verifying the implementation of standards, issuing certification and making periodic audits to ensure continued compliance. Hatanaka and Busch (2008) also distinguish between two types of TPCs depending on whether the CB is accredited or not. If not, the CB sets its own standards and issues certificates based upon these. In the other case, the standards are set by an accreditation body (AB). The CB then needs approval from the accreditation body to provide TPC for certain standards. Normally the accreditation body itself is controlled by a public accreditation body. In the case of Flandria, there is an internal control at the auction level (i.e. second party control) of the vegetables delivered by farmers to the auctions. Additionally, Certagro, as independent CB, has been appointed by LAVA, the owner of Flandria, to perform third party controls. Certagro itself has been accredited by BELAC, the Belgian Organisation for Accreditation. Figure 2.8 shows the different steps before Belgian endive are allowed to be labelled Flandria. First, the farmer launches a request to plant the crop. During the production process the farmer registers several crop related issues, such as crop protection measures applied or fertilization. Before harvesting a residue control is performed by an independent laboratory. If not satisfactory, the harvest is postponed. Else, the crop can be harvested and several other types of control are effectuated at auction level, complemented with a possible farm audit. Only after approval the Flandria label can be used.

Some question marks are placed with respect to the reliability of TPCs, as this might influence the transaction costs. Hatanaka and Busch (2008) argue that CBs, in the pursuit of their competitive business objectives, cannot always guarantee full independency, as they dependent on the audited companies or the ABs for their profit generation. So, although TPC should work transaction cost reducing, there is the hidden danger that real transaction costs increase, as it is uncertain that the standards are met while monitoring costs have to be paid. Furthermore, similar to the recent proliferation of environmental standards and labels, the number of CBs has increased dramatically. Each of these CBs often applies its own rules and standards, as this is their basis for competition with other CBs. This again creates transaction costs for those farmers participating in different PIoS with different CBs, as they have to report the same issues multiple times in a slightly different way. In chapter 9, we return to the monitoring and control issue, when estimating farmers' willingness to accept different types of controls.

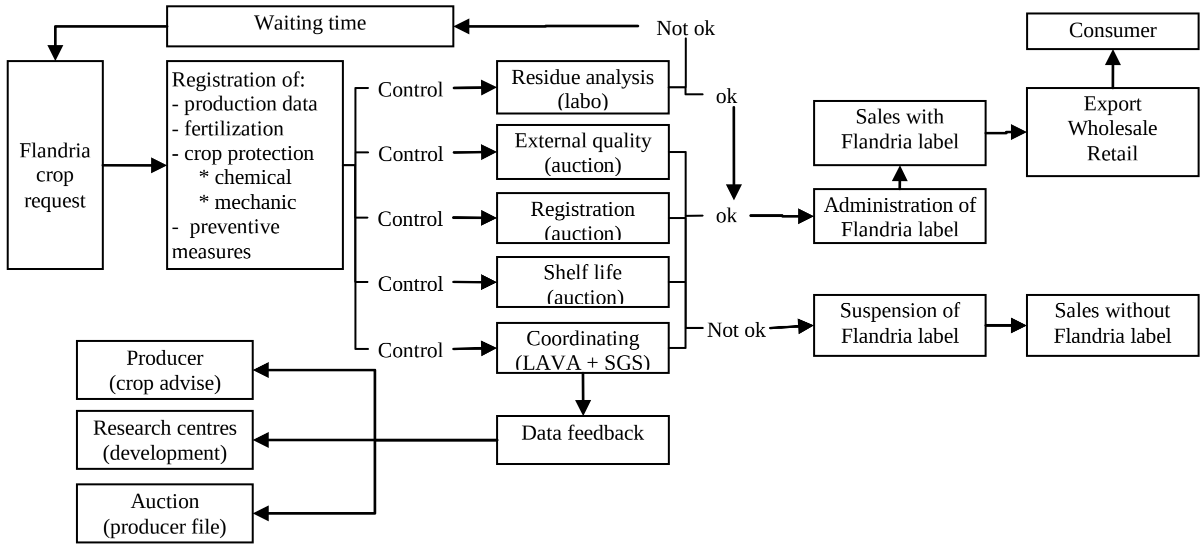


Figure 2.8. Steps before Belgian endive receives the Flandria label (source: LAVA). The coordinating controls are effectuated at farm and at auction level

2.5.4.4 The optimal level of private voluntary internalization – a modelling perspective

The fact that these private voluntary initiatives prevail in the market, indicates that they create added value for different potential beneficiaries ranging from the private producers who implement them, the consumer surplus due to increased quality perception and the society due to a reduction in externalities. The internalization is however limited up to the point that the producers' benefit of the internalization no longer exceeds the costs of internalization. The latter relates not only to increased production costs but also to transaction costs borne to signal the internalization (to consumers, regulators etc). We argue here that, although there might still be some room for further internalization, producers renounce from this extra internalization because the private benefits no longer outweigh the costs. Furthermore this equilibrium situation is only from a metastable nature because due to either increases in the regulatory standards or cost reductions the degree of internalization increases again. Cost reductions at the input side might result from the introduction of new technologies, while transaction cost reductions can occur due to increased consumer awareness.

The model we develop here combines amongst others insights from Lutz et al. (2000), who model quality differentiation in the presence of regulatory standards, Rodríguez-Ibeas (2007), who modelled the link between environmental product differentiation and environmental awareness and Roe and Sheldon (2007), who model the implicational of several policy approaches in the case of credence good labeling. These models are combined to appropriately reflect consumer behaviour in the presence of internalized externalities. We will also extend these models with transaction cost aspects. We will define equilibrium conditions both in prices and quantities for a product that internalizes an externality and a product that does not. In addition we will explore when social welfare profits from the internalization and the conditions for consumer surplus creation.

As is standard in vertical product differentiation models, we consider an industry of 2 firms i ($i=h$ and $i=l$), of which one produces a high quality product (Q_h) and the other a low quality product (Q_l). We assume that the quality difference fully relates to the amount of internalized externalities. As such we can decompose the quality Q_h into the intrinsic product quality Q_l and the internalized externality E_i. To further simplify the reasoning, we assume that both firms face the same costs relating to Q_l, and firm 1 has extra costs to internalize the externality (C_{ei}) and to signal this to the buyer (C_{label}). Firm 1 charges a higher price p_h for its product compared to firm 2 (p_l).

Assume furthermore that there is a continuum of consumers y, uniformly disturbed on the interval [0, 1] with density 1.

Consumer utility for a product is function of the product quality Q, the consumer's income y and the product price p, U=f(Q, y, p). Roe and Sheldon (2007) define consumer utility for a product with quality Q as $U=Q*(y-p)$[7]. They assume that preference for a quality level is driven by income. For products that signal the voluntary integration of an externality, we consider this assumption too restrictive. The proposition of Rodríguez-Ibeas (2006) to distinguish between consumers who care for these extra quality attributes and those who not seems a valuable extension to this model. Logically, for those who care, preference for the 'high' quality product will still remain function of income. The quality of the product with internalized externalities can be decomposed into a part solely relating to the intrinsic product attributes Q_l and a part relating to the externality E_i, in an additive function ($Q_h = Q_l + E_i$). This yields following general expression for consumer utility:

$$U = (Q_l + E_i)(y - p) \quad (1)$$

For the 'low' quality product a price p_l is charged. This enables us to decompose the price p into a component p_l relating to the intrinsic product Q_l and a price component $p_{ei} = p-p_l$ relating to the internalized externality. This makes the utility further decomposable into:

$$U_h = (Q_l + E_i)(y - p_l - p_{ei}) \quad (2)$$

$$U_l = (Q_l)(y - p_l) \quad (3)$$

We assume that the intrinsic preference for internalized externalities is uniformly distributed across the population with percentage α for each income level y. Thus for each y we have $\alpha\%$ of consumers that valuate $E_i>0$ and $(1-\alpha)\%$ consumers that valuate $E_i=0$. For the latter utility becomes $U=Q_l(y-p)$, under the assumption that α and y are, for simplicity, independent. Whether the $\alpha\%$ susceptible to E_i, buy Q_h depends on their income level, as shown in figure 2.9.

A consumer susceptible to the externality and with income level y is indifferent between Q_h and Q_l when $U_h=U_l$. This corresponds to an income level, based upon (2) and (3):

$$y_{indiff} = \left(\frac{Q_l}{E_i} + 1\right) p_{ei} + p_l = \left(\frac{Q_h}{E_i}\right) p_{ei} + p_l \quad (4)$$

Thus, $\alpha\%$ of consumers with $y > y_{indiff}$ will prefer good Q_h over good Q_l, while $(1-\alpha)\%$ will still prefer Q_l.

[7] The choice of a multiplicative form of utility is common in this vein of the vertical differentiation literature

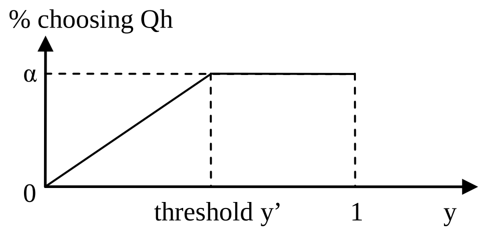


Figure 2.9. Consumers choosing Q_h (=Q_l +Ei) in function of income. From threshold y' onwards, income is no longer restrictive and α% chooses Qh

The firms' demand functions then become:

$$D_h(p_l, p_{ei}, \alpha) = \alpha(y_{max} - y_{indiff}) = \alpha\left[y_{max} - \left(\left(\frac{Q_l}{E_i} + 1\right)p_{ei} + p_l\right)\right] \quad (5)$$

$$D_l(p_l, p_{ei}, \alpha) = (1-\alpha)(y_{max} - y_{indiff}) + (y_{indiff} - p_l) = (1-\alpha)y_{max} + \alpha y_{indiff} - p_l$$
$$= (1-\alpha)y_{max} + \alpha\left(\frac{Q_l}{E_i} + 1\right)p_{ei} - (1-\alpha)p_l$$

Consumers with income $y<p_l$ will not buy the product Q_l.

Firm H's cost for internalizing the externality is $C(E_i)$. We can safely assume that this cost is convex in E_i and 0 if $E_i=0$, which makes following representation appropriate:
$C(E_i) = \beta(E_i)^2$
Furthermore, firm H faces fixed quality signaling costs C_{label} (for $E_i>0$). The only difference in costs between firm H and firm L relates to the internalization, so we can assume away costs relating to Q_l. Profit functions for the two firms now become:

$$\pi_H = (p_{ei} + p_l)\alpha\left[y_{max} - \left(\left(\frac{Q_l}{E_i} + 1\right)p_{ei} + p_l\right)\right] - \beta(E_i)^2 - C_{label}$$

$$\pi_L = p_l\left[(1-\alpha)(y_{max} - p_l) + \alpha\left(\frac{Q_l}{E_i} + 1\right)p_{ei}\right]$$

By taking the first order conditions of these profit functions, i.e. by differentiating them with respect to p_{ei} and p_l resp., we can obtain the Bertrand-Nash equilibrium[8]:

$$p_{ei} = f\left(y_{max}, \alpha, \frac{Q_h}{E_i}\right)$$
$$p_l = f\left(y_{max}, \alpha, \frac{Q_h}{E_i}\right)$$

From these equilibrium prices we see that both price p_{ei} and p_l are, apart from α and y_{max}, function of the ratio between Q_h and E_i, or the total quality level versus the extra quality due to the internalized externality.
For firm H to remain profitable, costs of internalization should not exceed benefits:

$$(p_{ei} + p_l)\alpha\left[y_{max} - \left(\left(\frac{Q_l}{E_i} + 1\right)p_{ei} + p_l\right)\right] > \beta(E_i)^2 + C_{label}$$

For firm H, y_{max}, the quality of the base product Q_l versus E_i and α determine the profitability.

As we now have a representation for equilibrium prices and demands, we can focus on the aggregate social welfare contribution of the private voluntary internalization of the externality. Confer Rodriguèz-Ibeas (2007), assume a fixed societal cost γ per marginal unit of externality. Social welfare consists of consumer surplus, producers' profit and net of social damage avoided versus created. E_{tot} signifies the total external damage when only Q_l is produced by firm H and firm L.

[8] the complex result goes beyond the expository objective of this chapter

$W(E_i, \alpha) = CS(E_i, \alpha) + \sum \pi_i\,(E_i, \alpha) - \gamma(E_{tot} - E_i)$
The question is now whether more welfare is created compared to the case without private internalization of externalities, confer the equation below:
$W(Q_l) = CS(Q_l) + \sum \pi_i\,(Q_l) - \gamma E_{tot}$
This will primarily depend on E_i, α and γ.

In this dissertation we will show different ways to calculate and approximate IE, α and γ. Internalized Externalities (IE) refers to the externalities which PIoS internalize compared to conventional systems. It thus relates to the environmental or social surplus value created by PIoS. This is addressed in chapter 5 (and 6). Alpha (α) on its turn relates to the consumer interst in these kind of systems. Chapter 3 focuses on this question. Gamma (γ) on its turn is the societal cost for removing externalities. In chapter 8 we show how the willingness to accept of farmers can be used to approximate this societal cost.

2.6 Sector players' attitude towards PIoS versus alternative strategies for enhanced ecological sustainability

During focus groups organised with different sector players, a selection of the strategies outlined above were extensively discussed with the participants. In addition, sector players were asked to formulate missing strategies and to jointly scale the strategies based upon their contribution towards ecological sustainability. In the mean time, sector players were asked whether the strategies are economically viable for the sector. The different sector players questioned are: promoters of a labelling initiative and representatives of the Administration and of producers, retailers, consumers and the auctions.

Figure 2.10 shows the perceived contribution of each initiative towards ecologic sustainability and the economic viability according to the participants. This figure should be interpreted as indicative, given the complexity of this subject. This figure is based upon qualitative information, hence the distance and level of contribution are only informative.

The focus groups participants were asked to identify additional strategies above those presented by the researchers. The following were commonly agreed upon:

- Short supply chain projects with direct communication between producers and consumers;
- The stimulation of farmers' awareness, resulting in more compliance with the laws;
- Adapted legislation instead of more restrictive legislation: extra restrictions aren't necessary, the legislation should be more in line with the reality in the field, improving compliance.
- Regional labels;
- More follow up from government (i.e. more and more appropriate controls)

2.6.1 Contribution towards ecological sustainability

According to the stakeholders, PIoS, in the form of ***voluntary labels*** (f.e. Flandria) and ***certification books*** (f.e. EurepGAP), are both an equally interesting tool for stimulating ecological sustainability. Within the different labelling initiatives, the sector players identify major differences in contribution towards sustainability. Organic labelling for example is perceived as highly favourable for ecological sustainability. On the other hand, the scale of

the initiative is also important, with scale referring to the number of participants. Some labelling initiatives are less restrictive compared to organic production, but their number of members widely exceeds the organic label membership, hence their overall contribution towards sustainability may be larger.
In chapter 1 we listed some references with respect to ecological sustainability contribution of PIoS, which gave a rather mixed impression, especially because implementing a rule not necessary results into a measurable environmental effect.

The ***Label-with–credits*** system is a variation of the credit system explained under the section Command-and-control measures. This system is, according to the stakeholders, perceived far too complex to be workable in practice. Labelling and certification systems evolve continuously. To adapt the complex label-with-credits system on a timely basis seems very laborious and it is likely to result in difficulties for the farmers to keep track of it. The advantage is that farmers can position themselves versus other farmers, as they have an exact measure of their contribution to ecological sustainability. From the perspective of excess usage reduction, this system clearly seems ecologically advantageous, because farmers' excessive use of harmful products is punished. Potentially pesticide use will increase for those farmers who didn't reach their upper limit yet.
Manhoudt et al. (2002) have a similar opinion about the credit system used in the AMK standard. They consider the credit system to be very complex. The option of compensating pesticide use with credits earned for other management activities substantially reduces the transparency of the system, especially as every farmer has a different pesticide application schedule, they argue.

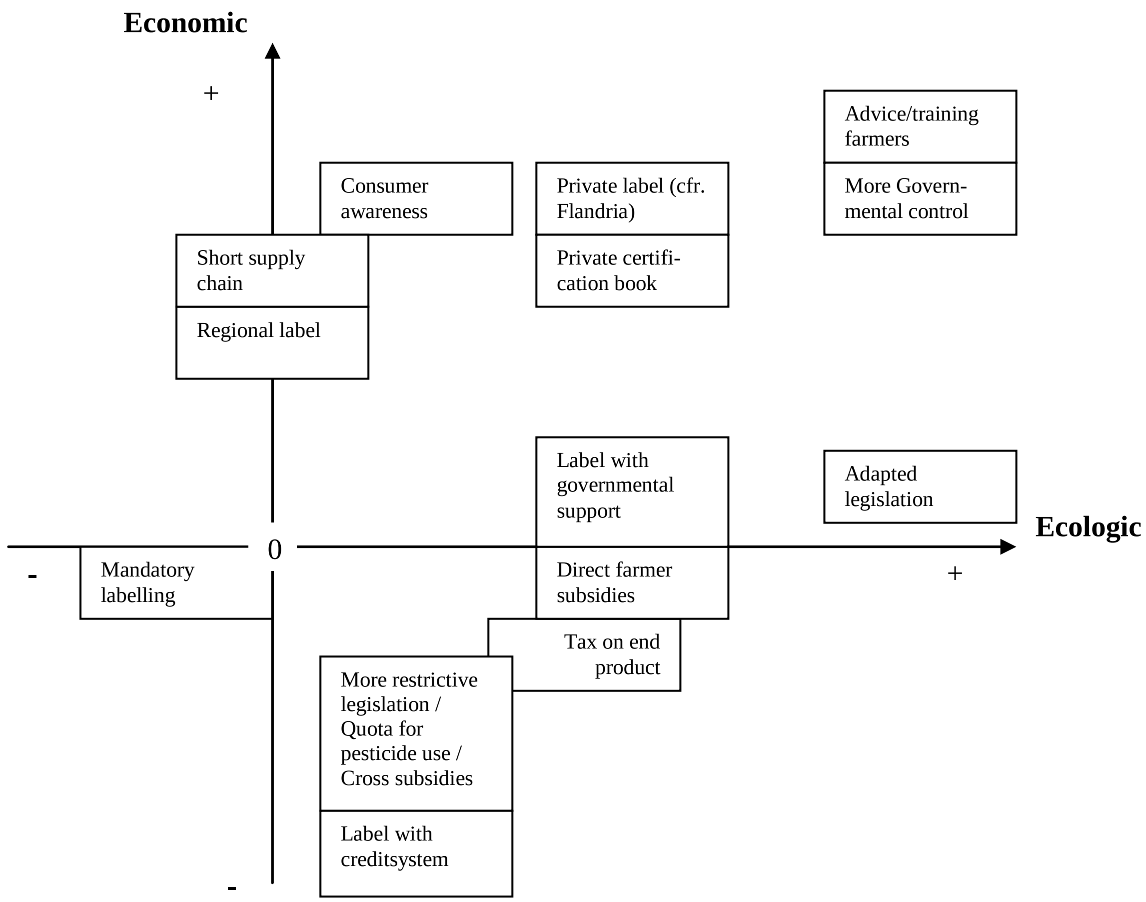


Figure 2.10: Contribution of different strategies towards ecological and economic sustainability

According to the stakeholders, both ***more restrictive*** and ***adapted legislation*** have a positive impact on ecological sustainability. When the legislation becomes too severe, agriculture is no longer profitable, hence an adapted legislation is perceived as a better tool. The focus group members argue that the legislation should not be restricted further, to give market initiatives the possibility 'to breath'. A more restrictive legislation can only work when it is applied all over the world. Another problem is the increased possibility of non-compliance and shifting away towards uncovered areas. High public costs for monitoring and control are therefore associated with more restrictive legislation. Adapted legislation means taking the production circumstances into account. An example: nowadays there is a fertilization stop starting from August 31st. When September is very rainy, all fertilizers leach out in the groundwater. In that case, spreading the application of fertilizers is more effective and less harmful. However, in case of dry weather, this law is very effective.

The stakeholders notice a clear ecological effect of ***subsidy, tax*** and ***VAT-differentiation measures***, which is more directly measurable compared to voluntary labelling initiatives, because an increase in price reduces the demand. The problem with taxes is that, if they are not imposed on every product, they will always be evaded. They should also be imposed at the European level, otherwise farmers purchase pesticides in neighbouring countries. In case of a VAT-differentiation, it is very difficult to quantify the exact height of the levy. Another problem could be the building up of stocks when the tax is announced.

Creating consumer awareness is considered successful when it leads to a change in purchasing behaviour. The impact is considered rather small because alerting consumers is very difficult. The consumer does not want to make this decision, other people should perform this task (f.e. by imposing a more restrictive legislation). The effect will only be measurable in the long run. A circular reasoning can be made: labels are not successful because the consumer is uninterested, and the consumer is uninterested because labels are not well communicated.

Because farmers are the prime actors affected by strategies aiming at a change in pesticide use, all participants perceive ***increasing farmers' awareness*** as essential for enhanced sustainability. The measure does not affect the target group financially, hence acceptance and success will be more than reasonable. New developments should be demonstrated by means of effective field tests. An example is a control field with calendar spraying versus a field sprayed only after monitoring. Farmers will believe the effectiveness of a measure when proof is delivered in practice.

Because of the decrease in transportation distances, the contribution of ***short supply chains*** to ecologic sustainability is considered reasonable. In many cases, product packaging is also diminished, also decreasing the environmental burden. This system is only suited for a part of the producers and chain members, hence its impact will remain rather small.

Regional labelling does not directly affect ecologic sustainability regarding pesticide use. It can motivate consumers to purchase locally produced food, reducing the transportation burden. A lot depends on the prescriptions in the 'cahier de charge'.

Some participants do not perceive ***quota on pesticides/active ingredients*** as ecologically sustainable, because farmers will always try to use their full quota. Concerning the amount of pesticides allowed, the legal standard is probably the reference, hence the contribution of this system can be considered equal to the legal situation.

Direct subsidies for farmers will have ecological benefits in the short run. If it results in changing the attitude of the participants, the long run effect can also be positive. The system 'observe and alert[9]' is a good example.

In theory, the system of ***cross subsidies*** seems very suitable and promising for shifting consumption in a more environmentally sound direction. In practice however, this system is regarded as not applicable. Retailers fear difficult negotiations with suppliers and non cooperation of competitors.

With ***better governmental monitoring and control***, participants mean more controls, and more effective controls, predominantly aimed at the group of 'free riding farmers'. The contribution towards ecological sustainability seems important, because it will eradicate current misuses effectively. The polluters will be punished, instead of the farmer community as a whole or the consumers. The measure is also less visible (compared to a change in price f.e.), hence acceptance will be larger. Problems are the time consuming controls, the administrative burden for the farmers, and the financing of the system. A penalty system could solve this last problem.

2.6.2 Contribution towards economic sustainability

The private voluntary ***label*** strategy can be an improvement in the field of economic sustainability. The Flandria-label for example adds surplus value to the product, it covers an extensive product range, it is well accepted in the domestic and export market and it groups the major part of Flemish vegetable growers among other things. Quality of GlobalGAP products is lower compared to FlandriaGAP products, but market certainty is equal for both certification schemes. Flandria is perceived as socio-economically more interesting than GlobalGAP, because farmers perceive a private cahier de charge (GlobalGAP) as an obligation, while participating in a farmer driven label (Flandria) is considered as an honour. The label stresses the distinctive features of the product. A cahier de charge without label is also interesting for farmers when it is widely accepted in the market place and when it offers new marketing opportunities.

According to the focus group members, a ***label with governmental support*** is not giving enough market impulses to be viable in the long run. It is not because of governmental support that a label will be more economically viable. In the early stage, governmental support can be defendable to cover initiation costs. For example, the governmental support for communication is larger for organic products compared to Flandria (in percentage of the total private budget for communication). Whether this will result in continuation of organic farming will depend on the quality of the support provided. The participants face some difficulties with placing this initiative on the economic axis, because the effect can be either positive or negative. Players do agree that a label with governmental support has more chances. A lot of labels result from private initiatives, but their growth rates largely depend on the reception of governmental support.

Because the ***label-with-credits*** system is too difficult to explain, to implement and to monitor, it is perceived as not viable. It is also technically not workable. The administrative burden is

[9] Pest development on crops is monitored in special field trials. When the economic damage threshold is nearly reached, warning messages are given to farmers with these crops

quite large for the farmer and the controlling body. It is also too flexible, creating uncertainty for the farmers. Moreover, the system is too detailed. Every instruction book works per definition with one or another coding system, which is a mixture between workability and accurateness. This strategy is also very difficult to explain to the consumer. Because of the multitude of variables in food systems, the points system is not feasible. In the extreme case, a farmer has to choose between losing his crop and being punished.

A ***more restrictive legislation*** will have an adverse effect according to the stakeholders. With the level of severity, adherence becomes more difficult and cheating more common. The only advantage is that measures for enhanced ecological sustainability are expanded to every farmer, resulting in a more equal distribution of the burden. This situation is comparable with the Flemish environmental policy. This policy is too extensive, resulting in a contra productive effect. Market actors reason: *'To be able to drive 60 on average, one must accelerate to 70 from time to time'*. Climatologic circumstances should also be given proper attention. A product that cannot be produced in Belgium, due to a restrictive legislation, will be imported, resulting in a worse off situation for ecological sustainability (due to transportation). The consumer wants to have everything at his/her disposal, at any time. ***Adapted legislation*** is considered more neutral, as it is more giving and taking. Administration, for example, is labour intensive, but in the end it is time and cost saving. Another example is the necessity for a unified pesticide regulation per climate zone at the EU level. The European and international legislative prescriptions should be taken into account before imposing a more restrictive policy. Adaptation of legislation will result in lower investment costs.

For Methyl Bromide (MeBr) a kind of ***quota*** existed in Belgium (however, since 1/01/2006 it has been prohibited in Belgium). Because no alternative pesticides exist, the economic effects are disadvantageous, but the ecologic consequences are very positive. One should distinguish quota on resources (pesticides) from quota on production quantity. The focus group members fear that, in the latter case, a black market for the product will be created. Another distinction should be made between quota and managing the quota in a sustainable manner. If, for example, a farmer spills his complete quota in the creek at the border of his production area, ecologic sustainability will be worse off. Typically, every farmer will have used the full amount of his quota each year. Players regard this strategy as economically neutral. An international quota on the resources will result in an ecological advantage, but a quota per hectare (f.e. for the management of Phytophtora) will create an economically unviable situation at micro level.

A ***VAT-differentiation*** (VAT = Value Added Tax) for sustainable products is considered economically advantageous. For organic products, price is a determining factor in the purchase decision, so for these products this system would be favourable. As demonstrated in numerous quantitative studies, price is considered as a key determining factor for the 'average' consumer, therefore economic viability of the more ecologically inspired initiatives will most likely improve. In this case, integrated farming schemes such as Flandria will probably be positioned between organic and conventional farming. Because of the unstable political environment (changing ministers every 4 years), the tax levels could change continuously. Another option is levying taxes on the production resources (f.e. on pesticides). The influence on farmers' economic situation will be negative, because the surplus prices at factor level will probably not result in higher prices downstream.

According to the focus group participants, the process of ***creating consumer awareness*** is considered very slow, hence the effects will only be visible in the long run. The stakeholders suggest that integration of certain topics, such as reading labels, in the education program of pupils could be a means. Normally, awareness should be created mainly through the product label, but consumers are generally uninterested in the extra information on the package. Two questions are at stake: do consumers understand the extra information and aren't they frightened by it? A good example are the E-numbers, the consumer does not understand these. Another problem associated with the strategy, is the lack of confidence in scientific research. Legislation is based upon solid scientific research (for example in case of MRLs), if extra labelling is necessary the impression is created that policy makers fail in their duties (the creation of reliable standards). Creating awareness concerning production methods seems economically interesting, because a more informed consumer is prepared to pay more. Communication with the consumers should be as clear as possible. In chapter 3 we discuss the consumer awareness after 10 years of Flandria labelling.

Initially, the strategy of ***creating producers' awareness*** triggers costs for the informing and receiving parties, but the optimizations will result into beneficial economic effects in the longer run. The important role of meetings between farmers is also stressed. All participants do agree that this strategy is a must for increased sustainability.

In the case of ***short supply chains***, the producer (seller) acts as a label. This system is considered no better or worse than the auction system. It is a system that will probably remain a niche in the market place. A farmer has to opt for a sales system suitable for his company and his personality. One should not forget that this market form is time consuming, relatively uncertain and more demanding for the farmer (selling skills). It is more direct than the regional label system, resulting in a more stable cooperation between market actors; therefore its economic viability may be higher in the long run.

A ***regional label*** is considered less structured, less coherent as private labelling and certification, because the composition of market actors is more subject to change (each time other industries cooperate together). In the short run it is economically viable, but the question is whether the fragile alliances will last in the long run, resulting in weak sustainability. Because a private label is more structured, it is probably more sustainable compared to regional labels and alliances. The quality difference between products in the same label can be substantial, because the only binding factor is the regional origin. Participants consider the basis too small to be successful.

The environment is one of the four pillars to receive COM-support (support for Common Market Order for fruit and vegetables, mainly given to farmers unions). Environmental criteria are also of major importance for receiving farm level support from the VLIF (Flemish Agriculture Investment Fund). Supporting systems are nowadays usually linked to environmental measures. Participants are convinced of the economic stimulus given by ***subsidies***. They perceive it as comparable to the strategy 'labels with governmental support'. When governmental support for the auctions would be substantially reduced, the sector would be confronted with a serious economic viability problem (which may raise the question whether the auction system is viable in the long run).

The retail sector does not consider the strategy ***cross subsidies*** as economically feasible, because the competition pressure is too high. In smaller retail shops as well, this strategy is not workable, because they also face intensive competition and their product range is too small. Similarly, producers will not accept the shift in money.

Governmental control is considered too lax. A good and fair control is advantageous for the honest producers and for the community as a whole. It can also reduce risk occurrence (a good example: pre harvest control in lettuce is currently done by the government). The fine level should also be considerable, otherwise abuse is stimulated.
It should however be noted (as will be indicated in chapter 9) that farmers are generally not very keen on increasing number of controls, whether performed externally or internally. Nowadays, the Food Agency (FA) makes no distinction between producers participating in private schemes or not. The former are also privately controlled (mostly by a third party), the latter not, implying that the latter are far less subject to controls. Typically, the share of free riders is larger in the latter group, because the need for compliance with the private scheme regulations hampers abusive behaviour. The farmers participating in private schemes hence argue for more governmental control within the group of non participants, given that an isolated crisis can influence the sector as a whole.

2.7 Conclusion

Nowadays, different mechanisms operate in the market place to reduce the ecological burden from excessive pesticide use. These mechanisms can be subdivided into 4 distinguishable groups;

1. Know how and information dissemination;
2. Regulatory instruments (e.g. emission standards, product bans), whereby public authorities mandate the environmental performance to be achieved, or the technologies to be used, by firms;
3. Economic instruments (e.g. taxes, tradable permits, refund systems), whereby firms or consumers are given financial incentives to reduce environmental damage;
4. and Voluntary instruments, (e.g. voluntary codes, ecolabelling schemes) whereby firms make commitments to improve their environmental performance beyond what the law demands.

Each of these mechanisms has an impact on both ecologic and economic sustainability. Private voluntary mechanisms are perceived as the new tool for a more market oriented restriction of the resource use. Several changes in the public and private institutional settings have promulgated the introduction and acceptance of various types of voluntary mechanisms. They play on the moral responsibility of the actors involved and on the social sanctions to which the latter will be exposed in case of non compliance.

According to the focus group participants, the contribution of a particular measure to ecological and economic sustainability seems strongly correlated. Some measures with a poor chance of economic survival receive a comparably low score for ecological sustainability (f.e. cross subsidies or more restrictive legislation), although the strategy in practice could prove beneficial for ecology.

The three ecologically most advantageous systems (training and advice for farmers, more governmental control and adapted legislation) can be positioned in the public policy sphere, aiming at an **optimisation of the current policies**. The two economically and ecologically most beneficial systems (training and control) do not require major (financial) adaptations from the market players, instead, the government bears the extra costs. The implementation process for both strategies is also quite uncomplicated, and they result into a direct pay-off.

The other strategies can be considered as **'new' tools**, possibilities in the market place, to shift current practices away from unsustainable behaviour. Private initiatives (such as certification and labels) are perceived as beneficial for sustainability because they are voluntarily initiated by the private sector, hence their market support may be considerably higher compared to governmental initiatives. Private initiatives have an economic purpose, aiming at gaining or keeping a certain market share. When the diversification strategy is based on ecologic features of the product or production process, the contribution towards overall sustainability seems guaranteed.

Chapter 3. **Consumer interest in PIoS**

This chapter is based upon Mondelaers, K., Verbeke, W. and Van Huylenbroeck, G. (2009). Importance of health and environment as quality traits in the buying decision of organic products. British Food Journal, 111 (10), 1120-1139.

3.1 Introduction

This chapter investigates the consumer interest in PIoS, which is an important precondition for the success of the market oriented PIoS. PIoS differ from other commodities based upon their voluntary internalization of externalities. This internalization is not free of costs. Participants in PIoS hope to recover these costs partially or fully by attracting interested consumers. In this chapter an experiment is constructed that tests whether consumers are interested in environmental claims and whether they associate these claims more with products from PIoS compared to other products.

The chapter focuses on organic vegetable products as PIoS-products, as they make the strongest environmental claim. For an overview of consumer attitude towards Flandria labelled vegetables, our other case of PIoS, we refer to the work of Verbeke et al. (2007). This paper addresses consumer attitudes, behaviour and perception towards tomatoes in general, and the Flandria tomato label in particular based on cross-sectional data collected through a self-administered consumer survey (n = 373). Buyers, who constitute 26.8% of the sample, perceive Flandria tomatoes as superior to other tomatoes because of their guarantee of origin, better taste and stricter production control. However, they also report the strongest perception of Flandria as an ordinary tomato as compared to nonbuyer segments. Overall, findings indicate that the Flandria label – after being intensively used for 10 years for a wide range of other fruits and vegetables besides tomatoes – has become fairly standard for tomatoes with little perceived differentiation apart from its certified production and origin.

Consumer food choice is the result of the quality expectations before and quality experience after the purchase. Based on information economics theory, a useful classification of quality dimensions for food, is the division into search, experience, and credence dimensions. Search attributes, such as colour, price and size, are attributes that can be considered before the actual purchase of the product and experience attributes are those which consumers perceive after the purchase and use of the product. While search and experience characteristics can be verified before or during consumption, credence attributes such as environmental impact or animal welfare are not revealed even after consuming the product (Marette et al., 1999). Credence attributes mainly focus on the quality of the production process, and less on the intrinsic characteristics of the product itself. Therefore, quality-of-life issues, such as food ethics, environment and health cannot be verified upon purchase or consumption. In recent years however, these attributes have become more important as components of consumer value (Verbeke et al., 2008). Grunert (2002) mentions quality labels as a possible solution to inform consumers about credence characteristics of food products. A typical process-related quality aspect, and consequently a credence attribute, is organic agriculture (Grunert et al., 2000).

In recent years we can notice an increasing demand for organic produce (Willer and Youssefi, 2007). The reason behind this growing interest is that organic products are perceived as less damaging to the environment and healthier than conventionally grown food products by a growing number of consumers (Chen et al., 2007). Magnusson et al. (2003) also identify concerns for health and for the environment as the two most commonly stated motives for purchasing organic foods with personal health being more important than concerns for the environment (Tregear, et al., 1994; Wandel and Bugge, 1997). According to Magnusson et al. (2003) health and environmental motives differ from each other because the health concern can be regarded as anthropocentric or egoistic (benefits to the individual or his/her family) while consideration for the environment and animal welfare are rather altruistic (benefits to society rather than the individual).

According to Saher et al. (2006), there are indications that opinions about organic farming are from an intuitive nature, with supporters not purely relying on scientific facts but on personal experiences, convictions and beliefs. As explained by Saher et al. (2006), rational and intuitive thinking are the two orthogonal types of information processing, with rational thinking being defined as emotion-free, evidence based reasoning, and intuitive thinking predominantly as building on information sources such as personal experiences and feelings. Given the current lack of systematic scientific evidence arguing in favour of organic credence characteristics, consumers indeed have little other options than to form intuitive quality expectations.

Verhoef (2005) investigated to what extent economic variables (such as price, quality), emotions, social norms and environmental attitudes could explain purchase intention and purchase frequency of organic meat. He concluded that perceived quality positively influences the purchase intention, while purchase frequency is not affected by quality perception. He furthermore finds that green behaviour only weakly influences purchase intention and does not result in increased purchase frequency. As indicated by Roberts et al. (1996) and Wong et al. (1996), the majority of people are not prepared to compromise on other functional characteristics like quality and convenience for a better environment.

This study tests whether and to what extent consumers perceive organic products as healthier and more environmentally friendly than conventional products. We also test whether consumers consider health traits more important than environmental traits. Therefore, a choice experiment with an organic carrot label and two conventional carrot labels containing the same set of quality traits was presented to a sample of Flemish consumers. Relevant search and experience attributes were assumed identical for the three carrot labels. One of the two conventional carrot labels represents a non-branded or generic product, cheaply priced with base level credence attributes.

The main objective of this chapter is thus to analyse whether health and environment related credence attributes are intuitively associated more with organic than with conventional products.

The experiment also allows to test whether the perception concerning these credence attributes differs between organic user groups, as some consumers buy organic more often than others. To reach the traditionally small group of heavy users, choice based sampling was applied. Within this chapter, the following hypotheses, derived from the literature cited above, are tested[10]:

1. Consumers prefer health over environment related quality traits;
2. The organic label plays a significant role in shaping consumers' choice for organic products;
3. Vegetables from organic farming are perceived as healthier and more environmentally friendly than vegetables from conventional farming;
4. Purchase intention (buying or not buying organic products) is mainly driven by health related quality traits;
5. Both health and environmental issues influence purchase frequency, though to a different extent.

3.2 Materials and methods

3.2.1 Methodology

To test the above hypotheses we make use of a stated choice preference experiment and modelling. In such an experiment consumers are placed within a hypothetic choice setting environment in which they are asked to choose their most preferred alternative from a predefined set of alternatives with certain characteristics.

The stated choice preference technique allows an ex ante assessment of both the use and non use value of the main characteristics of a good or service, opposite to revealed preference or contingent valuation, being an ex post analysis method and restricted to goods or services as a whole, respectively. To model choice behaviour by a decision maker (e.g. a consumer), most studies depart from the principles of the **Random Utility Theory** (McFadden, 1974) and the Characteristics Theory of Value (Lancaster, 1966). The latter states that individuals derive utility from the characteristics of goods rather than directly from the goods themselves. Random utility models are derived from assumptions about individuals' evaluation of goods and services. These assumptions about individuals' behaviour are introduced to account for the researcher's inability to fully represent all variables that explain all preferences in an individual's utility function. The random utility hypothesis states that individual agents choose among the available alternatives the one that maximises their utility and that the distribution of choices made in a population is a reflection of the distribution of individual preferences. Therefore, the probability (P_{in}) that a consumer n chooses alternative i (which has an attribute vector X_{in}) from a choice set of J alternatives (in our research limited to three) can be written as (1):

$$P_{in} = P(U_{in}) > P(U_{jn}) for\ all\ j \neq i \quad (1)$$

This equation indicates that a consumer will choose alternative i in the choice set only when this alternative has the highest utility, compared to the other two alternatives in the choice set. The utility function U can be further decomposed into a deterministic part (V), which is a function of the observed factors (the product quality traits incorporated in the experiment), and a stochastic part (ε_{in}). The latter results from unobservable factors which affect choice, unobservable taste variations, measurement errors in the explanatory variables in function V and model specification errors. Because the researcher has no knowledge about ε_{in}, these terms are treated as random, as well as the utility for each alternative.

[10] Please note that these hypotheses do not relate to the hypotheses defined in the conceptual framework.

As introduced by McFadden (1974), the indirect utility function is assumed to be linear in the parameters, and as such, takes the form as in equation (2) for an individual n facing choice i:

$$U_{in} = \alpha_{in} + \beta_n^{'} x_{in} + \varepsilon_{in} \quad (2)$$

The deterministic part can be further decomposed into α_{in}, which is the individual n's intrinsic preference for choice i, x_{in} the vector of attributes of alternative i in the choice set faced by n and β_n the vector of choice parameters, which are the weights associated with the attributes x_{in}. Depending on the assumptions about the error term, different models can be derived. The most general (and restrictive) model, the **Multinomial Logit model**, assumes an identical and independently distributed (iid) Gumbel distributed error term (Train, 2003 in Liljenstolpe, 2005), with the following choice probability (equation 3):

$$P_{in} = \frac{e^{\alpha_{in} + \beta_n^{'} x_{in}}}{\sum_j e^{\alpha_{jn} + \beta_n^{'} x_{jn}}} \quad (3)$$

As described by Liljenstolpe (2005), the conditional Multinomial Logit probability takes a closed form between 0 and 1, and the unconditional Multinomial Logit probability is derived by summing over all respondents and choices:

$$LL(\alpha_{in}, \beta_n) = \sum_{n=1}^{N} \sum_{i=1}^{I} y_{in} \ln P_{in} \quad (4)$$

The dummy variable y_{in} takes value 1 for the chosen alternative and 0 for the non-chosen alternatives. From the first order condition of the log-likelihood function, the model coefficients can be estimated.

An extension to the Multinomial Logit model is the **Nested Logit model**, in which the assumption of iid and Independence for Irrelevant Alternatives (IIA) is relaxed. In the Nested Logit model the alternatives are grouped into subsets, and the variance is allowed to differ across the subsets while the IIA assumption is maintained within the subsets (Shen, 2005). This model allows to test whether the respondent's choice process is sequential, i.e. first based upon one attribute (e.g. organic or not in this study), and within this choice upon the remainder attributes. The assumption is that if the utility functions of two alternatives share a common set of missing attributes, all of which have a similar influence upon the utilities of these two alternatives, then the variance of the unobserved effects for each of those alternatives is likely to be similarly influenced, suggesting that such alternatives are situated in the same branch of a Nested Logit tree (Hensher et al., 2005). If the remainder alternative is influenced by a different set of 'missing' attributes, the variance in its unobserved effects will also differ, providing us with a measure for the appropriate tree structure.

The **Latent Class Logit (LCL) model** is another extension. The underlying theory of the Latent Class model posits that individual behaviour depends on observable attributes and on latent heterogeneity that varies with factors that are unobserved by the analyst. In Latent Class models it is assumed that individuals are implicitly sorted into a set of Q classes. To which class a particular individual belongs is unknown to the analyst, whether known or not to that individual (Greene and Hensher, 2002). The central behavioural model is a logit model for discrete choice among J_i alternatives, by individual i observed in T_i choice situations:

$$P_{it \backslash q} = \frac{exp\,(x_{it}^{'} \beta_q)}{\sum_{j=1}^{J_i} exp\,(x_{it}^{'} \beta_q)} \quad (5)$$

The prior probability for class q for individual i H_{iq}, can be written as (Greene and Hensher, 2002):

$$H_{iq} = \frac{exp\,(z_i^{'} \theta_q)}{\sum_{q=1}^{Q} exp\,(z_i^{'} \theta_q)} \quad (6)$$

where z_i is a set of observable characteristics determining class membership. The likelihood for individual i is then the expectation over classes of the class specific contributions:

$$P_i = \sum_{q=1}^{Q} H_{iq} P_{i\backslash q} \quad (7)$$

This model allows to test whether the different user groups perceive the presented attributes differently, without imposing that the sample is split a priori into subsets.

3.2.2 Experimental setup

A choice experiment with three alternative labels was presented to the participants in a consumer survey on organic vegetable consumption. This survey was conducted in Flanders, Belgium during Winter 2007. In total 1,200 questionnaires were distributed from which 553 were returned and 529 were useful for statistical analysis (which corresponds to a valid response rate of 44%).

To reach the group of heavy users of organic products, 600 of the 1,200 questionnaires were sent to randomly selected members of the Association for Ecological Life and Production style (VELT), of which 270 were returned. VELT-membership is a proxy of greener consumption behaviour, and is intimately related to organic consumption.

The remainder questionnaires were distributed to a sample representative for the Flemish consumer population through a convenience non random sampling procedure. The average age of the sampled consumers (46.6 years) was slightly older than the Flemish average (40.2 years, NIS, 2005). All participants were involved in food purchasing decision-making. The sample was biased towards higher education (59.9% in the sample, versus 32% in the population (NIS, 2005). The sample is for the remainder of the socio-demographic characteristics representative for the Flemish population.

The total sample was split into four user groups, based upon the reported share of organic vegetables in the participant's total vegetable purchases (Table 3.1).

Table 3.1. Division of the total sample into user groups based upon organic share in total vegetable purchases

	Organic share x (%)	Percentage (frequency)
Non user	x=0	8.9 (47)
Light user	0<x≤20	21.4 (113)
Medium user	20<x≤80	47.1 (249)
Heavy user	x>80	22.7 (120)

Carrots were selected as the carrier vegetable, due to their popularity, well known quality traits (such as a high β-carotene content) and availability both as raw or processed in the organic and conventional version. The presented carrot labels mentioned the product price per kg, as well as health and environment related product traits and a label (organic, conventional A and conventional B). Due to the difficulty for consumers to attach (and retain) meaning to product attributes such as biodiversity, nitrate leaching or β-carotene content, we combined carrier symbols familiar to consumers (see Figure 3.1) with these attributes, such as a dung cart for nitrate losses or pictures of rare birds for signalling biodiversity.

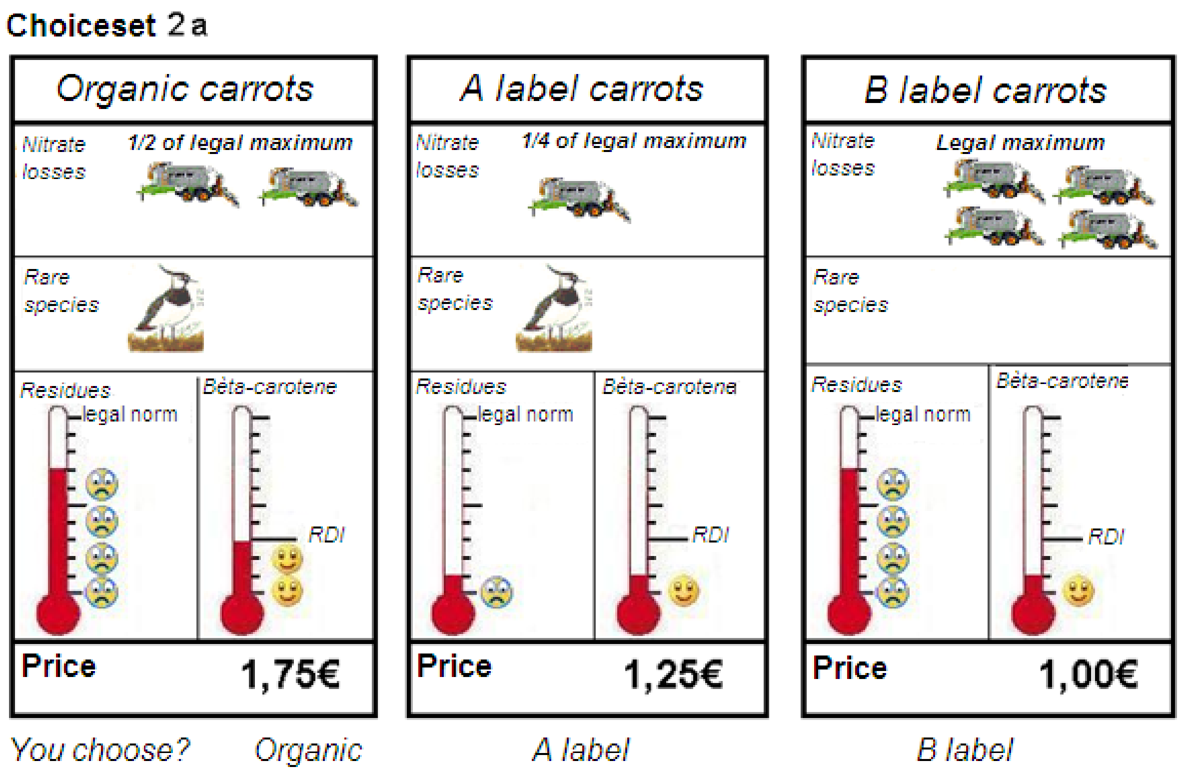


Figure 3.1. Example of the visual representation of one of the 64 choice sets with the organic, the A and the B-label and their characteristics.

An 'opt out'-choice was not incorporated to avoid an 'easy way out' for consumers that are facing decision difficulty (Kontoleon and Yabe, 2003), although it has been recommended by some recent state of the art choice experiment design guidelines (Louvière et al., 2000 or Adamowicz and Boxall, 2001). Instead, we incorporated a fixed conventional B scenario, which reflects the cheapest option available in the market, with the least interesting product traits. From a theoretic point of view, this B scenario provides us with an anchor point given that, by their nature, utility estimates are estimates of differences in utility. A zero utility is associated with this B scenario, enabling us to interpret the utility estimates of the remainder alternatives and attribute levels relative to these of the fixed B scenario. Both price and other product attribute levels varied over the two remaining alternatives in each choice set. As can be seen in Table 3.2, four linearly related levels were assigned to each product attribute.

Table 3.2. Attributes and attribute levels in the choice experiment

Quality Trait	**	Attribute	Level 1*	Level 2	Level 3	Level 4
	-	Price	1.00€	1.25€	1.50€	1.75€
	+	Label	ORGANIC	A	B	
Environment	-	Nitrate leaching on the farm site	Legal maximum	¾ of legal maximum	½ of legal maximum	¼ of legal maximum
Environment	+	Biodiversity on the farm site	3 rare bird species	2 rare bird species	1 rare bird specie	0 rare bird specie
Health	-	Residue level (% of MRL)	10	30	50	70
Health	+	Vitamin content	½ RDI	RDI	1,5 RDI	2 RDI

*Level 1 is also the base scenario flagged as the B-label
** Expected utility change when level increases
MRL= Maximum Residue Limit; RDI = Recommended Daily Intake

For each of the two quality traits (health or environment), two attributes were included in the choice experiment, of which one triggers desirable (positive) expectations and the other undesirable (negative). The choice of the attributes (and their levels) was the result of careful deliberation between the choice experiment preconditions and objective scientific boundaries, the latter based upon an extensive literature review (Hoefkens et al., 2009 and Mondelaers et al., 2009).

The first health attribute assesses consumers' sensitivity to residues in carrots. To obtain realistic levels, we departed from the Cadmium levels currently measured in conventional and organic carrots (Figure 3.2). The maximum level corresponds to 70% of the Maximum Residue Limit (MRL), the minimum level to 10%.

The second health related attribute, the β–carotene content, is desirable and relates to the nutritive value of carrots. β–carotene is the precursor of vitamin A. The Recommended Daily Intake (RDI), expressed in µg/day, is situated between 3,000 en 6,000 (IOM, 2001). The selected boundaries for the choice experiment were 2,000 and 8,000 µg carotene per kg carrots (or in case of a RDI of 4,000, ½ of the RDI to 2 times the RDI), which corresponds well with the real levels of β–carotene in carrots, whether conventional or organic (Figure 3.3).

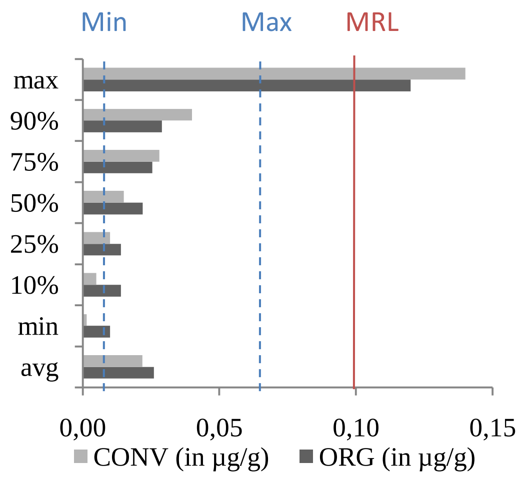


Figure 3.2. Cadmium levels in organic and conventional carrots (Hoefkens et al., 2009). The choice experiment boundaries are indicated as dotted lines and the Maximum Residue Limit (MRL) as a full line.

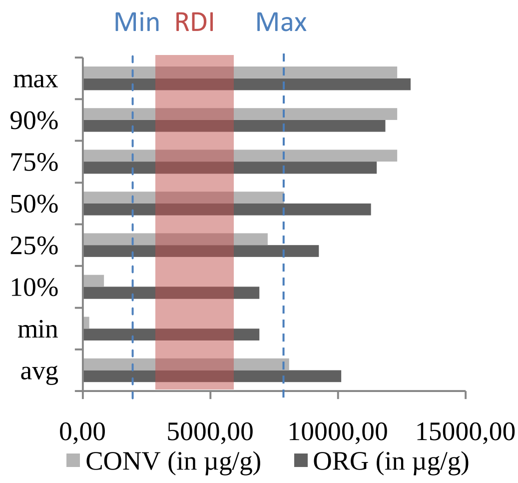


Figure 3.3. β–carotene levels in organic and conventional carrots (Hoefkens et al., 2009). The choice experiment boundaries are indicated as dotted lines and the Recommended Daily Intake (RDI) as a box.

The first environment related attribute is the number of rare bird species on the farm, which is desirable and is a proxy for biodiversity on the farm. From the 40 Flemish bird species on the list of threatened species, 10 are bound to agricultural areas (Platteau et al., 2005), of which five decreased since 1990 with more than fifty percent. The lower boundary of this proxy was set to zero rare species on the farm, and the upper boundary to three rare species.

As an undesirable environmental trait nitrate leaching on the farm site was selected, given the importance of the nitrate problem in agricultural areas in Flanders. As documented by Mondelaers et al. (2009), nitrate leaching levels on organic and conventional farms varied between 0 and 152 mg N/l, the latter being an outlier. The EU directive 1991 prescribes a maximum nitrate leaching level of 50 mg N/l. The attribute levels were based upon this limit and varied from ¼ of this limit to the actual limit.

The health and environment related traits described above, as well as the price attribute, varied in a similar way for the organic and the A-label, while the B-label attributes were fixed (see Table 3.2, level 1). The six year average prices for carrots in the retail outlets vary between 0.76€/kg for conventional carrots to 1.38€/kg for organic carrots (prices from 2001 to 2006, GfK panel data, 2007), which represents a relative price difference of 80% and which corresponds well with the presented price range of 1 to 1.75€/kg in the choice experiment. The price attribute was introduced to be able to assess the willingness to pay (WTP) for different tested attributes.

3.2.3 Other practical considerations

A full factorial enumeration of possible combinations of the results into 4^{2x4} alternatives. With one alternative fixed (the B scenario), only two alternatives vary per choice set. Each of these carries a label (organic or A). The necessary degrees of freedom is 31 (1 + 5 attributes x 2 alternatives x (4 levels - 1), Hensher et al., 2005), hence an orthogonal set of 32 profiles is sufficient. To avoid the random recombination of profiles into choice sets, we followed the procedure as documented by Louvière et al. (2000), and constructed an orthogonal set of 64 profiles with 10 attributes and four levels per attribute. The first five attributes relate to the organic alternative, while the last five relate to the conventional A label. We opted for this procedure instead of using foldovers to guarantee orthogonality across and within alternatives. The orthogonality of the design ensures that the attributes presented to individuals are varied independently from one another (zero correlation). This property guarantees that the influence of changes in any of the presented attributes on respondents' choices (or utility) can be measured independently. With the help of statistical software (SPSS) 64 profiles were constructed. The resulting sets were split into blocks of four choice sets per survey, to make the respondent' choice task manageable. Each survey participant was asked which type of carrot he/she would prefer from each choice set, given the three alternatives' characteristics, label and price and as such had to do four times the experiment.

In this experiment we opted for an orthogonal design instead of more efficient designs, such as a D-optimal design, as the latter require a priori knowledge concerning the sign and magnitude of the taste parameters (see Bliemer and Rose, 2003). As Bliemer and Rose (2003) indicate, in cases where one has no information on the parameter estimates whatsoever, it is common practice to assume that the prior parameter estimates are all equal to zero. When only alternative-specific parameters are to be estimated, an orthogonal design will be the most efficient design, assuming that the parameter estimates are zero. Therefore, an orthogonal design will be a good design in a scenario when no prior information is available to the analyst. According to Louvière et al. (2000) and Bliemer and Rose (2003), required sample size can be calculated as:

$$N \geq \frac{1-p}{Spa^2}\left[\Phi^{-1}\left(1-\frac{1}{2}\alpha\right)\right]^2 \qquad (8)$$

with p the true choice proportion of the relevant population, a the level of allowable deviation in percentage, S the number of repetitions per respondent and the inverse cumulative distribution of a standard normal defined by the desired confidence level. If we assume equal proportions for each alternative (i.e. p=1/3), a desired precision a of 10% (i.e. 10% deviation around p allowed), a confidence level of 95% and S=4, the required sample size N is 192. The sample sizes in our study exceed this required size with N=266 for the VELT –group and N=256 for the non VELT-group.

A weighting variable was introduced to correct for disproportional sampling of certain choice sets. The weighting variable is defined as (Louvière, 2008):

$$w_i = \frac{average\ \ sampling\ \ of\ choice\ sets}{sampling\ \ of\ choice\ set\ i} \quad (9)$$

3.3 Empirical findings

3.3.1 Importance of label and quality traits: base model using MNL

In the first analysis, the sample is restricted to the non-VELT members in order to provide an estimate for the overall Flemish population. The most simple model assumes generic β-parameters for the different quality traits and a linear relation between the attribute levels. The average unobservable variation between the three alternatives can be captured by means of an alternative specific constant for the organic and the A label carrots. The results are reported in Table 3.3.

The utility of the B label name is arbitrarily set to zero. The B label with its negative credence attributes receives a negative utility of -4.44. If we arbitrarily set the full B alternative to zero, the organic label with the same characteristics receives a positive utility score of 0.972. First, consumers on average reacted positively on the presence of a label. This signals that consumers attribute quality traits other than those mentioned in the experiment to the labelled carrots. However, unexpectedly, they are quite indifferent whether the label is ‘Organic’ or simply ‘A’.

Table 3.3. Estimation of choice parameters β: generic model with linear attribute levels

Attribute	β-coefficient	Standard error	P[β≠0]	WTP (€)
Organic label	0.972	0.199	0.0000	0.54
A label	0.856	0.201	0.0000	0.48
Nitrate leaching	-1.379	0.194	0.0000	0.08*
Vitamin A	0.471	0.090	0.0000	0.03**
Biodiversity	0.165	0.044	0.0002	0.01**
Residue	-2.150	0.234	0.0000	0.13*
Price	-1.791	0.187	0.0000	
B label***	0.000			

* WTP for a 10% decrease in a negative trait; ** WTP for a 10% increase in a positive trait; ***arbitrary set to 0
N=1024; LogL=-771,4; $\chi^2_{(5)}$ =262

Second, the model confirms our prior expectations on desirable and undesirable quality traits. ‘Nitrate leaching’ and ‘Presence of residues’ trigger negative consumer responses, while ‘More biodiversity’ and ‘Vitamin A content’ are perceived as positive, and thus desirable. The price component is furthermore negative and significant, as can be expected. Third, these results indicate a perceived higher disutility for the negative quality traits compared to the positive. This finding confirms that consumers react more heavily to undesirable stimuli than to desirable stimuli (Verbeke, 2005), identified by Kahneman et al. (1990, 1991) as the endowment effect which explains why economic agents attach a higher value to potential losses than gains.

The attributes themselves need to be taken into account as well, because there might be an imbalance (i.e. one attribute might be too dominant compared to the others). An increase in residue content from 50 to 70% of the MRL is considered four times less desirable than a decrease in vitamin A content with ½ of the RDI. Thus, consumers indeed seem to be much more sensitive to attributes that relate to food safety risks than to nutritional benefits. Fourth, the first hypothesis that health related issues will trigger a stronger consumer response than environmental issues, can be confirmed when comparing the negative health attribute 'Residues' with the negative environment attribute 'Nitrate leaching', or the positive trait 'Vitamin A' with 'Biodiversity'. However, the 'Nitrate leaching'-attribute has a stronger influence than the positive health attribute 'Vitamin A'-content. Apart from the endowment effect mentioned above, a plausible explanation is the fact that consumers probably correlate nitrate leaching with nitrate content in the carrot, which is again an undesirable food safety attribute. The nitrate leaching problem has also received considerable media attention in Flanders in recent years.

3.3.2 Willingness to pay estimates

The ratio of a variable of interest and the monetary variable will yield a monetary value for a change in the attribute level of the variable of interest, as far as the latter variable is statistically significant (Hensher et al., 2005). In our choice experiment the price attribute is highly significant, as well as the other attributes. WTP's can thus be calculated for these attributes, using the formula: $-\beta_x/\alpha$ with β_x being the taste parameter of the x^{th} attribute (in 'utils' per unit of attribute x) and α the taste parameter of the premium (in 'utils' per unit of premium).

We start from a carrot price of 1€/kg for the B-labelled carrots, which corresponds well with the current price level in real markets. As reported in Table 3.3, the average extra WTP for a kg of carrots labelled 'Organic' or 'A' is 0.54€ and 0.48€, respectively, which means 50% extra. The question is now whether we may assume that the average price premium consumers are willing to pay for organic vegetables is 50% or whether we have to take the 'A'-label price as a reference and conclude that there is no willingness to pay extra for organic carrots in our experiment. This will be explored in subsequent sections, but our findings support the hypothesis that organic vegetables are by a majority of respondents merely perceived as quality niche products. The WTP for a 10% reduction in residues (within the boundaries of the experiment) amounts to 0.125€, or 12.5% extra. For a 10% reduction in nitrate leaching, the average WTP is 8% extra. WTP's for positive traits are considerably smaller, 0.03 and 0.01€ for a 10% increase in vitamin A content and biodiversity on the farm site, respectively.

3.3.3 Relation between label and quality traits

The previous model assumed linearity of the attribute levels and generic choice parameters. Wald tests for restrictions argue in favour of the first assumption. The estimation of a model with alternative specific choice parameters for the organic carrots yields a log likelihood of -752, which is significantly better than the previous model, as confirmed by the log likelihood test ($39.07 > 11.07 = \chi^2_{(5)}$). This new model supposes a different response from consumers whether the quality trait is presented on an organic versus conventional package. The insignificant β–estimate for the organic label indicates that consumers, on average, choose organic carrots based upon the quality attributes and not on the label name (Table 3.4). It means that respondents did not take any additional attribute into account than those mentioned in the experiment, or, put differently, the positive attitude towards organic products is linked to the health and environment related quality traits of organic products. Thus, although the label itself does not trigger a positive utility score, it does so indirectly through better scores for the remaining attributes. The A-label on the contrary is significant and positive, thus it triggers higher quality expectations than the name B or organic, and these expectations relate to other attributes than those mentioned in the experiment. Interestingly, a difference in biodiversity is not an issue when the conventional carrot is preferred, as can be seen from the insignificant β-estimate.

Table 3.4. Estimation of choice parameters β: model with linear attribute levels and alternative specific β-parameters for the organic carrots

Attribute	β-coefficient	Standard error	P[β≠0]
Organic label	-0.741	0.658	0.2601
Org. Nitrate leaching	-1.234	0.259	0.0000
Org. Vitamin A	0.421	0.132	0.0015
Org. Biodiversity	0.373	0.066	0.0000
Org. Residue	-1.384	0.317	0.0000
Org. Price	-1.927	0.270	0.0000
A label	0.773	0.256	0.0026
Nitrate leaching	-1.697	0.275	0.0000
Vitamin A	0.644	0.132	0.0000
Biodiversity	-0.070	0.067	0.2941
Residue	-3.216	0.353	0.0000
Price	-2.097	0.268	0.0000
B label*	0.000		

*arbitrary set to 0; N=1024; LogL=-751.90; $\chi^2_{(10)}$ = 310

The organic carrots trigger less extreme reactions than the conventional (e.g. lower disutility for nitrate leaching but also lower utility for vitamin A). As such, two carrots with the same quality traits (e.g. the most positive attribute levels), one being organic, the other an A label carrot, yield similar utility scores (as also confirmed by the previous model).

3.3.4 Purchase intention and frequency

To explore the difference in preference structure between consumers who frequently buy organic and those who don't, the full sample with the different user groups can be used. We build further on model 1, assuming generic (i.e. not alternative specific) parameters for the health and environmental quality traits and linearly related attribute levels.

Table 3.5. Influence of purchase intention: β-parameters for non users versus users

	Non User			User		
Attribute	β-coefficient	s.e.	P[β≠0]	β-coefficient	s.e.	P[β≠0]
Organic label	0.397	0.413	0.337	1.546	0.179	0.000
A label	0.425	0.423	0.316	1.115	0.183	0.000
Nitrate leaching	-0.749	0.473	0.113	-1.397	0.148	0.000
Vitamin A	0.340	0.230	0.139	0.462	0.066	0.000
Biodiversity	0.140	0.116	0.228	0.239	0.033	0.000
Residue	-2.583	0.606	0.000	-2.463	0.177	0.000
Price	-2.999	0.485	0.000	-1.265	0.137	0.000
B label*	0.000			0.000		

*arbitrary set to 0
Model 'non users': N=188; LogL=-157,9; $\chi^2_{(5)}$=73
Model 'users': N=1900; LogL=-1254,8; $\chi^2_{(5)}$=466

To test the hypothesis that purchase intention for organic vegetables is triggered by other traits than purchase frequency, we compare the model estimates of the non user group with those of the user group (Table 3.5). Findings indicate that the purchase intention of the non user group is mainly based on the quality traits price and food safety (residue content), while the decision process of the user group is more complex and also involves environmental traits and the label name. As expected, both the price and residue attribute trigger a strong negative utility response. The non users are the only user group where the attribute ‘Residues’ is not the least preferred. The insignificance of the attributes in the non user model, except for residue and price, might be partly due to the small group size (n=47). On the contrary, price and residue content are highly significant, so these are clearly the main decision variables in this group.

The parameter estimates as depicted in Figure 3.4 reflect the preference of the light, medium and heavy user groups for the product attributes in the experiment.

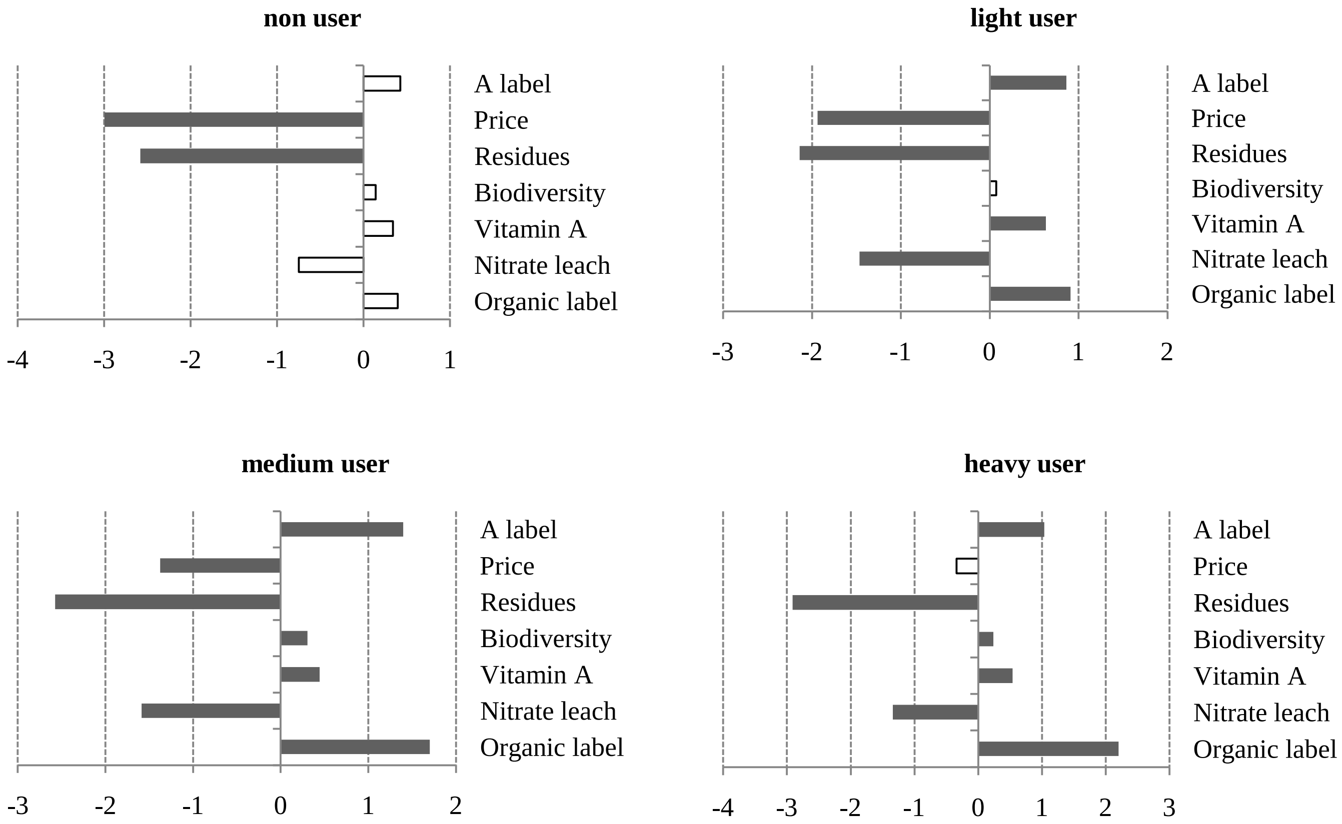


Figure 3.4. Choice parameters for the choice attributes per user group. White bars indicate estimates insignificant at the 5% level. Model ‘non users’: N=188; LogL=-157,9; $\chi^2(5)$=73; Model ‘light users’: N=452; LogL=-340,1; $\chi^2(5)$=117; Model ‘medium users’: N=980; LogL=-612.2; $\chi^2(5)$=277; Model ‘heavy users’: N=468; LogL=-250,2; $\chi^2(5)$=105

For the light users, all attributes are significant, except the environmental attribute ‘Biodiversity’. All estimates have the expected sign and the negative health and environmental traits have a higher utility compared to the positive characteristics. For this user group, the organic or A-label are equally important (as confirmed by the Wald test) and both trigger a positive utility. The medium users are the only user group taking all the attributes into consideration, including the biodiversity item. Compared to the non user and light user groups, the utility of the price attribute decreases further, while both the A and organic label gain importance. The label ‘Organic’ furthermore receives a significantly higher utility estimate than the A-label, as confirmed by the Wald test. The heavy user group finally is the only group where the price attribute is insignificant, i.e. within the price fork of 1€ to 1.75€, the heavy user is price insensitive. The remainder of the attributes are in line with those of the medium user group, apart from the value attributed to the label name ‘Organic’, which is among heavy users twice as important as the A-label, indicating that heavy users choose in most cases the organic product irrespective of the other quality attributes.

3.4 Latent Class analysis

A more advanced way of measuring parameter heterogeneity across individuals is the Latent Class model, in which the individual resides in a latent class, not revealed to the analyst (Greene, 2007). Estimates consist of the class specific parameters and for each subject a set of probabilities is defined over the classes. Although class membership is not observed, observable characteristics can be introduced that help to achieve class separation, such as organic user group in this particular study. The advantage of this approach compared to the above arbitrary division of the sample in subsamples is that all the information contained in the sample is used to estimate the class models instead of the limited information contained in the subsample. Table 3.6 shows the results for the Latent Class model in which the variable "organic user group" was used as the observable characteristic. The model with two classes is optimal, since the parameters of the models with more classes inflate rapidly. The likelihood of the model (-1318) is significantly better than the model without the latent classes (-1510), as confirmed by the likelihood ratio test.

Table 3.6. Latent class estimation of choice parameters β: model with linear attribute levels and alternative specific β-parameters for the organic carrots

	Latent class 1			Latent class 2		
Attribute	**β-coefficient**	**Standard error**	**P[β≠0]**	**β-coefficient**	**Standard error**	**P[β≠0]**
Organic label	3.964	1.102	0.000	4.728	1.328	0.000
Org. Nitrate leaching	-1.591	0.207	0.000	-0.462	0.496	0.351
Org. Vitamin A	0.551	0.102	0.000	-0.220	0.262	0.402
Org. Biodiversity	0.299	0.501	0.000	0.185	0.115	0.107
Org. Residue	-2.262	0.254	0.000	-2.260	0.707	0.001
Org. Price	-0.848	0.211	0.000	-8.749	0.746	0.000
A label	4.103	1.005	0.000	1.709	0.419	0.000
Nitrate leaching	-1.411	0.217	0.000	-0.264	0.502	0.600
Vitamin A	0.455	0.100	0.000	0.623	0.253	0.014
Biodiversity	0.219	0.051	0.000	-0.161	0.121	0.181
Residue	-3.057	0.276	0.000	-0.866	0.622	0.164
Price	-0.984	0.202	0.000	-7.123	0.706	0.000
B label	0.000			0.000		

N=2088; LogL=-1318; $\chi^2_{(16)} = 383$

In the first class, which has 86% probability that a respondent resides in this class, all parameters are significant and in line with our previous estimates. The label name has become a more decisive characteristic, opposite to the price level whose importance has decreased compared to the model without latent classes. These results indicate that the members of this first class choose against the B scenario, regardless of the price difference. Both the A alternative and organic alternative have similar parameter estimates, so the respondents are rather indifferent between both.

In the second class, with an average probability of 14%, the parameters for the majority of the credence attributes are insignificant. The organic label again receives a high and positive score, while the score of the A label is considerably lower. Furthermore, the price parameter is very negative in this group. This group can therefore be considered as very price sensitive consumers. Main decision variables for these consumers are thus price and presence of the organic label, the rest of the attributes are hardly relevant for them. Further analysis shows that this class is mainly composed of individuals that (at least once) chose the B alternative as their preferred alternative.

3.5 *Heterogeneity between alternative choice patterns: the Nested Logit model*

How do consumers process the different labels? Do they first decide based upon the organic label name and then upon the remainder attributes (Figure 3.5 left), or do they first decide based upon the quality level and then upon the remainder attributes (Figure 3.5 in the middle), or do they simply process all quality attributes and the label name simultaneously (Figure 3.5 on the right)? A Nested Logit model, which compares the variation in the two different branches of the models in Figure 3.5, allows for testing these alternative scenarios. Considering the tree model on the left, one could assume that consumers process both the A and B label in a similar way, which differs from the way they process the organic label. This yields one organic branch and one conventional decision branch. If both branches are statistically equal than the consumer processes all attributes simultaneously (right case). If the consumers focus on quality versus generic products, we obtain the tree structure in the centre of Figure 3.5.

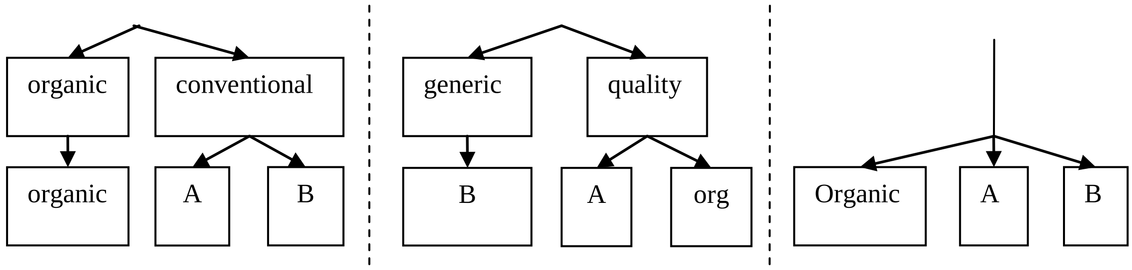


Figure 3.5. Nested Logit models for the choice experiment. Left: organic processed differently than conventional, Middle: quality products processed differently than generic product, Right: no prioritisation

Both for the sample reflecting the Flemish consumer population and the sample of VELT members, Wald tests show that the variation in each of the branches is not statistically different (the inclusive values IV are similar), so the model on the right is the appropriate one for the full sample. Consumers thus generally process the information on the three alternatives in a similar way.

However, the Latent Class model hinted that both groups process the labels differently. If we split the overall sample into two groups based upon highest class probability, we can test the nested models on the subsamples. Regrettably, the combination of Nested and Latent Class Logit models is not yet operationally developed, so we have to follow this procedure. For both classes the 'quality versus generic' model is the most appropriate (Figure 3.5 in the middle). The inclusive value (IV) for the generic branch is assumed fixed at 1, to enable testing of IV of the quality branch. For the members of latent class 1, the IV of the quality branch is not significantly different from zero, which indicates that we should consider two different models for this group, i.e. one model for the comparison of label A and Organic and one for the B label, as depicted in Figure 3.6. As the B label is almost completely ignored by this group, it can reasonably be assumed that the class 1 members only consider the A and Organic label. Hence, a Binary Logit model could be appropriate to describe this group.

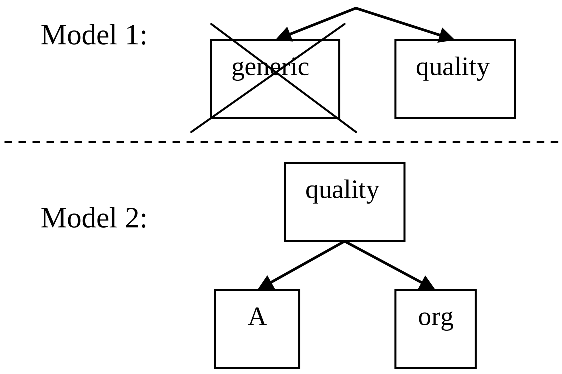


Figure 3.6. Decision model for members of latent class 1

For the second latent class, the IV of the quality branch differs significantly from zero and from 1, which indicates that the nested model is the appropriate one. Members of this group thus intuitively cluster the A and Organic label versus the B label before deciding.

3.6 Discussion and conclusion

Because the experiment's attribute levels have been based upon real levels currently observed in the market place, our approach to compare the attributes one to another is appropriate. We do not wish to make any statement of the importance of these attributes versus other search and experience attributes such as taste, colour, shape and smell. To test the latter, the experimental design should be different.

Our first hypothesis, 'health traits are more important during the buying decision than environmental quality traits', could not be fully confirmed, given the relatively high score for the attribute 'nitrate leaching on the farm site'. Instead we noted that undesirable traits trigger a stronger response than desirable traits. Within these negative or positive response classes, the health related variables score 'better' than environment related variables. This might argue for a decision tree in which the first trade off is made in favour of 'avoiding an undesirable outcome' and the second in favour of the 'personal health benefit compared to the environmental benefit'. The food safety related 'residue'-item yields the heaviest consumer reaction. This can be reasonably explained by the prospect theory of Kahneman and Tversky (1979), which argues that consumers prefer avoiding risks to capturing gains.

Our second hypothesis, 'the organic label plays a significant role in consumers' choice for organic products', can only partly be confirmed. Consumers do prefer organic products over B-labelled products, but not over A-labelled products, which argues for the consideration that most consumers classify organic products among other 'quality niche products'. However, in response to hypothesis 3, 'organic farming is perceived as healthier and more environmentally friendly than its conventional counterpart', consumers define the quality traits differently between both the organic and the A-label. Organic and the A-labelled carrots in the experiment with the same health and environmental characteristics obtain a similar total utility score, while the individual choice parameter scores for the health and environmental attributes are higher for the organic carrot variant. This means that the respondents relate the quality of organic vegetables to the attributes mentioned in the experiment, while the A-label quality traits are mainly absorbed in the positive A label specific constant, and thus may cover other attributes not mentioned in the experiment.

The fourth hypothesis, which states that purchase intention is primarily based upon quality traits, can be confirmed. The attributes of influence for those who do not buy organic are

restricted to food safety and price, while those who buy organic also attach value to the label name and the environmental attributes.
The fifth hypothesis explores whether in our experiment buying frequency and the presence of environmental and health traits are correlated. Apart from the insignificant biodiversity proxy in the case of light users, this does not seem to be the case. However, over the different user groups, two other, albeit opposite, trends can be detected. The first relates to price, which shows a decreasing importance from non to heavy users. This confirms the finding of other studies (O'Donovan and Mc Carthy, 2002, Bonti-Ankomah and Yiridoe, 2006) that the perceived price difference is the most important barrier for new users to buy organic or for light users to increase their purchase of organic foods. Among heavy users, the price is not an issue, at least within the experiment's price range. The second trend relates to the (organic) label value, which increases from non to heavy users, indicating that when the buying frequency of organic vegetables increases, more unobserved preference attributes (which could relate to taste or appearance) are associated with the organic label.
The more advanced Latent Class and Nested Logit model confirm the importance of the price when purchasing food. The group of consumers which is extremely price sensitive, associates a higher utility with the organic label compared to the A-label. This suggests that these consumers are aware of the specialty character of organic vegetables. However, owing to the high perceived price premium, they favour non organic products. Presence of residues in the organic carrots is not appreciated, probably because this is against the 'organic philosophy'. The large group of less price sensitive consumers on their turn processes both the A and organic label in a similar way, i.e. all attributes are relatively equally important. The organic quality traits receive slightly better scores, indicating that these traits are intrinsically associated more with the organic carrots. The Nested Logit model shows that this group hardly considers the B-label.
We can conclude that there is differential consumer sensitivity for the type and quality of credence attributes and that the organic label is associated more with health and environment related quality traits. To maintain (and reinforce) this perception among consumers and organic product positioning, it is recommended to give this perception additional scientific underpinning.

The above conclusions hold for the PIoS-case of organic farming. In this dissertation we discuss two cases of PIoS, organic farming and Flandria, which follows the principles of integrated farming. Given that the environmental measures in the organic standard surpass those of the Flandria-standard, it is interesting to know whether the obtained results for organic farming also apply for more generic standards such as Flandria. The question we pose ourselves here is whether a certification scheme, such as Flandria, with a less clear positioning on ecological themes, is still perceived as an ecological standard (the organic label in our experiment) or merely as a quality standard (the A-label in our experiment). To answer this question, we can refer to Verbeke et al. (2008). In this research the consumer attitude and behaviour towards Flandria labelled tomatoes after 10 years of Flandria labelling was investigated. Details on the set up of this research can be found in the paper. One interesting finding of the paper, which is also relevant for chapter 2, is that approximately one third of the respondents were unfamiliar with the Flandria label, even after 10 years of existence and advertisement campaigns. Of the aware respondents, approximately one third buys the Flandria labelled tomatoes on a regular basis. Buyers of the Flandria-labelled tomatoes have a more positive attitude towards the tomatoes compared to the aware non buyers. Main associations relate to 'Belgian origin' (probably due to the name), the perceived 'better quality and taste' and the 'stricter production control'. The 'use of integrated pest management practises' is less known both by buyers and non buyers. Both the buyers and non buyers do not associate ‘absence of pesticides’ and ‘organic farming’ with Flandria tomatoes. The article also investigated potential motivations for unaware and aware non buyers to buy Flandria-tomatoes in the future. For both groups, the most important motivation would be ‘if no other tomatoes were available’, followed closely by ‘if more information was provided’, ‘if proven to be healthier’ and ‘if more environmentally friendly’. The article concludes that the Flandria-label has become quite standard and little differentiated. If we compare this with the findings in this chapter, Flandria-labelled tomatoes seem to reside under the A-mark tomatoes, with a positioning based upon origin and overall quality perception instead of on environmental practices. As discussed in Verbeke (2005), the provision of ever more and too detailed information entails a risk of information overload, resulting in consumer indifference or loss of confidence. Verbeke (2005) proposes segmentation and targeted information provision as potential solutions to market failure from information asymmetry. As also confirmed by the focus groups, see Chapter 2, Flandria is mainly perceived as a label of origin and quality. When Flandria would seek a positioning based upon origin, quality, taste and environmental friendliness, this would result into information overkill for the consumer. Bearing this in mind, the label promoters chose to use the integrated farming efforts strategically as a support for the general quality perception. Simultaneously, by implementing integrated farming practises, the positioning of more environmentally oriented labels such as organic farming can be more easily countered. Given our finding that health related quality attributes score better than environment related attributes, this choice seems indeed successful when the label is not targeting a niche.

Chapter 4. **Retail interest in PIoS**

This chapter is an adapted version of Aertsens, J., Mondelaers, K. and Van Huylenbroeck, G. (2009). Differences in retail strategies for marketing organic products. British Food Journal, 111 (2),138 – 54.

4.1 Introduction

This chapter discusses why PIoS are of more strategic importance for some retailers and less for others. A retailer (potentially) engages in PIoS when the PIoS-products are of strategic importance for this retailer.

In this chapter, the case of organic farming products is used as example of PIoS. Main growth in organic production occurred only in the 1990s, following a number of food scares in the conventional sector. In the last decade organic markets in the world and in Europe have grown strongly (Hamm and Gronefeld, 2004). Sahota (2007) reports a growth of the global organic food and drink market revenue of 43% between 2002 and 2005. The European organic market comprises over half of global revenues and its growth has been estimated at 10 to 15% in 2005 (Richter and Padel, 2007). Different sources expect that in the next few years global growth rates will be 15% (Agriholland, 2007) to 20% (Organic Monitor, 2006). Thus, the organic market is the fastest growing sector of the food industry and exceptionally high market growth rates are leading to undersupply in various regions (Organic Monitor, 2007).

As consumers become more sophisticated in their consumer behaviour towards organic foods, companies are focusing on supply chain management to ensure traceability, high quality, sufficient supply volumes and supply continuity. Because assuring supply becomes a major concern, a number of European companies have started to invest in developing countries to lock-in supply (Organic Monitor, 2006).

While supermarket chains dominate the sales of organic vegetables and fruit in Europe with a market share of 48% (Organic Monitor, 2005) experts rank them as the most important sales channel for future organic food market development both in urban and rural areas (Padel and Midmore, 2005). However, strong differences exist between European retailer groups with respect to marketing organic products (Richter and Hempfling, 2002).

In this chapter we assess these differences more deeply, based on an in depth analysis of the strategies of the three largest Belgian retailers selling organic products. We explain why the strategies differ markedly even though the general characteristics of the retailers seem to be similar. Both the marketing mix and the organisation of the supply chain are considered. The general findings are relevant to other countries and non organic premium products.

In the next sections the theoretical framework and the methodology are explained. We formulate several hypothesis based on a review of the literature. This is followed by a description of the organic market structure in Belgium. Next, we focus on the overall characteristics and strategies of the three retailers studied. Then, the overall strategy is related to the strategy in marketing organic products in general and organic beef in particular. In the following discussion we come back to the hypotheses and use the empirical findings to discuss them. The paper ends with a general conclusion.

4.2 Theoretical framework

We first discuss the importance of strategic products to retailers and then explain why products from PIoS might be of strategic importance for certain retailers. Subsequently we discuss the additional considerations retailers need to make when adopting PIoS as strategic products.

When it comes to tools to put certain products in the market, Lazer (1961) argues that retailers can use their retailing mix in both the commercial and operational part. The commercial part aims at increasing effectiveness by adjusting the Product mix, the Price mix, the Presentation and the Promotion mix. The operational part mainly aims at increasing the efficiency through an adequate Place mix, Physical distribution mix and Personnel mix (Brown et al., 2005). Jointly these concepts are better known as the seven retail P's. Further in the paper we describe important differences between retailers in the positioning of organic products using their retailing mix. We also refer to Mickwitz (1959) who argues that in the different phases of the Product Life Cycle, a different implementation of the marketing mix is optimal.

Chen et al. (2006) suggest that there exist strategic product categories that are more important than others in consumers' store choice decisions. Marketing research also suggests that in-store stimuli such as display and atmosphere have a great influence on consumer buying behaviour and may encourage sales by maximizing impulse buying and cross-selling (Donovan and Rossiter, 1982, Kotler, 1974, Corstjens and Doyle, 1981). For example, a factorial experiment revealed that an in-store display of an item creates excitement and increases the average amount purchased (Chevalier, 1975). The effect of one category on the profits of other categories in the store is particularly important in the calculus of marketing decision making. Retailers have to pay extra attention for these strategic product categories (Chen et al., 1999). The question is then what makes some products of strategic importance to retailers? Strategic products attract (new) customers to the retailer. In order to identify strategic products, according to Abell (1980), retailers need to answer the following related questions: "who are our main customers?" and "what products and services do they want?". Retailers can answer to these in three steps: 1) *Segmentation* of the customers based on their preferences; 2) *Targeting* or choosing the most interesting customer segments; 3) *Positioning*: developing a marketing mix to reach these segments. For this positioning which can be seen as a form of differentiation, the retailer should develop a product offer, that will be regarded as most desirable by the customers in the targeted market segment (Sanchez and Heene, 2004). When different retailers target different customer segments, their optimal product mix should be different. We can than argue that products that especially attract targeted customers are of strategic importance to retailers. The attraction can come both from functional value as from underlining the image of the retailer in aspects that are important to the targeted customers. It is interesting to combine the concept of "strategic" product lines with the framework of Morschett et al. (2006) which is based on Porter (1985). They argue that two distinctive types of competitive strategies exist: the cost leadership and the differentiation strategies. Strategic products may play a fundamental part in a retailer's differentiation strategy. Our question is then whether commodities from PIoS can be such strategic products?

The potential retailer interest in PIoS can be related to Corporate Social Responsibility (CSR). PIoS and CSR share a lot of similarities, as explained in chapter 1. The EU definition of CSR is (COM, 2001): *"a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis."* While CSR mainly refers to intra firm processes, PIoS often refer to inter firm arrangements, and more specifically to hybrids. Hybrids are organisational structures where multiple actors cooperate and contract together, while still remaining competitors. The principles of intra firm strategic CSR outlined by Burke and Logsdon (1996) can be extrapolated to PIoS. Burke and Logsdon (1996) describe how CSR can actually create value for the firm, when it is applied strategically. 'Strategic CSR' yields substantial business-related benefits to the firm, in particular by supporting core business activities and therefore contributing to the firm's effectiveness in accomplishing its mission. Burke and Logsdon identify five dimensions of corporate strategy which relate CSR to value creation by the firm. 'Centrality', as a first dimension, is a measure of the closeness of fit between a CSR policy and the firm's mission and objectives. 'Visibility' is the extent to which social activities may be observed by the firm's stakeholders. In the context of CSR, 'Appropriability (or specificity)' may be defined as the ability of the firm to extract economic benefits from a social project. The fourth dimension, 'Voluntarism', refers to the sense in which social activities are undertaken freely, because firms want to, rather than as a result of legal constraints or fiscal incentives. The final dimension, 'Proactivity', reflects the degree to which behaviour is planned in anticipation of emerging economic, technological, social or political trends. So, in order to be of interest for a retailer, PIoS should contribute to these five dimensions of strategic CSR.

Not every retailer has the same CSR strategy. Tulder et al. (2009), in their analysis of CSR business models in the retail industry, identified four approaches to CSR. First, the 'inactive approach' reflects the classical notion of Friedman that the only responsibility companies (can) have is to generate profits. This is a fundamentally inward-looking (inside-in) business perspective, aimed at efficiency and competitiveness in the immediate market environment. The motivation for CSR is primarily utilitarian (Swanson, 1995), derived from so-called 'consequential ethics' where the focus is on the end result, rather than the means by which it is achieved. In this goal-oriented approach, CSR is aimed at profit and sales maximisation, return on investment and sales. A slight variation on the inactive attitude is the 're-active approach', which shares the focus on efficiency but with particular attention to not making any mistakes. This requires an outside-in orientation where entrepreneurs monitor their environment and manage their primary stakeholders so as to keep mounting issues in check without otherwise allowing it to give rise to fundamental changes in the business philosophy and primary production processes. Entrepreneurs are socially responsive and respond specifically to actions of external actors that could damage their reputation. Third, an 'active approach' to CSR represents the most 'ethical' entrepreneurial orientation. Entrepreneurs who pursue this approach are explicitly inspired by ethical values and virtues (or 'positive duties') on the basis of which company objectives are formulated. These objectives are subsequently realised in a socially responsible manner regardless of actual or potential social pressures by stakeholders. Such entrepreneurs are strongly outward-oriented (inside-out) and they display a certain 'missionary urge' which sometimes makes them heroes to NGOs but often an annoyance to 'true' entrepreneurs. Finally, one can speak of a 'pro-active approach' if an entrepreneur undertakes activities aimed at external stakeholders right at the beginning of an issue's life cycle. Effective CSR is characterised not only by proactive business practices, but also by interactive business practices, where an 'inside-out' and an 'outside-in' orientation complement each other.

So, strategic CSR is of differential importance for retailers. From section 1 we know that strategic products are of interest for retailers pursuing a differentiation strategy. When the differentiation strategy contains elements of CSR, PIoS products can become strategic products. We explained that PIoS products should contribute to the five dimensions of strategic CSR. But, as PIoS products are external to the retailer, some additional considerations and efforts are required before PIoS are adopted by retailers. Mainville et al. (2005) identified the key factors influencing the adoption of private certification standards by retailers (see Table 4.1). The identified factors can also be related to the decision of a retailer to engage in PIoS.

Table 4.1. Factors influencing the retailer's decision to adopt PIoS

General conditioning factors	Benefit/cost effect	Retailer characteristics
• Strategic objective of PIoS • Institutional context • Product and market characteristics	• Output price differentials • Input price differentials • Transaction cost differentials	• Product requirements • Importance of product in sales • Scale of operations • Market power of firm • Reputation and brand capital

Source: adapted from Mainville et al. (2005)

Mainville distinguishes between general conditioning factors, benefit/cost effects and firm/organisation characteristics. As discussed before, standards can have standardizing, risk reducing and differentiating functions. While the main strategic objective of PIoS is their differentiating function, the risk reducing and standardizing functions are also of concern for retailers (see chapter 7). The exogenous institutional context relates to the formal (legislation, such as due diligence) and informal rules (social norms) in which the retailer and the PIoS operate, while the endogenous institutional context relates to the institutions and governance structures put in place to coordinate the transaction between PIoS-producer and retailer. Product and market characteristics refer to the necessity to adapt and coordinate the supply chain given that PIoS-products have certain specific (credence) attributes. Output price differentials refer to the potential premium price for PIoS-products at consumer level, given that these are strategic products. Input price differentials depend on the bargaining power between PIoS-producer and retailer, as well as on the difference with non-PIoS-products. Transaction cost differentials relate to the endogenous institutional arrangements set in place to organize the PIoS-supply chain and to signal the PIoS to the end consumer. With respect to retail specific characteristics, Mainville identifies a relation between a retailers's non mainstream product requirements and the decision to engage in private certification, which can be linked to the appropriability-dimension of CSR discussed above. Whether the PIoS-product is a central product to the revenue of the retailer can be associated with the 'centrality' dimension of strategic CSR. Further, the larger the scale of operations, the more the fixed costs associated with strategic products can be distributed over other products. Bargaining power over suppliers can help to enforce PIoS-standards advantageous to retailer. Finally, when a retailer has a certain reputation and brand capital, PIoS can be more important, as discussed above. This also relates to the visibility-dimension of strategic CSR.

Richter and Hempfling (2002) who studied strategies of retailers for marketing organic products in eleven European countries found that these may differ importantly. They identified three main strategies. First, a "maximum strategy", which involves: (i) a large range of more than 400 different organic products at the points of sales, (ii) making organic products a significant part of the company's advertising and promotional campaigns, (iii) assuring the quality of the products. Second, a "basic strategy" involving a range of 50 to 250 organic products. Third, a "minimum strategy" involving a range of no more than 50, mostly dry, organic products. Richter and Hempfling (2002) also categorized retailers as “leaders” or “adapters”. Leaders follow a maximum strategy and want to be the regional market leader in organic products. Adapters apply a basic or minimum strategy. Adapters compose their organic product inventory according current trends in demand or as a reaction to the strategies of their main competitors. They sell organic products, but without strong active engagement and effort.

Could organic products have strategic importance and if so what makes them special for consumers? Several authors examined the factors that influence consumers to choose organic rather than conventional food (Midmore et al., 2005, Zanoli and Naspetti, 2002, Zanoli, 2004).
Both private use values such as health, taste and freshness, and public use values such as environmental conservation and animal welfare play an important role (Oughton and Ritson, 2007, Krystallis and Chryssohoidis, 2005, Yiridoe et al., 2005, Baltussen et al., 2006). Codron et al (2006) show that recently, ethical, health and environmental values become increasingly more important for consumers. Wirthgen (2005) also indicates that marketing on “the regional origin” can be a successful strategy for product differentiation. Thus as consumers perceive that organic products score very well on these points, some retailers may develop organic, fair trade and sustainable products strongly to enforce their image as social responsible retailer. De Ferran and Grunert (2007), Hughes (2005) , Jones et al. (2005) show that these values are indeed taken up by some retailers, e.g. as part of their corporate social responsibility policy.

“Organic” as an emerging market. When retailers develop a strategy for marketing organic products it is important to take into account that this is still an emerging, innovative market. Ansoff (1957) and Danneels (2002) argue that the introduction of new products in new markets usually requires special efforts and thus demands a lot from the retailers’ resources. Danneels (2002) identifies two types of firm competences that may be required for product innovation: (1) new technological competences, and (2) new customer competences. For the emerging organic market both competences have to be developed. Danneels (2002) indicates this situation as “pure exploration”. This means that the choice for a “maximum strategy” for promoting “organics” demands a lot of resources that not all retailers can or want to provide. For some it may be more interesting to adopt a “second mover strategy” in order to limit costs or resources (Lieberman and Montgomery, 1998).

These combined elements from the literature result in the following propositions, which we will return to after the presentation of the empirical findings.

Proposition 1: Organic products may be a strategic product category for some retailers.

Proposition 2: The (perceived) characteristics of organic products have strategic importance for retailers that want to create an image with the same values.

Proposition 3: In order to favour strategic products, retailers may not only use the commercial but also the operational factors of the retail mix.

Proposition 4: Due to the characteristics of the organic market as an innovative, emerging market, there may be certain first mover advantages.

Proposition 5: Investments by retailers in products which have strategic importance for them, will pay off indirectly.

Proposition 6: For some retailers organic products have no special strategic importance.

Proposition 7: For emerging product markets, some retailers may benefit more from a second mover strategy.

4.3 Methodology

Data for our analyses are combined from different projects studying the organisation and development of the organic sector in Belgium, between February 2003 and the end of 2007. Information concerning the strategies of the retailers was collected through interviews with at least five staff members at each of the retailers. The contacted staff members belonged to different departments (Purchase, Quality and Merchandising, Marketing) and were involved in different product categories (e.g. organic beef and organic vegetables). Also a point of sales director of the retailer group has been interviewed. These data were combined with our own observations at the points of sale and a review of press communications and relevant reports. GfK-household panel data, recording all purchases of 3000 Belgian households, were used to compare the importance of different sales channels. A postal survey with 529 respondents and a response rate of 44% was used to gain insight in the behaviour and perception of Belgian consumers towards organic products.

4.4 Characteristics of the organic market in Belgium

Both Richter (2002) and Hamm and Gronefeld (2004) consider the Belgian organic market as a growth market. However after the boosting effect of the major food crises in 1999 (dioxin) and 2001 (BSE), total consumer expenditures on organic food have dropped again by 28% between 2001 and 2005 (Stockemer and Van Raemdonck, 2005). With a total sales turnover of 201 million euro for organic fresh products and a share of 1.5 percent of total fresh food expenditures in 2005 the market for organic fresh food remains marginal in Belgium (VLAM, 2006). In 2007 total turn over amounted to 283 million euro, which indicates a growth of 9,95% compared to 2006 (Tas, 2008).

Table 4.2. Market share, growth rate of share and ratio organic versus conventional share for different sales channels

	Market share (%)[1]		Average growth rate (% points)[2]	Organic vs. conventional share (%)[3]
	2001	2005		
Supermarket	49	60	+ 5,3	90
Specialized shop	32	20	- 10,5	90
Other[4]	19	20	+ 2,9	190

1. based upon expenditure per capita (VLAM, 2006); (Baecke et al., 2002)
2. average growth of market share yearly, 2001 base year
3. data for vegetable products (Mondelaers and Van Huylenbroeck, 2005)
4. Other: markets, on farm sales, box schemes and others

In the early 1990s, specialised shops were the dominant sales channel for organic products in Belgium. But, as indicated in Table 4.2, their share has decreased significantly and continuously, predominantly in favour of supermarkets. We can also conclude from Table 4.2 that alternative channels, such as markets and on farm sales capture a higher share of the organic product market compared to their conventional counterparts. The explanation is that organic has a connotation of “alternative” that matches well with the alternative channels both in the view of buyers and sellers.

4.5 *Main characteristics and strategy of the retailers*

In order to respect confidentiality we refer to the three main Belgian retailers of organic food as R1, R2, and R3. We remark that the third retailer has also three supermarkets where only organic products are sold: we refer to these as R3-bio. Further there are also retailers in Belgium, e.g., some hard discounters, who so far do not sell (fresh) organic products.

Table 4.3 presents the main characteristics of the retailer groups investigated. The total number of super- and hypermarkets they operate in Belgium varies between 125 and 170. One noteworthy difference is that R2 has also an important number of hypermarkets (>2500 m² or 27.000 square feet), whereas R1 and R3 only have supermarkets (< 2500 m²). Another distinction for R2 is its more important section of non-food articles, contrary to R1 and R3, which only offer these products to a limited extent.

Table 4.3. General characteristics of the retailers, overview

	R1	R2	R3		R3-bio
hyper (F1) and/or super (F2)	F2	F1+ F2	F2		F2
Specialisation	Food	Food+ Non Food	Food		Food
# points of sales (F1+ F2) 2004	125	F1: 56 + F2: 78	170		3
average surface of PoS (m^2)	1400	F1: 4000; F2: 1700	1400		670
turnover 2003 (billion EUR)	3,7	4,6	3,6		~ 0,01
% of total sales volume for F1+ F2	20%	31%	19%		~0,05%

PoS: Point of Sales
sources: interviews, press, yearly firm reports. (*) F1: >2500 m^2; F2: 650-2500m^2;

In Table 4.4, below, we summarise some characteristics from the retailing mix that indicate how the different groups position themselves in the market.

The main strategy of **R1** is a market specialisation strategy or in this case a differentiation strategy (Sans, 2003). As indicated in R1's mission statement, their key focus is delivering superior value and gaining a leading position in mature and emerging food segments. R1 particularly targets consumers searching for high quality, convenience and healthy products. This is implemented by developing strong local chains and maintaining high social, environmental and ethical standards. R1 also provides a large selection of high quality food products in a very pleasant shopping environment. Special attention is given to several "emerging" product segments, such as organic products, fair trade and convenience food (Belga Press Release, 4th of January 2007). To maintain their quality image and to strengthen consumer loyalty, R1 attaches an extra label for quality control and traceability to these emerging product lines. R1 tries to be the market leader in these "niches" by being the first in offering the products. The prices of R1's products are however on average 19% higher than the ones offered by R3. The price difference amounts to 55 percent when basic unbranded products are compared (Labarre and Starquit, 2005).

The overall strategy of **R2** is different. R2 aims for full market coverage by offering food and non-food, branded and unbranded products in both high and low price categories. Instead of targeting specific consumer segments, R2 tries to attract the total population of consumers. R2 hereby challenges both R1 and R3. At the points of sale they opt for a pleasant shopping environment. The number of retail staff available for assisting clients is however smaller when compared to R1 (especially when expressed per m^2 of sales area). Although R2 claims to offer the lowest price for some products, on average their prices are intermediate between R1 and R3: +9% with respect to R3 (Labarre and Starquit, 2005).

In its turn the overall strategy of **R3** is different. R3 focuses especially on an efficient "operational mix" or in other words on a low cost logistic. This strategy is visible at the points of sale that resemble a warehouse. The points of sale are not nicely decorated, but aim at a practical handling when supplying the racks and during shopping. R3 specifically targets consumers that want to buy food at the best quality/price ratio. R3's unique selling proposition is based upon the lowest price in the region both for national brands, which account for 70% of their product range, and "store brand" products.

Table 4.4. Strategy of the retailers, overview

MARKETING MIX	R1	R2	R3		R3-bio
food prices (strategy)	High	medium-low	lowest		low or medium
assortment of food	very large	large	large		large
assortment of non-food	Medium	F1:very large; F2: large	medium		small
quality	+++	++	+++		+++
shopping atmosphere	very pleasant	(very) pleasant	basic / ok		pleasant
service, # servants in shop	++	+	++		++

source: press releases + own observations

In Table 4.5 the price premiums for national brands, unbranded basic ('white') products and organic products of R1 and R2 are compared to R3's. The data clearly show that R3 has the lowest price for all products.

Table 4.5. Price premium of R1 and R2 compared to R3

	National brands[1]	Basic products[2]	Organic products[3]
R1	+10%	+55%	+19%
R2	+6%	+3%	+29%

source: (Labarre and Starquit, 2005): 683 stores visited, 141 national brand products in the basket
source: (Labarre and Starquit, 2005): 683 stores visited, 73 basic products ('white products')
source: (Jooken and Niclaes, 2002): 86 stores visited, 41 products in the basket

4.6 Retailers and their marketing strategy for organic products

In this section we compare the marketing strategies of the three retailer groups. The main characteristics are summarised in Table 4.6 below.

R1 makes a real effort in selling organic products, using the different elements of the marketing mix. In Belgium, R1 was the first to offer organic products, starting in 1985 with organic bread and some other basic products. Concerning the organic product mix, R1 excels at product range level, with 650 product references in the organic version or 4% of their total product range compared to 236 for R2 and 312 for R3. R1's product range covers all the main food product classes. Table 4.5 indicates that R1 comparatively takes a lower profit margin on organic products. Where for the basic products R1's price is on average 55% higher than R3's, for organic products the price is only 19% higher than R3's. And where R1 has higher prices than R2 for the conventional national brands and basic products its prices are about 10% lower for the organic products. With respect to the presentation, R1 places its organic products in positions which are highly visible, attracting attention towards them by systematically using green signalling flags marked with "bio". Promotion is also emphasized by advertising the offer of organic products in their weekly 'flash'-magazine and the organization of an 'organic products' week. Due to this combined approach R1 has increased its share of the total sales of organic products in super- and hypermarkets in Belgium to 50%, though its share of overall super- and hypermarket sales is only 20%. R1 has attained this relatively high market share, even while the average price of its organic products is 19 percent higher than R3's.

Table 4.6. Strategy of the retailers, when supplying organic products in general

	R1	R2	R3		R3-bio
assortment, or # org. products in 2001	600	236	312		7000
org. fresh meat, cheese	available	available	not available		available
org. vegetables, fruit,	available	available	available		available
org. dairy, bread, juice, dried products	available	available	available		available
retailers own org. mark and label	yes	yes	yes		yes
turn over organic (mio EUR)	~80	~30	~55		~10
share of total organic sales by supermarkets (%)	~50%	~20%	~30%		
organics as part of total turn-over	~ 2,2%	~ 0,7%	~1,5%		100%
placement of org. products	good not best	moderate	good		only organic
flags / signalling	very visible flags	less visible	visible stickers		only organic
prices of organic products	119 (+19%)	129 (+29%)	100 (=ref.)		112 (+12%)
Quality of the org. Vegetables	high (cat.1)	medium (cat. 2)	high (cat.1)		high (cat.1)
year of introduction of org. products	1985	1996	1991		2001 = opening

Sources: collected information and own observations

R2's strategy is very different when it comes to selling organic products. R2 makes no special efforts to promote them. R2's organic product range consists of only 236 products, which is about 2.6% of their total product range. Organic products constitute less than one percent of their total turnover and organic sales have declined during the last two years. Whilst prices for basic products at R2 are on average 3% higher than at R3, prices for organic products are 29% higher than at R3. And where prices for the basic products are about one third lower than at R1 the prices of organic products are about 10% higher. With respect to the presentation, organic products are not placed at more visible spots in their stores. Flags are not used systematically to indicate the placement of organic products. Sometimes the careless product placement on the shelves makes the organic label invisible. These observations indicate the lack of knowledge and/or attention of the employees at the point of sales concerning organic products. When it comes to the sales of organic vegetables, where R1 and R3 always provide vegetables of high quality, (Class 1), R2 provides lower quality (Class 2).

R3's strategy for organic products is part of the sustainable "Green Line" product policy. This policy emphasizes their willingness to promote environmentally friendly production and distribution. Starting from R3's basic concept that no superfluous costs may be made, the policy is translated as "investments in environmental friendliness take place if they pay back". R3 is creative in developing this concept by limiting transport miles, recycling, cost efficient and ecological packaging, use of wind energy, and other similar measures. Of the 312 organic products in R3's assortment, more than 190 are private label products. Organic food generates 2% of their turnover and the growth rate is 5% higher than for other products. The organic products are presented in highly visible places in store. As other "Green Line" products they are easily recognisable by a green price sticker on the shelves, while most products have white stickers and red stickers are used to indicate the cheapest products. An effort is made to promote "organic". R3 has a history of offering both basic and high quality products. In the last ten years many of its high quality products have been replaced by organic quality products.

R3 not only challenges the organic leadership role of R1 in its conventional stores, it also targets the organic heavy users in specialised shops: R3-bio. Up to the end of 2007 the number of specialised organic shops remains limited to three, but according to the chief manager of R3-bio the aim is to open up to 15 of these shops in the following years in order to have one in every city in Flanders. Given the rise in sales of organic products at these points of sale with 25% in 2004, the strategy seems successful (De Standaard, 2005). All food products in these shops are organic. The organic range of 7000 products is much deeper and wider compared to specialised shops or other supermarkets which enables customers to buy all the products on their shopping list in the organic version while choosing between a variety of alternatives. Some non-food products that give special attention to ecology are also for sale. These stores are still less profitable compared to the traditional points of sale of R3. But it is likely that when more of these shops open more profits will be made through economies of scale. The staff at R3-bio's points of sale is well informed about the meaning of organic products. A qualified herbalist is present in every R3-bio store.

4.7 Retailers and their engagement in marketing organic beef

In this section we compare the marketing of organic beef by the three retailer groups. This is summarised in Table 4.7 below.

Table 4.7. Characteristics of retailers when supplying organic beef

	R1	**R2**	**R3**		**R3-bio**
sales volume (kg per week), 2004	5800	1300	0		245
% of total sales in F1+ F2, 2004	72%	16%	0		3%
start of supply of organic beef	1997	1997			2001
role in chain organisation	important role	outsourced to transformer			Moderate
effort in chain organisation	high	low			Moderate
agreement on future producer price	fixed	market dependent			
price paid to producers	very high (120 = +20%)	moderate (100)			
consumer prices	105 => (+5%)	100			
risk in case of low demand	for producers	for producers			
country of origin	Belgium	Belgium			Belgium

Source: own research

R1 allocates relatively a large amount of resources to the marketing of organic beef and does this both in the commercial and operational part of its retail mix. One aspect of this is R1's active role in organising the supply chain. Already in 1997, before the dioxin and BSE food scares, R1 made an agreement with a cooperative of organic beef producers to provide high quality meat. By paying a very good price to the producers (see table 4.7) and cooperating for about 10 years, an important degree of trust has been created among these producers. This commitment helped to convince the producers to make important, sometimes "irreversible", investments in quality aspects that go beyond the requirements defined in the organic regulation. For example only animals from two specific breeds are allowed (Aertsens and Van Huylenbroeck, 2004). These measures explain why consumer prices of organic beef are 5% higher than at R2. When taking account of all R1's efforts, the price charged to the consumers can be considered relatively low. R1 also promoted organic beef by emphasising its direct contact with the local producers' cooperative when advertising organic beef, thus appealing to consumers who attach more and more importance to food safety, traceability, origin and authenticity (Jones et al., 2001). By all these efforts, R1 succeeded in gaining a share of 72% in the turn-over of the organic beef sold by the super/hypermarkets in Belgium. This percentage is even higher than the 50% of the overall organic products mentioned before.

R2 invests little effort and less money in organising the supply of organic beef. In practice it has outsourced the organisation of the supply to a processor who also collects the animals from the organic farmers. The price paid to the producers of R2 is about 20% lower than R1's. Though the consumer price is 5% lower than at R1's, the sold volume of organic beef is less than a quarter of R1's volume, due to a lack of promotional and other efforts.

As indicated above **R3** does not supply fresh organic meat in its normal supermarkets. However it does so in its three exclusive organic supermarkets (R3-bio). This is due to several factors: First, R3 has a well organised high quality conventional butchery at all of its points of sale. These butcheries are an asset in attracting clients. According to the "organic reference standard" it is necessary to strictly separate between conventional and organic products. Therefore offering organic meat in this butchery is not allowed. Secondly, offering pre-packed organic meat is not considered a good option as the management argues that the conventional meat supplied is already of very high quality, and that it may have an antagonistic effect to offer a more expensive organic meat. Third, R3 argues that as it has three supermarkets selling only organic products (R3-bio) it does not make sense to offer all organic products also in the conventional supermarkets. They refer to this as avoiding "cannibalism".

4.8 Discussion

In this section we match our empirical findings to the hypotheses that we formulated at the end of the theoretical framework. Our approach is more qualitative. Future research may test some of our hypotheses using a more quantitative approach.

Proposition 1: Organic products may be a strategic product category for some retailers.

For R1, the allocation of resources to the marketing of organic products strongly indicates the strategic importance of organic products for R1. Further R1 wants to differentiate itself from other retailers and to enforce its leading position as a quality distribution chain (Sans, 2003). In an interview, a representative of R1 confirmed this view: "The nice shopping environment and the large selection of high quality and differentiated products is attracting consumers who are willing to pay more for a better quality".

R1 specifically targets consumers that are not primarily price oriented. High income families form an important part of their loyal customers. Studies for Belgium (Stockemer and Van Raemdonck, 2005) and for Europe (Zanoli, 2004) point out that there is a positive relation between higher income and higher consumption of organic food. Furthermore, organic buyers, on average, have higher purchasing power, and they spend up to 4% more on Fast Moving Consumer Goods compared to an average Belgian household (Stockemer and Van Raemdonck, 2005). For R1 this makes that they are a segment that they want to attract to their points of sales.

The organic farming CSR-strategy itself can be termed 'active'. This is the most 'ethical' entrepreneurial orientation, as the underlying principles are inspired by ethical values and social pressure is neglected. The strategy of R1 with respect to organic products can be termed ‘pro-active’, as R1 was early engaged in the organic products’ life cycle. The strategy of R3 with respect to organic products shares some ‘pro-active’ elements as well as ‘inactive’ elements, as the strategy is mainly inspired by (cost-) efficiency improvement, which makes the motivation primarily utilitarian. R2’s organic product strategy can be termed ‘re-active’, as it is used as a means to avoid negative reputational effects due to absence of these products.

Organic farming products as PIoS contribute to the different dimensions of the CSR strategy of retailer R1 (and R3 to some extend). First of all, the principles underlying organic farming are also ‘central’ to the strategic objectives outlined in the mission statement of R1. Organic farming products are furthermore important in making the CSR strategy of R1 (and R3) ‘visible’. This visibility is further pronounced by additional signalling of organic products via packaging and in store advertisement. The ‘appropriability’, or the possibility to extract economic benefits from organic products as part of the CSR strategy, mainly relates to the signalling function of organic products (see next Proposition also). These products help R1 (and R3) in targeting the desired consumer segments. Furthermore, organic farming is a strong example of ‘voluntarism’, another dimension of strategic CSR. Organic producers voluntarily apply more environmentally friendly production principles. ‘Pro-activity’, as a final dimension, can also be related to R1’s strategy, as explained above. R1 engaged very early in the organic market, while organic farming itself is a pioneer in environmentally friendly and socially sound production.

Proposition 2: The (perceived) characteristics of organic products have strategic importance for retailers that want to create an image with the same values.

This proposition investigates the ‘centrality’-dimension of organic products to the retailer’s strategy, as explained above. Before, we learned that R1 particularly targets customers searching for high quality, healthiness, new and artisanal food products. These characteristics match very well with what consumers perceive to be properties from organic products.

It became clear that the perceived environmental friendliness of organic products fits very well in R3’s sustainable “Greenline” strategy. This helps to explain why “organic products” are important for R3.

Proposition 3: In order to favour strategic products, retailers may not only use the commercial but also the operational factors of the retail mix.

The empirical data clearly revealed that R1 invested not only many resources from the commercial (Product quality and assortment, Price, Presentation, Promotion) but also from the operational mix in promoting the organic product segment. Especially its operational efforts in organising the organic beef chain highlighted this. When applying Mainville’s framework, main reasons are the importance of the organic products in the total sales, certainly in comparison to R2, and the fact that organic products are non mainstream products. As outlined in the organic principles, organic products need to be treated separately from conventional products, requiring organisation of a specific supply chain.

In contrast it became obvious that R2 did put very little effort in these different factors to promote organic products.

Proposition 4: Due to the characteristics of the organic market as an innovative, emerging market, there may be certain first mover advantages.

Lieberman and Montgomery (1998) indicate that first mover advantages may find their origin in three factors: (i) gaining technology leadership, (ii) gaining control of resources and (iii) binding customers to the firm. Considering the commercialisation of organic (beef) products by R1 mainly the second and third factors are relevant. Through its strategy R1 is *"gaining control of the resources"*. In the organic sector the number of supplier organisations is still very limited (especially in Belgium). As indicated in Table 4.7, R1 'controls' 72% of the total organic meat volume through their vertical alliances, leaving only limited options for the other retailers. This is similar for other organic segments, e.g vegetables. The approach of R1 in striving for sustainable exclusive relationships with high quality suppliers, makes them gain control over local resources that their competitors will not be able to copy. Several papers, e.g. Bernués et al. (2003), find that consumers of (organic) meat or organic products in general prefer the products to be produced in their home country. Through its strategy R1 is also *"binding customers"*. Being the first and leading firm to sell organic products thus results in first mover advantages.

In this context it is interesting to apply Mickwitz' (1959) findings to R1's strategy of marketing organic beef. Mickwitz found that in succeeding phases of the Product Life Cycle, different marketing mix instruments become more efficient. Also, more investments are needed in the early phases (introduction, growth, maturity) and more gains will occur in the later phases (saturation, decline). Following Mickwitz, during the introductory phase of *the Product Life Cycle*, R1 has especially focussed on providing high quality organic beef by specifying process criteria to its suppliers. The high prices R1 pays to organic beef producers are not charged completely to the consumers. R1 in the past ten years applied a market penetration strategy (and certainly not a skimming strategy). In the second or growth phase, again following Mickwitz, the retailer started to invest more in promoting organic beef as the growth of organic beef consumption was stagnating. The investments of R1 in marketing organic beef have certainly paid off in terms of market share. Although R1's investments in developing the supply of organic beef are not covered by the consumer price of organic beef in the short run, following Mickwitz theory, they will most probably be covered in the long run.

Proposition 5: Investments by retailers in products which have strategic importance for them, will pay off indirectly.

The chief organic beef buyer at R1 claimed: "We are rather making losses than profits, when commercialising organic beef. But it is an investment in the future". Investments in the overall quality of the supply of organic (beef) products as a strategic product will underline the quality image of R1 positively. This may attract (new) customers that buy other products and help to recover these investments faster.

This proposition has the important consequence that retailers should pay (more) attention to effects of some product categories on others. Now, a lot of retailers have purchase and sales managers that are responsible for strictly delimited categories, this organisational structure may hamper the development and promotion of strategic products, like organic products.

Proposition 6: For some retailers organic products have no special strategic importance.

From our empirical part it became clear that for R2 "organic products" have much less importance than for R1. Richter and Hempfling (2002) would describe R2's strategy as a "basic" or "adapting" strategy. For R2 organic products have no special significance. The provision of a limited range of organic products is mainly targeted as a defence against R1 which might be successful in attracting and holding new customers from R2.

We noticed a strong positive correlation with the consumer segments that are targeted. Where R1 targets especially high income consumers, R2 targets all segments. Further in the retailer spectrum there are hard discounters in Belgium that do not offer (fresh) organic products at all.

Proposition 7: For emerging product markets, some retailers may benefit more from a second mover strategy.

R2's and R3's basic strategy make sense because of "second mover advantages". As adapters or second movers they can reduce their costs and avoid some first mover risks. R1, as the first-mover firm incurs higher costs partly by having to learn competences partly in educating its customers about organic (beef) products, but mainly by developing and adapting the supply chain and the standards underlying PIoS, in order to meet the quality standards of R1. As the learning experience is to some extent spread among all producers, R2 and R3 on this point benefit from this learning experience and incur much lower costs. Also by applying a "wait and see" policy they do not run the risk of investing in a market that might prove unbeneficial.

4.9 Conclusion

We noticed that different retailer groups which at first sight have similar characteristics, can have very different strategies for marketing organic products. For some retailers, organic products are of strategic importance, as part of a differentiation strategy. This is due to their perceived values, such as environmental friendliness, social responsibility and high quality. The merit of strategic products in this sense are not in generating a lot of sales but in their possibility to improve the retailers image and thus attract extra customers who will also buy additional products at the store. Some retailers are willing to take very low margins and to invest many resources in all seven (commercial and operational) factors of the retailing mix in order to put these strategic products in the spot light. When the products, as is the case for organic products, are part of an emerging market, the development of both new technological and customer competences may be necessary. This demands huge investments and time but may result in first mover advantages by binding both suppliers and clients to the retailer. Other retailer groups for whom organic products are not of strategic importance, can benefit more from a second mover strategy. They offer only a basic assortment and thus limit the risk of investing a lot in an emerging market that might turn out to have a limited future. However when the emerging market would turn out to have a bright future, the "adapters" will invest later and then benefit from the learning experience that has already been developed in the sector. Our results also hold for other product types in emerging markets that for some retailer groups have strategic importance such as fair trade products, regional high quality products, convenience products.

PART 2: Performance of PIoS

As explained in chapter 2, private certification schemes are perceived by market and public actors as promising tools to realize sustainable growth, as they are market driven and have a voluntary nature. Chapter 3 and 4 confirm that also consumers and retailers are interested in these tools.

From chapter 3 we learn that different types of consumers attach a different value to environmental attributes. For some these attributes are irrelevant, while others are willing to pay premium prices for it. The differential interest of consumers in PIoS can be explained in two ways:

1. Some consumers are more susceptible to environmental issues compared to others;
2. Some attach more credibility to the environmental claim made compared to others.

With respect to point 1, chapter 3 indicates that we can draw a clear parallel between environmental quality attributes and other quality attributes of food products. Both add extra value to the product and for both an extra price is charged. But there is also an important difference. As opposed to other quality attributes, environmental quality attributes face the consumer with the consumer-citizen paradox, as shown in figure II.1 below. As private utility maximizers, consumers would like to enjoy the environmental service while not paying for it. When every consumer would exhibit this free rider behaviour, no public goods are internalized and the citizen foregoes utility (i.e. the tragedy of the commons). The trade-off between consumer and citizen is person dependent. This creates the possibility for private actors to target these differential consumer interests. As a result, many types of PIoS can be designed that target specific consumer segments.

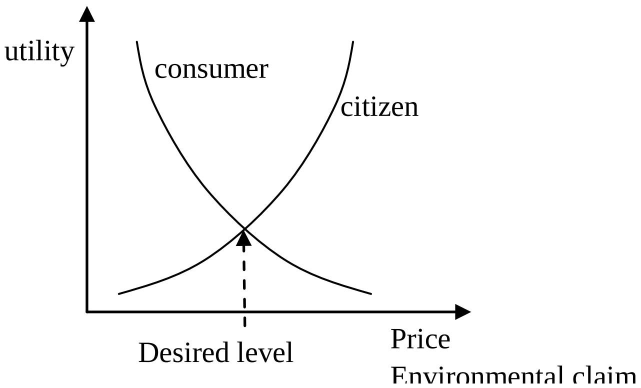


Figure II.1. Relation between consumer utility and citizen utility and desired level of environmental claim

The second point, the consumer's perception of the credibility of the claim, depends, apart from the consumer, on the actual validity of the claim and the way the claim is communicated. The link between the environmental benefit and the product is often very weak. It is not by eating one CO_2-neutral food product that global warming is resolved. Moreover, it is not because one consumer eats CO_2-neutral food that the environmental effect is reached. From the previous chapters we can derive that the stronger the environmental claim, ceteris paribus, the more costs need to be made to make this claim legitimate. Two opposing demand side effects result from this. First, a strong claim will be better understood, given the multitude of claims made in the market. Second, in a competitive market the extra costs need to be recuperated by adding a price premium. As such the consumer faces a trade-off between credibility of the environmental claim and price premium.

In chapter 4 we explained why firms proactively engage in CSR and PIoS. A nice summary of how CSR, and by extension PIoS, can be used strategically is given by Husted and Allen (2007), as depicted in Table II.1. They compare traditional CSR with a traditional firm strategy and strategic CSR. Husted and Allen (2007) build further on the framework of Burke and Logsdon (1996), who identify five dimensions of corporate strategy which relate CSR to value creation by the firm[11]. Similar to consumers' perception of traditional food quality attributes versus environmental quality attributes, strategic CSR shares some common and opposing features to a traditional innovation strategy. For some retailers strategic CSR corresponds better with their traditional innovation strategy compared to others. The five dimensions are informative in this sense, as shown in Table II.1.

Table II.1. A Comparison of Traditional CSR, Strategic CSR, and Traditional Strategy (Husted and Allen, 2007)

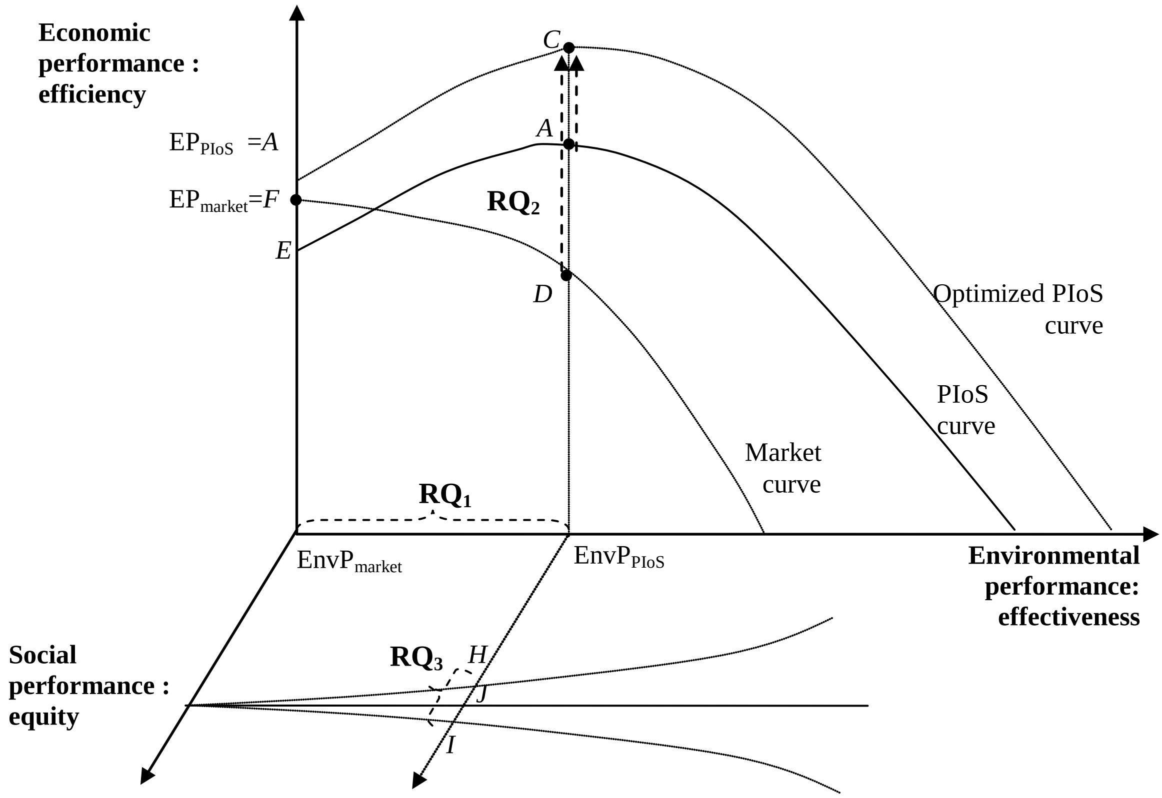
Strategic dimensions	**Different Approaches to CSR and Strategy**		
	Traditional CSR	**Traditional strategy**	**Strategic CSR**
Visibility	Irrelevant: Doing good is its own reward - and is profitable in the long run	Build customer awareness of product and brand	Building customer and stakeholder awareness of product with CSR value added
Appropriability	Irrelevant: Doing good is its own reward - and profitable in the long run	Manage supplier, customer, and competitor relations to capture value added for firm	Manage stakeholder relations to capture value added for the firm
Voluntarism	Participate in social action beyond that demanded by the firm's interests and the law	Firm innovation based on ability to learn: non - deterministic behavior	Participate in social action beyond that demanded by law
Centrality	Irrelevant: Doing good is tied to social need and not to core business mission	Create value via product/ service innovation	Create value via product/ service innovation linked to social issues
Proactivity	Anticipate changes in social Issues	First-mover advantage	Anticipate changes in social issues that present market opportunities

With this is mind, we can now move to the first set of core research questions in this dissertation. Part 2 concentrates on the actual performance of PIoS compared to the spot market benchmark.

As explained above, the consumers' interest in PIoS depends, amongst other things, on the credibility of the environmental claim. Therefore, our first main research question RQ1 investigates the ecological performance of PIoS. Chapter 5 addresses this question by focusing on the *environmental effectiveness of PIoS*. In Figure II.2 this corresponds to measuring the difference between $EnvP_{PIoS}$ and $EnvP_{market}$.

Above, we also indicated that private actors engage in these systems because of strategic reasons. Central to the adoption of the PIoS strategy is the appropriability, i.e. the ability of the firms to extract economic benefits from the PIoS strategy. In a second main research question RQ2, addressed in chapter 6, we want to investigate the *economic performance of farms participating in PIoS*. As a measure for economic efficiency we introduce and adapt the sustainable value method. In Figure II.2 this corresponds to measuring the difference between point A and C for the PIoS versus point D and C for the conventional market.

[11] For an explanation of these five dimensions, see chapter 4 Theoretical framework



Figuur II.2. Research questions in Part 2

Chapter 4 highlighted the retailer interest in these farm certification schemes. In the introduction we explained that PIoS often refer to inter firm arrangements, and more specifically to hybrids, which are organisational structures in which multiple actors cooperate and contract together, while still remaining competitors. Typical for the latter is the potential to exhibit market power and to influence the distribution of gains and costs. Therefore, in a third main research question RQ3 we want to investigate the *(internal[12]) social performance of these hybrid PIoS*, by qualitatively explaining the effects of the evolution towards a single retail driven PIoS system. In Figure II.2 point J reflects equity among chain members as currently encountered in the market. Point I and H reflect positive, resp. negative deviations from this equity level within PIoS.

[12] i.e. within the value chain

Chapter 5. **Ecological performance - environmental effectiveness of PIoS**

This chapter is based upon: Mondelaers, K., Aertsens, J. and Van Huylenbroeck, G. (2009). A meta-analysis of the differences in environmental impacts between organic and conventional farming. British Food Journal, 111(10), 1098-1119.

5.1 Introduction

In this chapter 5, the environmental effectiveness of PIoS is compared with the market alternative. This chapter thus wants to test hypothesis 1 defined in the conceptual framework:

Firms participating in Private Institutions of Sustainability contribute more to ecosystem sustainability than firms who do not

The organic farming system is used as proxy for the PIoS, as the private actors involved in it voluntary follow more restrictive rules, while the conventional farming system represents the market regulated by public institutions. Environmental effectiveness[13] is restricted to the measurement of the physical impact of agricultural practices on the environment.

The influence of conventional agricultural production on ecosystems has been widely documented (see for example the journal Agriculture, Ecosystems and Environment). In Europe, especially since the 1950s, increase in use of external input factors, e.g. fertilizers and pesticides, has resulted into significant increases in productivity, but simultaneously in a higher environmental pressure. Organic agriculture tries to respond to this challenge by limiting the use of external inputs and integrating several practices which are considered more environment friendly. The organic production system strives at a minimal disruption of the natural equilibrium, and at the same time, high-quality food production by banning residues harmful for human and animal health. Therefore the use of chemical fertilizers, pesticides and genetically modified organisms are prohibited. The organic principles of regulation also stimulate processes of recycling, closed loop systems, and the use of production techniques which allow domestic animals to exhibit species specific behavior. For countries in the EU the regulation is stipulated in EEC regulation 2092/91 and subsequent. In recent years a lot of research has investigated whether the application of the organic farming principles indeed results in differences with respect to environmental pressure. In this article this literature is reviewed and statistically meta-analyzed for possible differences in the impact of organic and conventional farming on nitrate and phosphorous leaching, biodiversity, organic soil content and greenhouse gas emissions. The article is constructed as follows: first a theoretical framework is given, next the applied methodology is introduced, followed by the results and a discussion.

[13] Environmental effectiveness is not synonymous to the degree of internalization of external costs, as the latter term introduces an economic notion.

5.2 Theoretical framework

The relation between the agricultural system and the environment is complex. Different analytical frameworks have been constructed to simplify the description and measurement of this relation. The Principles > Criteria > Indicators (PCI) framework (Peeters et al., 2005) for example departs from hierarchical levels to facilitate the definition of indicators enabling the evaluation of the sustainability of agriculture. Another possibility is the transition framework (Meul et al., 2007), in which sustainable development is considered as a complex long term process of change, defining different actions to translate theoretical concepts into practical measures. These actions are in succeeding order: vision development, strategy definition, action and progress monitoring. In this study, we opted for a third possibility, the Driver-State-Response (DSR) framework developed by the OECD (1993) for policy analysis of the state of the environment.

The Driver-Pressure-State-Impact-Response (DPSIR) framework, applied by the European Environmental Agency (EEA, 1999), directly results from this framework. As explained by Platteau et al. (2005), the DPSIR-frame shows the cause-effect relation of agricultural activity on the environment. A certain societal activity, in our case agriculture, is the 'driving force' disturbing the environment. Because agriculture makes use of the environment, it exercises a certain 'pressure' on the environment. Due to this pressure, the environment is characterized by a certain 'state', which, on its turn can influence ('impact') the wellbeing of men, the ecosystem or the economy. Finally, undesired levels of drivers, pressures, states or impacts might trigger a 'response' from the society. At each of these levels, indicators are defined. The DSR and DPSIR framework have been applied a multifold times for the analysis of agricultural systems, for example by COM (2000), Verhaegen et al. (2003), Wustenberghs et al. (2005), Platteau et al. (2006) and Van Steertegem et al. (2006). Also for the specific comparison of organic and conventional farming it has been a well used guiding tool, with most important studies by the Bichel Committee (1998), Stolze et al. (1999) and Hansen et al. (2001).

Table 5.1 below summarizes different indicators that can be linked to the DSR-framework.. As explained in chapter 1, the ecosystem is simultaneously a source of resources for agricultural production, a sink of wastes from agricultural production and a provider of essential services to agriculture. Table 3.1 also shows the environmental function that can be associated with each indicator. In the table it is also indicated what type of ecological cost is created due to the agricultural production. A distinction is made between scarce resource consumption, creation of positive and negative externalities.

Table 5.1. Indicators for the comparison of the organic and conventional system

DSR Framework	Indicator category	Indicator	Economic valuation	Environment function
DRIVING FORCE				
D1 D2 D3 D4 D5	**Farm input and output**	Nutrient use Energy use Water use Pesticide use Land use	Resource consumption Resource consumption Resource consumption Resource consumption Resource consumption	Source/sink Source/sink Source/sink Source/sink Source/sink
STATE				
Predecessing driver				
D1, D4, D5 D1, D4, D5 D1, D4, D5 D1, D4, D5	**Ecosystem**	Floral diversity Faunal diversity Habitat diversity Landscape	Positive externalities Positive externalities Positive externalities Positive externalities	Source/Service Source/Service Source/Service Source/Service
	Natural resources			
D1 – D5 D1 D1, D4 D1, D2, D5 D1, D3, D5	*Soil*	Land use efficiency Organic matter Biological activity Structure Erosion	Resource consumption Resource consumption Negative externalities	Source/Sink Source/Sink Source/Sink Source/Sink Sink
D1 D1 D4	*Ground and surface water*	Nitrate leaching Phosphorous leaching Pesticides	Negative externalities Negative externalities Negative externalities	Sink Sink Sink
D1 D1, D2 D1, D2 D1, D2 D4	*Climate and air*	NH_4 CO_2 N_2O CH_4 Pesticides	Negative externalities Negative externalities Negative externalities Negative externalities Negative externalities	Sink Sink/Source Sink Sink Sink
D2 D1	*Energy*	Non renewable energy Phosphorous		
	Health and welfare			
D1 – D5 D1 – D5 D1 – D5	*Animal health and welfare*	Husbandry Nutrition Health	Positive externalities Positive externalities Positive externalities	Sink Sink Sink
D4 D1 D1, D4 D1, D4 D1 – D5	*Quality of produced food*	Pesticide residues Nitrate Mycotoxins Heavy metals Desirable substances	Negative externalities Negative externalities Negative externalities Negative externalities Positive externalities	Sink Sink Sink Sink Sink
RESPONSE				
	Consumer reaction, Agrofood chain, Farmer behavior, Government policies			

Sources: adapted from Hansen et al., 2001, Stolze et al., 1999, TAPAS, 2003, OECD, 1999, Bichel Committee, 1998

5.3 Methodology

As indicated, this paper aims at synthesizing current scientific findings regarding the differences in environmental state of the organic and conventional farming system. A technique particularly suited to do so is meta-analysis, which is according to Hedges and Olkin (1985) the quantitative synthesis, analysis and summary of a collection of studies. As Arnqvist and Wooster (1995) explain, meta-analysis refers to a specific set of statistical quantitative methods that are designed to compare and synthesize the results of multiple studies. In many ways, the procedures involved are analogous to those of standard statistical methods, but the units of analysis are the results of independent studies rather than the independent responses of individual subjects. Current meta-analysis offers formal methods for most types of statistical inference from a set of studies. Meta-analysis allows the following questions to be addressed: (1) What is the combined magnitude of the effect under study? (2) Is this overall effect significantly different from zero? (3) Do any characteristics of the studies influence the magnitude of the observed effect?

Arnqvist and Wooster (1995) outline the procedure to be followed. (1) all studies addressing a common question or hypothesis are collected. (2) data or test statistics from these studies are transformed into a 'common unit', called 'effect size'. Common measures of effect size are the standardized difference between means of experimental and control groups or the Pearson product moment correlation coefficient. (3) these effect sizes are combined into a common estimate of the magnitude of the effect. (4) based upon the variation in effect size results, the significance level of the overall effect size found in (3) is computed. (5) the statistical homogeneity of the effect sizes is calculated. This is conducted to determine whether all studies appear to share a common effect size or not. Finally, (6) the studies used in the meta-analysis are grouped according to various characteristics of the single studies, and the effect sizes between these groups of studies are statistically compared and analysed.

In case it is impossible to estimate the standard deviations of the mean for organic and conventional agriculture, and thus impossible to conduct a meta-analysis, the Sign-test (Abdi, 2007), an alternative (less powerful) method can be applied. This binomial test allows to test whether the frequency of studies with a higher (or lower) value for organic farming significantly differs from the frequency that is found by chance.

Depending on the desired outcome, different output variables can be chosen in meta-analysis. In our case, the response ratio (R) , see formula (1), or the ratio between some measured quantity in the experimental (organic) and control (conventional) group, is an interesting measure for the size of the 'experimental' effect (which is the difference between the organic and conventional data point). This R-value estimates the proportionate change that results from an experimental manipulation (Hedges et a., 1999), here the organic farming practices. Hedges et al. (1999) argue to use of the natural log (L_i), see also formula (1), because this value linearises the metric, treating deviations in the numerator the same as deviations in the denominator and resulting in a much more normal sampling distribution of the Log response ratio in small samples.

$$R = \overline{X_E} / \overline{X_C} \text{ and } L_i = \ln(R) = \ln(\overline{X_E}) - \ln(\overline{X_C}) \qquad (1)$$

Under the assumption that $\overline{X_E}$ and $\overline{X_C}$ are normally distributed, L_i is approximately normally distributed with mean the real log response ratio and variance given in formula 2.

$$v_i = \frac{(SD_E)^2}{n_E.\overline{X}_E^2} + \frac{(SD_C)^2}{n_C.\overline{X}_C^2} \qquad (2)$$

With SD = standard deviation of the experimental resp. control group
n = number of observations in the experimental resp. control group

According to Hedges et al. (1999), there are two components of variance in the sample log response ratios. One component is due to sampling variation in the estimate for each experiment, the other is due to between experiment variation. Between experimental variation quantifies the degree of true (nonsampling) variation in results across experiments. The statistic Q can be used to test the statistical significance of this second variance component. When this between experiment variance component is significant, the metric denotes a random effect (contrary to a fixed effect), meaning a combination of studies that differ from each other. In that case, caution with the interpretation of the study results is necessary, as well as a correction of the weighting factors (see Hardy and Thompson, 1998).

For our study we based ourselves on literature references fulfilling the following three criteria: 1) peer reviewed; 2) studies from 1992 owards (year of EEC regulation 2092/91); and 3) (semi) paired samples, this means that organic and conventional data are compared within the same study. Weighting of the references is based upon the possibility of deriving the standard error (s.e.) from the references. Hereby, three cases are distinguished: 1) the s.e. is reported in the study, hence the data point can enter the meta-analysis; 2) the s.e. is not reported, but multiple data points are available in the study , enabling the calculation of a standard deviation based upon the available data which can be entered in the meta-analysis data base; and 3) no s.e. is reported, only a single observation is available. The latter data point has not been retained for the meta-analysis, but is only used in the sign-test.

5.4 Results and discussion

To assess the difference in environmental pressure between organic and conventional agriculture we investigated the following indicators of the environmental state: land use efficiency, organic matter content, nitrate and phosphorous leaching, biodiversity and greenhouse gas emissions. Where relevant and possible, the differences found are linked to differences in driving forces (management practices) between organic and conventional farming.

In table 5.2 the analysed references are organized per investigated indicator. Table 5.2 furthermore contains studies that are of interest for the topic under study but did not meet our criteria for meta-analysis indicated above.

5.4.1 Land use efficiency

Land use is an important indicator for natural resource consumption. The land use efficiency indicator is informative because land (especially in densely populated regions) is a scarce good and agriculture has to compete for it with other users (housing, industry, nature reserves). Therefore, policy makers can take differences in land use efficiency into account when they assess environmental impacts expressed per unit area. Some ecologists do contest this approach as they have a more ecocentric rather than a anthropocentric view on ecological problems, partly ignoring that total consumption and production in the end determine the pressure on the ecosystem. For more local problems, such as , e.g. nitrate leaching, the leaching per unit area is most informative, however for more global problems, e.g. greenhouse gas emissions, the pollution per kg food product is more informative.

Table 5.3 summarizes the results of the meta-analysis for land use efficiency. Following references were retained: Korsaeth and Eltun (2000), Kirchmann and Bergstrom (2001), Knudsen et al. (2006), Hansen et al. (2000), Sileika end Guzys (2003), Haas (2002), Torstensson et al. (2006), Taube et al. (2005), Mader et al. (2002), Poudel et al. (2002) and Eltun (1995). Based upon the general results of 10 studies of organic farming in developed countries, a random effect ratio of 0,83 is found, or in other words a land use efficiency of 83% for organic farming compared with conventional farming.

Table 5.2. References used in the meta-analysis. First screening indicates all references that are of interest for the topic. References used in the meta-analysis are listed afterwards

Nitrate leaching	
First screening	Biro et al. (2005), Condron et al. (2000), De Neve et al. (2003), Eltun (1995), Haas et al. (2002), Hansen et al. (2000), Kirchmann and Bergstrom (2001), Knudsen et al. (2006), Korsaeth and Eltun (2000), Kristensen et al. (1994), Ostergaard et al. (1995), Pacini et al. (2003), Pimentel et al. (2005), Sileika and Guzys (2003), Stopes et al. (2002), Syvasalo et al. (2006), Torstensson et al. (2006), Ulen (1999)
Kg/ha	Eltun (1995), Condron et al. (2000), De Neve et al. (2003), Biro et al. (2005), Syvasalo et al. (2006), Sileika and Guzys (2003), Haas (2002), Torstensson et al. (2006), Korsaeth and Eltun (2000), Hansen et al. (2000), Stopes et al. (2002), Knudsen et al. (2006), Pimentel et al. (2005), Pacini et al. (2003)
Comparison per ha and per kg	De Neve et al. (2003), Sileika and Guzys (2003), Haas (2002), Torstensson et al. (2006), Korsaeth and Eltun (2000), Hansen et al. (2000)
Simulation	Condron et al. (2000), De Neve et al. (2003), Knudsen et al. (2006), Hansen et al. (2000)
Lysimeters / drainage pipes	Eltun (1995), Biro et al. (2005), Syvasalo et al. (2006), Sileika and Guzys (2003), Haas (2002), Torstensson et al. (2006), Korsaeth and Eltun (2000), Stopes et al. (2002)
Arable farming	Eltun (1995), Biro et al. (2005), Sileika and Guzys (2003), Torstensson et al. (2006), Hansen et al. (2000), Knudsen et al. (2006), Haas (2002)
Mixed farming	Eltun (1995), De Neve et al. (2003), Syvasalo et al. (2006), Hansen et al. (2000), Stopes et al. (2002), Condron et al. (2000)
Land use	
First screening	Eltun (1995), Haas et al. (2002), Hansen et al. (2000), Kirchmann and Bergstrom (2001), Knudsen et al. (2006), Korsaeth and Eltun (2000), Mader et al. (2002), Poudel et al. (2002), Sileika and Guzys (2003), Taube et al. (2005), Tostensson et al. (2006)
Full rotation	Korsaeth and Eltun (2000), Kirchmann and Bergstrom (2001), Eltun (1995), Sileika and Guzys (2003)
Cereals	Knudsen et al. (2006), Hansen et al. (2000), Torstensson et al. (2006), Mader et al. (2002), Poudel et al. (2002)
Organic matter	
First screening	Bakken et al. (2006), Clark et al. (1998), Flieβbach et al. (2007), Foereid et al. (2004), Girvan et al. (2003), Gosling and Shepherd (2005), Nguyen et al. (1995), Pulleman et al. (2003), Herencia et al. (2008), Stalenga and Kawalec (2008), Stolze et al. (2000)
In meta-analysis	Gosling and Shepherd (2005), Nguyen et al. (1995), Girvan et al. (2003), Fliebach et al. (2007), Stolze et al. (2000), Clark et al. (1998), Pulleman et al. (2003)
Phosphorous leaching	
First screening	WUR (2007a, 2007b), Torstensson et al. (2006), Ekholm et al. (2005), Nguyen et al. (1995), Marinari et al. (2006), Clark et al. (1998), Bengtsson et al. (2003), Haas et al. (2001), Langmeier (2002), Condron et al. (2000), Fagerberg et al. (1996), Gosling and Shepherd (2005), Gustafson et al. (2003), Liebig and Doran (1999), Loes and Ogaard (2001), Oberson et al (1993), Reganold et al. (1993), Sileika and Guzys (2003), Steinshamn et al. (2004), van Diepeningen et al. (2006), Watson et al. (2002)
P in	WUR (2007a, 2007b), Torstensson et al. (2006), Ekholm et al. (2005), Nguyen et al. (1995), Marinari et al. (2006), Clark et al. (1998), Bengtsson et al. (2003), Haas et al. (2001), Langmeier (2002)
P out	WUR (2007a, 2007b), Torstensson et al. (2006), Ekholm et al. (2005), Nguyen et al. (1995), Marinari et al. (2006), Clark et al. (1998), Bengtsson et al. (2003), Haas et al. (2001), Langmeier (2002)
P balance	WUR (2007a, 2007b), Torstensson et al. (2006), Ekholm et al. (2005), Nguyen et al. (1995), Marinari et al. (2006), Clark et al. (1998), Bengtsson et al. (2003), Haas et al. (2001), Langmeier (2002)
Greenhouse gases	
First screening	Casey and Holden (2006), Dalgaard et al. (2006), de Boer (2003), Flessa et al. (2002), Haas et al. (2001), Kaltsas et al. (2007), Meisterling et al. (2009), Olesen et al. (2006), Petersen et al. (2006), Syvasalo et al. (2006), Stalenga and Kawalec (2008), Woor et al. (2006)

Per hectare	Haas et al. (2001), Dalgaard et al. (2006), Olesen et al. (2006), Casey and Holden (2006), Kaltsas et al. (2007)
Per Life Weight	Dalgaard et al. (2006), Olesen et al. (2006), Petersen et al. (2006), Syvasalo et al. (2006)

For cereal crops, the random effect indicates a land use efficiency of 81% for organic farming compared to conventional. When only those studies are combined that report data for a full rotation, organic land use efficiency is approximately 20% lower than conventional. This latter case is a fixed effect, thus the heterogeneity in the set of studies is no longer significant.

Table 5.3. Land use efficiency differences between organic and conventional farming expressed as Response ratio (i.e. ratio of organic and conventional output per hectare)

Land use efficiency	N	n	No weighting	Fixed effect	Q	Random effect	CI
All sources	10	70	0,814	0,841	27,1* (24,99)	**0,827**	0,76 – 0,90
Per rotation	4	47	0,802	**0,806**	8,6 (12,59)	/	0,69 – 0,89
Cereal crops	5	64	0,777	0,828	11,4* (11,07)	**0,809**	0,70 – 0,93

( ) = χ^2_{df-1}, α= 0,05; N=number of studies; n=number of paired observations; CI = confidence interval
* Between study variability significant

A recent extensive American meta-analysis by Badgley et al. (2007) collected return ratios from 138 different sources. They report an average organic / conventional yield ratio of 91% for developed countries for all crops, which is thus higher than our estimate. They furthermore calculated an average organic / subsistence farming ratio of 174% for developing countries. Based upon their calculations, organic farming would be able to feed the world without bringing extra farmland into use. Rosegrant et al. (2006) tested different conversion scenarios on world scale level. In case of converting 50% of the European and North American agriculture to certified high input organic agriculture, world production would decrease and prices increase (with approximately 10%) according to their calculations, which may eventually result in a slight increase in malnourished children in developing countries (0,3 to 0,7%). When converting half of the production in sub-Saharan Africa to non certified low input organic farming world production would slightly increase (due to the current large share of subsistence farming) and world prices hardly decrease (1 to 2%, given the limited share of Africa in world market production). Because Africa's world market dependency decreases in this scenario, the number of malnourished children will decrease (with 0,8 to 1%). Of course such scenarios are highly dependent on the assumptions behind it such as e.g. comparing an semi optimised system with a non-optimised system.

5.4.2 Organic matter content in the soil

A second environmental state indicator related to resource use is organic matter depletion in the soil. In the European Thematic Strategy for the protection of the soil, soil organic matter content is defined as the key indicator for soil quality because an optimal level of organic matter signifies a good agricultural and environmental soil condition, characterized by reduced erosion, high buffering and filtering capacity and a rich habitat for living organisms (COM, 2002). Stoate et al. (2001) warn for reduced water retention in dry zones and reduced drainage in wet zones when there is a loss of organic matter. Mullier et al. (2006) for example report for Belgium that in the last 20 years the number of parcels with organic matter content below the optimal zone has increased significantly (from 23 to 50% of the arable land, Mulier et al., 2006). Organic matter content is also important for the CO_2 sequestration (Platteau et al., 2005), given that on average 50 to 58% of organic matter is carbon.

A number of studies don't find convincing evidence for a difference in organic matter content between organic and conventional parcels (Nguyen et al., 1995 for the arable phase; Friedel, 2000; Girvan et al., 2003; Gosling and Shepherd, 2002 and 2005; Bakken et al., 2006 and Cuvardic et al., 2006). A series of other studies (Condron et al., 2000; Fliessbach and Mäder, 2000; Fliessbach et al., in press; Mäder et al., 2002; Foereid and Hogh-Jensen, 2004; Hansen et al., 2001; Stolze et al., 2000; Marriott and Wander, 2006; Shepherd et al., 2002; Armstrong-Brown et al., 1995; Clark et al., 1998; Raupp et al., 1995; Loes and Ogaard, 1997, Liebig and Doran, 1999, Wander et al. 1994, Stalenga and Kawalec, 2008, Herencia et al., 2008 and Pulleman et al., 2003) report a difference in favour of the organic management practices. A number of these studies can usefully be combined into a meta-analysis (Table 5.4). Main reasons for non compliance of a number of studies were the absence of a standard deviation, no peer review, no paired comparison, organic matter content monitored during conversion, study dating before 1992 or use of a different technique. Given that organic matter content is mainly expressed as a percentage, the fixed effect value reported in table 3 indicates that the organic matter content on organically managed fields on average exceeds the conventional value with 6,4 percent points. As the 95%- confidence interval shows (the ratio is not encompassing 1), organic matter content on organic plots is significantly higher than on conventional plots. When also accounting for the studies of Pulleman et al. (2003) and Herencia et al. (2008), in which very high and significant differences in organic matter are reported, a random effect of 1,12 is found, with CI between 1,052 and 1,189. Herencia et al. (2008) report very low organic matter contents prior to the experiment, which might explain the drastic changes in organic matter afterwards.

Table 5.4. Differences in organic matter content between organic and conventional farming expressed as Response ratio (i.e. ratio of organic and conventional organic matter content)

Organic matter content	N	n	No weighting	Fixed effect	Q	Random effect	CI
Organic (%) / Conventional (%)	7	77	1,058	1,064	15,77 (16,9)	/	1,046 – 1,081
Organic (%) / Conventional (%)	9	103	1,128	1,091	152,71 (19,7)	1,118	1,052 – 1,189

( ) = χ^2_{df-1}, α= 0,05; N=number of studies; n=number of paired observations; CI = confidence interval
* Between study variability not significant

As main reasons (drivers) for the decrease in organic matter content in conventional agriculture, Platteau et al. (2005) and Mulier et al. (2006) refer to: the increase of the plough depth; the lower input of stable organic matter by means of organic manure and soil improvers; the decrease of the practice incorporating crop residues during ploughing; the increase of conversion of grassland into arable land; more stringent manure application rules and even a higher mineralization rate due to climate change. Hodges (1991, in Shepherd et al., 2002) identifies following practices that may explain the better performance of organic farms: mixed farming systems and crop rotation; recycling of manure; use of green manure and the addition of organic manure. Hansen et al. (2001) attribute the better score of organic farming to the more generalised use of capture crops, the recycling of crop residues, the use of organic instead of synthetic fertilizers and relatively more permanent pastures.

5.4.3 Nitrate leaching

Nitrate leaching is one of the main negative externalities of intensive agricultural production. There seems a positive correlation between the increase in productivity and the increase in nitrate leaching (Kirchmann and Bergstrom, 2001). The EU introduced regulation which aims to protect water bodies against pollution induced by nitrates from agricultural sources. Even today, a considerable part of European regions have difficulties to comply. Platteau et al. (2005) report that nitrate concentrations in surface water in Flemish agricultural zones exceed in 40% of the measurement points the limit of 50 mg NO_3^-/l water imposed by Europe (Nitrate Directive, EC 1991 and Drinking Water Directive, EC 1980). Several authors have studied potential nitrate leaching differences between organic and conventional farming. Table 3 summarizes the response ratios derived from these studies. When taking all studies referred to into account (see Annex 1), an average random effects log response ratio of -0,387 (or a response ratio of 0,677) is found. The leaching is significantly lower for organic farming, which is indicated by the confidence interval (ratio not containing 1). The high level of heterogeneity between studies (hence the random effect) probably originates from differences in soil types (from sand to clay), region (12 different countries), farming type, research method and the time of measurement. These results should therefore be interpreted with caution. When the studies are grouped based upon farming type or research method, the heterogeneity remains, except for the 4 simulation studies (see Table 5.5 also).

Table 5.5. Differences in nitrate leaching between organic and conventional farming expressed as Response ratio (i.e. ratio of organic and conventional nitrate leaching)

Nitrate leaching	N	n	No weighting	Fixed effect	Q	Random effect	CI
General (kg/ha)	14	116	0.703	0.745	76,7* (36,6)	0,679	0,53 – 0,87
Arable (kg/ha)	7	76	0,618	0,839	24,1* (16,9)	0,652	0,46 – 0,92
Mixed (kg/ha)	6	42	0,795	0,816	33,3* (18,3)	0,695	0,45 – 1,08
Field measure (kg/ha)	8	82	0,740	0,717	53,1* (27,6)	0,690	0,50 – 0,96
Simulation (kg/ha)	4	28	0,576	0,850	9,00 (12,6)	/	0,50 – 1,45

( ) = χ^2_{df-1}, α= 0,05; N=number of studies; n=number of paired observations; CI = confidence interval
Field measure = drainage pipes/porous cups/lysimeters
* Between study variability significant

The calculations for mixed farming, with animal and plant production on the same farm, show a wide confidence interval encompassing 1, thus for this farm type we cannot conclude that organic farming performs significantly better. The same conclusion holds for the simulation studies, which is interesting given that the calculations show a fixed homogeneous effect. Two of the four simulation studies are conducted by the same research group, which might explain the homogeneity. Three studies expressing nitrate leaching in mg/l also find evidence in favor of organic farming (Korsaeth et al., 2000; Haas et al., 2001 and Torstensson et al., 2006).

Besides studying the response ratio, which is a relative measure, it is interesting to look at the absolute value of leaching in both systems and compare it with the EC's target value of 50 mg NO_3^-/l. Based on 12 studies the weighted average leaching of nitrate is 8,93 kg/ha for organic farming and 20,85 kg/ha for conventional farming. Whether this results in a nitrate concentration in surface waters above the EC threshold is amongst others function of soil type, precipitation and temperature (Wachendorf et al., 2004). For the Netherlands and Flanders for example, which are two regions with high levels of nitrate leaching, the EC threshold limit is not exceeded when leaching is lower than 34 kg NO_3-N ha^{-1} $year^{-1}$ (Hack-ten Broeke, 2000). Nitrate is a typical local environmental problem, thus measurement in kg per hectare at farm level or mg/l in the river system is appropriate.

In this section's introduction we mentioned the possible link between productivity increase and nitrate leaching. Combining the 6 different studies that also report yields, we again find a significantly smaller nitrate leaching per hectare for organic farming (see Table 5.6).

However, expressed per kg product, the average fixed effect is nearly equal and from the confidence interval we cannot conclude that there is a significant difference. It means that on the basis of this limited set of studies we may conclude that both organic and conventional systems seem to be equally efficient in the creation of agricultural product per unit of nitrate leaching.

The main drivers behind the higher nitrate leaching in conventional farming are the larger amounts of fertilizer application, lower use of green cover crops, lower C to N ratio and a higher stocking density per ha.

Table 5.6. Ratio of organic and conventional nitrate leaching per hectare and per kg product

Nitrate leaching	N	n	No weighting	Fixed effect	Q	Random effect	CI
General (kg/ha)	6	59	0,612	0,670	9,62 (15,50)	/	0,51 – 0,88
General (kg/kg product)	6	59	0,950	0,953	12,89 (15,50)	/	0,56 – 1,62

( ) = χ^2_{df-1}, α= 0,05; N=number of studies; n=number of paired observations; CI = confidence interval
Between study variability not significant

5.4.4 Phosphorous leaching

Due to the low mobility of phosphorous (P) in the soil, in most circumstances, the important sources of P loss are erosion and drainage (Sharpley and Menzel, 1987, Finck, 1992, Edwards and Withers, 1998). However, in some regions with high historical levels of P, sandy soils and a flat topography, P leaching might also be an important source of loss (Van de Bossche et al., 2005). Excess levels of soil P are linked with eutrophication of ground and surface waters.

We could only find a limited number of studies (Sileika and Guzys, 2003; Torstensson et al., 2006 and Ekholm et al., 2005) that directly report differences in P leaching (in kg/ha) between organic and conventional farming. The first two studies are long term field trials with drainage pipes, the latter a simulation study. The three studies are inconclusive whether organic or conventional farming performs better (random effects and wide confidence interval containing the value 1). The reported levels of leaching are also rather small, thus the relative measure is in this case disinformative. Torstensson et al. (2006) and Sileika and Guzys (2003) find a difference of 0,03kg/ha and 0,04 kg/ha respectively, in favor of conventional farming.

Edwards & Withers (1998) concluded that the loss of P from agricultural land is controlled by factors that are independent of the annual P surplus. Both Clark et al. (1998) and Djodjic et al. (2005) found a positive correlation between P balance and P leaching. Loes and Ogaard (2001) and Hansen et al. (2001) used the P balance as an indicator for P availability. Van de Bossche et al. (2005) used available P as a proxy for P leaching, by calculating the soil P saturation (Psat), i.e. the ratio between the amount of P in the soil and the P absorption capacity of the soil. According to VLM (1997), regions with P leaching risk have a P saturation between 30 to 40%, while P saturated soils have a value above 40%. Van de Bossche et al. (2005) found a Psat of 37% for organic parcels, which was slightly below the average for the East-Flemish region where the study was conducted (Psat of 39%). The study contained a high share of organic horticulture sites, which receive an above average P input and also, some farms only recently converted to organic farming. The study of Goulding et al. (2000) reports an Olsen P index of 0 or 1, which is a P deficit for most crops, for 39% of organically managed soils versus 15% for conventionally managed soils in the UK. Haraldsen et al. (2000, Norway) also noticed a decline in available P after conversion to organic farming. Similarly, Oberson et al. (1993) showed significantly lower levels of available P in organic compared to conventional farming systems. Loes and Ogaard (2001) came to the same conclusion during a long term field trial on 5 organic farms. They also showed that the P loss in the top layer could be approximated by use of P balances.

Given the restricted number of studies directly measuring P leaching, we will also use the P balance (i.e. P output – P input) as a proxy. Because this balance might be negative, the log response ratio cannot be calculated. We will therefore use the Hedge's g, which is the weighted mean of the standardized difference between the control and experimental group (see Hedges and Olsin, 1985 or Van Zandt, 1998). Both for the P input and the P balance, the measure seems to indicate a lower measure for organic farms, but the confidence intervals are too wide to conclude for a significant difference. The fixed effect for P output indicates a significantly smaller P output for organic farms.

Table 5.7. Ratio of organic and conventional phosphorous input and output per hectare and Hedge's g for the P balance

Phosphorous leaching	N	n	No weighting	Fixed effect	Q	Random effect	CI
P input (response ratio)	12	66	0,882	0,980	79,6* (7,81)	0,704	0,46 – 1,07
P output (response ratio)	9	62	0,773	0,805	13,7 (15,50)	/	0,70 – 0,92
P balance (Hedge's g)	8	78	/	-2,311	1,0 (18,30)	/	-4,93 – 0,30

( ) = χ^2_{df-1}, α= 0,05; N=number of studies; n=number of paired observations; CI = confidence interval
* Between study variability significant

The different sources of evidence reported here, although inconclusive, seem to indicate a tendency towards lower P leaching levels on organic farms. The most important driver is the lower fertilizer application in organic farming.

5.4.5 Greenhouse gas emission

The emission of greenhouse gases during production is another negative externality, described into detail in recent documents of IPCC (2007). The Stern Review (2006) adds a more economic focus to the discussion. The three most important greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Each of these gases contributes differently to climate change (1 ton N_2O = 310 ton CO_2–equivalents and 1 ton CH_4 = 21 ton CO_2–equivalents). According to IPCC (2007), agriculture's share in greenhouse gas emissions is approximately 13,5%. These emissions mainly originate from methane fermentation during animal digestion and slurry depots; from nitrous oxide production during biological processes in the soil; from the combustion of fossil fuels (CO_2 and N_2O emission) and CO_2 emission due to reduction of the soil organic matter content (see previous paragraph).

Dalgaard et al. (2001, Denmark) concluded that conventional farming realizes the highest energy production, while organic farming has the highest energy efficiency. In another publication (Dalgaard et al., 2006) they found a higher emission per unit area for conventional farming. Wood et al. (2006, Australia) concluded based upon a Life Cycle Assessment (LCA) that direct energy use, energy related emissions and greenhouse gas emissions are higher for the organic sample, but indirect contributions are much lower, resulting in an overall substantially higher impact of conventional farming. Leifeld and Fuhrer (2005, Switzerland) link the decrease of agricultural emissions in Switzerland to the increased conversion towards integrated and organic farming. The results of Flessa et al. (2002) indicate that conversion to organic farming reduces the emission per hectare, and a status quo for the emissions per unit product. Olesen et al. (2006) found a lower emission per hectare for organic farms, using a simulation model. Casey and Holden (2006, Ireland) concluded based upon their LCA of conventional and organic farms that the evolution towards more extensive systems results into lower emissions per unit product and simultaneously decreases production. Lotter (2003, USA) in his review of organic agriculture in the USA poses that greenhouse gas emissions are lower in organic farming. Syvasalo et al. (2006), who compared N_2O and CH_4 emissions per hectare on organically and conventionally managed parcels, could not find a difference between both systems. De Boer (2003) compared the emission per liter milk calculated in different LCA studies with own data, and warned for the difficulty to compare LCA's given the lack of international standardization. He furthermore remarks that, due to the higher methane production per liter in organic farming, a reduction of the emission compared to conventional farming can only be reached by drastically decreasing carbon dioxide and nitrous oxide emissions. Haas et al. (2001, Germany) found in their LCA per hectare a higher greenhouse gas emission potential for conventional farming, while expressed per ton milk emissions were equal. In the LCA of Cederberg and Mattson (2000, Sweden) emissions per liter were higher in the conventional system. In a recent Dutch report (Bos et al., 2007) greenhouse gas emissions were simulated with model farms. For dairy farms, they found a lower emission for organic farming both per hectare and per liter milk. For arable farming, with soil type being determinative, emissions are lower per unit area but higher per unit product. Gomiero et al. (2008) also focus on the issue of CO2-emissions in their comparison of organic and conventional farming. As they mainly cite Stölze et al., 2000, they report higher CO2-emissions in conventional farming when expressed per hectare, while per production unit there is a mixed effect. Stalenga and Kawalec (2008) compared the greenhouse gases emission (N_2O and CH_4) per hectare of 20 organic farms in a Polish region with the average conventional emission for that region. They found lower CH_4 emissions (14% lower) and much lower N_2O emissions (only one third of conventional emissions). Finally, Meisterling et al. (2009) calculated the Global Warming Potential (GWP) expressed as g CO2-equivalents per kg of bread for a conventional and an organic product life cycle. In their streamlined LCA, the GWP impact of producing 0,67 kg of conventional wheat flour (for a 1 kg bread loaf), not including product transport, is 190 g CO2-eq, while the GWP of producing the wheat organically is 160 g CO2-eq.

Summarizing, over the different studies, organic farming seems to score equal or better when emissions are expressed per unit area. Per unit product no general direction is noticeable. In Table 5.8, the results of a limited meta-analysis are reported, as many studies only report single values and no standard deviation. These results indicate a better score for organic farming when expressed per unit area, and no difference when an output measure is used, which supports the qualitative conclusions.

Table 5.8. Ratio of organic and conventional greenhouse gas emission per hectare and per unit product

Response ratio	N	n	No weighting	Fixed effect	Q	Random effect	CI
Greenhouse gas (per ha)	5	112	0,608	0,572	42,5* (21.03)	0,571	0,47 – 0,69
Greenhouse gas (per kg)	2	53	0,899	0,930	3,6 (16,9)	/	0,76 – 1,13
Methane (per ha)	3	21	0,600	0,662	0,3 (5,99)	/	0,45 – 0,97
Nitrous oxide (per ha)	4	31	0,860	0,624	18,5* (14,07)	0,610	0,48 – 0,78

( ) = χ^2_{df-1}, α= 0,05; N=number of studies; n=number of paired observations; CI = confidence interval
* Between study variability significant

What drives the different scores between both farming systems? Organic animal farming has a lower animal stocking rate per hectare, but a higher use of roughage feed per cow, which will influence differences in methane emission. The higher concentrate use in conventional farming increases the carbon dioxide emission. Given the prohibition of chemical fertilizers and pesticides in organic farming, greenhouse gases generated during production of these inputs remain absent. More fuel combustion during mechanical weeding counterweights this effect. In the study of Casey and Holden (2006) regression analysis was used to show the relation between driving factors and emission. They showed a positive correlation between total greenhouse gas emissions per unit area and the feed concentrate dose, the stocking rate and the amount of synthetic fertilizers applied. The latter two also increase the emission per unit life weight. They furthermore showed a very clear correlation between the emission per hectare per year and the production (number of kg produced per hectare per year).

5.4.6 Biodiversity

For a definition of biodiversity we refer to UN (1992). More biodiversity positively influences the natural buffering function of agrarian areas, which involves recycling of nutrients, control of local micro climate, regulation of local hydrological processes, regulation of undesired organisms, detoxification of noxious chemicals and genetic material for crop improvement (Harlan, 1975 and Altieri, 1994). When studying agriculture and biodiversity it is important to distinguish between agro-biodiversity (breeds used by the farmers) and natural biodiversity (wild life) still present up and around the fields. Both aspects are interesting.

Concerning agro-biodiversity a report from FAO (1998) mentions that centuries of human and natural selection have resulted in thousands of genetically diverse breeds within the major livestock species. These breeds are carefully selected to fit a wide range of environmental conditions, tasks and human needs and forms a rich genetic legacy. Domestic animal diversity, represented by this wide range of breeds, is essential to sustain and enhance the productivity of agriculture. No major livestock or poultry species is in danger of extinction, but numerous breeds within those species are declining in population and size, and many have already disappeared. In Europe, half of all breeds of domestic animals that existed 100 years ago have become extinct, and 43 percent of the remaining breeds are endangered (FAO, 1992). The 1995 edition of FAO's "World Watch List for Domestic Animal Diversity" includes data on 3,882 breeds for 28 domestic species. It concludes that globally 30% of breeds are classified as endangered and critical. Due to the specific characteristics of the organic farming system, other breeds may yield better results and thus organic farming may contribute to the preservation of a wider range of breeds. When we take Belgium as an example, in conventional cattle breeding, the Belgian white blue has become more popular (33% in 1985 versus 51% in 2000, NIS), while in organic agriculture the main breeds are Limousin (70%) and Blonde d’Acquitaine (25%), due to the ban on systematic Caesareans. The Belgian Red, on the FAO list of threatened bovine species (FAO, 2000) has in the mean time declined from 6% in 1985 to 1% in 2000 (TAPAS, 2002). A similar reasoning can be made for plant species used in the agricultural system.

Concerning the impact of agriculture on the natural biodiversity we give an example from Flanders (Belgium) (Nara, 2005; Platteau et al., 2005 and Dumortier et al., 2003). In the past 12 years , 10 out of 20 bird species specific for the agricultural biotope have disappeared or seriously declined, while only 6 made progress. Since 1900, the number of butterfly species has decreased with 25%, while a further 50% is threatened. Only a very small share of wild plants bound to agricultural land, are found on intensively managed parcels, and none of these species is threatened.

The last few years, four major reviews have focused on the question whether there is a difference in biodiversity contribution between organic and conventional farming. In the review of Soil Association (2000), 9 studies were intensively revised and 14 were

summarized. Based upon these, the authors concluded a higher abundance of wild and rare plants, more arthropods, harmless butterflies and spiders and more birds up and around the field. With respect to species richness, they found more wild and rare plant species and more spider species. The most high profile review on this topic is from Hole et al. (2005). They screened 76 studies and report a clear positive effect of the organic management practices on biodiversity. Over the different taxons, they found 66 cases where organic agriculture had a positive effect, against 8 with a negative and 25 with a mixed or no effect. The review of Stockdale et al. (2006) focuses on which management practices influence which species.
A full meta-analysis is conducted by Bengtsson et al. (2005). They calculated the Hedge's g and response ratio for 63 paired studies in total. Their main conclusions are generally a positive effect of organic farming on species richness, with on average 30% more species compared to conventional fields, and a positive effect on abundance within species (on average 50% higher). They clearly warn for significant heterogeneity between studies, with for example 16% of the studies indicating a negative effect of organic farming on species richness.

Hole et al. (2005) extensively described the possible influence of management practices (drivers) on biodiversity. They identify three broad practices that are strongly associated with organic farming as being of particular benefit to farmland biodiversity in general: (1) Prohibition/reduced use of chemical pesticides and inorganic fertilizers; (2) sympathetic management of non-crop habitats and field margins; and (3) preservation of mixed farming.
Some recent studies add to the understanding of potential differences in biodiversity impact. Belfrage et al. (2006) also find higher numbers of both bird diversity and bird abundance on the organic farms than on the conventional farms. They however remark that the largest difference in bird abundance and diversity was found when comparing small and large farms, with high values correlated to small farms. Clough et al. (2007) and Gabriel and Tscharntke (2007) show that the type of management (organic or conventional) might cause considerable shifts in species community structure.

5.5 Environmental sustainability of other certification schemes

To allow us to generalize our findings over other PIoS, we also report here the assessment of the **environmental** sustainability of other farm certification initiatives in the Belgian fresh fruit and vegetable sector. The assessment is based on an in-depth analysis of the guidelines prescribed by different certification schemes. The research was performed by the Departement of Phytopharmacy, University of Ghent, in close cooperation with the author. The developed method for environmental sustainability analysis is based on an approach already applied in France (Girardin and Sardet, 2002). It is a multicriteria (MC) procedure in which experts score each of the relevant certification book rules (as currently encountered in the market place) for their marginal contribution to different environmental sustainability pillars.

5.5.1 Applied methodology

The methodology consists of three phases (Figure 5.1). In a **first** step the different aspects of environmental sustainability are defined. Environmental as well as human health aspects were incorporated. Following aspects were taken into consideration: (1) air quality, (2) climate conservation, (3) biodiversity and landscape, (4) water quality, (5) soil fertility, (6) pest pressure reduction, (7) scarce resource use, (8) waste reduction and management, (9) noise quantity reduction, (10) food safety and (11) worker safety. This list of selected sustainability items is not exhaustive, but based on an extensive literature review of the available scientific literature (Doom, R., 2001; Girardin and Sardet, 2002; Melo and Wolf, 2005; de Snoo and van de Ven, 1999). For each of these aspects a checklist was compiled. All the certification book rules that were thought to have an impact on the sustainability aspect under study were taken up in the list.

In a **second** phase these checklists were submitted to experts in the different disciplines of environmental sustainability. The experts were asked to rank the prescription rules in descending order of importance, starting with the rule that has the lowest positive impact on the sustainability item under study. On the basis of the rankings made by the experts, weights could be attributed to all of the rules mentioned in the checklists by using the revised Simos methodology (SRF) (Simos, 1990a, 1990b; Figueira and Roy, 2002).

In a **third** phase the weights of the rules were multiplied with a factor which reflects the mandatory level of the rule. The mandatory level of a particular rule is determined by a code that is attributed to each rule by most certification schemes. Three codes are distinguished. First of all there are ‘Major Musts’. These criteria have to be followed at all times. Secondly, criteria can be classified as ‘Minor Musts’. This implies that a certain percentage of all those criteria have to be followed by the farmers. This percentage differs according to the certification scheme studied. Finally there are the ‘Recommendations’, which are not obligatory. Subsequently a total score for each environmental sustainability item was calculated by adding the individual criterion scores. In a last step the total environmental sustainability scores were determined by multiplying the theme-sustainability scores with weights attributed by experts corresponding to the respective themes of environmental sustainability (also determined by means of the revised Simos procedure). On the basis of the calculated environmental sustainability scores for the specific certification books, one can pass judgements on the contribution of a particular certification book to environmental sustainability and its pillars. Next, the ecological sustainability of the selected labels and certification schemes is compared and assessed by means of determining the distance to a so called ideal point and anti-ideal point. The ideal point is represented by an ideal certification book composed of the best rules of the specifications of the selected standards. This ideal point represents the solution where all objectives achieve their optimum value and implicates a score of 100 for each environmental sustainability aspect. The label or certification scheme contributing the most to environmental sustainability has the lowest distance to the ideal point. On the other hand, the anit-ideal point has a score of zero and corresponds to following the legal requirements.

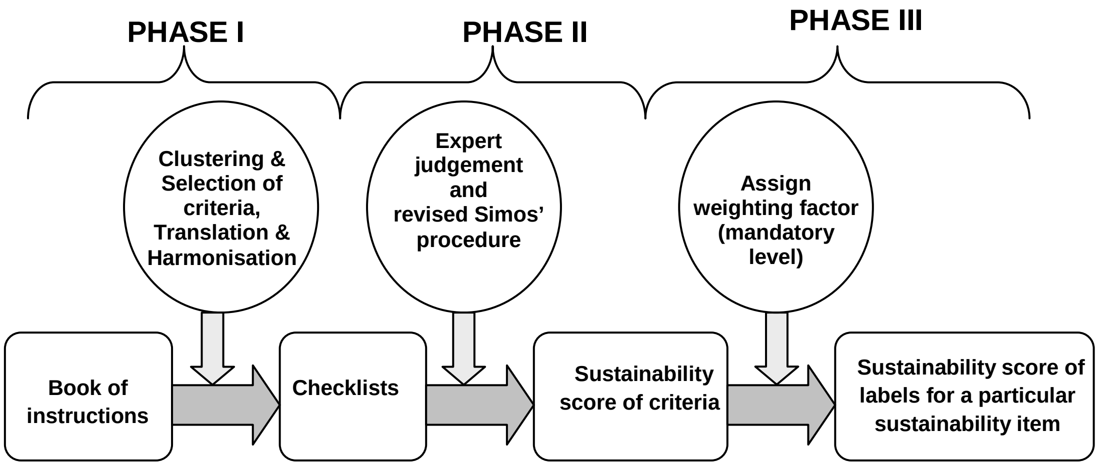


Figure 5.1. Overview of the technical-scientific analysis method

5.5.2 Results of MC-analysis

For an overview of the different labels and certificates studied, we refer to Van Huylenbroeck et al. (2007). As an example we give the results for the Fruitnet[14] certification in Figure 5.2. The full line reflects the scores of the ideal standard, while the dotted line represents the scores for the Fruitnet label. The further the dotted line is from the centre of the graph, the better the scores. The greater the distance between the dotted and the full line, the higher the scope for improvements. Figure 5.2 also shows the contribution of each item to the overall concept of environmental sustainability. The further the full line is from the centre of the graph, the more important the item is. Water quality is considered the most important, noise quantity reduction the least important with respect to environmental sustainability. The results clearly indicate possible further ways to develop the standard.

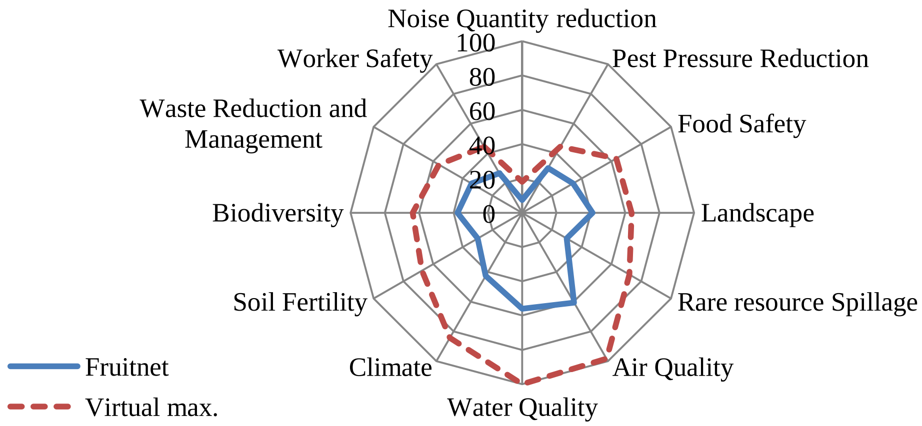


Figure 5.2. The environmental performance of the Fruitnet label

In Table 5.9 the results of the other analysed certification schemes are summarized. The scores on the different sustainability items reflect the importance given by the different certification schemes to these aspects. The Fruitnet standard e.g. imposes stringent specifications regarding pest pressure reduction. This can easily be explained since the main goal of integrated farming is to reduce the quantities of pesticides applied. IPM farmers only intervene when really necessary, relying on analytic and diagnostic procedures before using agrochemicals. Observation systems for pest scouting are used to detect the presence of pests, and more specifically to determine the extent of their population.

In general, Fruitnet scores also well on other aspects, indicating a rather balanced and comprehensive certification book. This is e.g. not the case with GlobalGAP that scores high on food safety and workers' safety but scores low on e.g. climate conservation and landscape. Also Biogarantie (organic label) scores high on nature protection criteria but has only few rules with respect to noise quantity reduction, food safety and workers' safety.

[14] In 1990 the member producers of GAWI (Group of tree cultivators applying the integrated techniques in the Walloon Region) created the FRUITNET specifications (asbl GAWI, 2007). These specifications contain all the guidelines of the IOBC (International Organization for Biological and Integrated Control of Noxious Animals and Plants) for the integrated production of pip fruit, completed with additional guidelines relating to environmental and biological control measures (e.g. nesting boxes, hedges, introduction of auxiliaries, introduction of natural enemies, etc.). Moreover, the Fruitnet system guarantees traceability from producer to the point of sale. In addition to the internal control by Gawi Fruitnet asbl, external control is applied by independent accredited control bodies. Fruit origin and quality control measures are emphasised. Besides, growers producing according to Fruitnet must comply with the EurepGAP specifications since 2003 (FRUITNET, 2007).

This analysis thus helps to reveal which aspects are well developed and underdeveloped in a certification initiative.

Table 5.9. Overview of the scores of the analysed certification schemes on the different environmental and human health sustainability aspects

Sustainability aspect	**Labels** Bio-garantie	Charte Perfect	Global GAP	Flan-dria	Flandria GAP	Integrated Pitfruit	Fruit net	Terra Nostra
air quality	55.6	62.4	45.4	49.0	56.0	54.7	61.5	32.3
climate conservation	51.5	63.7	27.9	29.0	40.4	40.2	50.4	38.3
soil fertility	48.7	45.9	33.5	25.7	46.1	25.7	44.5	39.1
pest pressure reduction	63.7	53.6	55.2	38.6	60.2	62.7	67.7	46.7
water quality	52.7	56.7	44.3	35.0	54.1	36.9	56.0	32.1
biodiversity	59.8	42.7	38.5	29.5	41.5	41.1	59.3	20.7
landscape	43.2	38.6	21.5	12.3	23.0	43.9	64.4	14.3
waste reduction	61.7	65.3	25.3	6.7	27.5	20.0	60.9	0.0
scarce resource spillage	37.1	55.0	29.2	23.9	48.4	27.8	41.5	28.2
noise quantity reduction	28.0	57.5	36.9	40.1	61.1	11.6	41.1	20.0
food safety	42.7	71.0	52.6	42.5	55.5	40.0	54.1	40.6
worker safety	31.0	57.3	61.0	32.6	59.7	33.3	59.9	18.3

As we can see from Table 5.9, all certification schemes contribute positively to sustainability aspects compared to the legally required minimum (which corresponds to a zero score). For waste reduction the certification scheme Terra Nostra does not take supralegal measures, and Flandria only to a limited extend. Overall, a very good score is found for Fruitnet, Biogarantie (which is the organic label) and FlandriaGAP.

5.6 Discussion and conclusion

The main hypothesis to test in this chapter was whether firms participating in Private Institutions of Sustainability contribute more to ecosystem sustainability than firms who do not. Testing is done with a meta-analysis of differences in environmental state between the conventional farming system and the organic system, and – for extrapolation to other private certification schemes - with a multicriteria-analysis of certification rules of eight private farm certification schemes.

The meta-analysis resulted in the following evidence in favour of the hypothesis. Soils in organic farming systems have on average a higher content of organic matter which is important for a good agricultural and environmental soil condition, characterized by reduced erosion, high buffering and filtering capacity and a rich habitat for living organisms. We can also conclude that organic farming contributes positively to agro-biodiversity (breeds used by the farmers) and natural biodiversity (wild life). Concerning the impact of the organic farming system on nitrate and phosphorous leaching and greenhouse gas emissions the result of our analysis is not that straightforward. When expressed per production area organic farming scores better than conventional farming. However, given the lower land use efficiency of organic farming in developed countries, this positive effect expressed per unit product is less pronounced or not present at all. For the selected environmental effects a significant difference per hectare mainly originates from a difference in input intensity (less fertilizer use, lower animal density, no chemical inputs). None of the differences in environmental effects can be attributed to a standalone management practice, it is the combined effect of several modifications to the conventional practices that results into the lower environmental pressure per area of production.

The multicriteria assessment of the other certification schemes shows that all initiatives contribute positively to environmental sustainability compared to the legally required minimum. The analysis also shows the difference in sustainability focus of the analysed schemes. Some schemes, such as GlobalGAP and Terra Nostra only take limited engagements, while other schemes, such as Fruitnet, Biogarantie and FlandriaGAP, are more restrictive. The environmental efforts of the latter schemes are communicated towards the end consumers by means of labels on the packaging.

One important difference between the meta-analysis and the multicriteria analysis is that the meta-analysis measures the real contribution towards environmental sustainability by analyzing differences in environmental state of farms participating in a PIoS and farms who do not, while the multicriteria analysis only measures the potential contribution of the certification rules to environmental sustainability, according to experts. When the certification book rules are not followed by the farmers, due to the absence of a complementary farm advice and monitoring and control system, the actual contribution to environmental sustainability can differ significantly.

The meta-analysis also reports a high level of heterogeneity among studies. The importance of local aspects, such as soil type, climate, altitude and legislation, becomes evident and advocates for caution with generalizing. This also urges us to nuance the findings of the multicriteria-analysis, as differences in local conditions are not accounted for in this analysis. Quoting Rigby and Cáceres (2001), “the notion of sustainability is such a site-specific, individualistic, dynamic concept, that arguing that one particular set of codified production practices are its practical expression seems incorrect and likely to attract unnecessary criticism. In this sense, the sustainability concept may be viewed similarly to appropriate technology, in that the appropriateness of particular technologies will also vary temporally and spatially”. So, from a sustainability perspective, the management practices and rules of prescription should have been devised as such that production is optimized while minimizing local environmental impacts. For that it is necessary to monitor how the management practices influence local conditions, by means of site and situation specific indicators, as heterogeneity both in the physical, social and market environment ask for locally adapted rules. This focus on the relation between rules of prescription and site specific impact is currently lacking both in the organic and conventional system, which may explain the huge variation found between the studies. Organic standards are almost alike in different regions, to ensure that products labeled ‘organic’ are produced under the same conditions. This standardization is necessary to allow trade across the globe. As described in chapter 7, the move towards globalized meta-certification systems makes certification rules less locally adapted.

Another discussion point relates to the land use efficiency issue. As argued by Glendining et al. (2009), extensification of farming, which is thought to favour non-food ecosystem services, requires more land to produce the same amount of food. The loss of ecosystem services hitherto provided by natural land brought into production is greater than that which can be provided by land now under extensive farming. This loss of ecosystem service is large in comparison to the benefit of a reduction in emission of nutrients and pesticides. Rigby and Cáceres (2001) also take up the issue of productivity in relation to sustainability. They warn for simply equating sustainable agriculture with low-yield farming, as the issue of providing food and fibre for the (growing) non-agricultural population also needs to be addressed. For the question whether to focus on indicators expressed per unit area or per unit product, the systemic level is of importance. The former inform us whether the sustainability of the local ecosystem is under threat, which is important from an environmental perspective. The latter, as they measure eco-efficiencies, explain which system creates most output per environmental burden, which is also very relevant from a social perspective, given the need for food security. The indicators expressed per hectare indicate that conventional farming is potentially more harmful for local ecosystem sustainability. The case of nitrate leaching is in this sense informing, as this is typically a local problem. To know whether ecosystem sustainability is really endangered, the indicator scores should be compared with absolute local sustainability thresholds. The indicators expressed per unit product show no significant difference between conventional and organic production. To know which system to choose, we have to consider whether it is better to use more land for extensive production or less land in an intensive way. The choice may be different in different regions, and also depends on increasing pressure from both non agricultural human activities, non food agricultural production and nature.

Chapter 6. **Economic performance - sustainable value creation by PIoS**

This chapter is based upon the paper: Mondelaers, K, Lauwers, L. and Van Huylenbroeck, G. Sustainable value creation by Private Institutions of Sustainability. Submitted to Ecological Economics

6.1 Introduction

The former chapter explains differences in environmental effectiveness (and efficiency) between organic farming as a PIoS and conventional farming, based upon different disaggregated indicators. It is however impossible to say whether organic farming, as example for the private institution of sustainability, is on an aggregated level the most efficient way to attain sustainability. In this chapter 6, the economic performance of organic farming is measured and compared with the market alternative. This chapter thus wants to test hypothesis 2:

Firms participating in Private Institutions of Sustainability create more 'sustainable value' than firms who do not

The organic farming system is again used as proxy for the PIoS, as the private actors involved in it voluntary follow more restrictive rules, while the conventional farming system represents the market regulated by public institutions. Economic performance is measured as 'sustainable value'.

The Sustainable Value (SV) method, as developed by Figge and Hahn (Figge and Hahn, 2004, Figge and Hahn, 2005, Hahn et al., 2007) offers an interesting starting point for analyzing and comparing the overall sustainability performance of firms or systems, especially because it offers a value oriented perspective. The method compares the value created by a firm with the opportunity costs of the employed resources, and thus focuses on the allocation of resources between users. A firm's output is compared with the output of an appropriately chosen benchmark. At the input side, environmental and social impacts are also accounted for. The sustainable value method is based on the concept of eco-efficiency and it can also take social impacts into account. Important is that the method is not burden but value oriented. A burden oriented approach focuses on minimal resource use or environmental and social impact, which corresponds to the denominator in an eco-efficiency measurement, while this value based method aims at maximizing the output for a given resource use, which is the nominator of eco-efficiency. Van Passel (2007) made a first attempt to apply the method in the agricultural sector, by studying the sustainability performance of Flemish dairy farms. To analyze differences in SV scores between organic farming, considered in this chapter as the PIoS under study, and conventional farming, we introduce the original Figge and Hahn SV calculation method in paragraph two. In paragraph three we integrate our own comments as well as the comments formulated by Kuosmanen and Kuosmanen (2009) on the appropriateness of the benchmark choice. In a fourth paragraph we introduce the specification for the production function of the conventional system on the one hand and the PIoS on the other hand. Paragraph five and six then focuses the chosen capital forms and on the data. In paragraph seven the results are presented, while paragraph eight concludes.

6.2 Sustainable value

For a detailed description of the sustainability concepts on which the SV method is based, we refer to Figge and Hahn (2004, 2005). In essence, it builds upon the constant capital rule (see f.e. Constanza and Daly, 1992), stating that development can be called sustainable, if it ensures constant capital stocks or at least constant capital services over time. The different capital forms that can be distinguished are man-made capital (such as produced goods), human capital (such as knowledge and skills), natural capital (such as natural resources), and social capital (Figge and Hahn, 2004). The logic of SV does not allow any additional environmental or social impact, therefore the macro level environmental or social capital is unchanged. SV is, therefore, based on the paradigm of strong sustainability (Figge and Hahn, 2004).

We will first introduce the main building blocks of the SV method (and the associated formulas): the value spread, the value contribution, the sustainable value and the return to cost ratio. As shown in formula A, the value spread (VS) reflects how much more efficiently a form of capital is being used in comparison to a benchmark (Figge and Hahn, 2005),.

$$VS_i = \left(\frac{y}{x_i} - \frac{y_b}{x_{b,i}}\right) \qquad (1)$$

with y = output or value added of a firm, y_b of the benchmark
with xi = use of the capital form i by a firm, $x_{b,i}$ by the benchmark

The value contribution (VC) than allows calculating how much value the firm has created by using this capital form more productively than a benchmark (formula 2):

$$VC_i = VS_i . x_i \qquad (2)$$

The sustainable value, i.e. the value created by a productive use of all forms of capital (Figge and Hahn, 2005), on its turn sums over the different resources and corrects for the number of resources used (formula 3):

$$SV = \frac{1}{n}\sum_{i=1}^{n} VC_i \qquad (3)$$

The Return to Cost ratio (RtoC) is than the ratio of the value created by a firm versus the total opportunity cost of a firm's capital base and can be expressed as (formula 4):

$$RtoC = \frac{y}{y - SV} \qquad (4)$$

Clearly, the outcome of the calculation is highly dependent on the benchmark choice and the forms of capital that are incorporated (as well as their measurement unit, whether physical or monetary). We can distinguish between average and best performance benchmarks, data driven and normative benchmarks (see Kuosmanen and Kuosmanen, 2009). Figge and Hahn propose the market as average benchmark, as the market is free of unsystematic risk and thus offers the best available alternative under risk. One of the most appealing aspects of the sustainable value method is the simplicity with which the sustainability score can be calculated. As always, this comes at a cost. Kuosmanen and Kuosmanen (2009) showed that the SV formula is mathematically a special case of the output difference of a particular firm and a benchmark, for which a linear production function is assumed with fixed coefficients. Formula 5 expresses the general case, formulas 6 and 7 the restriction imposed by Figge and Hahn.

$$SV = y - f(x) \qquad (5)$$

$$f(x) = \sum_{r=1}^{R} \beta_r \, x_r \qquad (6)$$

$$\beta_r = \frac{y_b}{Rx_{b,r}} \qquad (7)$$

with R the number of resources

6.3 Redefining the opportunity cost

According to Figge and Hahn (2004), the sustainable value method is based upon the notion of opportunity costs. The method shows how much more value is created because a company is more efficient than a benchmark and because the resources are allocated to the company and not to benchmark companies. Figge and Hahn (2004) define an average benchmark based upon the aggregate of individual firm resource and output data. Further in the text we show how this benchmark is constructed. Figge and Hahn (2004) make several restrictive assumptions for their definition of the opportunity costs in the multiple resource multiple output case, as is documented by Kuosmanen and Kuosmanen (2009). In this section we document three reservations with respect to the Figge and Hahn benchmark definition. The first relates to the linearity of the benchmark function, the second and the third to the coefficients of this linear function. These coefficients are an aggregation of individual firm level average productivity coefficients. Both the aggregation process itself and the use of average productivity coefficients are question of debate.

In line with Figge and Hahn (2009), we argue that the idea of a market-based opportunity cost instead of firm specific opportunity costs, is interesting, given that the market is free of unsystematic risk, and can thus be considered as the best available alternative when an investor (such as a policy maker) is risk averse.

Figge and Hahn, however, consider the market as a black box in which only the ins and outs are relevant. We argue here that to obtain the right opportunity costs, insight is needed in this black box. The market is composed of a series of atomized subentities (the farms), with a specific structure and interactions between these subentities. One cannot impose another structure to this market than the one that is found in reality.

Opportunity cost is defined as the value of the best alternative foregone. In the spirit of SV the market price should reflect the market return on capital (Figge and Hahn, 2009 p4). This market return is however realised with a set of capital forms, not with a single capital form. The correct opportunity cost measure for a resource x_1 in that case is the productivity of the benchmark for x_1, **conditional** upon the availability of the other resources required for the production process. This calls for the use of a **production function,** to enable us to take into account this conditionality. So, instead of working with average productivities, as Figge and Hahn suggest, we propose to work with the individual firms' production functions to construct an aggregate opportunity cost. It is very well possible that a firm has a high average product for a particular resource, but a marginal product of zero. Adding extra resources to this firm does not increase production. Average product than gives the wrong signal.

As shown by Kuosmanen and Kuosmanen (2009), the production function[15] of a firm can be approximated by the first order Taylor series. In the spirit of SV, we can compare the output that a firm i creates with its resource bundle with the output that the benchmark would create, applying the concept of marginal productivity for each resource. Note that the formula below coincides with Kuosmanen and Kuosmanen (2009) formula 6:

[15] Note that the production function is not strictly limited to economic resources, also social and ecological resources can be incorporated.

$$SV_i = y_i - \sum_{j=1}^{j=j} \frac{\partial y_b}{\partial x_{jb}} x_{ji} \qquad (8)$$

with SV_i = sustainable value of firm i; y_i = output of firm i; $\partial y_b / \partial x_{jb}$ = marginal product of the benchmark for resource x_j; x_{ji} = amount of x_j used by firm i.

Assume that the industry is composed of 2 firms A and B, with firm A producing y_a with resource x_{1a} and x_{2a}. Similarly, firm B produces y_b with the same resource x_{1b} and x_{2b}. Introducing the Kuosmanen and Kuosmanen first order Taylor approximation of the production function and aggregating over the two firms, the total benchmark output looks like:

$$y^* = y_a + y_b = \left[\left(\frac{\partial y_a}{\partial x_{1a}}\right) x_{1a} + \left(\frac{\partial y_a}{\partial x_{2a}}\right) x_{2a}\right] + \left[\left(\frac{\partial y_b}{\partial x_{1b}}\right) x_{1b} + \left(\frac{\partial y_b}{\partial x_{2b}}\right) x_{2b}\right] \qquad (9)$$

Figge and Hahn assume for the benchmark the same, fixed opportunity cost per resource type for all firms, as is shown mathematically below. The total benchmark output is according to Figge and Hahn:

$$y^* = y_a + y_b = \frac{y_a + y_b}{2(x_{1a} + x_{1b})}(x_{1a} + x_{1b}) + \frac{y_a + y_b}{2(x_{2a} + x_{2b})}(x_{2a} + x_{2b}) \qquad (10)$$

$$y^* = \frac{y_a + y_b}{2(x_{1a} + x_{1b})} x_{1a} + \frac{y_a + y_b}{2(x_{1a} + x_{1b})} x_{1b} + \frac{y_a + y_b}{2(x_{2a} + x_{2b})} x_{2a} + \frac{y_a + y_b}{2(x_{2a} + x_{2b})} x_{2b} \qquad (11)$$

$$\frac{y^*}{x_a^*} = \frac{y_a + y_b}{2(x_{1a} + x_{1b})} \text{ and } \frac{y^*}{x_b^*} = \frac{y_a + y_b}{2(x_{2a} + x_{2b})} \qquad (12)$$

Thus, according to Figge and Hahn, opportunity costs of all firms for a resource x_1 are the same and equal $\frac{y_a + y_b}{2(x_{1a} + x_{1b})}$, which is the Figge and Hahn benchmark productivity for x_1. In their aggregation process, Figge and Hahn set $\frac{\partial y_a}{\partial x_{1a}} = \frac{y_a}{x_{1a}}$, i.e. the marginal product of a firm A equals its average product. To complete the aggregation process, they (knowingly or not) impose a weighting for these average products based upon a firm's share in total industry resource use. In the Figge and Hahn calculus, this weighting mechanism in fact acts as the reallocation mechanism of resources over firms. When a firm A uses a share $s_{1a} = \frac{x_{1a}}{\sum_k^n x_{1k}}$ of total resource x_1, its' weight in the aggregated average product for x_1 is s_{1a}. Put differently, firm A will receive a share of s_{1a} of a firm *i*'s resource x_1 when the resource bundle of this firm *i* is reallocated to the benchmark. For resource x_1 in our 2 firm example the Figge and Hahn average benchmark productivity becomes:

$$\frac{x_{1a}}{x_{1a} + x_{1b}}\left(\frac{y_a}{x_{1a}}\right) + \frac{x_{1b}}{x_{1a} + x_{1b}}\left(\frac{y_b}{x_{1b}}\right) = \frac{y_a + y_b}{x_{1a} + x_{1b}} \qquad (13)$$

When two different resources x_1 and x_2 are in use Figge and Hahn simply divide this aggregated average product by two, to avoid double counting.

As argued by Kuosmanen and Kuosmanen (2009), even the production function based upon marginal products is a linear approximation of the true production function. This linear production function does not take the interdependency of resources into account to create (also interdependent) outputs.

Constructing aggregate production functions from firm production functions is heavily contested in the literature (see f.e. Felipe and Fisher, 2003 for a nice overview)[16]. We

[16] To quote Solow: I have never thought of the macroeconomic production function as a rigorous justifiable concept. In my mind, it is either an illuminating parable, or else a mere device for handling data, to be used so long as it gives good empirical results, and to be abandoned as soon as it doesn't, or as soon as something better comes along (Solow 1966, 1259-1260).

therefore argue, as Kuosmanen and Kuosmanen (2009) do, to work with the firm level production functions, to avoid the linearity restriction and the lack of resource interdependency. On the other hand, we support the idea of F&H that an investor's alternative to a given firm is the market. Therefore we propose to construct the market as benchmark as the sum of the individual firms with their specific production functions. Our proposed SV formula becomes:

$$SV_i = y_i - \sum_{k=1}^{n} f_k\left(w_k x_{ij}\right) \tag{14}$$

with SV_i=sustainable value of firm i; y_i=output of firm i; n= number of firms in the industry; w_k= weight of firm k in the benchmark; $f_k(x_{ij})$= firm k's production function; j=index for resource j; x_{ij}=the amount of resource j consumed by firm i.

Different definitions of the weighting vector w_k will define a different benchmark and different opportunity costs for firm *i*. Based upon this weighting vector, we can propose alternative benchmark definitions that do take the market structure into account. Weighting vector w_k can be:

1. $w_k=1$ for the firm's peer on the frontier, this is the best alternative available from a micro-economic perspective, and $w_k=0$ for the remainder firms. As such we find the Kuosmanen and Kuosmanen (2009) proposal;
2. $w_k=1/n$. All firms in the market contribute evenly to the benchmark. This also means that all firms receive an equal share of firm *i*'s resource bundle;
3. $w_{kj} = x_{kj} / \sum_{k=1}^{n} x_{kj}$. Resource *j* specific weight is based upon a firm's share in total resource j consumption. This is the weight also used by Figge and Hahn;
4. $w_{kj} = \frac{(\partial y / \partial x_{kj})}{\sum_{k=1}^{n}(\partial y / \partial x_{kj})}$. Resource *j* specific weight based upon the firms' relative marginal products, as this reflects a firm's willingness to pay for an extra unit of resource *j*;
5. any other socio-economic and ecologic sound option.

6.3.1 Option 1: benchmark is the firm's peer on the frontier

The opportunity cost of the firm is determined by the peer firm located on the frontier, as this is the best available alternative for this firm in the market. This approach is proposed by Kuosmanen and Kuosmanen (2009). A firm's peer is determined by a radial expansion of the output until the frontier is met. The total opportunity cost for the firm is the output generated by the peer with the resources of this firm. This approach is appealing as we do not have to scale up from the firm to the market level, and we therefore not have to make any related assumptions. It however foregoes the possibility to invest different resources in different firms in the market. It also results into firm specific benchmarks instead of a single market level benchmark, which is conceptually different from the idea of Figge and Hahn.

6.3.2 Option 2: the benchmark is an average of all firms in the industry

All firms contribute evenly to the aggregate benchmark, i.e. the resources of firm i are spread evenly across all firms in the industry. For each firm k the production function is taken into account. The total extra output generated by the market is then compared with the output of the firm. This approach assumes that the probability of each firm to receive the resources is equal. The logic of this approach is that, as the market is characterized by all kinds of (efficient and inefficient) firms, this should be reflected in the distribution of the resources over the firms.

6.3.3 Option 3. benchmark are all firms, weighting based upon resource use

Figge and Hahn's idea behind this weighting vector is that a firm k contributes to the aggregate average product of a resource based upon its share in total industry consumption of this resource. As argued above, the production function should be taken into account, and the simplistic aggregation procedure based upon average products abandoned. For the rest this weighting vector can be applied as it is reasonable to assume that the shares of firms in consumption of a resource remain constant, as to reflect the current market conditions.

6.3.4 Option 4. benchmark are all firms, weighting based upon marginal products

Another plausible option would be that when the firm's resources are redistributed in the market, the firms acquire resources according to their relative marginal products for each of the resources. The marginal products reflect the firms' willingness to pay for the resource. If a firm's marginal product is high, it has a high incentive to acquire an extra unit of the limiting resource, while a firm with lower marginal product has a lower incentive to acquire the resource. The marginal products are thus used as weighting mechanisms.

Opposite to option 1, options 2, 3 and 4 assume **fixed (aggregate) opportunity costs** for all evaluated firms, i.e. each firm i is always compared against a fixed benchmark, only the resource allocation across firms is different. The result is that the benchmark is comparable to Figge and Hahn's benchmark, but with different opportunity costs.

Another consequence of a benchmark based upon the production functions of individual firms instead of an aggregated function is the possibility to aggregate firms with different production technologies in the single overall benchmark.

For the benchmarks defined above, the constant capital rule (see Paragraph 2) still applies, as the resources are only reallocated across firms. No resources are destroyed or created, only value is.

6.4 Specifying the production function

As identified by Kuosmanen and Kuosmanen (2009), the sustainable value formula of Figge and Hahn (2004) is a special case of a production function in which the difference with a benchmark is interpreted as the sustainable value:

$$SV_i = y_i - OC(x_i) = y_i - f(x_i) \qquad (15)$$

with $OC(x_i)$=opportunity cost of using resource x_i

After rearranging, there is a clear link between formula 1 and efficiency analysis, as can be seen from formula 2, in which u_i resembles the inefficiency term, f(.) is the production function; y_i is the output and v_i is the random noise term.

$$y_i = f(x_i) - u_i + v_i \qquad (16)$$

The opportunity cost OC in formula 15 indicates the weight of a given resource at a benchmark level in attaining a certain output level. The choice of the benchmark level is in this respect crucial, as discussed before. We will test the different benchmarks further in the text. In determining the underlying production frontier, one can distinguish between parametric and non parametric production function approaches. In the latter case, the production function is not subject to a specific functional form, although no correction is made for outliers when defining the benchmark. The parametric benchmarks do take noise into consideration, but they impose a restrictive functional form. The stochastic frontier models attribute the difference between the benchmark and a particular firm partly to random noise and partly to inefficiency.

Typical for organic farming in general (and consequently of our FADN based data set) is the low number of organic farms compared to conventional farms. As a consequence the number of observations for organic farms in our sample is restricted, which complicates statistical analysis. Therefore we opt for a non parametric production technology approach, as it is not so sensitive to small sample problems[17]. In chapter 10 non parametric production functions are also used, which makes comparison between chapters more straightforward.

When a non parametric production model is used, the according piecewise linear production technology is formulated as (based upon Lee et al., 2002):

$$T(x) = \{(y): y \leq Y\lambda, x \geq X\lambda, e^T\lambda \leq 1, \lambda \in \mathcal{R}_+^i\} \quad (17)$$

Following model then reveals the firm level output oriented inefficiency θ_i:

$$Max\ \theta_i \quad (18)$$

$$\text{s.t.} \sum_{k=1}^{K} \lambda_{k,i}\, y_k \geq \theta_i y_i \quad \text{for each k}$$

$$\sum_{k=1}^{K} \lambda_{k,i}\, x_k \leq x_i$$

$$e^T\lambda \leq 1 \quad \lambda, \theta \geq 0$$

with i= firm index, k=also firm index, θ_I=firm distance parameter, λ=weight of peer, y=output, x=input, e^T= matrix of 1's

When the benchmark is the firm's peer on the production frontier this model directly reveals the opportunity cost for the resource use of a firm i. The associated SV measure can be easily obtained as:

$$SV_i = y_i - OC(x_i) = y_i - \theta_i y_i \quad (19)$$

The remainder benchmarks are a composite of all firms in the industry. For each firm the production function is taken into account. To obtain the opportunity costs, the following procedure is applied: the resources of a firm i of which we want to calculate the SV_i, are divided across all the firms in the industry (including firm i) based upon the weighting vector w_k defined in paragraph 3. Each firm in the sample now has a new resource vector x_{new}. The associated new output y_{new} for each firm is calculated with the help of an inverse DEA, which is based upon fixing the efficiency level θ_i to the one obtained above (Wei et al., 2000, Yan et al., 2002):

$$Max\ y_{new,i} \quad (20)$$

$$\text{s.t.} \sum_{k=1}^{K} \lambda_{k,i}\, y_k \geq \theta_i y_{new,i} \quad \text{for each k}$$

$$\sum_{k=1}^{K} \lambda_{k,i}\, x_k \leq x_{new,i}$$

$$e^T\lambda \leq 1 \quad \lambda \geq 0$$

with i= firm index, k=also firm index, θ_I=firm distance parameter obtained prior, λ=weight of peer, y_{new}=new output, x_{new}=new input, e^T= matrix of 1's

By subtracting for each firm the initial firm output from the new output and summing over all firms, the additional market output generated with firm i's resource vector is obtained. Comparing this with the output generated by firm i, yields the SV_i.

[17] with the exception that most firms will end up with an efficiency score of 1

To make the comparison between the organic and conventional farming system, we will calculate the revenue weighted overall SV score per farming system. This revenue weighting is applied to accommodate for size differences across firms, in the same spirit as Fare and Zelenyuk (2003) for industry technical inefficiency. The (organic or conventional) revenue weighted system sustainable value than equals:

$$\overline{SV_i} = \sum_{i=1}^{n} S_i\, SV_i \quad \text{with } S_i = \frac{y_i}{\sum_{i=1}^{n} y_i} \qquad (21)$$

with $\overline{SV_i}$ = farming system weighted SV score; S_i=revenue weight; y_i=firm i revenue

The above measure is calculated separately for the organic and conventional system. It can be tested whether the two obtained average scores differ statistically. To allow comparison between systems with different size classes, a relative measure is more informative. Such a relative measure can be constructed in analogy with the RtoC (return to cost, see formula) ratio of Figge and Hahn (2004), and called the revenue weighted system sustainable efficiency:

$$\overline{RtoC_i} = \sum_{i=1}^{n} S_i \frac{y_i}{y_i - SV_i} \qquad (22)$$

An interesting feature of the original Figge and Hahn sustainable value methodology is the decomposition of the SV score into value contributions (VC's) from the different capital forms. A positive VC score indicates that this capital forms contributes to a firm's sustainable value creation, while a negative score indicates the opposite. This decomposition is straightforward when Figge and Hahn's restrictive assumptions with respect to the benchmark are made (see earlier). As we relax these assumptions in this paper, restoring this feature[18] asks some elaboration. Kuosmanen and Kuosmanen (2009) show how the production function can be approximated by a first order Taylor series in which the marginal products are multiplied with the resource consumption. A comparison between firm i's marginal product for resource x and the weighted marginal product of the benchmark yields a good approximation of the value spread (see formula 1) of firm i for x. We can call the latter term the marginal value contribution of x to firm i's SV:

$$VC_{x1,i} = \left(\frac{\partial y_i}{\partial x_{1,i}} - \sum_{i=1}^{n} w_i \frac{\partial y_i}{\partial x_{1,i}}\right) \qquad (23)$$

This marginal value contribution shows how much more (or less) value is created when an additional unit of resource is invested in the firm instead of in the market. To obtain the (organic or conventional) system value contribution, an aggregation procedure is required, which can also be based upon a return based weight S_i. For the organic system for example the system's marginal value contribution becomes:

$$\overline{VC_{x1}^{org}} = \sum_{i=1}^{n_{org}} S_i^{org} \left(\frac{\partial y_i^{org}}{\partial x_{1,i}^{org}} - \sum_{k=1}^{n} w_k \frac{\partial y_i^{all}}{\partial x_{1,k}^{all}}\right) \qquad (24)$$

6.5 *Capital forms*

Closely related to the question of how sustainability issues can be linked to farm level activities[19], is the question of what is considered as a resource and what as an output. The issue of 'endogeneity' is imminent, because outputs can (partially) loop back to become resources. Several authors (see Tyteca, 1996 f.e.) have focused on this issue. In essence, we have three broad options, depending on our preferred focus:

1) SV = SV(w|y, x) or
2) SV = SV(y, w|x) or

[18] from a benchmark which takes the production functions of each firm into account
[19] see chapter 4 also

3) SV = SV (y|w,x)

with w = vector of peculiar outputs (f.e. undesirable output of waste); y = vector of desirable outputs; x = vector of resources

For option 1 the focus is on the peculiar outputs, which is only partially reconcilable with SV's underlying idea of economic value maximization (Figge and Hahn, 2005). However, it can be useful in a particular SV analysis focusing on these peculiar outputs. As indicated by Figge and Hahn (2005), values other than the economic notion of value can also enter the SV calculation. Option 2 considers all wanted and 'unwanted' outputs as outputs, which is theoretically appealing but not straightforward because some outputs are difficult to monetize. Furthermore, the term 'value created' should then be redefined. Option 3 considers the peculiar outputs as resources, following the idea that these are necessary (to some extent) to produce the wanted output and that they are also a limiting factor for the production of the wanted output. In this paper we apply the latter approach.

Resources (here synonymous to capital forms) can be expressed in physical or monetary terms. This leads us to the question whether the market price is a good reflection of the 'true' price of a scarce resource or an environmental or social impact (micro-allocation[20]: see Constanza and Daly, 1992). There is currently quite some discussion on how value should be approached in a sustainability assessment, because the time horizon is beyond a human life span and because value as a measure for wellbeing extends the economic term exchange-value. As indicated by Stahel (2005) and others, increased production of exchange-values does not necessarily mean an equal increase in human wealth. There is a huge area of ecological goods and services whose use-values are not reflected in their market prices, which generates all kinds of market inefficiencies if the market is left to its own devices (Stahel, 2005). This is partly due to the fact that natural capital has simply been taken as a free gift by the economic agents. Stahel following Marx (1967) rightly indicates that value is an emergent, context dependent, relational property. Different social, cultural and environmental contexts can radically alter the use value of given goods. Some farm related examples are water scarcity in Spain versus flooding in the Netherlands or manure excess in Flanders versus shortage in the developing countries. Stahel also critiques the present day cost analysis methodologies that only try to complement the classical price formation framework (based upon the intersection between a production function and a demand curve), by expanding the production function in order to include hidden social and ecological costs which were not accurately reflected by standard economics. He warns for the current use of internally generated price signs which are blind to the needs of the larger social and ecological systems on which the economic subsystem depends. The SV method exhibits this hidden danger as well. SVA is on the other hand a relative measure of sustainability. Up to now, for the application of the SV method as an interfirm comparison method, the economic exchange-values have been used. For the resources the physical amount is used as it is for some resources uncertain to what extend the market price reflects the real 'value' of the resource, while for other resources there is no market price.

[20] Constanza and Daly (1992) distinguish between macro- and micro-allocation, the former concerns the valuation of natural capital when matter-energy is allocated across the boundary separating the economic subsystem from the ecosystem, while the latter concerns the allocation among competing uses of matter-energy that has already entered the economic subsystem. The cost and benefit functions relevant to the micro-allocation problem are those of individuals bent on maximizing their own private utility, while the cost and benefit functions of macro-allocation are at the level of social preferences, which are not captured in micro-allocation market prices.

The first element at the 'resource'-side is human (and knowledge) capital, which is vested in both labourers and farm managers and constitutes of experience and skills gathered through education and life.
According to Beeton (2006), social capital is a measure of community intangibles such as networks, cultural pursuits, trust, linkages, and commitment to local well-being and shared values. It is immediately clear that these issues are hardly measurable.
Natural (or environmental) capital is often a public or common good associated with a place or part of a complex legally evolved web in which components are owned in the form of bundles of rights (Beeton, 2006). Natural capital can be related to land, air, water, biodiversity and energy. The environment simultaneously fulfils the function of source (nutrients), sink (waste) and service (landscape) for agricultural production. With respect to land, the area used and the soil alterations are of concern. Below and above certain thresholds, this soil condition might be irreversible damaged. The challenge is first of all to determine this optimal range of soil parameters for each type of soil and place and second to find out whether and to what extend the thresholds are surpassed on these particular spots. Water is another natural capital stock. Both the quality of water and water use can be influenced by the farming practices. For plant production, water quality is mainly influenced by fertilizer (nitrogen and phosphorous) and pesticide application. For animal production the water used for cleaning and rinsing of the stables also ends up, via the manure, on the field. If we think about the influence of agriculture on the atmosphere (as a sink), we mainly think about methane, ammonia and carbon dioxide emissions. The first two are strongly associated with animal production, the latter with the use of fossil fuels for energy. At the farm level we can distinguish between direct and indirect energy consumption, with the latter referring to energy consumed during the production of the agricultural inputs. Nature is furthermore both a source and a sink for biodiversity. A distinction can be made between genetic, species and ecosystem biodiversity (OECD, 2008). A second distinction can be made between wild and 'cultivated' biodiversity.
Finally, manmade capital can be subdivided into financial and physical capital. The latter can be further decomposed into fixed and variable capital sources. Fixed capital refers to the machinery and buildings up and around the farm, while variable capital are inputs such as seeds, animals, feed, fertilizers, pesticides and labour.

6.6 Data set properties

The method derived in the earlier paragraphs is applied on a Belgian FADN data sample of dairy farms, derived from the EU FADN data. Finding the appropriate proxies for the above capital forms from EU FADN is not straightforward. As EU FADN is used for accounting purposes, natural and especially social capital cannot be deducted easily. We assume here that differences in natural and social capital between the conventional and organic system are captured in the augmented price for organic milk. For a detailed description of the variables and the calculated indicators available in the EU FADN data set, we refer to the EC documents RI/CC 882 and RI/CC 1256. Main classification of farms in EU FADN is based upon farm type, economic size and region. In this paper, data for specialised dairy farms in 2004 is used. Data for years 2000 to 2003 is used to describe the production technology and potential differences between organic and conventional farming, as we dispose of an unbalanced panel for these years. In table 6.1 some sample characteristics for the year 2004 are presented.

For this study we select the resources that most directly influence the milk production: concentrates (in ton), forage crops (in ha), labor use (in 100 hours), farm capital use (in 100€) and dairy cows (number). Physical output is measured as total milk production (in 1000 l).

This physical outcome was then multiplied with the market price off farm for conventional and organic milk. Differences in subsidies are not accounted for. As such a uniform output (revenue) measure for both systems is obtained. Some data conversions were necessary to construct these physical inputs from the costs reported in FADN. A stochastic frontier analysis revealed that these variables influence total milk production. Prices were obtained from EU FADN or from KWIN (2007).

Table 6.1. Descriptives of dataset specialised dairy farms, 2004

	Total		**Conventional farms**		**Organic farms**	
sample size	271		258		13	
	Mean	**s.e.**	**Mean**	**s.e.**	**Mean**	**s.e.**
Milk output/cow	5931	1620	5936	1647	5815	989
labor input (h/year)	3432	195	3405	1655	3982	2332
Livestock Units	52.4	20.9	52.5	20.9	50.0	21.8
farm capital (in 1000€)[1]	19.59	13.93	19.64	14.02	18.62	12.64
Fodder (ha)	47.48	24.08	46.59	22.85	65.34	38.76
Concentrate (ton)	194.8	137.4	197.6	138.8	139.1	94.0

[1]depreciated

The above numbers indicate a more labour intensive organic production, with less concentrate and a higher fodder use, and slightly less livestock units. Production per livestock unit is also lower.

Organic resources can be easily reallocated to conventional farms to create value there. Due to the restrictions in the cahier the charge, some conventional resources can only be employed to a limited extend in organic farming, while others are fully prohibited. Furthermore, some seemingly similar resources, f.e. organic and conventional fodder, are not the same, as the organic resource is produced according to the organic standards. As part of the organic inputs are allowed to be from conventional production, the reallocation of conventional resources over organic farms will not be problematic.

6.7 Results

6.7.1 (Dis)similarity of production function

As the PIoS system and the conventional system follow different production principles, this will result into a potentially different production technology. To test this for our sample, the production frontiers of both systems should be estimated and compared, which is most straightforward in a parametric setting. Apart from our sample discussed above, we dispose of an unbalanced panel of 14 organic farms with 44 observations over 4 years (2000-2003) and 1168 observations for the conventional panel. Due to wrong skewness, a Cobb Douglas frontier cannot be estimated for the organic panel, only a cross section is estimable[21]. Therefore we only report the results here for expository reasons. A time component is added to account for variability in years. As can be seen in Table 6.2, the production function differs between conventional and organic farming. In organic farming the number of cows is more determining, as well as the concentrate gift. Fodder, expressed in hectare, is more important in conventional farming.

[21] We acknowledge that, to avoid variation in a specific year, an average of the different years could have been taken. We however abandoned this as the panel data are unbalanced. We belief that the same conclusions hold when the data are averaged over the years

Figure 6.1 below captures graphically how the organic and conventional production frontiers potentially share some common and some unique characteristics and that a metafrontier can be constructed that envelops both frontiers. Recall that Y is expressed in monetary units[22]. In this paper we will follow this approach by estimating a non parametric metafrontier. This is intuitively appealing as some 'organic like' conventional farms might act as peers for organic farms and vice versa. Of the 13 organic farms in our sample, 8 are located on the frontier. All estimations in the following sections are based upon this meta-frontier of organic and conventional farms jointly.

Table 6.2. Production frontier for organic and conventional system (2000 – 2003)

	All		Conventional		Organic	
Sample size	1212		1168		44	
LogL	44.32		38.72		29.43	
	Coefficient	**s.e.**	**Coefficient**	**s.e.**	**Coefficient**	**s.e.**
Constant	7.042	0.134	7.012	0.142	7.616	0.046
Farm capital	0.134	0.103	0.134	0.104	0.064	0.006
Cows	0.592	0.023	0.593	0.023	0.738	0.013
Fodder	0.195	0.018	0.201	0.020	0.029	0.008
Concentrate	0.045	0.012	0.040	0.014	0.096	0.006
Labour	0.008*	0.011	0.007*	0.011	0.096	0.002
T1	-0.013*	0.016	-0.012*	0.016	0.026	0.002
T2	-0.036*	0.015	-0.035	0.015	-0.067	0.001
T3	-0.009*	0.016	-0.007*	0.016	-0.028	0.006

* insignificant at 5% level

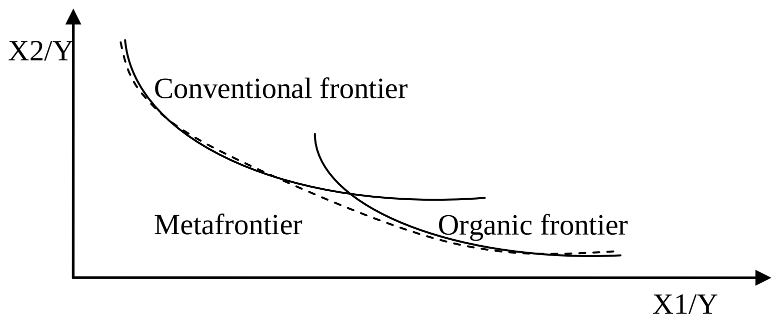


Figure 6.1. Metafrontier organic and conventional farming

6.7.2 Alternative benchmark definitions

In this section we document the results for the alternative benchmark definitions. In a similar way as Fare and Zelenyuk (2003) aggregate firm inefficiencies to obtain an estimate for the overall industry inefficiency, we aggregate the firm SV-scores for each farming system, organic or conventional. Table 6.3 reports the SV estimates for each system given the different benchmark definitions. The results of table 6.3 are discussed in the following sections.

Table 6.4 shows the rank correlation between the benchmarks. This rank correlation is low, indicating that the different definitions of the benchmarks influence the ranking of the firms significantly. This result urges for the proper motivation why a certain benchmark type is chosen.

[22] When output is expressed in liter milk, the conventional production frontier logically envelops the organic, as organic farming principles are more restrictive.

Table 6.3. SV estimates for organic and conventional farming based upon different weighting vectors

	Conventional (€)			Organic (€)		
Weight	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**
Peer only	-138700	0	-18500	-27400	0	-7500
Share in x	-86554	66773	10824	-8018	52540	23340
Marginal product	-48954	-6231	-19601	-34293	-5426	-19315

Table 6.4. Rank correlation between benchmarks

	Share in x	Peer only
Share in x	1	
Peer only	0.537 (0.000)	1
Marginal product	0.032 (0.591)	0.383 (0.000)

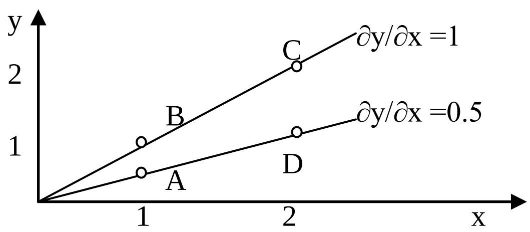
( )=significance (two tailed)

Figure 6.2 shows graphically that the resource reallocation towards the benchmark differs completely depending on the chosen benchmark type. The figure shows a simple example of 4 firms applying a linear production technology. When the 'Peer only' weighting scheme is applied, all resources are reallocated to the best alternative for the firm in the industry (in casu firm B). The 'Share in x' weighting scheme divides firm A's resource x over all the firms in the industry based upon their relative share in current resource consumption. The 'Marginal product' scheme on its turn uses the relative marginal product as weight for the redistribution.

Figure 6.2. Reallocation of firm A's resource x over the different firms A, B, C, D in the industry based upon the alternative weighting schemes.

Firm	A	B	C	D
(x; y)-vector	(1; 0.5)	(1;1)	(2;2)	(2;1)
Peer only	-	1	-	-
Share in x	1/6	1/6	1/3	1/3
Marginal product	1/6	1/3	1/3	1/6

Weight 'Share in x'=x/∑x
Weight 'Marginal product'=∂y/∂x/∑∂y/∂x



6.7.2.1 Benchmark is peer on the frontier

When the firm is projected towards its radial peer on the frontier, the SV indicates how much output (in €) the investor (the society, the policy maker) has missed by allocating resources to this particular firm and not to the benchmark peer. In the conventional system, on average[23] 18500€ is foregone, while in the organic system this is only 7500€. An independent sample T test shows that both means differ significantly (P=0.028, equal variances can be assumed). The reason for the difference can of course be due to size differences. When we express the SV in relative indices, by means of the return weighted system sustainable efficiency (see formula 22), the organic system scores an average of 0.946 versus 0.855 for the conventional system. Part of the high efficiency score of organic farming is probably due to differences in production function[24]. Another determining issue is the price difference per litre organic or conventional milk.

Table 6.5 shows the marginal value contributions for the organic and the conventional system. In the 'Peer only' setting, a smaller negative VC is better. For the organic system, the number of cows is the main contributor to the negative SV. An investment of 1 additional cow in the

[23] output weighted
[24] Note that the same meta-frontier is used as benchmark, as explained earlier

organic system instead of investing it in the best peers available generates an average negative value of 178€. However, when the same cow is invested in the conventional system, 211€ is foregone. In the conventional system, the other capital forms contribute more to the negative SV compared to the organic system. Organic farms seem to be very efficient in their use of fodder, as only 0.14€ is foregone per extra hectare of fodder crops. In the conventional system 80,5€ is missed per extra hectare.

Table 6.5. Organic and conventional marginal value contributions for the different capital forms

Capital form	Organic	Conventional
Capital (€/€)	-2.42	-23.39
Concentrate (€/ton)	-9.65	-18.35
Fodder (€/ha)	-0.14	-80.52
Cows (€/cow)	-178.00	-211.24
Labour (€/h)	-0.25	-0.50

6.7.2.2 Benchmark composed of all firms, weighting based upon resource use

This benchmark bears most resemblance to the Figge and Hahn benchmark. Each firm in the industry receives a share of firm i’s resource according to its share in total use of that resource. As such the actual structure of the industry is mimicked.

The results in Table 6.3 indicate that both systems on average create positive value when the resources are invested in the individual firms rather than in the market as a whole. For the whole industry, the return weighted average sustainable value is 11503€, which indicates that keeping the current industry constellation instead of reinvesting the firms resources over the firms in the industry creates sustainable value. When we compare the conventional and organic sustainable value to this weighted average, we see that the conventional system underperforms (-679€) while the organic system outperforms the industry average (+11837€).

Table 6.6. Organic and conventional marginal value contributions for the different capital forms

	Marginal value contribution		Marginal product
Capital form	Conventional	Organic	All
Capital (€/€)	2.01	-35.40	107.95
Concentrate (€/ton)	0.70	-12.31	88.03
Fodder (€/ha)	22.25	-391.18	424.01
Cows (€/cow)	-33.33	586.01	1120.71
Labour (€/h)	0.33	-5.88	8.81

Table 6.6 shows the return weighted marginal value contributions for both the organic and conventional system. The return weighted marginal product of all firms is also reported. These figures indicate that most value is created when we invest additional units of labour, capital, concentrate and especially fodder into the conventional farms, while an additional dairy livestock unit generates considerably more value in the organic system. As already seen before, fodder is used very efficiently in the organic system, hence the marginal product for fodder is low in the organic system, which explains the negative value contribution.

6.7.2.3 Benchmark composed of all firms, weighting based upon marginal product

The idea behind this benchmark is that, as the market is characterized by competition, the resources are allocated to the firms with the highest willingness to pay. The willingness to pay for a resource is the firm’s marginal product for that resource. Based upon these, a weighting vector can be constructed that reallocates a firm’s resources over the market. Table 6.3 reports the sustainable values. Average sustainable values are now almost equal for the organic and conventional system. Also note that all values are negative, i.e. even the best firm in class is unable to generate more value than the market when the resources are invested there where they generate most value. This is due to the fact that even firms which are located on the production frontier have low marginal products for some resources.

Table 6.7. Organic and conventional marginal value contributions for the different capital forms, benchmark composed of all farms, weighting based upon marginal product

	Marginal value contribution		
Capital form	**Conventional**	**Organic**	**All**
Capital (€/€)	-4,01	-4,65	-4,04
Concentrate (€/ton)	-335.50	-356.16	-336.61
Fodder (€/ha)	-699.50	-1201.72	-726.53
Cows (€/cow)	-372.23	249.59	-338.76
Labour (€/h)	-149.31	-156.17	-149.68

Table 6.7 reports the return weighted average marginal value contributions for the organic and the conventional system, given the benchmark based upon marginal product. If an extra euro of capital is invested in an average[25] conventional farm instead of based upon the relative marginal products of capital of all firms in the industry, 4.01€ is foregone. This amounts to 4.65€ in the organic case. Interestingly, investing extra dairy cows in an average organic farm yields a positive marginal value contribution, indicating that the marginal product for dairy cows in an average organic farm exceeds the marginal product weighted marginal products of all farms in the industry (see formula 23 also).

6.8 Discussion and conclusion

This chapter focuses on the economic performance of PIoS compared to conventional farms. More specifically, hypothesis 2 is tested and confirmed: firms participating in Private Institutions of Sustainability create more 'sustainable value' than firms who do not. The applied method also shows that more value could have been created when the resources would have been applied more efficiently. To come to these conclusions we adapted the SV-methodology developed by Figge and Hahn (2004).

We first argued that the traditional sustainable value formula of Figge and Hahn (2004) needs revision by taking the firm specific production functions into account. This allows proper assessment of the value created when a firm's resources are invested in this market and not (only) in that particular firm. The sustainable value method heavily depends on the definition of the benchmark. Based upon the chosen redistribution mechanism of resources across firms, the benchmark definition is different and hence, the obtained sustainable values are different.

The question is of course, what is the correct benchmark, and under which conditions? Both Figge and Hahn (2009) and Kuosmanen and Kuosmanen (2009) agree that opportunity costs can be defined as the return that would have been created if the resources had been used in the best available alternative. Figge and Hahn (2009) depart from the idea that the best available alternative and thus opportunity costs should be determined on the individual firm level. They argue, following the methodological tradition of financial economics, that the best available alternative is defined by an average return on resources of many different companies. Under the condition of uncertainty, investing across many economic entities reduces risk through diversification, leading to a higher utility for a risk-averse investor.

[25] return weighted

The ‘Peer only’ benchmark assumes certainty about the return on capital use. The merit of this benchmark mainly lies at a micro-economic level, as it shows for each firm what its improvement potential is, i.e. how much extra value can be generated when the firm applies its resources in a more efficient way. The fact that the return on investment in the real world is uncertain is however not accounted for. Under the condition that the resources and the production technology are fully identified, both the benchmark firm and the evaluated firm are subject to the same risky environment. This benchmark than solely indicates the best management for the resources. For our specific case of PIoS we saw that the organic system has a higher return-weighted sustainable efficiency, indicating that the potential for management improvement is lower in organic farming compared to conventional farming. Organic farms thus operate more closely to their peers.

The ‘Share in x’ benchmark is composed of many different economic entities. The weight of a firm in this benchmark depends on its resource use. As mathematically shown earlier in the text this benchmark definition corresponds most with the traditional Figge and Hahn sustainable value benchmark. As it distributes the resources of the evaluated firm over the market according to the current resource distribution in the market, this benchmark reflects the actual market behaviour best. Typically, both positive and negative sustainable values can be obtained with this benchmark, which is logic as some firms perform better than the market while others do worse. The outcome of this sustainable value analysis is that we know whether a firm has positively or negatively contributed to the current sustainable value creation in the market.
According to Figge and Hahn (2009) investing in a market based benchmark will reduce risk. The question emerging in this case is to know what part of the calculated sustainable value relates to unsystematic risk and what part is the true measure of sustainable value?
For our case of PIoS this benchmark shows us that the organic system contributes more to the market’s current sustainable value creation compared to the conventional system. The marginal value contributions on their turn indicate that additional dairy livestock units create most sustainable value when invested in the organic system, while the other resources have more potential for increased value creation when they are invested in the conventional system.

The benchmark based upon ‘marginal product of a resource’ allocates an evaluated firm’s resources to the firms in the market based upon their willingness to pay for these resources. For several reasons this is an interesting benchmark. First it fits perfectly in the definition of best available alternative. By decomposing each resource in subunits and investing these into firms according to their marginal products, most value is created in the system. Opposite to the prior benchmark, this benchmark takes the firms productivity in the use of the resources into account. Second it reflects the behaviour of the market when the evaluated firm drops out of the market, as firms will then compete for the resources set free. This measure thus indicates how much value is foregone by investing into a specific firm instead of investing in the market according to the market’s potential for value creation.
When applied to the PIoS case we see similar scores for the organic and conventional system. This can be explained by analysing the marginal products. Organic farming is rather efficiently applying resources with the exception of dairy cows. The marginal products for the other resources are therefore fairly low, which results into an overall similar score as the conventional system. For these resources, the organic farms also do not contribute much to the benchmark, because the benchmark is defined in such a way that firms with higher marginal products receive more of the resources set free. The organic system’s marginal value contribution is positive for dairy cows and extremely negative for fodder.

In the organic rules and regulations, the number of livestock units is restricted to 2 per hectare (EEC No 2092/91). Our analysis shows that this rule is currently blocking the organic system to create more value. For the conventional system the amount of fodder (expressed in hectares) is currently a key prohibiting factor for increased value creation. In Belgium traditionally the agricultural area has been limiting the growth of farms, as it is a very land intensive system.

For this example of Belgian dairy farms in 2004, the price difference between conventional and organic milk amounts to 0.0588€/l. A price of 0.30€/l is paid for off farm conventional milk. The price difference reflects the surplus value created by organic farming. Although the return figure is used as output, a better sustainable value is still found for organic farming, according to the three benchmarks. This indicates that the market assumes that the organic milk contains (external) quality features additional to the capital forms used in the example.

Chapter 7. **Social performance - Endogenous development of PIoS and convergence to a premium spot market**

This chapter is based upon Mondelaers, K. and Van Huylenbroeck, G. (2008). Dynamics of the retail driven higher end spot market and its institutions. British Food Journal, 110 (4/5), 474 – 492.

7.1 Introduction

This chapter studies the internal social performance of PIoS. PIoS, as hybrids, are initiated in a value chain in which different value-chain members cooperate and compete. In farm certification schemes farmers and retailers are the most important value chain members. According to Bunte (2003), social supply chain performance depends on two elements: (1) efficiency (profit) and (2) equity (people). Efficiency, which is concerned with the creation of value added, is discussed in the previous chapter. In this chapter we focus on equity, which is concerned with the division of value added over the respective stakeholders. To explain effects on the equity within the PIoS we first illustrate the (potential) evolution of PIoS towards a retail driven premium spot market. By comparing the characteristics of this premium spot market with these of the regular spot market and of the original PIoS we want to test hypothesis 3:
Private institutions of Sustainability can lead to more equity among value chain members

The analysis in this chapter is qualitative. We start with a scene setting.

In line with broader economic developments, the market for fresh food products has evolved from a regional to a global one, as illustrated by Busch and Bain (2004). This enables further product differentiation, but also simultaneously increases information asymmetries. The latter trigger the need for more elaborate governance systems, such as quality assurance systems. Henson and Reardon (2005) view the emergence of private food safety and quality standards as an increasingly prominent driving force of agri-food systems across the globe. These standards have evolved in response to regulatory developments and, more directly, consumer concerns, and have become a means of competitive positioning in markets for high-value agricultural and food products. According to Mainville *et al*. (2005), standards can have different functions and are primarily used for standardizing, differentiating and reducing risk. They can be used to regulate both intrinsic (such as product safety and health) and extrinsic (production system and environment related) quality attributes (Grunert, 2005). They can specifically target agricultural production (e.g. EurepGAP), relate to post production requirements (e.g. British Retail Consortium, BRC) or combine both (e.g. organic farming). The use of these standards can be communicated to end consumers by means of a label, a strategy mainly used for diversification purposes.

Baines *et al*. (2000) have argued that consumers and, indeed, the whole food chain would benefit from the development of certification schemes with a common standard for food safety, irrespective of the country of origin. Promulgating such harmonized standards would reduce the risk and the costs involved in assessing food safety. Giraud-Héraud *et al*. (2005) have documented the emergence of a new type of retailer-led spot market, characterized by (predominantly safety) standards that are common to several retailers. They identified GlobalGAP as one of the telling examples of retailers' shift away from more intense (vertical) relationships with producers.

The preferred type of chain governance system closely relates to the type of relationship that exists between primary production and distribution. Traditionally, the partnerships between buyers and sellers in the market for fresh agricultural products have ranged from the classic spot market to vertical integration. Codron *et al*. (2005) classified these partnerships into three main groups: (1) farmer-driven initiatives, comparable to a 'national brand'-approach, (2) retail driven vertical alliances between producers, manufacturers and retailers and (3) generic standards common to several retailers. The Belgian Flandria initiative discussed in this paper is an example of the first type, and the Belgian Fruitnet – Delhaize Alliance[26] or the 'Filières Qualité'[27] of Carrefour are examples of the second type. Where these three types of relationship once co-existed, we have recently seen an apparent shift towards the third type, with GlobalGAP being the leading example in Europe. Other initiatives now find that they need to ensure that they are at least GlobalGAP compatible. The proliferation of the GlobalGAP standards is therefore leading to a new type of (hybrid) market organization, the retail driven higher end spot market. This market contains all characteristics of the regular spot market, with price competition and unrestricted access, except for a series of supra-legal demands which are formalized in a private certification standard. The retail chains involved are all active in the higher end of the market, although often in different regional settings. In this paper we draw on the case of vegetable certification in the region of Flanders to analyse the emergence of the higher end spot market and its implications for competing certification standards.

This case study illustrates the problems involved by exploring the transition of the original Belgian farmers' driven vegetable certification system Flandria, to its transitional stage FlandriaGAP and then to becoming the GlobalGAP benchmark. It illustrates the influence of the higher end spot market on farmer and regional attempts to achieve market differentiation. The products we focus on are fresh vegetables marketed through auctions. The main actors involved in the higher end spot market are the vegetable growers and six Belgian fruit and vegetable auctions, united under the umbrella of LAVA (Administrative and Logistic Association of Auctions), Belgian food retailers and independent controlling bodies (e.g. Certagro). Government, farm suppliers, pressure groups and consumers are also involved in and influenced by the initiative, although less directly. In this chapter we try to explain this convergence in PIoS.

The chapter is structured as follows. The next section provides the details about the case study on which this chapter is based: the Flandria certification scheme and its evolution towards GlobalGAP. Next, the theoretical framework is introduced followed by a description of the various data sources consulted. The following section describes the institutional setting of certification of fresh vegetables in Belgium, which is followed by a description and analysis of drivers involved in promoting a premium private market and single certification system. The penultimate section considers the new certification system as a balance between the stakes of the involved market players and the chapter finishes by drawing some general conclusions.

[26] From 1991 on an intensive cooperation exist between 70 Belgian fruit tree growers following the rules of integrated production, and the Delhaize group. Additional quality criteria, such as sweetness, juiciness and colour, also have to be met (www.delhaize.be, 28/06/07).
[27] In France, Carrefour has established 245 'filières' with more than 35500 producers of cheese, vegetables, fruit, wins, meat and fish, resulting in 74 'Filière Qualité' labelled products. Worldwide, 350 'filières' have been realised (www.carrefour.fr, 28/06/07).

7.2 From Flandria to GlobalGAP

The Flandria label was initiated as a quality certification system in Belgium by auctions owned by farmer cooperatives. In 1995 the first tomatoes and chicory were sold in the Belgian auctions under this new quality label. Today, more than fifty Flandria products are offered at the Belgian auctions. The label is a guarantee for a high quality product, cultivated in an environmentally friendly way and fully traceable. Particular specifications are set for each type of product to ensure environmentally friendly production. For example, for crop protection, organic resources are preferred over synthetic ones and early observation and warning systems are used. The use of fertilizers is based on the results of soil analyses and considerable attention has to be paid to hygiene aspects. There are relatively strict requirements for residue monitoring. The first line of control of the products occurs at the auctions, with an external control body responsible for second-line control, monitoring the automatic control system within LAVA and monitoring and controlling residues. Flandria's market share varies according to the type of vegetable. Of the fruit-type (usually glasshouse) vegetable crops (such as tomatoes, peppers and cucumber) delivered to the auction at Mechelen, more than 80% is certified under Flandria (for 4 of them it is more than 90%). More than 90% of all the principal salad leaf varieties (lamb's lettuce, iceberg lettuce, classic lettuce) are produced under Flandria standards. Eight out of twelve of the open air vegetables (such as cauliflower, broccoli, leeks and carrots) also reach the 90% level. Although covering most generic products in Flanders, Flandria vegetables remain a (quality) niche at the European level (accounting for approximately 3% of total sales, FlandriaMail). Currently about 3,500 (of the 4,508 registered fresh vegetables production units in Flanders) adhere to Flandria standards (FlandriaMail, 2005, National Institute for Statistics, 2005).

Shortly after, in 1997, the Euro-Retailer Produce Working Group (Eurep) launched EurepGAP as a quality system to set benchmarks in the agricultural sector. The first EurepGAP specifications were established for fresh fruit and vegetables, followed by working documents for other agricultural sectors. The documents were drafted in cooperation with producer organizations and certification bodies. EurepGAP, in 2008 renamed into GlobalGAP, has been developed to become a complete accredited certification system. The retailers' intention is to continue to develop this system into a world standard for different sectors of agricultural production. Today, GlobalGAP certificates are issued in more than 60 countries. The number of GlobalGAP approved farms has nearly doubled every year from 4,000 in 2002 to 35,000 in 2005 (GlobalGAP, 2005). In Belgium, there are some 2,000 participating producers (EurepGAP, 2006) and thirty two European retailer and food service groups have subscribed as members of the fruit and vegetable pillar. Since it was established in 2001, 13 major certification schemes have been benchmarked against the GlobalGAP standard (EurepGAP, 2007).

Given the need to meet the requirements of the distribution sector due to the rapid success of GlobalGAP, the auctions "Mechelse Veilingen" and "Veiling Hoogstraten" decided to benchmark the Flandria quality label to the GlobalGAP standard by adding FlandriaGAP specifications. This implied an extension of the environmental production requirements, together with rules on food safety and hygiene, work safety and social norms. The two auctions switched over completely to the FlandriaGAP Specifications in 2004. Since 2006 about 1000 growers associated with the Auction of Mechelen follow the more restrictive FlandriaGAP/GlobalGAP standard, a number which has grown rapidly since October 2005 when there were just 208 (153 greenhouse gardeners and 55 outdoor vegetable growers, MV

Info, 2005). The rapid increase in the number of FlandriaGAP certified producers is proof of the rising demand from buyers for products that meet these more restrictive process standards.

7.3 Theoretical framework

Our main research question in this chapter, the equity among value chain members within Private institutions of Sustainability, can be approached by studying the effects of the evolution towards a premium spot market on the different PIoS value chain members. This research question can be broken down into three interrelated questions. The first is: why do certification schemes exist? The second is: why do these evolve towards a single standard? The third question is then: how does this evolution influence the internal construction of the certification value chain? Transaction cost theory usefully explains the existence of certification systems. The evolution of multiple certification systems towards a single standard can be explained by combining this theory with the principles of system innovation. Finally, in describing the influence of a single certification standard on the existing value chain equilibrium, we rely on Porter's theory of competitive (and cooperative) forces.

As explained in chapter 1, economic exchange inevitably entails transaction costs. These include the costs involved in searching (for information), negotiating and monitoring and enforcement (Hobbs, 2003). They emerge because (1) individuals have a bounded rationality, due to the complexity and uncertainty of the working environment; and (2) some economic actors exhibit opportunistic behaviour (Williamson, 1979, Simon, 1982). Both these factors can lead economic actors to incur high costs in terms of time and resources, in searching for information on the contracting environment and the firm they want to conduct transactions with. Transaction cost economics demonstrates that contractual arrangements align with the prevailing governance structure; simple transactions use and require simple governance structures, while more complex exchanges are associated with more complex forms of organization. Deviations from this pattern are less efficient and incur high transaction costs (Leiblein, 2003). In this respect the certification system can be seen as a governance structure put in place to reduce the transaction costs arising from the variation in both the product and process characteristics of many suppliers. These factors can all vary since agricultural production is characterized by uncertainties, due to varying climate and soil conditions, working with living materials and differences in managerial capacities and attitudes. Certification provides a procedure through which a third party gives written assurance that the product, process or service conforms with agreed standards, and this acts as a form of communication along the supply chain (ISO, 1996). The certification system defines the standards, the procedures by which they should be implemented, monitored and enforced and the type of agents subject to it. It gives rise to a hybrid market organization, which falls between the spot market with loose contractual arrangements between many unrelated agents and a single, hierarchically organized firm where transactions are internalized (see chapter 1 also).

Certification schemes and their resulting networks of actors are constantly evolving. From a system innovation perspective the recent (and ongoing) merger of the multiple certification schemes towards a single coordinating scheme which creates a higher-end spot market can be considered as a sectoral system of innovation. Malerba (2002) defines a sectoral system as an innovation that simultaneously combines the creation, production and selling of products by a group of agents. Central to the line of argument employed in this paper is that the agents' interactions are shaped by specific institutions (rules and regulations), of which the certification scheme is the most important. These institutions typically frame the boundaries of the system and as a result, the dynamics within the sectoral system are highly dependent upon the dynamics within these institutions. To capture the dynamics in certification standards, we depart from the three processes that drive economic change, as defined by Nelson (1995). These are: processes of variety creation, followed by processes of selection, which reduce the heterogeneity due to (random) variety creation and a last phase that consists of inertia and continuity, i.e. preserving what survived the selection procedure.

The processes triggering change in the certification institutions, particularly towards a single coordinating scheme, take place due to a mixture of internal and external forces along the hybrid value chain. The certification system, as a social construct, reflects the equilibrium of the stakes of directly, and indirectly, involved stakeholders. This equilibrium and the dynamics therein are shaped by the competitive pressures and opportunities for cooperation between organizations within and outside the certification network. Porter (1979) identifies five competitive pressures which limit the profits that an organization can earn in an industry. His framework, later defined as a zero sum game, identifies the following competitive pressures: internal rivalry, supplier power, buyer power, the threat of substitute products and the threat of new entrants. Sanchez and Heene (2004) illustrate how these five pressures might be reoriented to become sources of mutual gain through cooperation, thereby creating positive sum games. Applying Porter's concepts to the production of fresh vegetable commodities, the vegetable producers participating in a certification scheme can be considered as the core firms of the industry. The buyers in our analysis are the retailers, while the suppliers are agrochemical companies, breeding stations and other suppliers of agricultural inputs. New entrants are those farmers not yet participating in the certification network and substitute products come from competing certification schemes in the fresh vegetable market.

7.4 Data and methodology

Although this paper is mainly theoretical and qualitative it builds upon data collected through four sources of information: focus groups with the principal stakeholders, a farmers' questionnaire, in-depth interviews with key players and a literature review. Focus groups are discussion sessions between several stakeholders under the supervision of a moderator (see Morgan, 1993; Grudens-Schuck *et al*., 2004). The main subject of the discussion is fixed but, the discussion topics evolve depending on the composition and priorities of the stakeholder group. The technique is particularly useful in exploring the reasoning behind certain points of view and to detecting possible synergies or conflicts in the objectives of the participants.

From March, 2005 to June, 2005, six focus groups were conducted with the principal stakeholders, including the vegetable growers, auctioneers, pressure groups, retail and government representatives. Each focus group covered a different subject and consisted of a different composition of stakeholders, in line with the subject, as shown in Table 7.1. They were moderated by two representatives from a bureau specialized in this kind of participatory research, while the researchers were present as observers. The bureau was also entrusted with the selection of the participants, starting from the researchers' network of contacts.

The questionnaire was undertaken in January 2006 and involved personally interviewing 68 farmers participating in the FlandriaGAP initiative. The questionnaire was aimed at measuring the (dis)utility for farmers applying the standards required (Van Huylenbroeck *et al*., 2006). Although this paper does not discuss the quantitative results of this survey, the contacts with the farmers during the surveying cycle provided qualitative information that supplemented the topics raised in the focus groups. In addition private and governmental experts in the field of standards and labelling were consulted and their comments further strengthened (or challenged) the results from the cycle of the focus groups. These interviews included three meetings with representatives of the Auction of Mechelen, one with a representative of the Brava Auction and one with government officials from the Food Agency. During four user group meetings, the results of this (and related) research were presented to and discussed with a total 24 representatives from the auctions, retail sector, consumer groups, the farmers' union, government officials and pressure groups.

Table 7.1. Structure of focus group sessions

	Stakeholder type	**Subject**
Focus group 1	Vegetable growers aligned to 3 different certification schemes * (9)	- motivation for participation in the initiatives - (dis)advantages
Focus group 2	Vegetable growers in FLANDRIAGAP and GLOBALGAP (13)	Consequences of participation at farm level
Focus group 3a and Focus group 3b	Certification representatives, auctioneers, retail, consumers and producer organizations (5+4)	- producers' stakes versus other stakeholders' stakes - certification initiatives versus other measures aimed at reducing pesticide use
Focus group 4	Vegetable growers, initiators, auctioneers, retail (6)	driving forces and evolution within the initiative
Focus group 5	All involved stakeholders (13)	feed back and discussion

Number of participants in parentheses
* Biogarantie, FLANDRIA and GLOBALGAP

This chapter makes use of descriptive and explorative information from the focus group sessions with the aim of testing the hypothesis that PIoS lead to more internal social sustainability. It combines the information of focus groups one to five. More detailed information w.r.t. focus group design, script, constellation, moderation, reporting, content, dynamics and analysis can be found in Mondelaers et al. (2005).

As documented in Strauss and Corbin (1996), a three step procedure was followed, consisting of a descriptive phase, an explorative phase and a theorizing phase. To process the focus group information open coding, axial coding and selective coding was used, albeit informally. According to Strauss and Corbin (1996), open coding is the analytical process through which concepts are identified and their properties and dimensions are discovered in the data. For the descriptive phase we made use of this approach. Axial coding on its turn is the process of relating categories to subcategories, while selective coding refers to integrating and refining a theory. For the explorative phase, we used axial coding in two dimensions: to relate concepts and opinions to certain stakeholder groups, with the aim of identifying opposing or reinforcing opinions, and to upscale certain opinions and views to more broad categories. In the final selective coding phase, the identified concepts were positioned in Porter's theory of competitive forces and sources for mutual gain, adapted for the case of PIoS.

The chapter is also structured accordingly. First, descriptive research, which is predominantly based upon focus group four and previous in-depth interviews, led to the description of the institutional context of certification (paragraph 7.5) and the processes of change (paragraph 7.6). Second, explorative research starting from the information of focus groups one, two and three, led to the identification of perceived advantages and disadvantages according to the various stakeholders (paragraph 7.6). Experienced benefits and costs for farmers and retailers and the distribution of the costs over the different parties, documented in paragraph 7.6, were also discussed in focus group sessions 2, 3a and 3b. Third, in paragraph 7.7, the explorative research is further structured along the dimensions of Porter's five competitive forces and sources for mutual gain. Both paragraph 7.6 on the division of costs and benefits and paragraph 7.7 on the sources for competition or mutual gain contribute to the testing of the chapter's underlying hypothesis that PIoS contribute to equity within the value chain.

Validation and objectivity was guaranteed in multiple ways. First, during processing, four different data sources (in-depth interviews, focus groups, literature review and a questionnaire) allowed to triangulate commonly discussed aspects, such as reasons to participate, costs and benefits, construction process etc. After focus groups one to four, a descriptive and explorative phase was conducted by two researchers jointly. The obtained descriptive and explorative research results were then presented to the focus group participants in a final feed back focus group and integrated in areport that was circulated to the focus group participants. The resulting conclusions were also presented to the user committee of the FWB-project D/2006/1191/23 (Van Huylenbroeck et al., 2006).

7.5 The institutional setting of certification

For the description of the institutional setting of certification in the fresh vegetable sector, we refer to chapter 2, paragraph 4.

Over the past decade several certification standards have been initiated that surpass legal requirements to comply with the extra demands from market players downstream in the food chain. The economic crisis in 1995 in the tomato and endive sectors led the auctions to elaborate and implement the Flandria certification standard, which now certifies more than 50 product families (fruit and vegetables). The cornerstones are product quality, integrated farming practices and traceability. The certification efforts are communicated towards the end consumer through the Flandria label. Since the beginning of 2005, the new Flandria certification manual has encompassed more stringent measures concerning the production process, by including the ICQC standard, which was initiated by a consortium of fresh food chain members.

Since 2004 there has also been a more prescriptive FlandriaGAP version of the Flandria certification book. This combines the standards of GlobalGAP and other major European certification initiatives (e.g. Q&S) and the governmental law on self regulation into a workable certification manual for Flemish farming. It places extra emphasis on measures related to food safety, environmental care and workers' health and safety. Only 2 out of the 6 Belgian auctions in Flandria, follow this certification standard, of which the Auction of Mechelen is the most important, with almost 40% of all auctioned vegetable products in Belgium passing through it. The auction representative indicated that over 70% of the Flandria fresh vegetables are exported, hence this certification standard should be considered in an international context.

7.6 Convergence towards a premium spot market with a single certification standard

7.6.1 Dynamics in farm level certification systems

International buyers, including the major retailers now increasingly demand the GlobalGAP standard. The auctions have two options in increasing the supply of the GlobalGAP certified produce: a soft or a more direct transition, with the latter based upon price incentives for early converters, a strategy applied by the competing Reo Auction. The Mechlin Auction introduced the FlandriaGAP standard, instead of the more standardized GlobalGAP standard, to provide a softer transition for its affiliated farmers, because the majority of them operate on a small scale. However, the FlandriaGAP-initiative is gradually being fully replaced by the GlobalGAP-system, due to the continuous demand for GlobalGAP-products, mainly from non-Belgian buyers. The 2005 version of FlandriaGAP was fully compatible with the existing GlobalGAP standard and was replaced by it in 2006.

The drive towards GlobalGAP has had other effects apart from the emergence and disappearance of the FlandriaGAP certification system. Table 7.2 shows that the Flandria standard has been degraded to a second class process standard, but remains a first class product standard. Pressure from downstream market players (mainly German retailers) has led the auction to now sell the FlandriaGAP/GlobalGAP and Flandria products in separate blocks. Initially prices will remain the same, but gradually this system will provide a price premium for the FlandriaGAP/GlobalGAP block, further encouraging conversion to this more demanding standard (MV Info, 2006).

Table 7.2. Evolution of preferential positioning of Flandria

<table>
<tr><td rowspan="2">Period</td><td rowspan="2">Product Quality level 2</td><td colspan="2">Product Quality level 1</td></tr>
<tr><td>Process quality level 2</td><td>Process quality level 1</td></tr>
<tr><td>1995 - 2000</td><td>Flandria declassed *</td><td>Flandria</td><td>/</td></tr>
<tr><td>2001 - 2005</td><td rowspan="2">Flandria declassed / GlobalGAP Q2</td><td>Flandria</td><td>FlandriaGAP/GlobalGAP Q1</td></tr>
<tr><td>2006 -</td><td>Flandria</td><td>GlobalGAP Q1</td></tr>
</table>

Q1 = product quality level 1; Q2 = level 2
* declassed = not up to the Flandria quality level

The gradual shift from the Flandria standard to the GlobalGAP standard can be interpreted as a (retail driven) sectoral system of innovation, as described in the theoretical framework. This example allows us to derive a more formal analysis of the dynamics operating within these certification schemes. Figure 7.1 represents these dynamics graphically. In the first stage, several innovative farmers agree upon similar product features and production practices doing so as they see a competitive advantage in this harmonization. Certification is then used for communicating their efforts to players downstream in the value chain. This leads to a consolidation phase taking place, at the farm level. During the maturation of these multiple certification systems, a second consolidation phase takes place, between the different co-existing certification schemes, driven by transaction cost economics (mainly under retail pressure) and the economies of learning at the certification level (cross-adoption of modifications). This finally results in a majority of farmers participating in a single certification initiative (or several look alike initiatives), comparable with the spot market situation before the certification round started, although now operating more restrictively. Some innovators remain above this spot market level, and they will trigger a second certification round, which departs from a higher level.

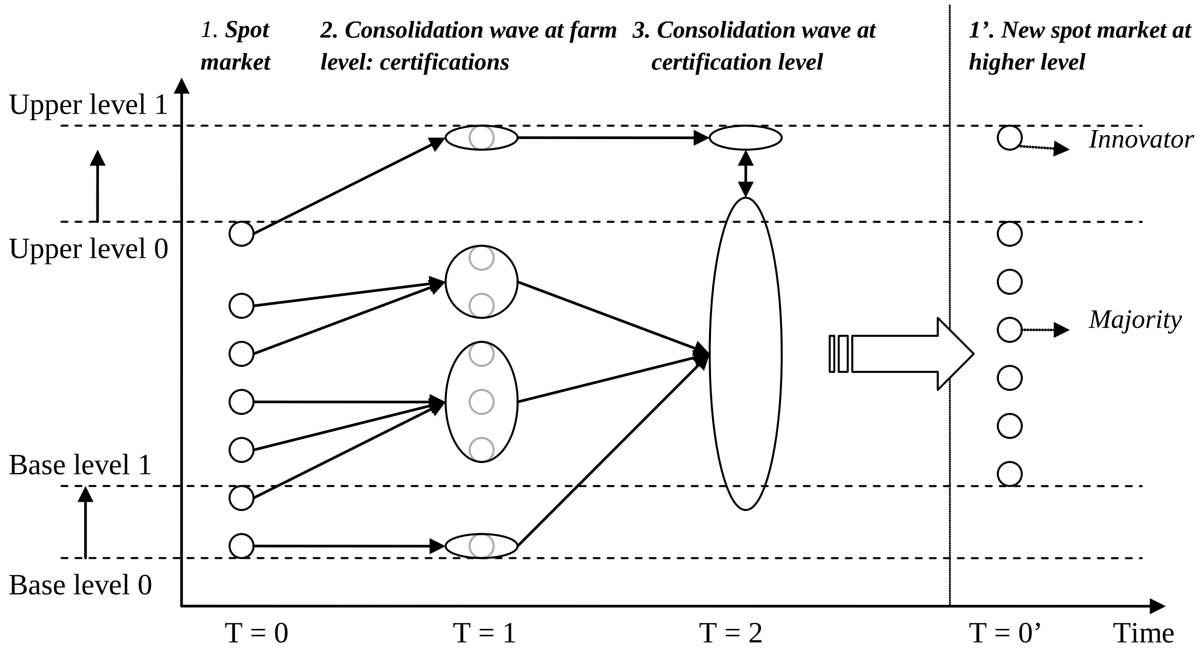


Figure 7.1. Evolution of certification systems

As in other process of economic change (Nelson, 1995), this cycle involves processes of variety creation, followed by processes of selection (at farm and at certification level) and processes of inertia/continuity. Currently, the result of the consolidation of certification schemes is the GlobalGAP standard, which now acts as the basis for the premium private spot market. The dynamics within the fresh commodity sector and its standards will result in this premium private standard becoming the basic standard, which will eventually be incorporated into the legislation of the regions where the standard is applied. It may then form the basis for new initiatives aimed at further improving quality or new forms of differentiation (in other words a starting point for a new innovation cycle).

7.6.2 General drivers for a single certification standard

Many forces influence the adaptation of standards. With FlandriaGAP (2004) these included: changes in the current legislation, fine tuning with other private initiatives, changing demands from buyers, new production techniques, scientific results, and the views of participating organizations (e.g. auctions, auditors and control bodies). The revision of certification standards is quite similar among the different certification systems: with a technical committee proposing changes and a steering committee analysing and approving them. Individual producers have no direct impact on the rules and formulations in the '*cahier de charge*' or standards book, but their views are taken into account when revising the standards. Farmers normally communicate problems related to impractical rules to the samplers at auction level. These, together with statistics from the control body on the number and kind of breaches inform the standard setting and help to adapt unrealistic prescriptions.

Private standards and certification systems are put in place for strategic reasons, for the purposes of standardization, differentiation and reducing risk (Mainville *et al.*, 2005). During the focus group sessions, those involved in the certification process were asked to discuss their primary motivation for participation. Their responses, summarized in Table 7.3, confirm the strategic objectives that Mainville *et al*. identify.

Table 7.3. Certification book participation - top of mind reasons

Producers	Auctions	Retail	Consumer	Summary
Trust – vs. short supply chain	Trust in the chain	Protection (due diligence)	Information	Risk reduction
Differentiation	Differentiation / recognisability	Differentiation*	Choice	Differentiation
	Uniformity / standardization	Uniformity and clarity		Standardization
Involvement/ optimization				Optimization
License to deliver		Imposing demands on suppliers		Necessity

* depending on the type of initiative. GlobalGAP e.g. has no differentiating functions

The focus group participants associate the following, closely linked, terms with the question 'why is GlobalGAP used?': basic certification book, uniformity and insurance of the product. For the retailers, the most important characteristic of GlobalGAP is its focus on food safety, while producers see GlobalGAP as a safeguard for the retailers. Retailers find that it provides a useful mechanism for reducing their liability, under the due diligence principle enshrined in national legislation (Hatanaka, 2005)[28]. Unlike product standards, such as Flandria, the GlobalGAP standards are not communicated to end consumers, making it akin to a private label rather than a national brand. This leads producers to see the scheme as something that is a 'necessary condition to enter certain channels', 'requested and/or imposed by downstream players', 'a safeguard for distribution channels ' which involves 'passing the burden onto producers', all topics that relate to and reflect market power and chain management.

However, the non-visibility of GlobalGAP to end consumers is related to other associations such as 'basic product' and 'no product quality demands', as the standard does not offer any guarantees about product quality. Retailers avoid using this generic standard as a label, because there is a risk that consumers will associate it with low product quality. The association of 'basic product' is in turn closely linked with the third topic, uniformity. This guarantees that products, no matter what their origin, are substitutable as they are produced following the same rules. This characteristic increases the negotiation position of the retailers on international markets and reduces transaction costs. GlobalGAP has been launched to harmonize the multitude of initiatives in the market, and this gives rise to it being associated with 'similarity', 'basic conditions' and 'too abstract. Product specific requirements, which are often closely linked to climatic and regional conditions, are not included. From the point of view of those who promoted the Flandria label the emergence of GlobalGAP is not favourable, as it has proven to be a direct (and more successful) competitor to their own initiative. The farmers have difficulties with the new scheme as it is no longer a farmer driven initiative, and they do not identify with it as much.

7.6.3 The single certification standard from a transaction cost perspective

In general, the adoption of the quality assurance systems can play a role in reducing transaction costs in the food chain. However, in the short run, firms incur sunk costs (e.g. start-up costs) related to adopting the quality system. These sunk costs will, of course, vary

[28] The Belgian Law on product liability (22/03/1991) prescribes that the supplier (the retailer here) is considered to be the producer when he is unable to identify the producer.

depending on firm size, product type and existing quality system. There is also an evident desire to shift the costs of quality control to other actors in the chain.

To position their products in the top quality segment of the market, retailers use strategies of horizontal differentiation, based upon the product's unique features (e.g. its packaging), and vertical differentiation, based upon the quality level (see Chan Choi and Coughlan, 2006). For the quality based strategy, the retailer might invest in vertical alliances with producer organizations (POs). Their joint effort is then communicated to end consumers through a retailer or a channel private label (see de Fontguyon *et al*., 2003 also). However, for their main range of bulk products, which are only horizontally differentiated from those of their competitors, this strategy is too costly. This opens the doors for a new type of hybrid market, the higher end spot market, with generic standards common to several retailers. Given the recent mergers at the retail level and the associated increase in market power (Clarke *et al*., 2002; McCorriston, 2002), the creation of such a premium private spot market, with higher safety and quality standards, seems attainable. But as Codron *et al*. (2005) indicate there is the possible danger that liability problems will occur if the standard is too generic and not sufficiently distant from the standard spot market. Conversely if the standard is too severe, the compensation mechanisms have to be more elaborate, increasing the associated control and monitoring efforts, as well as other transaction costs. Furthermore, the independence of the actors involved (i.e. producers) may decrease due to the need for asset specificity. The risk of empty shelves may then become a problem because supply may be too small (as was often the case for organic products in the past). This higher end spot market results from cooperation between competing parties, a phenomenon termed coopetition (Sanchez and Heene, 2004 or Tsai, 2002). However, rather than sharing their resource base, retailers now pool their market (and negotiation) power to demand common certification standards, enabling them to source from different markets all over the globe (see also Chae and Heidhues, 2004). The resulting coordinating institution, the certification scheme, with GlobalGAP as a telling example, acts as a safeguard for the uniformity of production process, regardless of the region of production and differences in regional legal institutions. Parallels can be drawn between this evolution and the drive towards modularity in other industries, a concept described by Langlois and Robertson (1992). Because adherence to the certification standard is not communicated to the end consumer (but is only Business to Business), the retailers retain all the options for a private branding policy. As indicated in Fulponi (2006), retailers' incentives for the presence of quality assurance schemes can be summarized in the word 'reputation'. The main objective of the higher end spot market is thus to guarantee, based upon predefined process and product safety and quality features, the maintenance of a safety and quality image, even for the bulk products of the quality retailer. Furthermore, as argued by Hatanaka *et al*. (2005), because the monitoring of the standard is transferred to an independent control body, the retailers' responsibility for policing the safety and quality of their products is minimized, enabling them to invest in other domains (such as R&D). Liability also shifts from the retailers to the third party certifiers. The costs of monitoring food safety and quality are mainly shifted to the suppliers.

From the farmers' point of view, the emergence of a premium spot market has both beneficial and prejudicial effects on their transaction costs. The benefits come from having to comply with only one single certification standard, instead of a multiplicity of public and private standards. This reduces their administrative and cognitive burden. In addition their individual negotiation and information costs are less than for those farmers not participating in private certification systems. The disadvantage emerges from the fact that the premium spot market is primarily designed to allow buyers to source products from geographically and temporally separate markets and agents, without increasing their transaction costs. This demand results in a certification manual which incorporates all the legal and extra-legal requirements of different markets and different, merged, certification standards. The certification standard is therefore not well adapted to local farming conditions and might be perceived as too abstract, with some parts being redundant. Furthermore, it throws producers from different regions, with different climatic and soil conditions, into direct competition with each other. The retail sector has largely succeeded in shifting the transaction costs towards the upstream chain members.

Transaction costs are also an issue at the consumer level. Retailers have increasingly supplemented their national brand product offer with their own private label products. These make the upstream supplier quasi invisible and oblige customers to rely more and more on the safety and quality systems operated by the retailer. Furthermore, the sheer number of products available makes it impossible for a customer to process all the information relating to the intrinsic and extrinsic quality cues of these products, obliging the customer to rely upon the retailer's safety and quality mechanisms. Because a major part of consumers' transaction costs are now transferred from the product to the retailer level, these can be significantly reduced. Once the choice for a type of retailer is made, the consumer can presuppose certain quality and safety product features. The last decade has seen growing consumer acceptance of these private label products (see also Nielsen, 2005) which enable the retailer to create more customer loyalty than national brands, which are also available in competitors' stores.

Despite this, national brands that link back to the producers will remain important, especially in the agricultural and food processing sector, because consumers are increasingly unaware of their food's origin and the way it is produced. It is important therefore that retailers also invest in generic standards as well as in more costly vertical alliances with producers. In that case, the generic certification standard still acts as the *sine qua non*, the starting point for negotiation, and is then supplemented with more binding and specific contractual arrangements.

7.7 The premium spot market as a zero or a positive sum game?

The type and number of rules in *a cahier de charge* and the degree to which they are binding are a result of negotiations between the involved stakeholders. The *cahier de charge* therefore reflects the equilibrium between the different objectives and the power of the value chain members. This changing equilibrium is the main reason for the merger of certification systems. In this analysis we limit ourselves to examining certification schemes that operate at the farm level, where the farmers (and their unions) and food retailers are the principal actors. The following section describes the tensions between competitive pressures and the sources for cooperative gain when certification systems, constructed by multi-stakeholders, merge into a single standard.

Figure 7.2 summarizes the competitive forces that exert competitive pressure on certification schemes. First of all, one can distinguish an increase in **internal rivalry** between the farmers participating in a single, cross border certification scheme. Although united under the certification (or farmers' union) umbrella, they are in fact all competing for access to the same preferential sales channels. Certification offers the framework for competition, the rules and terms under which competition takes place. A first condition is thus to ensure that all the actors remain within this framework and avoid **free rider behaviour.** This necessitates an independent, watertight system of monitoring, control and penalties. This framework, by stipulating all the product and process requirements, further limits the opportunity for farmers to differentiate their product offer from their fellow farmer competitors on non-price dimensions, shifting competition to price. Thus the remaining best option for farmers to gain competitive advantage is to lower their operating costs, through pursuing economies of scale at the farm level. This contributes to the existing trend in agriculture in general, of a shift towards a smaller number of larger scale firms. Small scale firms competing under the same (certification) conditions as more cost efficient large scale firms thus risk the danger of **exclusion**.

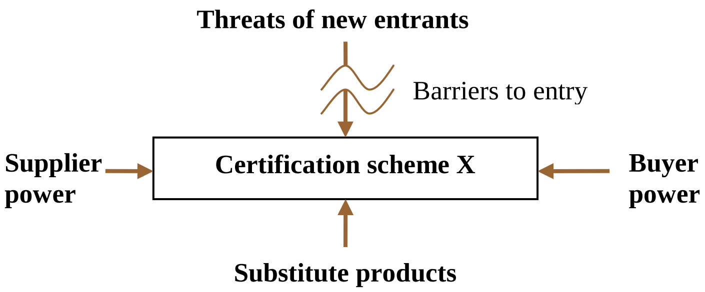


Figure 7.2. Competitive forces for actors in certification schemes
Source: adapted from Sanchez and Heene (2004) and based upon Porter (1979)

Certification also acts as a **barrier to entry** for new competitors, due to the need for asset specificity. This restriction is balanced by the preference amongst buyers and the auctions for schemes which can guarantee a sufficient supply at all times, which necessitates a minimum number of farmer participants. The farmer unions also see unlimited access for farmers as linked with increased supplier power. However, there is always risk in this of slipping into mainstream bulk production, eroding the preferential position of the certification scheme. This further increases internal competition within the scheme, which might explain the negative attitude of farmers toward unrestricted access.

Substitute products in this framework should be regarded as the products from competing certification schemes. The wave of convergence between different certification schemes has substantially decreased the switching costs for buyers (and customers). This process might further trigger the price competition and downward pressure on the prices paid to farmers.

Although not the core subject of this paper, it is clear that certification schemes potentially increase **supplier power**. These schemes both narrow the available resource base and impose stricter criteria for end product quality, thereby limiting farmers' choice over the use of inputs. The concentration of suppliers further increases this possibility as well as the potential for increasing **dependency**.

The main threat to the viability of certification schemes seems however to come from the increasing **buyer power**, triggered by the (international) wave of concentration at the retail level (see also McCorriston, 2002) and cross border alliances (see Dobson, 2003). These retailers increasingly operate internationally. Their ability to source from different markets, together with their close contact with end consumers, creates a situation of information asymmetry, which in turn further increases retailer power. They use this power to lobby for convergence between the different certification schemes which helps them to further reduce their switching costs. They also use this power to force new demands into the certification standards and to push prices at the auction level further downwards. As with suppliers, the concentration among buyers also increases the danger for **dependency**. However, due to the large number of participants, the farmers, through their unions, can also exert buyer and supplier power, and thus counter some of these effects.

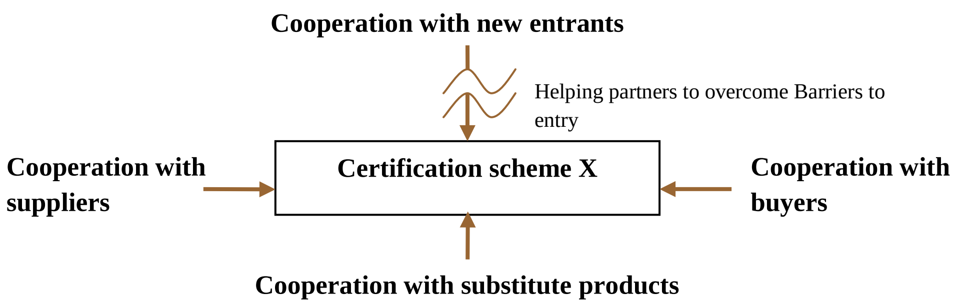


Figure 7.3. Sources for mutual gain through cooperation
Source: adapted from Sanchez and Heene (2004)

Certification standards can be regarded as equilibrium constructs which, rather than zero sum games (where one organization can only benefit at the expense of another, Porter, 1979) are positive sum games, in which cooperation leads to win-win situations for all cooperating participants. Figure 7.3 illustrates the sources of mutual gain through cooperation. The situation of simultaneous cooperation and competition is more formally termed ‘coopetition’. The socio-economic construction of certification systems is one of the best examples of market players joining forces to create mutual gains and reduce common costs.

The drive towards a single certification network (and thus a premium private spot market) creates synergies among the participating **farmers** which, in terms of certification system, lead to economies of scale and economies of learning. The economies of scale mainly relate to the increase in market power (both as buyer and supplier), and accrue at the farmer union (auction) level. Thus, although the increase in number of participants reduces the negotiation power of individual farmers, their joint negotiation power increases. However, with the auctions evolving from producer organizations to mediators in the chain, it is not always clear whether they fully exert this market power. Furthermore, the disappearance of FlandriaGAP indicates that the supplier power of the auctions was less than the joint buyer power of the retailers who drove the shift to GlobalGAP. Economies of scale also reduce some fixed costs inherent to certification, due both to the reduction in the number of initiatives and because the costs for the remaining initiative can be distributed among a larger group of participants. The certification standards also offer an ideal negotiation base for more intense cooperation between both suppliers and buyers, without imposing the high transaction costs that occur when personal contracts have to be negotiated. For example, through their joint buying power, farmers can influence the phytopharmacy industry to develop more crop specific or less intrusive pesticides. At the buyer side, the certification book is the key for unlocking the preferential sales channels of quality oriented retail chains. Economies of learning emerge from the incorporation of all the small size initiatives into a single certification standard, which result in a crosspollination of ideas and experiences between participants and promoters. The mutual gains of cooperation with new entrants and substitute products are mainly due to increased learning effects and increased market power. Certified producers experience transaction cost advantages, compared to producers selling to the spot market which, in turn, enables more investment in product development.

From buyer (retailer) point of view, the unified certification system results in economies of substitution and economies of scope. The former exist when one resource in an organization can be replaced by another without incurring the significant cost of redesigning the organization (Sanchez and Heene, 2004). The certification system allows the retailers to become modular organizations that can quickly incorporate alternative resources (products) into their processes (or product range). The economies of scope exist because the retailers' fixed use assets, which were restricted to a single product type (and thus certification system), have become flexible use assets, which can be dedicated to all the certified products, due to the single certification standard. The cooperation between different retailer groups, necessary to create the single standard, creates further advantages related to economies of scale (increased market power).

As multi-stakeholder constructions certification systems provide protection against some external threats. Participants are better protected against the adverse effects of food scares which are, according to the focus group participants, mainly caused by irregularities among uncertified producers. Certification thus creates more trust and credibility in the market. It might also improve the cost position relative to substitute products (by working together to develop new methods, materials and technologies). The extra added value (compared to the regular spot market) opens market opportunities (increased market share or better prices) in the higher quality segment. Finally, the promoters of the certification system can act as advocates for participants' interests to government agencies.

7.8 Conclusions

Our main research question in this chapter, the equity among value chain members within Private institutions of Sustainability, is approached by studying the effects of the evolution towards a premium spot market on the different PIoS value-chain members.

First, there is an apparent shift from multiple certification systems to a single certification standard and a premium spot market, with recent mergers between major certification schemes, perhaps the most notable of which is GlobalGAP.

The dynamics of certification standards can be broken down into, and understood in terms of three processes that drive economic change (Nelson, 1995). In a first stage, processes of variety creation result in several distinct certification initiatives, which all grow in terms of member numbers, through subsequent processes of inertia and continuity. The first stage of initiation and growth takes place at the farm level, with farmers developing and deciding to participate in a premium initiative. The second stage, at the certification system level, is driven by processes of selection and merges the different certification systems into one single standard. The certification manual, which is a balance between the objectives of all involved stakeholders, is however from a meta-stable nature (i.e. it will keep evolving gradually), resulting in a continuous repetition of this two-stage two level game of variety creation and selection.

The resulting single premium spot market is preferable to quality oriented retailers as it lowers their transaction costs when sourcing quality products. Due to the increase in uniform supply in this market segment, suppliers once again are driven to be price takers in a competitive market. The development of generic certification standards is the direct result of several retailer groups joining forces and using their joint market power to influence producer organizations (in the Flemish case the auctions), who were once more powerful, to adapt their own, national brand-like certification schemes. In this sense it is quite ironic that the initial GlobalGAP standard, for the rules regarding hygiene and production conditions, was based upon Flandria, the Flemish vegetable standard which is now, apart from its product quality pillar, inferior to and fully absorbed by GlobalGAP. The retailers' bundling of forces is viable because, due to the absence of a label, the certified bulk products can still be sold as retailer specific private label products. The only demand is that the quality level of the bulk vegetables is in line with the general quality level of all the private label products in the retailer's range. A national brand is mainly preferred for those products that result from a vertical alliance with a selected group of producers, and, typically, incorporate the retail brand name as well.

From the point of view of the farmers and auctions a single higher end spot market has the advantage of reducing transaction costs which are typically higher when numerous certification initiatives co-exist alongside each other. However, the single, unified standard is designed to be applied to many regions, and is therefore not very well adapted to local conditions. This induces extra transaction and input costs. Moreover the farmers and auctions have lost the preferential position they acquired as scheme initiators and have become followers. They have lost their own certification manual and label and now face increased price competition. For some types of firm, the current situation might result in higher levels of dependency and exclusion. However, by adhering to this new standard, their access to preferential sales channels remains open.

PART 3: Improving the performance of PIoS

In Part 2 the performance of PIoS was investigated. As chapter 5 indicated, farms participating in PIoS outperform conventional farms with respect to environmental sustainability. With respect to the economic performance, Chapter 6 indicated that farms participating in PIoS create more sustainable value compared to farms who do not. In chapter 7 the social performance of PIoS was discussed by analyzing the retail driven evolution towards a premium spot market. This chapter concluded that PIoS on the one hand create possibilities for a better internal social performance of the value-chain and on the other hand exhibit the potential danger to be used as means to exploit market power.

Another conclusion that can be drawn from these three chapters is that PIoS performance can still improve. In the third part of this dissertation we want to estimate the potential for improving the environmental, social and economic performance of the PIoS. As a measure for the potential of environmental performance improvement, farmers' desired compensation is estimated in chapter 8. This chapter thus investigates the research question 4 "*what is the desired compensation for a better environmental performance?*".
Figure III.1 below recapitulates (part of) the conceptual framework outlined in chapter 1. When the rules of a PIoS are changed for the environmental better, the environmental performance of participants will shift to the right (black arrow). As a result the economic performance of the participating farms will change. When the change is positive farmers are willing to pay for it, when negative they want compensation. Consider a farm located in point A with EP_A and $EnvP_A$. A change in the PIoS rules may shift it to point G, with a better environmental performance and a lower economic performance. The desired compensation for the farmer is then EP_A-EP_G.

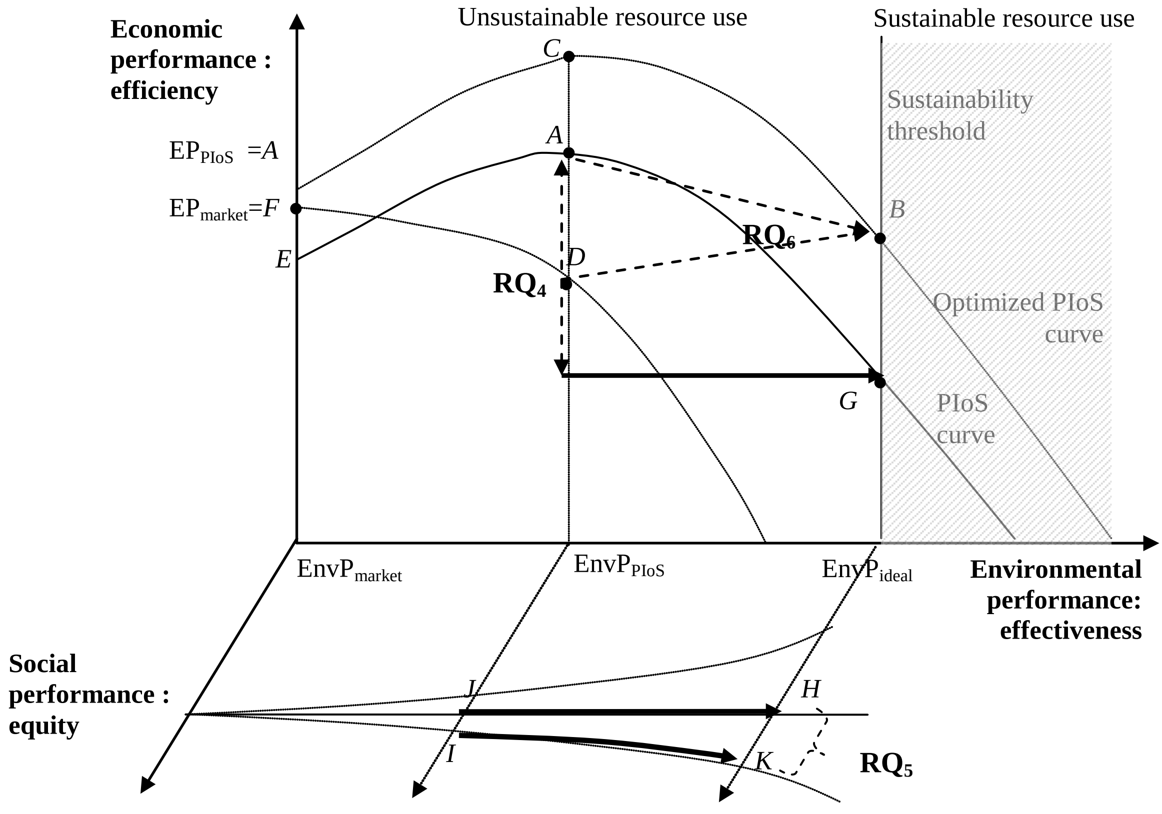


Figure III.1. Research question in part 3

Chapter 9 focuses on the improvement of the internal social performance of PIoS. It investigates the research question 5 *"How can institutional change in PIoS lead to more equity among participants?"*.
The endogenous processes of change within PIoS were explained in chapter 7. That chapter also emphasized the important role of retailers. Chapter 9 assesses farmers' attitude towards retail driven institutional change in PIoS. Changing institutions results into a new division of costs and benefits over the PIoS value-chain members. To come to equitable institutional change within PIoS it is important to assess the value chain members' expected costs and benefits for these changes. In Figure III.1 the arrow between point J and H shows how the environmental performance of a farm participating in a PIoS can change without a change in equity. The arrow between I and K shows the same change in environmental performance but with a positive change in equity within the PIoS.

Chapter 10 focuses on the identification of the economically most interesting PIoS-configuration when new sustainability targets are introduced. It investigates the research question 6 "*how sustainable efficient are the farms participating in the PIoS system when new sustainability targets are introduced*?".
Our knowledge with respect to sustainability changes continuously. As explained earlier, the environmental performance of PIoS can still improve. Figure III.1 indicates the threshold between sustainable and unsustainable resource use. Point B combines the point of sustainable environmental performance and maximal economic performance, given the existing PIoS configurations. The technique developed in chapter 10 helps to identify the improvement path for farms to ensure that the sustainability targets are met and simultaneously value creation is maximized.

Chapter 8. **Measuring the perceived opportunity cost of integrative PIoS**

This chapter is based upon:

- *Mondelaers, K., Garreyn, F., Roussel, L., Louviaux, M., Mormont, M., Pussemier, L., Steurbaut, W. and Van Huylenbroeck, G. (2007). Certified production systems: a way forward towards sustainability? In: Towards a safer food supply in Europe. Eds. Van Peteghem, C., De Saeger, S. and Daeseleire, E. Belgian Science Policy, Brussels, ISBN 978-90-8756-032-4*
- *Mondelaers K., Garreyn F., Steurbaut W., and Van Huylenbroeck G. (2008). Farmers' acceptance of further strengthening of private certification systems. Poster with oral presentation, EAAE 2008 Congress, Ghent, Belgium, August 26 – 29, 2008.*

8.1 Introduction

As shown in chapter 2, 3, 4 and 5, PIoS seem promising vehicles to implement extra sustainability targets, as they already incorporate sustainability concerns in their business objectives. Due to their private voluntary nature, they are also well accepted by private market actors. Introducing extra targets means that the institutions underlying the PIoS will be changed.

Private certification systems that introduce rules to reduce the environmental pressure can be considered as examples of institutions of sustainability (IoS). The latter term, introduced by Hagedorn (2002), refers to sets of rules (constraints) that we impose on our interaction with nature. By making the certification pesticide application more restrictive, the farmers internalize part of their external costs. In this context, Hagedorn distinguishes between integrative and segregative institutions. Integrative institutions, opposite to seggregative institutions, refer to (amongst other) the internalization of gains and costs. When the certification institution, as a set of rules, becomes more restrictive, f.e. in its pesticide policy, it evolves in the direction of an integrative institution, triggering higher transaction and opportunity costs for the participants, but simultaneously allowing them to reap some reputational gains from the institutional change.

In this chapter, the possible improvements in the pesticide application rules of an existing private certification scheme are taken as example for unravelling the 'costs of integration' for the farmers, participating in a certification initiative. The opportunity costs are the cost for the internalization of part of the external costs. The improvements proposed were obtained by comparing the existing certification scheme with a virtual optimal system, that combines the sets of rules of 'the best available alternatives in the market', based on the judgement of environmental experts. The main objective of this chapter is to illustrate how the opportunity cost of more integrative institutions can be assessed. This opportunity cost is approximated by the monetary compensation private actors expect for the introduction of extra sustainability rules. It therefore tests hypothesis 4 that *changes in institutions influencing the environmental performance of PIoS will change the private actors' desired pay-off structure.*

To know which rules have to be changed, two options can be identified. First option is to select the rules of the benchmark that guarantees a better environmental effectiveness. Another option is to invent new rules. The former procedure has the advantage that the possible environmental contribution of the rule is known ex ante. In this chapter the rules of competing PIoS that potentially would improve the environmental performance of the PIoS under study are selected. To test the hypothesis, a two step procedure is followed. In the first step rules are selected from competing schemes that, according to environmental experts, improve the environmental effectiveness of the PIoS under study. These rules are then, in a second step, proposed to the participants in the PIoS, to measure their willingness to accept the changes, as a proxy for the ***opportunity cost of integrative institutions***.

The standards applied in PIoS can be decomposed into sets of rules, which are listed in certification books (or cahiers de charge). Certification itself is the procedure by which a third party gives written assurance that the product, process or service is in conformity with these standards, and it can be seen as a form of communication along the supply chain (Börkey and Levêque, 1998). The certification books, containing the sets of rules, are social constructs, and reflect the equilibrium of stakes of direct and indirectly involved stakeholders. As explained in chapter 7, stakes and power distribution are in continuous evolution, making the certification book equilibrium only of a metastable nature. In this chapter we propose environmentally friendly adaptations of the pesticide rules of an existing private certification scheme in the fresh vegetable sector in Belgium and discuss the acceptance by the main stakeholder group, the farmers. The desired monetary compensation is used as proxy for the opportunity cost of integration borne by this group. The private scheme taken as a case study is the FlandriaGAP scheme, which is already an improvement of its predecessor Flandria. As explained in chapter 7, this scheme started in 1995 and became the major certification scheme in the Belgian vegetable sector. It offers a guarantee for a high quality product, cultivated in an environmentally friendly way and fully traceable.

One of the spearheads of environmental certification in the vegetable sector is the pesticide policy. The FlandriaGAP scheme aims at a reasoned cultivation and as such incorporates several pesticide related rules. Based upon focus group sessions with key stakeholders, improvements in the certification pesticide rules were suggested relating to dose, crop rotation, type of pesticide, origin of propagation material, order of pesticide application, crop resistance and number of treatments. Through multicriteria analysis, the positive contribution to ecological sustainability of these new rules is demonstrated. Restricting the certification pesticide rules will not be accepted by the participating vegetable growers without an adequate price compensation. By means of a choice experiment, farmers' disutility and willingness to accept (WTA) of these new rules is measured.

8.2 Measuring the opportunity cost of integration

In Hagedorn's Institutions of Sustainability framework (2002), introduced in chapter 1, the central position of the actor was highlighted. When institutional change takes place, the actor compares the gains from recontracting within the existing institutional framework with the gains from devoting resources to altering that framework (North, 1990). The opportunity costs for altering the framework are the gains from recontracting in the existing institutional framework. The actor's comparison is based upon a perception of reality, as the actor confines in mental models which are characterized by bounded rationality.

As explained in chapter 1, the relationship between economic and ecological performance of PIoS is either mutually enforcing (section AD in figure 8.1 below) or a trade-off (section DB and further in Figure 8.2). Consider a PIoS in point A in Figure 8.1 below with an environmental–economic performance combination ($EnvP_A$; EP_A). From an economic perspective, this PIoS would have ideally been located in point D, as this point maximizes economic performance. The ‘ideal’ opportunity cost of being in point A and not in D is therefore EP_D. In such a case there are either some real or some perceived institutional constraints that hinder the PIoS from reaching point D.

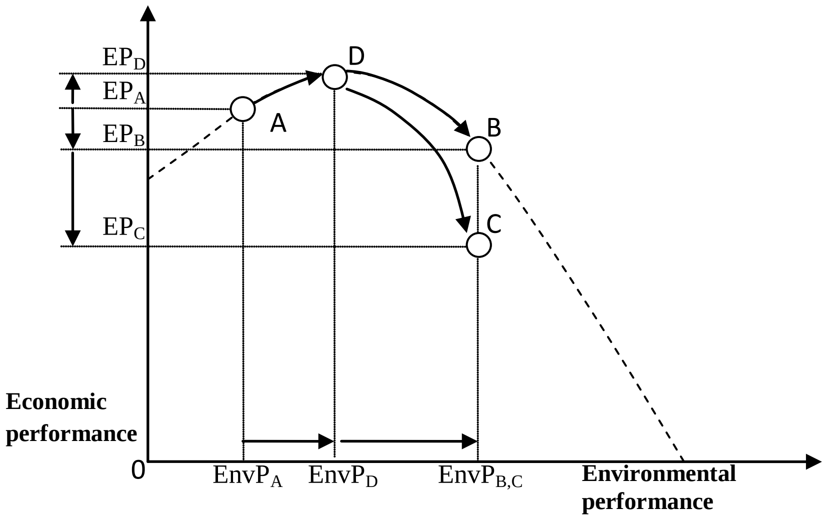


Figure 8.1. Effect of introducing extra rules on *perceived* economic and environmental performance of PIoS

Imagine now the introduction of a new rule, improving the environmental performance from point A to point D. The economic actor participating in the PIoS associates a positive utility with this change. He is indifferent between the current situation A and situation D when he has to pay EP_D-EP_A for the change. Conversely, a change to B creates negative utility for the PIoS-participant. Economic performance will deteriorate with EP_A-EP_B. The actor’s perceived opportunity cost of this rule is therefore a good proxy for the economic benefit foregone, which is EP_A-EP_B.

Two rules can have the same ecological contribution, but a different perceived opportunity cost. Rules B and C in figure 8.1 are exemplary. More overall utility is created by selecting B instead of C. Option B is the pareto-efficient alternative to option C, as environmental performance remains status quo but economic performance increase from EP_C to EP_B.

The Choice Experiments (CE) approach is based on the hypothesis that the value of a good or service depends on the attributes of the good and the levels these take (Louvière, 2000). This is based on the Characteristics Theory of Value of Lancaster (1966) who proved that individuals derive utility from the characteristics of a good rather than directly from the good itself. This assumption can then be modeled based on the Random Utility Theory (McFadden, 1974). Random utility models are based on assumptions about individuals’ evaluation of goods and services. Such assumptions about individuals’ behaviour are introduced to account for the researcher’s inability to fully represent all variables that explain all preferences in an individual’s utility function. The probability (P_{in}) that an individual n (in our case a farmer who has to choose between different sets of certification rules) chooses alternative i (which has an attribute vector X_{in}) from a choice set of J alternatives can be represented as:

$$P_{in} = P(U_{in}) > P(U_{jn}) \qquad \text{for all } j \neq i \qquad (1)$$

This formula indicates that a farmer will choose alternative i in the choice set if and only if this alternative has the highest utility for the farmer compared with all other alternatives in the choice set. The utility function U can be further decomposed into a deterministic part (V), function of the observed factors, which are the certification book attributes incorporated in the experiment, and a stochastic part (ε_{in}). The latter comes from unobservable factors which affect choice, measurement errors in the explanatory variables in function V and model specification errors. Amongst the many statistical distributions available, the one most extensively used in discrete choice modeling is the extreme value type 1 distribution (also known as Gumbel or Weibull, Louvière, 2000). The basic choice model, called the conditional logit choice or multinomial logit (MNL) model (Louvière, 2000), than has the following functional form:

$$P_i = \frac{1}{\sum_{j=1}^{J} \exp - (V_i - V_j)} \tag{2}$$

As suggested by McFadden (1974), the deterministic parts V_{jn} are assumed to be linear and additive functions in the attributes (Xs). Hence, V_{jn} can be written as:

$$V_{jn} = \sum_{k=1}^{K} \beta_k X_{jnk} = \beta' X_{jn} \tag{3}$$

If an element of X_{jk} appears in the utility expression (V_{jn}) for all J alternatives, such a variable is termed generic (i.e. the utility parameter β of X_{jk} is the same for all j). Because in our experiment all attributes (all certification book rules incorporated in the experiment) relate to one certification book (namely the existing FlandriaGAP system), the coefficients to be estimated can be treated as generic. For the estimation of the model parameters in the MNL model, conventional maximum likelihood procedures can be applied. Maximum likelihood estimates of β can be obtained by maximizing a log-likelihood function over the parameter space.

$$LogL(\beta) = \sum_{n=1}^{N} \sum_{i \in J_n} f_{in} \log \left[\frac{\exp(V_{in})}{\sum_{j}^{J} \exp(V_{jn})} \right] \tag{4}$$

In the standard interpretation, estimates of β represent so called taste parameters, as they are related to the intensity with which the associated attribute contributes to utility.

An advantage of the choice preference model is that each respondent can be asked to do the experiment with different choice sets a number of times, increasing the number of data points without increasing the sample needed in the same order and thus can be applied even with a limited number of respondents.

The basic aim of the Stated Choice technique in this context is to obtain utility estimates for the different options of the certification book rules incorporated in our experiment (i.e. the different attribute levels). This utility measure can then be interpreted (is there a utility difference between the levels?) and used for willingness to accept estimates, simulations and calculations of the effects of marginal changes to these levels. To obtain the utility estimates, multiple choice sets are constructed, each of which constitutes of several alternatives (3 in our experiments). The individual farmers were asked to choose amongst the three alternatives in a choice set their most preferred one. The alternatives on their turn are a combination of several attributes, with each of these attributes having different levels, depending on the choice set. As an example, with farmer 1 choosing alternative 1 in the first choice set, we know he derives a higher utility from the attribute levels of alternative 1 compared to those of alternative 2 or 3.

8.3 Experimental set up

In January, 2006, 68 farmers located in the province of Antwerp were personally interviewed. Table 8.1 summarizes the main descriptives and frequencies for the sampled farmer group.

Table 8.1. Descriptives/frequencies for sampled farmers

Item	Descr.
Number of farmers	68
Firm type (combinations possible)	
Open air	8,6%
Greenhouse traditional	40,0%
Greenhouse substrate	65,7%
Number of crops	
1	74,3%
2	14,3%
more	11,4%
Principal crop types	
Tomato (and varieties)	51,6%
Lettuce (and varieties)	31,4%

The selection of these farmers was purely at random, based upon visual recognition of the farms. This methodology was used because privacy policy forbids the auctions to make available the addresses of farmers producing under the certification standard. Because our principal aim was to test the methodology, the selection of farmers was for us of secondary importance. Therefore the results should be taken as indicative rather than inclusive. The survey consisted of three parts. The first part covered questions concerning personal and farm characteristics of the farmers affiliated to FlandriaGAP. In the second part, the vegetable growers were asked to choose amongst several alternatives based upon changes in the certification book as a whole, while in the third part, they were asked to make a choice amongst several alternatives with attributes only relating to pesticide use reduction.

The choice experiments are built round three scenarios, a base scenario reflecting the current prescriptions level, and two scenarios with more severe prescriptions. The choice experiment attributes and their levels as presented to the farmers were selected based upon the outcome of focus group sessions with farmers, environmental scientists, government officials, vegetable chain members and pressure groups. They imply a further restriction on the pesticide rules within the certification manual of the certification system under study. A further restriction of pesticide use is not warmly welcomed by the majority of the farmers, given the already limited freedom of movement in this area for the gardeners. In Table 8.2 the selected attributes and their corresponding levels are listed.

The full factorial (i.e. all possible combinations of attribute levels) results into $5 \times 2^8 = 1280$ alternatives. To reduce this number, an orthogonal main effects plan was constructed, which contains a minimum of 16 alternatives for this design. The alternatives in the resulting orthogonal plan are randomly combined without replacement into a choice set of 3 profiles (a base scenario, reflecting the current situation, and 2 hypothetical scenarios). Participating farmers were asked to choose their preferred alternative in each profile set. For the general experiment, 16 profile sets were constructed. To reduce the cognitive burden for the participants due to a high number of choice tasks (16), the design was split into blocks of 4 choice sets per respondent. The farmer was asked to choose amongst A, B, and C, after comparing the different attribute levels.

Table 8.2. Certification initiative attributes and attribute levels in choice experiment 2

Attributes	Attribute levels of current PIoS	Attribute levels of more integrative PIoS
Calculation of dose/ha	Current system (dose and area)	Driving speed and application pressure incorporated
Crop rotation	Not compulsory	Compulsory if technically feasible
Pesticides allowed	SRC list and positive list, subject to motivation	Only SRC* list
Propagation material	Current level (plant passport recommended)	Plant passport compulsory
Choice of pesticide	Motivation of choice sufficient	Follow colour code of SRC
Choice of crop variety	Trade-off between several criteria	Minimal dependency on agrochemicals
Treatments with highly noxious pesticides	Current level	Halving of the number of treatments
Relative change in price	0 %	0,5 % / 1 %/ 2 %/ 3 %

* SRC: Service for Residue Control

A first change to the PIoS could be the **calculation of dose per hectare.** Currently, the gardeners participating in FlandriaGAP have to calculate the applied pesticide dose by multiplying the dose per hectare with the area of treatment. Aimed at a more balanced application, gardeners could also take the driving speed and application pressure into consideration. The advantage is that the dose, when correctly calculated and applied, can be further reduced, because excess application due to irregular dispersion is no longer needed. This measure is currently already incorporated in the certification book of Charte Perfect and was rated highly by environmental experts.

In the cahier the charge of FlandriaGAP, **crop rotation** is recommended, but not compulsory. In the choice experiment, crop rotation was integrated because experts judged this measure as highly effective with respect to a further reduction of pesticide application. One of the major drivers for pest incidence in the current crop variety is, besides temperature and humidity, the crop variety in the previous period, because pests and varieties are inextricably linked. A logic but not always easy applicable measure is then variation in the crop variety, because pests lose their preferred host and thus perish more easily.

Within Flandria (and FlandriaGAP), the list of legally **allowed pesticides** is further restricted to fully comply with the principles of environmentally concerned agriculture. The farmers have to comply with the principles as outlined on SRC advice cards. The SRC is a non profit scientific institution founded by the LAVA auctions, VBT, the Belgian Farmers' Union and the Province of Antwerp, Belgium. Per type of pest, the SRC advice cards outline the pesticides allowed, the dose, the active ingredients, the waiting period before harvesting and the maximum number of treatments. For greenhouse gardening, the cards first recommend use of biological treatments and natural enemies and only in a second step the use of corrective chemical pesticides. For outdoor production, the cards are based on the POCER-indicator (Vercuysse & Steurbaut, 2002) with different colour codes depending on the toxicity level of the chemical pesticides. Within the FlandriaGAP certification book, the farmer is given the freedom to use products allowed by the Belgian government (www.fytoweb.fgov.be), when no other options within the list of SRC pesticides are applicable. Whenever this situation occurs, the farmer has to motivate his choice of pesticide and obtain a (written) approval. In the CE, the latter possibility was removed. This attribute should be considered as a proxy for the further restriction of pesticides allowed within the certification standard.

In the FlandriaGAP certification book, a plant passport (which documents the origin and treatment of the **propagation material**) is recommended, though not compulsory. Experts judge the use of reliable and pest free propagation material as a must for further reduction of pesticide application, for the obvious reason that contaminated material will evidently lead to higher pesticide application in the longer run. A considerable part of the questioned gardeners already comply with this rule, because they use propagation material from Dutch breeders. In such a case, documentation is provided and can easily be added to the rest of the registration material.

In the experiment, the attribute **choice of pesticide** was integrated, to measure whether farmers are sensitive to a restriction of the order in which pesticides should be applied. Currently, farmers can divert from the preferential ordering (which is indicated by the colour code Green – Yellow – Red), if they motivate why. In the experiment, the latter option was banned, meaning that farmers strictly have to follow the recommended ordering. This restriction can have some significant economic drawbacks from farmers' point of view. First, the pest development pattern (sometimes exponential) can urge the farmer to treat the crop with the best (often the most noxious) pesticide available. If the farmer first has to try less intrusive treatments, crop damage can become significant and quickly exceed the economic threshold level. Second, the use of a treatment that probably not fully eradicates the targeted pest is costly and economically inefficient, because the most effective pesticide will probably be necessary as well. Then why include this proposition? The measure could urge farmers to further increase their crop monitoring efforts (i.e. to intervene more timely), which will, in the end, prove to be both environmentally and economically advantageous, because less harmful pesticides are applied and crop damage (or the use of expensive pesticides) is reduced.

Nowadays, the **choice of the crop variety** within FlandriaGAP is subject to several stakes, which are the crop performance, the exterior product features, the shelf life, the yield and the scoring in taste panels (with consumers and experts). The environmental experts in the panels attached a very high score to the rules aiming at a choice of crop variety based upon pest resistance. In the CE, the attribute level 'choice of variety based upon minimal dependency on agrochemicals' was included, as an alternative for the current situation.

Another option for a decrease in the pesticide pressure on both soil and product is a further reduction of the **number of treatments** with the most dangerous chemical products (those labelled red on the SRC-cards). The drawback of this measure is that farmers will probably increase the dose per treatment. However, maximum dosages are now already fixed. This attribute reflects a situation in which more attention is given to the pesticide contamination during the product life cycle (and not only at the final product level), which is, up to now, a gap in the (European) legislation. The main drawback is the scientific foundation of the reduction of treatment numbers. Now, the treatment numbers (in combination with the dosage) are based upon the economic efficiency (how many treatments are necessary to stay below the economic threshold level) and the effect on ecology.

Different levels of price changes were added to be able to translate the obtained utility estimates into monetary units.

8.4 *Ecological contribution of the proposed changes to the PIoS*

In the study of Garreyn et al. (2006), multicriteria analysis, and more specific the revised Simos method (see Simos, 1990a and 1990b, and Figueira and Roy, 2002), was used to determine the relative score of all major Belgian fruit and vegetable certification initiatives on the ecology axis of sustainability. The developed environmental sustainability analysis method is based on an approach already applied in France (Girardin and Sardet, 2002). For a detailed description, see chapter 5 or Mondelaers et al. (2007). In short, expert panels were asked to rank the rules of different certification systems based upon their contribution to the different pillars of ecological sustainability. As such, a hypothetic ideal certification manual containing all the best rules of the different initiatives, as well as the relative distance in environmental performance of the existing initiatives from this hypothetic ideal, could be determined. The environmental performance measure furthermore allows to evaluate potential improvements of a PIoS, as illustrated in Figure 8.2. In this figure, the original Flandria certificate rules are compared to the FlandriaGAP (this is the EurepGAP aligned version of Flandria) standard and the proposed improved FlandriaGAP NEW standard. The proposed improvements were the criteria used in the choice experiment (CE). By using the scores from the expert panels for the rules integrated in the CE, we are able to calculate the increased beneficial effect on ecology of the introduction of these extra rules. For those rules in the CE that were not integrated in the general checklist, we used the scores of closely related rules (proxies). In total, seven FlandriaGAP-rules were changed.

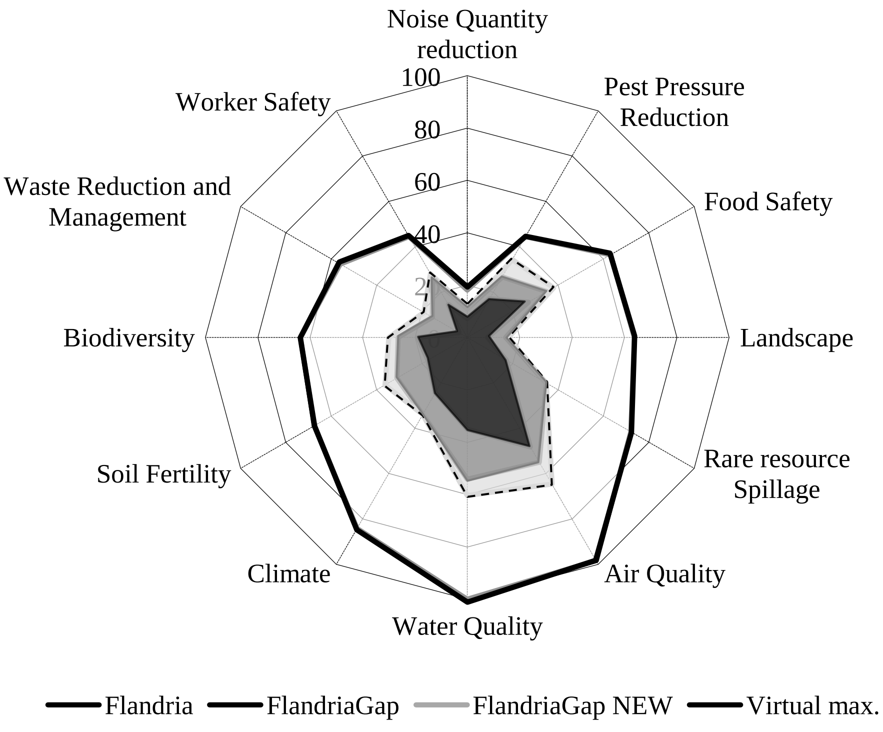


Figure 8.2. Performance of the Flandria, the FlandriaGap and the FlandriaGap NEW standard for ecologic sustainability

As can be seen in Figure 8.3, although the CE focuses on those measures in the certification manual relating to pesticide reduction, beneficial effects can be observed for several other environmental sustainability pillars as well.

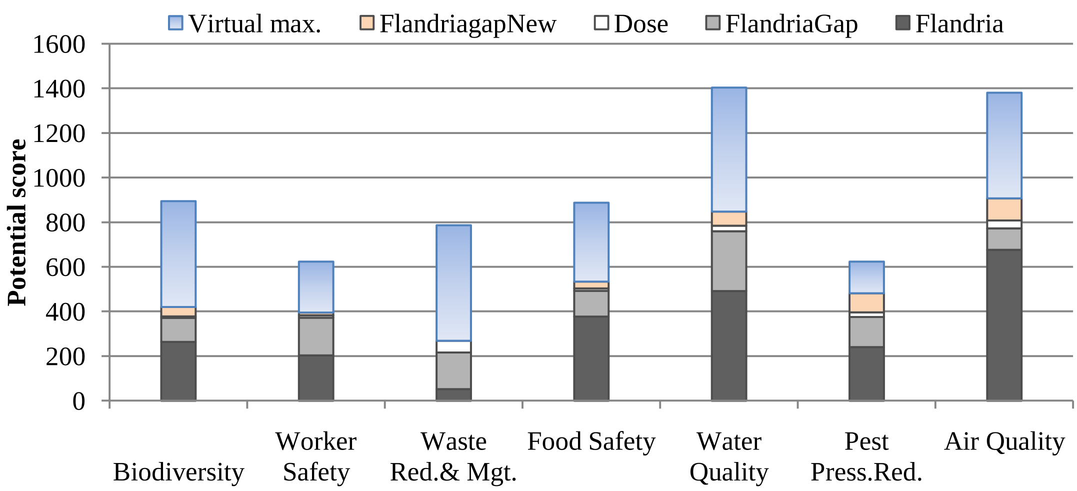


Figure 8.3. Effect of dose recalculation and other rules on environmental sustainability score of FlandriaGap

Thus, by changing one certification rule, induced effects resort for different sustainability items simultaneously. As an example, Figure 8.4 shows the effect on FlandriaGAP's scores of adding the rule '*for the calculation of the pesticide dose, driving speed and application pressure should be taken into account*'. This measure is not that effective for pest pressure reduction, as indicated by the small white section in the pest pressure reduction bar in Figure 8.4. But, unexpectedly, it contributes highly to the 'Waste reduction and management'-pillar. Furthermore, Figure 8.4 shows that the score of the hypothetical FlandriaGap NEW on Pest Pressure Reduction nearly reaches the virtual maximum score. Furthermore, the pillar 'Air Quality' receives the largest contribution from the 7 adapted rules jointly.

8.5 Perceived opportunity cost of integrative institutions

In this section we divert our attention to the affected farmer. The Likelihood Ratio test reported in Table 8.3 indicates that the choice preference model with estimated parameters for the attributes is a significant improvement compared to the model with constants only (the Base model). Table 8.4 reports the estimates for the attribute levels. We made use of dummy coding, hence the current situation is considered as having a zero utility (no negative nor positive utility). The table represents the alternative (more restrictive) attribute levels. The significant utility estimates all have the correct sign.

Table 8.3. LL ratio test for the model CE2

LL model	LLbase model	LL ratio	$X^2_{(6)}$	Sign
-197,91	-217,76	39,7	1,63	yes

The status quo coefficient is significant in this experiment, meaning that the farmer, regardless of the attributes, prefers the current situation over the new alternative, and hence is change averse. As was repeatedly indicated during focus group sessions with the farmers, they fear that price compensation for more restrictive rules will only be of a temporary nature, due to the main retailers' market power and the convergence towards a premium spot market (see chapter 7).

The measure **Calculation of dose per hectare** has the following implications for the gardeners:

- administration will increase and the calculation will become more difficult;
- application will be more demanding (speed and pressure control)
- new equipment will have to be bought

Due to the effects on action and administration level, farmers attach a significant negative utility to this measure.

Table 8.4. Farmers' utility estimates for the proposed pesticide policy changes

Attribute	Coeff	S.E.	P	Wta
Calculation of dose/ha	-0.976	0.285	0.001	2.31
Crop rotation	0.224	0.259	0.386	
Pesticides allowed	0.341	0.264	0.196	
Propagation material	-0.725	0.283	0.010	1.71
Choice of pesticide	0.225	0.249	0.366	
Choice of crop variety	-1.033	0.273	0.000	2.44
Treatments with noxious pesticides	-0.451	0.271	0.096	1.07
Relative change in price	0.423	0.125	0.001	
Status Quo	1.049	0.365	0.004	

Remark: attribute levels represent the alternative situation

Crop rotation in the CE was only considered obligatory when technically feasible. Because the majority of farmers questioned either applied hydroponic cultivation (55%) or greenhouse gardening in solid ground (33%), this attribute was not taken into consideration during their choice process, resulting into an insignificant coefficient.

The model indicates a non significant utility change for the rule '**pesticides allowed**', indicating that the group of farmers surveyed does not feel further restricted by the introduction of this item. This may seem counterintuitive, but based upon the survey sample, it is explicable. The extension of the list of pesticides beyond these allowed within FlandriaGAP is mainly of importance for the (small) group of farmers with niche products (such as parsley), because they have, for reasons outlined before, only a limited number of treatment options. This group is within the current sample underrepresented, resulting in an insignificant coefficient.

With respect to **propagation material** the gardeners consider the current situation as more advantageous compared to the more restricted situation proposed in the experiment. The coefficient associated with the attribute 'plant passport' is significant and negative. The question remains why farmers attach a negative utility to this optimisation, given that the burden of documenting the propagation material mainly resides with the breeder. Besides this, plant material from unquestionable origin further protects the farmer from the expensive use of corrective measures (whether biological or chemical) in later production stages.

The estimated coefficient for a change in the rule '**choice of pesticide**' is not significant, which indicates that, for the farmers in the sample, the restriction does not decrease (or increase) utility. Given that the majority of the sampled farmers are greenhouse gardeners, the following of the preferential ordering as indicated by the SRC-cards is a necessity, to preserve the populations of natural enemies of pests in the greenhouses. To start and maintain these populations is not straightforward (and costly), hence greenhouse gardeners will consider all options to reduce adverse effects on these populations. The latter is not the case in open air gardening, where building up populations of natural enemies is not practically feasible. Within this group, this attribute would probably proof to be significant.

However interesting from ecologic point of view, for the farmers (and other chain players) the change of **choice of crop variety** is not advantageous. It is even the most restrictive adaptation of the instruction book incorporated in CE, as confirmed by the magnitude of the coefficient. In the literature, the negative correlation between crop resistance and crop yield (and quality) has been widely discussed.

In the CE the utility measure for a change in **treatments with highly noxious pesticides** has the correct sign, but the coefficient is not significant, indicating that the surveyed farmers in general do not disfavour a further reduction of the treatments with red (i.e. the most harmful) pesticides. Again, it is worthwhile stressing that the Green – Yellow – Red colour code is mainly of importance for outdoor producers, and this group is undersampled in the current experiment.

With respect to an increase in **price**, the associated utility is positive, as one could expect. A unity increase in price (in %), results into a utility increase of 0,423. This number is used to calculate the Willingness To Accept (WTA) for the remainder of the attribute levels (see Table 8.5).

Based upon the estimates for the choice experiment, the most adverse modification of the certification book from farmers' point of view seems to be the demand to use the crop variety which minimally depends on agrochemicals. Taking into account that this measure is the one that most affects crop yields, this outcome is logic. The other alternative measures are not welcomed either, with recalculation of dose per hectare and documentation for propagation material as most significant ones. The fact that some of the proposed changes result into non significant coefficients is mainly due to the sample constellation, which predominantly constitutes of greenhouse (substrate) gardeners. A more extensive sample will probably yield more significant coefficients.

8.6 Trade-off between ecological contribution and economic cost

As an example, the following graph, Figure 8.4, combines the ecological, social and economic effects of introducing the new rule on dose calculation. The ecological and social contribution is clearly positive and covers different sustainability fields. From farmers' (economic) point of view however, the new rule seems disfavourable, as indicated by a negative WTA. To remain indifferent, the farmer expects a 2% increase in the current farm product price.

This negative WTA originates from different economic motivations simultaneously. As farmers are in general change averse, a new rule means the alteration of familiar practices. Secondly, the new rule demands a learning effort from the farmers: how does it need to be applied in practice, what should be calculated, etc. Thirdly, there is a need for investment in the appropriate spraying equipment (whether this is new or adapted equipment). Fourthly, the rule demands extra labour in the field, not only for the calculation of the new doses, but also during application (maintaining the previously calculated speed and spraying pressure). Finally, the rule also increases the registration efforts associated with certification.

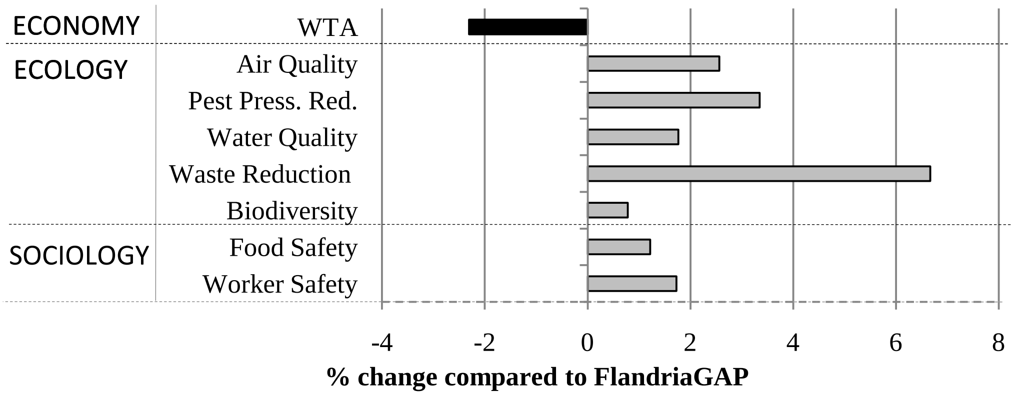


Figure 8.4. Impact of the new 'Calculation of dose/ha'- rule on ecology and economy

8.7 Conclusion

The method of choice preference analysis allows to assess the perceived opportunity costs of more integrative institutions ex ante. When the perceived utility increases or remains status quo, the integrative rule can be introduced without additional costs. This is the case when ecological and economic performance reinforce each other. When the perceived utility decreases, a trade-off has to be made between ecological and economic performance. The proposed method than gives an indication of the farm level desired compensation for the environmental change. Given this information, some new issues arise. First, a costly new rule is not necessarily the cheapest way to obtain the desired environmental effect. As becomes clear from the experiment, different rules contribute to the same pillars of ecological sustainability, at a different cost. First the pareto-efficient rules should be selected, i.e. rules that increase ecological performance and not decrease economic performance. A second issue is whether the environmental performance increase is worth the economic price and whether we as a society are willing to pay for this. If not, maybe there are cheaper ways to organize the environmental performance increase, such as end of pipe technologies or other abatement strategies that not reside within PIoS. Finally, if we agree that the environmental performance increase is worth the extra price, the question remains who will take the burden. We could apply the 'polluter pays'-principle and leave the cost to the farmer. Or we could subsidize the change and bear the cost as a citizen through increased taxes. Another option is to let the PIoS signal the change to green consumers and let those pay a price premium. The choice will depend on the costs of organizing the environmental policy under these different scenarios, and more specifically the transaction cost differences. When changes are made to the institutional structure of PIoS, associated transaction costs will also change. The next chapter focuses on the transaction cost changes that can be associated with a change in the purpose of the standard.

The choice experiment made clear that farmers generally advise against changes in the pesticide rules within the certification initiative, because they currently already feel under high pressure from government, society and buyers and thus do not see ample room for evolution. The resource base of farmers has been narrowed over the years, which is especially true for certified farmers, while the demands have become increasingly restrictive. Farmers fear that, due to the market power of buyers, a more demanding certification standard will, in the end, not be compensated by a corresponding farm level price increase. Thus, from a farmer's perspective, the main advantage of moving towards more integrative institutions is absent. However, by following the new rules, market access to preferred sales channels remains open. From a buyer and a society point of view, the new institution is a clear improvement, because external costs are internalized at fairly low costs, with possible reputational gains and without needing restrictive public interference.

Chapter 9. **Farmers' attitude towards institutional change in PIoS – the case of FlandriaGAP**

This chapter is based upon Mondelaers, K. and Van Huylenbroeck, G. (2008). Farmers' preferences in evolving certification and labelling systems. Oral presentation, 8th International Conference on Management in Agrifood Chains and Networks, Ede, the Netherlands, May 28-30, 2008. Nominated for best paper award

9.1 Introduction

In this chapter changes are modelled in the building blocks that define a PIoS: the purpose of the PIoS, the governance structure and the involved actors. By measuring the farmers' willingness to accept changes in these building blocks, the magnitude of perceived changes in transaction costs and opportunity costs can be estimated. While chapter 8 only focused on a change in the rules relating to the environmental performance of the PIoS, this chapter also analyzes changes in the governance structure and as such allows to estimate transaction costs additional to opportunity costs. This chapter also contributes to the measurement of institutional equity from the farmers' point of view, as it estimates their *desired* pay-off for changes in the institutions. It tests hypothesis 5: *Institutional changes in PIoS can simultaneously improve the equity among value chain members.*

Exogenous changes lead to endogenous changes in the institutional structure of PIoS, leading to changes in the opportunity and transaction costs for those who implement the PIoS. The certification standards, containing the prescription rules, are social constructs, and thus reflect an equilibrium of stakes at a certain moment in time. As stakeholder composition, stakes and power distribution can change over time the rules may also change. As described in chapter 7, we notice in general a demand for further harmonisation and convergence between different certification systems from the buyers (retailers) point of view, while farmer organisations will try to diversify their certification schemes in order to better position their products in the high quality market segment. Therefore, it is important to know in how far intended modifications to existing schemes imposed by the retail sector, are accepted by individual farmers and reflect their preferences. In this paper, a stated choice preference methodology is applied to analyse changes in individual farmers preferences when certification standards are modified. As is shown, the methodology applied may help to reduce the information asymmetry between stakeholders involved and help in order to optimise existing certification schemes. The methodology is applied for the Flandria label for fresh fruit and vegetables in Flanders.

9.2 Theoretical framework

PIoS give rise to an economic organisation structure which, from a transaction cost perspective, is termed a hybrid organization, as it is an intermediate between the spot market with loose contractual arrangements between many unrelated agents and a single, hierarchically organized firm where transactions are internalized. The resulting network of firms, composed of both farmers and downstream players, is defined by a set of recurrent contractual ties among for the rest autonomous entities. As in Hagedorn's IoS-framework, Williamson (2002) identifies the following key building blocks informing the logic of a contract and the comparative economic organization: the human actors, the unit of analysis, which is the transaction, the main purpose of the initiative and the governance structure. In our analysis, we consider PIoS as the contractual arrangements framing the hybrid organization's structure. Starting from the before mentioned building blocks we measure the farmers' attitude towards change in the system's boundaries. For reasons of clarity, we rephrase Williamson (2002)'s building blocks as questions:

- who is subject to the PIoS certification standards (actor level);
- what is the aim of the PIoS (transaction level);
- how is adherence monitored, controlled and rewarded (governance system level);

Human actors in the framework of Williamson (2002) are characterised by their key cognitive attributes, typically referred to as bounded rationality, their self interest attributes or opportunistic behaviour, and other attributes upon which their analyses rest. These human characteristics trigger the need for an appropriate governance structure for the certification system.

The second building block, the transaction, as unit of analysis, is closely linked to the main purpose of the contractual arrangement, Williamson's third building block. As indicated by Mainville et al. (2005), standards can take standardizing, differentiating and risk-reducing functions. The mixture of these three functions will determine the certification system's stakeholder composition and governance structure. Internally, the certification initiative aims at maximizing standardization of the participants' product and/or process features, because buyers need sufficient homogenous supply, both in time and in place. Meanwhile, externally, the initiative aims at maximizing differentiation from competing hybrids (i.e. certification systems) and/or the spot market, to maintain a competitive advantage. The system furthermore aims at minimizing risks typical for unregulated production. As indicated by Williamson (2005), the transaction's main drivers are asset specificity, possible disturbances to which the transactions are subject and the frequency with which transactions recur. Asset specificity increases when the distance from minimum legal requirements increases, which corresponds with the drive towards differentiation. The frequency with which transactions of certified products take place can be approached by the number of farmers engaged in the certification system, given that a farmer's production is either certified or not. An increasing number of transactions corresponds with the drive towards standardization. The third attribute, the possible disturbances to which transactions are subject, is also of interest in this chapter, given our aim of assessing farmers' attitude towards changes (disturbances) in the certification boundaries. As indicated by Menard (2004), partners to a hybrid agreement not only compete against other hybrids, they also compete against each other. We therefore hypothesize that the more farmers are engaged in the system, the more the system characteristics evolve in the direction of a pure market organisation. When this increase in members remains restricted to the farm level of the hybrid, it is further hypothesized that the incentive intensity will decrease. However, contrary to 'classic' transaction cost economics, it is hypothesized here that the binding contractual arrangements (the severity of the standard) will increase due to competition for the limited preferential sales channels and the resulting buyer power.

The last building block, the governance structure, is, according to Williamson (2002), described by the following attributes: incentive intensity, administrative controls and the contract law design. The first attribute, incentive intensity, is in the case of a hybrid typically intermediate between the high powered spot markets and low powered hierarchies, more formally termed as semi-high powered incentives. The type of incentive mechanism depends upon the type of certification system, ranging from access to preferential sales channels to fixed price premiums above the spot market price level. Administrative controls, also intermediate in the case of a hybrid, are supposed to increase when certification becomes more demanding. The contract law applied in the case of PIoS is typically the 'cahier de charge' or the instruction manual laid out for the farmers.

In this chapter, changes in PIoS are approached from a game theoretic perspective. Hereby we decompose the process of change in the certification institution into an iterative two stage game, with a first stage being exogenous to the individual decision maker, while the second stage is endogenous; as graphically indicated in the centre of Figure 9.1. The exogenous part consists of a rule making game at an institution forming level. At this level representatives of the different directly (and indirectly) involved stakeholder groups identify and negotiate areas of modifications in the PIoS. In the following section, the areas under negotiation are introduced and presented. Following Aoki (2006), to guarantee that the proposed changes are accepted by all stakeholders, the associated new pay-off structure should be satisfactory for the players at the second stage, the implementation level. At this institution dependent level, the producers accept or refuse the new standard and by doing so may demonstrate their preferences regarding the issues at stake. The negotiators at the institution forming level have in general only limited a priori knowledge on the true preferences and associated pay-off structures of the players at the institution dependent level. This chapter shows therefore also how the methodology of stated choice preference can be used to obtain this information ex ante, and thus as such contribute to the negotiation of a certification standard in bringing the pay-off structure more in line with expectations of the actors at the institution dependent level, creating institutional equity.

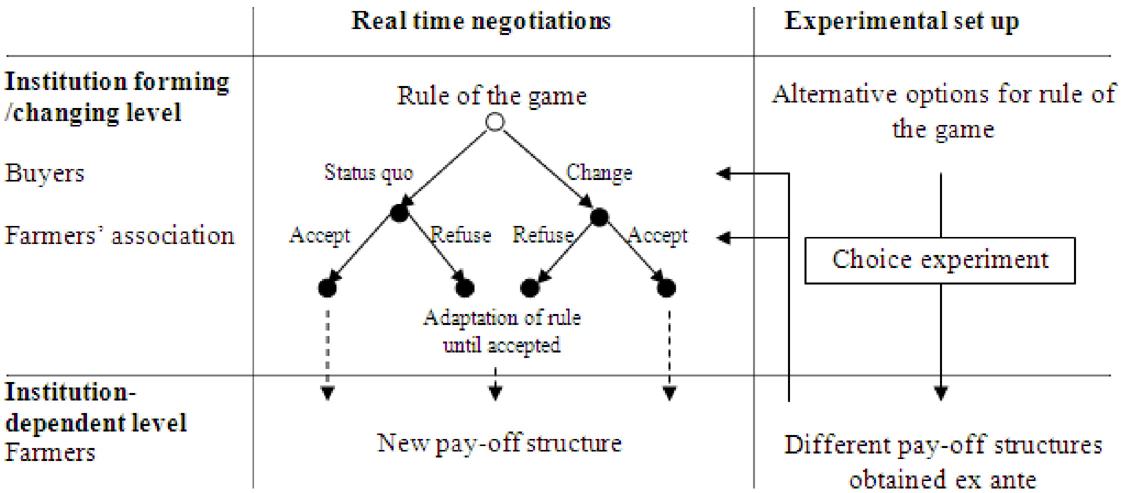


Figure 9.1. Process of change of certification rules as a two stage two level game

9.3 Changes at the rule making game level

Drivers for adaptation of standards are, amongst others, changes in the legislation, harmonisation with other initiatives, changing demands from buyers and the availability of new production techniques. Market actors do not fully agree upon the evolutionary potential of certification standards, resulting in opposite stakes in the chain. The retailers, who have largely succeeded in shifting the certification costs to the upstream players (Hatanaka et al., 2005), still see ample room for improvement. Farmers however question the economical feasibility of these modifications. Private voluntary certification initiatives can be classified based on following key features (Börkey et al., 1999): 1) their individual or collective nature; 2) their geographical delimitation going from local to global; 3) their binding/nonbinding nature; 4) the open or closed access to third parties and 5) whether they are target or implementation based. Main obstacles are, according to Börkey et al. (1999), free riding behaviour and the bargaining between agents to decide on the division of the cooperative gain.

During six focus group sessions with representatives of the different certification system stakeholders (farmers, auction and standard representatives, retailers, government officials, consumer organizations and pressure groups, see Mondelaers and Van Huylenbroeck, 2008), and some additional in-depth interviews, several possibilities for future strengthening the position of the FlandriaGAP label were identified as well as current bottlenecks within the certification system. The focus group sessions to a large extend reflect the negotiation process presently taking place at the institution forming level of the Flandria certification system. Following possible areas of change were identified:

1. The first modification relates to the human actors and questions whether the system should be geographically delineated and whether access to foreign poducers should be open or closed. The present initiative is geographically delimited to Flanders. However, given the success of the system, farmers from abroad (the Netherlands, France) are interested in joining the certificate. Both the certification management board and the buyers would welcome this, the former because of the possible increase in market power, the latter because of the increase in supply and choice.
2. A second possible change relates to the communication policy of the initiative. If communicated to the end consumer, the label name can act as a pull mechanism and as such increase the negotiation power vis-a-vis the buyers. However, opposed to this is the possible dependency on one channel due to the demand for exclusiveness from the buyers.
3. A next area of possible modifications relate to the governance and control structure in place to reduce free riding and to enhance trust in the initiative. From buyer point of view, the higher the number of controls, the better, because it makes the standard more trustworthy. As indicated by Hatanaka (2005), retailers have transferred part of their responsibility to third party certifiers and the costs of certification to the producers. Therefore, as another option, a degressive control system, in which the weak elements are controlled more than the others, might be more efficient from farmer and management board point of view, because fewer resources are needed.
4. The next rule 'type of certification, group or individual', relates to the division of tasks between management board and third party certifier. In case of group certification, the certification board controls the farmers (internal control) and the third party certifier controls the board (external control), while in case of individual certification, the third party certifier controls both management board and the farmers, which is more restrictive (and more costly) for the farmers and therefore favoured by the retailers.
5. Another bottleneck issue from farmer point of view is the administration. A more transparent monitoring and control policy, as requested by the buyers, entails an increase in administration required from the farmer.
6. Extending the coverage of the standard either requires adapting the current rules or adding new rules, both favoured by the buyers for diversification purposes. In the current system, some rules are more compulsory than others (some are recommended, other are 100% compulsory). Most changes in the standard therefore amount to transferring rules from the recommended to the compulsory level.

7. As identified by the participants, possible new rules for the current standard could relate to the addition of a more elaborated social component.

Thus, for each rule, different outcomes are possible, depending on the acceptance or refusal by the stakeholders at the institution forming level (see Figure 9.2 also). The proposed methodology enables us to determine ex ante in how far the intended modifications would result in a new pay-off structure for the farmers at the institution dependent level. As indicated before, this may serve as input for the negotiations at the institution forming level. In the discussion these above modifications are related to Williamson's building blocks discussed earlier in the text.

9.4 Applied methodology

As already indicated in chapter 3 and 8, the technique of choice modelling, that is part of the family of survey-based methodologies for modelling preference structures, is particularly suitable for this kind of analysis. We refer to these chapters for a description of the choice preference methodology.

9.5 Experimental set up for the farm level game

The questionnaire used to analyse the farmers' preference structure for intended modification in the FlandriaGAP certification standard, was first discussed with experts of the standard and pretested in December, 2005. After some minor adaptations, the final questionnaire was used in January, 2006 in a direct interview survey among 68 farmers located the province of Antwerp. The selection of these farmers was purely at random, based upon visual recognition of the farms (see chapter 8). This methodology was used because privacy policy forbids the auctions to make available the addresses of farmers producing under the standard. The region of Antwerp was selected because the auction of Mechlin, one of the main auctions for FlandriaGAP is located in this province, with the majority of market gardeners in their proximity. Because our principal aim was to test the methodology, the selection of farmers was for us of secondary importance and does not hinder the interpretation of the results, but may of course be important when generalising the findings. Therefore the results should be taken as indicative rather than inclusive.

The survey consisted of two parts. In the first part some questions were asked concerning personal and farm characteristics of the farmers affiliated to FlandriaGAP. In the second part, the vegetable growers were asked in the choice experiment to choose among several proposed alternatives that were constructed by different combinations of the proposed changes in the certification standard. The choice experiments are built around three scenarios or choice cards, a base scenario reflecting the current prescriptions level, and two scenarios with more (or less) severe prescriptions.

Table 9.1 summarizes the descriptives and frequencies of the sampled group of farmers. Based on a comparison with general data on vegetable growers, following remarks can be made. First, the number of farmers with a diploma of secondary education is higher than in the overall population. This suggests that there is probably a correlation between level of education and willingness to participate in a (quite difficult type of) survey. The result that all interviewees are full time farmers on the other hand is quite logic as hobby gardeners do not participate in demanding certification schemes such as FlandriaGAP. Third, the overrepresentation of greenhouse gardeners originates from the sampling procedure, based upon visual recognition of the farms.

Table 9.1. Descriptives/frequencies for sampled farmers

Item	Descriptives / Frequencies
Number of farmers	68
Average age	45 ± 7,5 (s.e.)
Diploma	94,3% completed secondary education
Extra diploma	22% (f.e. B or C course)
Primary occupation farming	100%
Member of Auction of Mechlin	97%
Manager since	1984 (average)
Firm size	16490 ± 15593 m²
Firm type (combinations possible)	
Open air cultivation	8,6%
Greenhouse traditional	40,0%
Greenhouse substrate	65,7%
Number of crops	
1	74,3%
2	14,3%
more	11,4%
Principal crop types	
Tomato (and varieties)	51,6%
Lettuce (and varieties)	31,4%
Net income available/year	
< €10000	6,2%
€10000 to €20000	37,5%
€20000 to €40000	43,8%
> €40000	12,5%

The modelling results as described below are based upon the full sample of 68 farmers. Each farmer was presented 4 choice sets (with 3 alternatives in each choice set), hence resulting in 272 observations or data points.

Table 9.2. Certification initiative attributes and attribute levels for the choice experiment

Attributes	Attribute levels
Free access	everybody accepted / only Flemish farmers accepted / only Flemish products accepted
Control	2 controls per year / 1 control per year / degressive control system
Certification	group certification / individual certification / free choice for farmers
Adherence to measures in certification book*	mm 100% / mm 80% / mm 90%
Administration	½ h per week / 1 h per week / 1and1/2 h per week
Social component	not integrated / limited / extensive
Communication	towards end consumer / towards retail / depending on preference retail
Relative change in price	-0,5% / 0%/+0,5%/+1%/+1,5%

*mm = minor must (reference level is mm 80% compulsory)

The attributes (with corresponding levels) are listed in Table 9.2. They reflect the changes proposed by the stakeholders in the rule making game. The full factorial (i.e. all possible combinations of attribute levels) results into $5 \times 3^7 = 10.935$ alternatives. To reduce this number, an orthogonal main effects plan was constructed, which contains a minimum of 27 alternatives for this design. The orthogonality of the design ensures that the attributes presented to individuals are varied independently from one another (zero correlation). This property guarantees that the influence of changes in any of the presented attributes on respondents' choices (or utility) can be measured independently (Louvière, 2000).

Next, the alternatives in the resulting orthogonal plan were randomly combined without replacement into a choice set of 3 profiles or choice cards (a base scenario, reflecting the current situation, and 2 hypothetical scenarios). An example of a choice set is given in Figure 9.2.

Attribute	Choice A	Choice B	Choice C
Type of certification	Group certification	Group certification	Free choice
Communication towards retail or consumer	Towards retail	Retail preference	Towards consumer
Mandatory level of minor musts	80%	90%	80%
Controls at farm level	Degressive system	2 controls/year	1 control/year
Time for administration	30 min/week	1h30 min/week	30 min/week
Origin	Only Flemish products	Only Flemish products	Everybody accepted
Extension with social part	limited	non	non
Relative change in end price	-0,5%	+1%	0%

Figure 9.2. Example of choice set

Participating farmers were asked to choose their preferred alternative in each profile set. For the general experiment, 27 profile sets were constructed. To reduce the cognitive burden for the participants due to a high number of choice tasks (27), the design was split into blocks of 4 choice sets per respondent. The farmer was asked to choose amongst A, B, and C, after having compared the different attribute levels.

9.6 Empirical results

9.6.1 Utility estimates

According to Mc Fadden, the deterministic part of the utility can be represented as follows:

$$V_{jn} = \sum_{k=1}^{K} \beta_k X_{jnk} = \beta' X_{jn}$$

With the help of statistical sofware (NLogit), estimates of the taste parameters (the β's in the formula), corresponding with the different attribute levels, were obtained using the Maximum Likelihood procedure. The results are represented in Table 9.4.

However, before starting with the interpretation of the model results, it is necessary to check the overall model significance, which is done with the LL ratio test (Hensher, 2005). Results are given in Table 9.3.

Table 9.3: LL ratio test for the basic model with linear continuous variables

LL estimated model	LL base model	LL ratio $-2(LL_{base} - LL_{estimated})$	X^2 statistic (14 – 3 = 11 df)	Sign.
-232,6215	-258,3015	51,36	19,7	yes
LL unrestricted* model	LL restricted** model	LL ratio -2(LLrest –LLunrest)	X^2 statistic (4 restrict. = 4 df)	Sign.
-225,9172	-232,6215	13,40	9,49	yes

* unrestricted model: the model which allows for non linear continuous variables
**restricted model: model which supposes strictly linear continuous variables

In our choice experiment, some of the explanatory variables are categorical, while others are continuous. The categorical variables are integrated in the model using effects coding. The latter is preferred above dummy coding because, in case of dummy coding, the base level is perfectly confounded with the grand mean (Hensher, 2005). Effects (and dummy) coding can also be used for continuous variables, in case the researcher suspects a non linear relationship between the attribute levels of the continuous explanatory variable and the choices made. A Wald test shows that the levels of the continuous variable 'Minor Musts compulsory' are indeed linearly related while the levels of the attributes 'Administration time' and 'Change in end price level' are non linearly related. The Likelihood of this new model is also better than the model with only continuous variables (see second part Table 9.3). One of the three options in each choice set reflected the base scenario, the current situation. An extra variable was therefore introduced in the model to measure the status quo effect in the experiment, i.e. to measure whether the gardeners systematically opted for the base case scenario or not. The coefficient of the variable 'Status quo choice' does significantly differ from zero, implying that this is the case. The selection of the third alternative was hence not solely based on the attribute levels of this alternative. The significant coefficient indicates that farmers were recognizing the base scenario and were therefore attempted to take this scenario (which indicates change adverse farmer behaviour).

Figure 9.3 presents the utility measures for the categorical variables as obtained by the MNL model in which non linear relations between the attribute levels were tested. Table 9.5 reports the numbers and p-levels. The figure gives an impression of the signs and the magnitudes of the utility estimates for the different (non continuous) attribute levels. These magnitudes should not be interpreted in an absolute sense (what means a disutility of 0,8 e.g.) but rather in a relative sense (f.e. farmers associate a higher disutility to a system with an extensive social component than to a system with 2 controls per year). To translate these utility measures into a less abstract variable, WTP/WTA measures or marginal utility effects can be calculated. The latter refers to changes in the probability that an alternative is being selected when changes are made in its attribute levels.

Some design orthogonality was lost due to the fact that the number of sampled farmers does not fully correspond with the number of choice sets in the orthogonal design. However, the method of auxiliary regressions as described by Gujarati (1995), that provides a formal way for testing for multicollinearity, shows that multicollinearity is not a problem in our experiment (see Table 9.4 below also).

Table 9.4. Test for multicollinearity: regression of the attribute on the remaining attributes

Dependent variable	R^2	R_i*	Multicollinearity
Type of certification	0,023	1,587	No
Type of communication	0,005	0,304	No
Compulsory level of rules	0,006	0,420	No
Number of controls	0,009	0,577	No
Administration time	0,006	0,381	No
Social part	0,010	0,651	No
Price	0,009	0,638	No

with H_0: the dependent variable is not collinear with the remaining attributes
* $R_i = R^2/(k-2)/(1-R^2)/(n-k+1)$ with k = 10 and n = 544; ** $F_{8, 535} = 1{,}94$

Table 9.5. MNL estimates for the choice experiment

Attribute	Attribute level	Coeff.[1]	Std.Err.	P-value
Type of certification	Group Certification	0.16670	0.18306	0.3625
	Individual Certification	-0.54927	0.20032	0.0061
	Free choice	0.38257	0.17313	0.0271
Communication	Preference retail	0.01781	0.18798	0.9245
	Towards retail	-0.30586	0.18832	0.1043
	Towards consumer	0.28805	0.17317	0.0962
Minor must compulsory (c)	80%/90%/100%	-0.05387	0.01689	0.0014
Number of controls	1	0.17716	0.17774	0.3189
	2	-0.59674	0.19951	0.0028
	degressive	0.41957	0.17428	0.0161
Administration (c)	0.5 h/week	0.46476	0.17081	0.0065
	1.0 h/week	0.47857	0.16691	0.0041
	1.5 h/week	-0.94333	0.21025	0.0000
Origin	Flemish gardener	0.35220	0.17301	0.0418
	Flemish product	-0.10155	0.17291	0.5570
	No constraint	-0.25066	0.18121	0.1666
Social part	Not integrated	0.75304	0.18219	0.0000
	limited	-0.01199	0.18003	0.9469
	extensive	-0.74104	0.21349	0.0005
Relative change price (c)	-0.5 %	-1.09694	0.34131	0.0013
	0.0 %	0.11610	0.23709	0.6243
	0.5 %	0.18384	0.23634	0.4367
	1.0 %	0.30145	0.23294	0.1956
	1.5 %	0.49555	0.27169	0.0682
Status quo choice		1.08636	0.54625	0.0467

1: utility estimates for the attribute levels

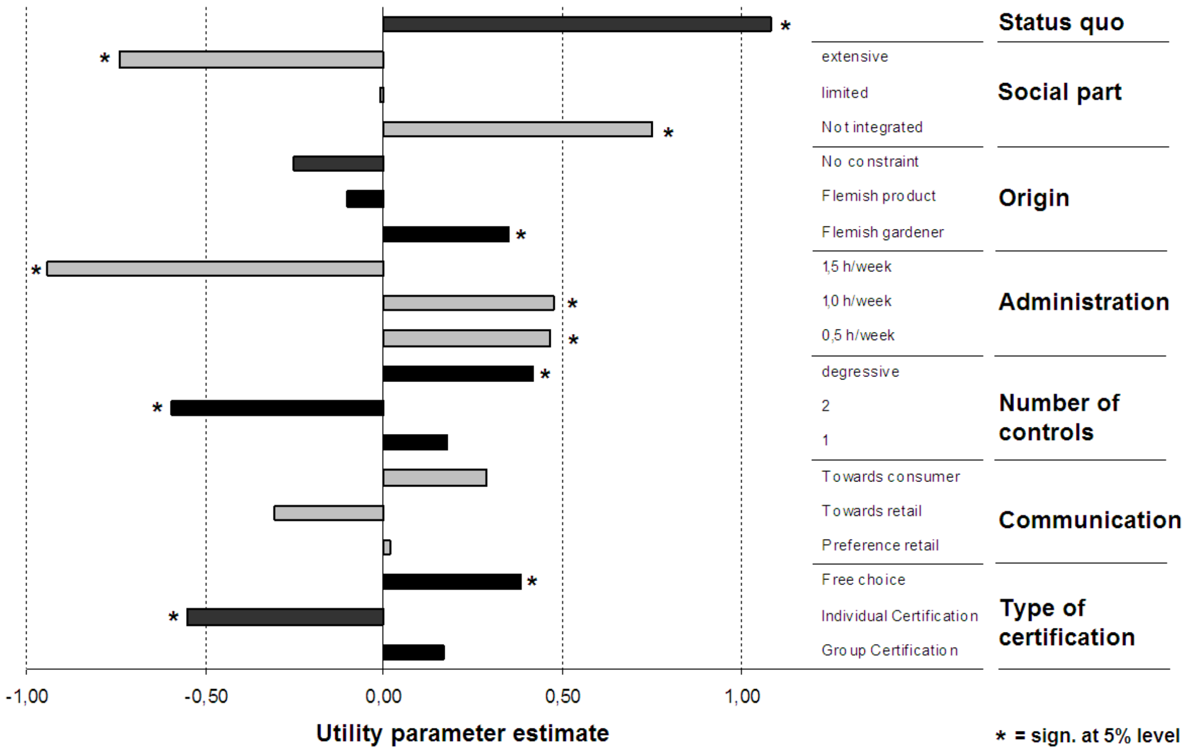


Figure 9.3. Utility estimates for the categorical variables of CE

9.6.2 Changes in the pay-off structure: willingness to pay and accept measures

With both the variable of interest and the monetary variable expressed as utility measures, the ratio between them provides a monetary value for a change in the level of the other variable. In calculating a measure of WTP, it is important that both attributes used in the calculation are found to be statistically significant (Hensher, 2005). In the CE reported, the price attribute is highly significant, as well as the other attributes except for 'Communication'. WTP's can thus be calculated for all other attributes, based upon the formula:

$$- \beta x / \alpha \qquad (5)$$

with βx the marginal effect of the xth attribute (in utils per unit of attribute x) and α the marginal utility of the premium (in utils/unit of premium). The price component has a nonlinear nature, hence a single price taste parameter α is absent. The non-linearity is situated around the zero percent change level, as confirmed by the Wald test statistic. The utility decrease for a decrease in prices resulted to be much higher than the utility increase for a same increase in price. This phenomenon has been described in the literature as the endowment or status quo effect (Tisdell, 2009). As suggested by the results in Figure 9.4, both the slope and the intercept of a price decrease differ from these of a price increase.

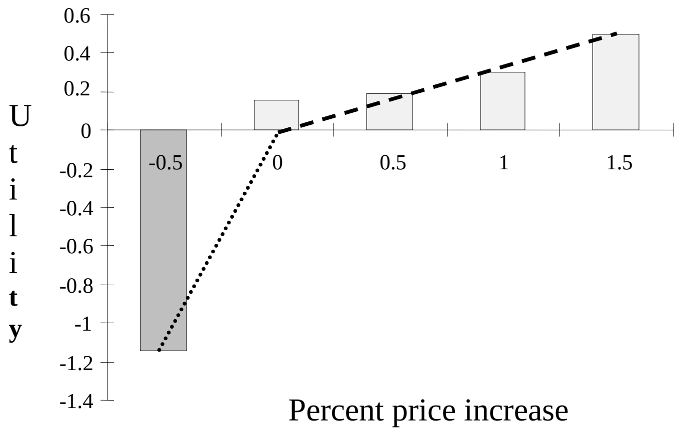


Figure 9.4. Nonlinear price - utility relation

To calculate a WTP for a positive utility, we should thus use the taste parameter (slope) of the line between 0 and -0,5 while for a WTA negative utility changes can better be approached by using the slope coefficient of the trend line between 0 and 1,5%. Thus:

If $\Delta p < 0$: $\alpha_1 = 2{,}28$
If $\Delta p > 0$: $\alpha_2 = 0{,}30$

These results are in line with what one could expect considering that farmers are in general 'negative price change adverse' decision makers. A change with a negative utility will only be accepted when a rather high price compensation is given (high WTA), while the WTP for a change with a positive utility is rather low.

For categorical variables, we opted for the calculation of a WTP based upon the change from one attribute level to another, as exemplified in Table 9.6 for the 'Social component'. The obtained result of 2.43% has to be interpreted as follows: for a change from a certification standard that does not contain a social component to a certification book with an extensive social component, the surveyed farmers on average expect a financial compensation of 2.43%, the latter meaning an upward change in price for the end product. Table 9.7 shows WTP and

WTA measures for the different components in the CE. It is worthwhile to mention that one should be cautious when extrapolating these findings beyond the upper and lower levels of the attributes in the experiment. The WTA for the attribute 'Minor must rules compulsory' for example should be interpreted between the boundaries of 80% and 100%.

Table 9.6. WTA calculation for categorical variable

Utils for 'Extensive social component' (U_E)	Utils for 'Limited social component' (U_N)	WTA = $-(U_E - U_N) / \alpha_2$
-0.74104	-0.01199	2.43%

With marginal utility of the premium: $\alpha_2 = 0.30$

Table 9.7. WTP and WTA measures (% change of end product price) for CE 1

Attribute (level)	WTP measure	WTA measure
Minor Musts compulsory		0.18% per 1% increase
2 controls versus 1 control		0.80%
Degressive controls versus 1 control	0.18%	
Administration (30 min/1h → 1h30min)		4.74%
Extensive social component (versus limited)		2.43%
No social component (versus limited)	0.33%	
Individual certification versus group cert.		1.83%
Only Flemish farmers allowed	0.15%	
Everybody allowed		0.84%

The calculated price changes vary between -0.5 % and + 5%, which is considerable, given that in vegetable production the farmer's margins are under high pressure. However, over the years, seasonal price variations can be more substantial. If we compare product prices for 2004 (a year with low prices) with those for 2003 and 2005 (see Table 9.8), variations easily exceed the 25% level (taken into account that supply was more or less constant (data from MV Info, 2006). Within the CE, farmers were asked to imagine an end product price occurring in an average year.

Table 9.8. Price variations for tomatoes and lettuce

Crop type	2003 Price	2004 Price	Price change*	2005 Price	Price change*
Tomatoes	0.92	0.60	-35%	0.76	+26%
Cabbage lettuce	0.38	0.28	-26%	0.38	+35%

* compared to previous year

A farmer expects for a 1% increase in the minor must level (i.e. instead of scoring 80 to 100 on the rules identified as minor musts, a farmer should at least obtain a score of 81, to be certified), an increase in the product price (at auction level) of 0.18%. EurepGAP, contrary to FlandriaGAP, has fixed the Minor Must level at 95%, an increase in the minor must compulsory level of 15%, which corresponds to a WTA of 2,7%. This may explain why not all farmers have so far adapted the more severe EurepGAP benchmarked FlandriaGAP standard.

Farmers clearly favour the degressive control system, they are on average willing to forgo 0,18% of their products' market price to change to this system. This system has several advantages. First, the control costs decrease (because each control has to be paid separately) and second, the risk of loosing the certificate decreases. Third, time loss (both for preparation and during the controls) reduces. Fourth, given that the certification books evolve continuously, this system can give the farmers some extra time to do the necessary investments and adaptations.

9.7 Discussion

In the following sections we discuss the farmers' attitude towards the proposed modifications in the standard. As explained in the theoretical framework, we distinguish between changes to the governance structure, the bargaining position of participants and the objective of the certification.

9.7.1 Changes in the governance structure

To cope with farmer related disturbances, due to opportunistic behaviour and bounded rationality, an appropriate governance and control system is put in place. In the choice experiment, the items 'type of process certification', 'number of controls', 'administration time' and 'incentive intensity' were introduced to capture these effects.

The **type of process certification** principally defines the authority who is performing the necessary controls. Together with the choice experiment attributes 'number of controls' and 'administration time', it defines the monitoring and control part of the certification's governance structure, which is aimed at countering the farmers' opportunistic behaviour and bounded rationality. Three types of certification were presented to the vegetable growers: individual certification, group certification and free choice between these two types for the farmer. In case of group certification, the farmers' cooperative (in casu the auction) is controlled and certified by an independent control body. This cooperative, on its turn, is responsible for the controls at farm level. The independent (third party) control body only examines a sample of the farmers. This is in contrast with individual certification were an independent control body directly controls the production process at individual farm level and issues an individual certificate. At present, farmers have a free choice, hence the two suggested levels imply a restriction for the farmer.

The game at the institution forming level concerns the trade off between the reliability of the standard and the costs associated with it. The buyers (retailers) opt for 'certification of the individual farms', because this makes the standard more trustworthy. From farmers' point of view, 'group certification' is preferable compared to individual certification because the farmers have more trust in the auction, which is still a farmers cooperative, than in a fully independent body, enabling more farmers to attain the certificate. Most of the farmers also prefer a less restrictive control system, given that controls are burdensome and might result in a (temporary) loss of the certificate. A part of the farmers favours the individual control system because they want to avoid the undermining of the standard by weak fellow farmers, or they participate in different certification schemes and thus automatically need an individual certificate. From auction's point of view more farmers attaining the certification standards means the creation of a larger supply (and thus more supplier power).

For the game at the institution-dependent level, the farm level, the experiment shows that the coefficients for 'Free choice' and 'Individual certification' significantly differ from zero, which implies that farmers clearly perceive a utility difference between free choice, group and individual certification. Stakeholders at the institution forming level should be aware that for accepting 'individual certification', farmers at the institution dependent level expect an extra compensation (1,83% per unit product) compared to the situation of group certification as it is judged to be more restrictive.

The **number of controls** is also of importance, for several reasons: the more controls, the less chance for evaders to survive in the system; the costs for control (i.e. monitoring costs) are borne by the farmer (or the auction, depending on the system) and controls are time- and effort-consuming. In the experimental set up, three attribute levels were presented to the farmers: 1 control/year, 2 controls/year and a degressive control system. In the present situation, farmers are on average controlled once a year. The degressive control system rewards farmers with positive control scores by reducing the number of controls in the subsequent years. This system is under consideration in several other European certification initiatives, among which Q&S (Qualität und Sicherheit) and Biogarantie. The sampled farmers clearly preferred the latter, due to reasons mentioned before. The surveyed participants perceive a significant negative utility when the number of controls is increased. Peeters et al. (2005), after surveying 193 Flemish market gardeners, found that 90% of the farmers understand the necessity of controls in relation to certification. The same survey indicated that two third of them dislike the controls. In our experiment, a significant positive utility is attached to the degressive control system, which indicates that farmers would welcome a change in this direction. The degressive control system is favourable from farmers' point of view because the farmer can save both time and costs in the future. The farmers will thus try harder to reach the 100% compliance level, resulting in a positive effect in the short run. Furthermore, by concentrating their efforts on the weakest elements in the system, the effectiveness of the third party controls will further increase, resulting in a better quality image for the scheme and reduced monitoring costs. Based on our results, farmers' representatives at the rule making game level may therefore defend this position because it reflects the preference of farmers and their expected compensation when this preferred situation is not attained.

Administration is one of the major transaction costs associated with certification. Given the information asymmetry, there is a tendency to increase the administrative part of the controls. There is a positive correlation between administration time and the three drivers of the certified product's transaction (asset specificity, possibility of disturbances and frequency of transactions). The administrative burden caused by certification books is a major source of complaints by farmers, because it has never been part of their core business and competence. The CE results confirm the negative utility farmers experience when administration time increases. The auctions have taken several actions to ease this administrative burden, f.e. by making crop registration available in an easy computer format and by subsidizing the purchase of computers. Farmers acknowledge that the administrative process becomes less cumbersome once they are used to the system. When the administration time due to the private certification system increases from less than one hour to one and a half hour per week, farmers expect a significant price increase of nearly 5%, which is a clear sign of farmers' extreme dislike of changes in this direction.

9.7.2 Changes in the stakeholder's bargaining position

Type of communication is introduced in the CE to measure farmers' fear for dependency relations with downstream players. Farmers were confronted with 3 attribute levels capturing this aspect of certification standards: communication towards end consumer (through label), communication towards retail and communication depending on the retailer's preference (label or not). Two opposite forces are at work here, which is also confirmed in the non-significant estimates of the experiment. On the one hand, a label might act as a pull mechanism (i.e. consumers specifically request the labelled product, which result in better prices or increased market shares). On the other hand, retailers prefer private labels instead of national brands, to increase consumer' store loyalty. When a supplier uses his own label, the retailer often requests the supplier's loyalty. In that case, offering an unlabelled quality product, which can still be privately labelled by the retailer, might be a better strategy to gain market share and buyer independency. The coefficients in the experiments do not significantly differ from zero, indicating that the average farmer is indifferent. Although farmers indicated during the focus groups that they feel a sense of pride when they recognize their products in the stores, they are, with the introduction of FlandriaGAP and EurepGAP, already used to BtoB communication.

Closely linked to the previous item is the question whether '**Free access**' of farmers is allowed. This item is integrated in the choice set because it is assumed that farmers do see a market advantage in restricting the number of farmers able to participate in Flandria, for three main reasons. Firstly, the name Flandria explicitly refers to the region of Flanders, hence it is perfectly suited for communication purposes. Secondly, if Flandria becomes a quality vegetable standard accessible to farmers in other countries as well, Flemish farmers could loose part of their preferential position in the European market, increasing internal competition amongst farmers. Thirdly, the Flandria certification standards are currently well adapted to local cropping circumstances. As is the case for GlobalGAP, a more generic certification book risks becoming too generalistic with rules to comply having less sense given the local situation. During the contacts with farmers, it became clear that a major part of them indeed struggles with the fact that foreign farmers can enter the Flandria scheme. On the contrary, a reasonable part of the farmers do not see a major problem in other fellow European farmers participating in the initiative, as long as they abide by the rules of the Flandria certification book. The different attribute levels presented to the vegetable growers are 'everybody allowed'; 'only Flemish farmers allowed' and 'only Flemish products allowed', the latter because some Flemish farmers also possess production units abroad (f.e. in Spain or the United States). The coefficients in the CE have the expected signs, and the attribute levels 'Only Flemish gardener allowed' and 'Everybody allowed' significantly differ from zero, at the 10% level, which indicate that the average farmer is not indifferent whether foreign farmers also enter the scheme or not. It should be remarked that it is contradictory that the attribute level 'Flemish gardener allowed' has a higher utility than the attribute level 'Flemish products allowed'. This may be due to the fact that the surveyed farmers did not really understand the meaning of the latter attribute level.

9.7.3 Changes in the purpose of the certification standard

Nowadays, measures indicated as '**minor musts**' in the FlandriaGAP standard are 80% compulsory, i.e. at least 8 out of 10 of these measures should be fulfilled. The 'major must' measures are 100% compulsory. The 'shoulds' in the certification book are considered as recommendations for the farmer, i.e. not mandatory, and these are not actively controlled by the inspectors. This attribute is integrated in the choice experiment to capture (a part of) the evolutionary potential of certification books, together with the social component (see further). An increase in rules means an increase in asset specificity, which might, in theory, result into more dependency. From researchers' point of view, it is argued that the measures indicated as 'minor musts' will be the first to evolve, to a 'major must' level, hence uplifting the compulsory level of the minor musts is considered as a good proxy for evolution of the current standard. As indicated by Vandenbergh (2004), on average, approximately 90% of the minor musts are fulfilled by the market gardeners following FlandriaGAP. The certification standard encompasses 55 minor must rules, compared to 68 major musts and 25 shoulds. The following levels of compliance were incorporated in the CE: 80% mandatory (base scenario), 90% and 100% mandatory. The 90% level has a (small) negative measure, indicating that farmers do not perceive too many difficulties in attaining this level, as confirmed by

Vandenbergh (2004). The 100% level on the contrary is perceived as highly disadvantageous, mainly due to the loss of degrees of freedom for farmers. During the focus group sessions, farmers indicated that approximately 5 to 10% of the measures in the instruction book are perceived as too restrictive, and not adapted to practical considerations. The measures obtained in the CE confirm this perception.

The attribute **social component** may not seem directly linked with certification books (in the Flemish context it should perhaps better remain within the legal prescriptions), but major retailers (mainly from Great Brittan) are now asking for specific social (labour) measures to be included in the prescriptions. The auction representatives question whether these issues should be dealt with in a certification standard. They argue that social regulations and welfare issues reside within the Federal Public Service Employment, Labour and Social Dialogue, not within a GAP. They further argue that the market gardener as employer has the end responsibility. GlobalGAP has chosen to integrate some of these rules, those which are still controllable by the same person responsible for controlling pesticide and fertilizer use, although these are two totally different disciplines. GlobalGAP, as a generic standard at international level, has opted for this choice due to the problems of child labour and fair trade. Three levels were integrated in our CE: absence of a social component, a limited social component and an extensively elaborated social component. The latter refers to a situation in which the farmer has to document all additional information concerning wages and other labour conditions, hours of work, number of contemporary employees etc. Wages should be in line with the legal prescriptions. For a limited social component, the farmer has to document how he creates a socially desirable working atmosphere (f.e. by providing a lunch area, by allowing labourers to question their situation etc.). In the CE, a significant positive utility is attached to the case in which no social component is added. The extensive social component however receives a highly negative utility, indicating that farmers prefer to avoid this situation.

9.8 Conclusion

As introduced in the theoretical framework, the transitional process in certification rules will only be supported if the new rules are generally recognised as necessary and resulting in satisfactory pay-offs (Aoki, 2006). Due to the (semi-) voluntary nature of private certification, modifications to the institutional rules need to be endogenously supported, both by buyers and suppliers. Each of these stakeholder groups is represented in the bargaining process for new standards, in this paper identified as the rule making game at the institution forming level. The result of this game is a new certification institution, which can or cannot be accepted by the individual producers and buyers. Given the bargaining power of the latter (in our case the quality retailers) their demands are normally well integrated in the new standard. Grades and standards, as outlined by Mainville et al. (2005), can take differentiating, standardizing and risk reducing functions. In each of these three fields, retailers still see ample room for improvement (Mondelaers and Van Huylenbroeck, 2007). For the individual producers the choice is restricted to participation or opting out. The choice preference experiment helps us to reveal ex ante how producers react on changes at the rule making level. The derived farmers' preferences and WTP/WTA measures can help negotiators to better assess the implications of modifications in the rules on the pay-off structure of those who have to implement the rules. Due to the fact that a decision maker in a choice experiment has to make a trade off between different attributes simultaneously, his choice can be considered as unbiased, reflecting his true preferences. As such, obtained estimates can be considered as indicative of the perceived costs at farm level for the implementation of the new rules. This specific feature is especially interesting for those rules of which associated costs are difficult to foresee in advance. The latter is typically the case for certification standards, given that they influence many aspects of the production process simultaneously.

The reaction of the farmers in our experiment can be summarized in one term: change averseness. North (1990) defines this as path dependency, where organizations shaped by an institutional matrix typically have a stake in perpetuating the existing framework, because the economies of scope, complementarities and network externalities from that given institution bias costs and benefits towards choices consistent with it. The current certification institution reflects an equilibrium between the interests of buyers and sellers. The producers' primal fear is the gradual weakening of their power, shifting the equilibrium in favour of the retailers. The farmers' change averseness can also be explained when considering the new pay-off structure, which should be satisfactory to make change sustainable. However, for those entering the new scheme this pay off structure remains unchanged, apart from a temporary price increase to motivate conversion. However, the pay-off structure does change for those who decide not to implement the new changes, because they are then excluded from the preferential sales channel. We therefore think that the developed methodology may be useful tool for facilitating this kind of applications and issues. A more wide application could also reveal the relation between pay-off structure and farm or farmers' characteristics.

Chapter 10. **Sustainable efficiency of PIoS when new sustainability targets are introduced**

This chapter is based upon the paper: Mondelaers, K., Kuosmanen, T., Van Passel, S., Buysse, J., Lauwers, L. and Van Huylenbroeck, G. Meeting industry sustainability targets by improving firm efficiency. Submitted to Journal for Environmental Management.

10.1 Introduction

There is a high potential for simultaneously increasing sustainability of the earth system and economic development by removing inefficiencies currently present both at the production input and output side. In this chapter a static view on sustainability is employed, by introducing capacity constraints as the boundaries above (or below) which the system cannot maintain its stable state. Currently these capacity constraints are often not respected. In this chapter it is shown how the efficiency improvement pathway of an industry and the firms within it can be calculated to come to a sustainable, profit maximizing state, given the existence of these capacity constraints. The main body of the chapter concentrates on the development of the calculation method. To measure whether PIoS contribute more to sustainable development when new sustainability targets are introduced, an application is worked out in which organic farming, as PIoS, is compared to conventional farming. This chapter will provide an answer to hypothesis 6: *Farms participating in PIoS are more sustainable efficient than farms who do not when new sustainability targets are introduced*

The term 'sustainable development' has since its first introduction to the general public after Rio[29], 1992, gained considerable attention. Many contributions have been made for the assessment of sustainable development, some from fragmentary, others from more holistic nature. The term sustainable development seems in itself contradictory: 'to sustain' versus 'to develop'. This contradiction in fact says that development is subject to the constraint of guaranteeing the sustainability of some elements upon which the development is realized.

Under the constraint of maintaining sustainability, mankind aims at increasing welfare, which is done through processes of growth and development. Simple growth, based upon an increase in resource use, puts a high stress on the surrounding environment. Development, as it focuses on improvements in the way the resources are used, is therefore a more promising path to welfare increase. In this chapter we focus on the potential of welfare increase through efficiency improvement, while guaranteeing ecosystem sustainability. We first develop a method to measure this and then apply it to the case of PIoS.

According to system theory, we can define a hierarchical system in which we find a supersystem and multiple subsystems, the latter being embedded in the former. The supersystem could be the earth system, while the subsystem could be a firm. Our final goal is to guarantee (or move to) a sustainable and welfare maximizing supersystem, with 'sustainable' defined as the ability of a system to continue over a certain time span (Hansen and Jones, 1996). What causes continuity (or failure) of the supersystem, can be related to the capacity constraints of the system, the thresholds above or below which the system cannot

United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 3-14 June 1992 recover. A practical example is global warming, or at a more local level, the pollution of aquifers. The current level of resource consumption is not always sustainable (see IPCC, 2007 f.e.), although this is now assumed in most economic models. To overcome this bottleneck, we could depart from the carrying capacity constraints of the supersystem.

We should be aware that the restrictions that determine subsystem sustainability are not (always) the same as those that determine supersystem sustainability. They can in fact be opposite. Voinov and Farley (2007), who approach the concept of sustainability from a system's perspective, argue that our current obsession with sustaining a growth-driven economic system probably comes at the expense of the ecologic supersystem. Advances in resource efficiency can be overcompensated because higher efficiency may lead to increased use of (environmental) resources. This is called the rebound effect (Mayumi et al., 1998, Herring and Roy, 2002). Voinov and Farley (2007) give the example of cancerous cells that can be successful as a subsystem and simultaneously have a pernicious effect on the human body as a supersystem. Because continuity of the supersystem and subsystem are not considered over the same time span, this conflicting situation can occur as the subsystem does not experience an incentive to restrict its resource use (its longevity is much shorter than this of the supersystem).
In addition to this, apart from the ultimate aim of guaranteeing survival of the supersystem (the earth), we can have the additional goal of maintaining lower level systems. Take the example of a river basin. When 1 river basin becomes algae infested, the continuity of the earth system is not threatened. We can however simultaneously define the goal of maintaining both this river basin subsystem and the supersystem, as long as we consider the former subordinate to the latter.

In this chapter we focus on the efficiency score of firms in an industry when this industry is characterized by overconsumption of scarce resources and/or overproduction of bad outputs. There is a potential for meeting industry sustainability targets by removing (part of) the firm level inefficiency. Moreover, there might even be a possibility to create more firm level output and profit, given the reaching of these industry constraints, when the remainder of inefficiency is removed. The objective of this chapter is to obtain a single firm index of 'sustainable profit efficiency', a term which simultaneously captures the meeting of (higher level) sustainability targets and the creation of more firm level value (output or profit). This chapter contributes to the literature on efficiency measurement by linking efficiency to absolute sustainability targets at industry level, a topic which is not yet deeply investigated. Several authors have associated inefficiency with firm level sustainability targets (such as Reinhard et al., 1999, Fare et al., 2004a, Coelli et al., 2007). Others have focused on the determination of the industry's efficiency score based upon the firms' inefficiencies (Blackorby and Russell,1999, Li and Ng, 1995 , Fare and Zelenyuk, 2003), while yet another stream of efficiency literature focuses on nonradial efficiency scores, the so called directional distance functions, with main contributions from Chambers et al., 1998, Chung et al., 1997, based upon the work of Luenberger, 1992 and recent advancements by Briec et al. (2003) and Kuosmanen et al. (2009). We will use elements from these three streams of literature in efficiency analysis to link inefficiency with sustainability targets. The focus on industry sustainability targets is of concern, as policy makers and practitioners are seeking the optimal way to distribute the burden of production over participants.

The chapter unfolds as follows. In a first part the sustainability targets are mathematically defined. The second part focuses on the potential interplay between efficiency and sustainability and identifies different states of the industry. In the subsequent parts 4 and 5 we focus on two of these states, an inefficient and unsustainable industry and an efficient but unsustainable industry and propose a way to calculate the sustainable profit efficiency of the firms in these industries. We then proceed to some extensions, such as multiple sustainability targets or uncertainty about the right sustainability target. The method is then applied to the case of dairy farms participating in organic and conventional farming. We end with some conclusions.

10.2 Defining capacity constraints

In ecology carrying capacity is defined as the maximal population size of a given species that an area can support without reducing its ability to support the same species in the future (Daily and Ehrlich, 1992). Seidl and Tisell (1999) mention that a judgement of an environmental situation or the decision of limits (e.g. the carrying capacity) is influenced by value-judgements and institutional settings. They also extend the biophysical concept with a social counterpart. Social carrying capacity, shaped by human consumption patterns, technologies, infrastructure and so on, refers to the maximal population size that could be sustained under various social systems, while biophysical carrying capacity reflects the maximal population size that can be sustained biophysically under given technological capabilities. The latter can only be higher or equal to the former. In this text we define a carrying capacity constraint as the total amount of a resource that can be consumed without endangering the sustainability of the surrounding biophysical ecosystem. Table 10.1 developed by Daily and Ehrlich (1992) provides a classification of resources based upon key sustainability issues. They distinguish between resources that are not necessarily degraded or dispersed in use while providing free services to humanity, such as microbial nutrient cyclers, natural pest control agents and pollinators (mutual benefit), opposite to resources such as food, drinking water and energy that are necessarily consumed, dispersed or degraded to derive benefits from them. The second distinction they make relates to renewable versus non renewable resources, with the latter being mainly flow limited while the former are generally stock limited. Last distinction they make is between availability of substitutes or not. Resources, such as fresh water, biodiversity and fertile soils, which have no substitute, are termed essential.

Table 10.1. Resource classification scheme with some examples (Daily and Ehrlich, 1992)

Resource type		**Not necessarily degraded or dispersed in use**	**Necessarily degraded or dispersed in use**
Nonrenewable (at current use rates)	Essential	Stratospheric ozone, tropical forests, biodiversity	Time or opportunity
	Substitutable	Materials that supply some services (e.g. diamonds and gold)	Nonrenewable energy sources (e.g. fossil fuels) some other minerals
Renewable	Essential	Ecosystem elements that supply services (e.g. soil microbes, pollinators)	Solar energy, fresh water, some soil used for agriculture
	Substitutable	Species that supply some services (e.g. animals for power, transport, insulin and vaccines)	Wood for construction, a particular food type

To go from Table 10.1 to a capacity constraint, an additional concept is needed. Daily and Ehrlich (1992) therefore defined a ‘maximum sustainable use’ (MSU) of a resource depending on its classification in Table 10.1. For degradable, substitutable resources Daily and Ehrlich (1992) define a quasi-sustainable consumption rate equivalent to the rate of generation of the substitutes. For a renewable essential resource that is necessarily consumed,

degraded or dispersed in the extraction of value from it, the MSU is equivalent to its renewal rate.
The authors also distinguish between scarce inputs and undesired outputs. For the latter they define the maximum sustainable level of abuse (MSA), or the maximal sustainable emission rate of a pollutant into the environment. This is the level of emission that produces the highest concentration of pollutant that can be tolerated by the most sensitive system element.

In this paper we do not focus on the way the MSU and MSA are calculated, as this is resource and situation dependent. We assume that both the actual resource use and the MSU (or MSA) are known. In our reasoning, the MSU is synonymous to the constrained resource use.

10.2.1 The systemic level: firm or higher level

Capacity constraints (or MSU's) can be defined at different systemic levels. We can distinguish between two cases: the first one relates the capacity constraint to the entities at the firm level and the second one relates the capacity constraint to a higher level[30]. In the first case no reallocation mechanism is necessary: if the threshold is surpassed the firm is termed unsustainable. This situation of a fixed firm level capacity constraint is similar to the one depicted in figure 10.2. A practical example might be nitrate leaching. It is not because it is potentially endangers the sustainability at firm level that the sustainability of a higher system level is under threat. In the second case, substitution of the impact between firms is allowed without necessarily affecting the aggregate capacity constraint. The greenhouse gas emissions for example threaten sustainability of a higher system, the earth's ecosystem. When the capacity constraint is situated at a higher level, there is a need for a redistribution mechanism over the different sub level entities. The question is, if the total amount of allowed greenhouse gases is constrained at f.e. country level, what is then the allowable share of the different firms? To attain the capacity constraint at a higher level, we have to reduce overall resource use[31]. In a 'classic' input oriented efficiency analysis we obtain an inefficiency measure for each firm in the sample. This inefficiency measure indicates that an equal output can be achieved with a lower input. If our objective now is to reduce overall input use (our bad output creation), this inefficiency measure can serve as the reallocation mechanism. The capacity constraint reflects the maximum amount of allowable total resource consumption. The desired reduction in overall resource consumption is the difference between the capacity constraint and the actual resource consumption. The best way to reduce the actual resource use is by removing the inefficiency until the industry reaches the capacity constraint.

10.2.2 Mathematical representation of the capacity constraint

The current resource consumption at a supra farm (f.e. regional) systemic level can be computed easily by aggregating over the different farms that are part of this systemic level. By means of environmental scientific studies we can obtain an estimate of the desirable resource consumption from a sustainability perspective. Imagine that this desired use (the MSU) is a percentage α of the current use. The supra farm level constraint can then be defined as:

$$\alpha \cdot \sum_k^K x_{1,k} \geq \sum_k^K x_{1,k}^c \qquad (1)$$

with $x_{1,i}$ the actual use of input x_1 by firm i, $(1-\alpha)$ the desired (macro level) reduction in input use, K the total number of firms subject to this constraint. x^c indicates the constrained input

[30] The case of a capacity constraint relating to a lower level falls back to the first case when you aggregate over the subentities of this lower level
[31] our bad output generation, depending on the type of constraint

use of firm k of input x_1. If not sufficient, input can be contracted further by reducing the output.

The case of a single resource constraint can be easily extended to multiple constraints. We will first develop the reasoning for a single higher level resource constraint and afterwards extend this to the cases of multiple higher level constraints and farm level constraints. We will also consider the case of uncertainty of the correct MSU.

For illustrative purposes, consider a second higher level constraint for resource x_2, described as:

$$\beta \cdot \sum_k^K x_{2,k} \geq \sum_k^K x_{2,k}^c \quad (2)$$

Both constraints together define a feasible set with maximum group boundaries of $\alpha \cdot \sum_k^K x_{1,k}$ and $\beta \cdot \sum_k^K x_{2,k}$. For a firm level capacity constraint $K=1$, and α is defined at the micro level.

When the number of firms subject to each of the constraints differ, f.e. K1 firms for constraint 1 and K2 firms for constraint 2, with K2 > K1, this equation becomes:

$$\beta \cdot \sum_k^{K2} x_{2,k} \geq \sum_k^{K2} x_{2,i}^c = \sum_k^{K1} x_{2,i}^c + \sum_{k=K1}^{K2} x_{2,i}^c \quad (3)$$

10.3 The interplay between efficiency and sustainability

Following Figure 10.1, representing an industry's production function with resource (set) X and output Y, can be used to explain how sustainability and efficiency relate. To the left of the capacity constraint, resource consumption is sustainable. The difference between inefficient resource use and unsustainable resource use is also depicted in Figure 10.2. Unsustainable resource use refers to the situation in which constant (natural) capital stocks are no longer maintained, or, put differently, that strong sustainability thresholds are surpassed. There is however no link with the output achieved. Inefficient resource use on its turn reflects a suboptimal relation between amount of resource used and output reached. We can distinguish between 5 cases, as shown in Figure 10.2.

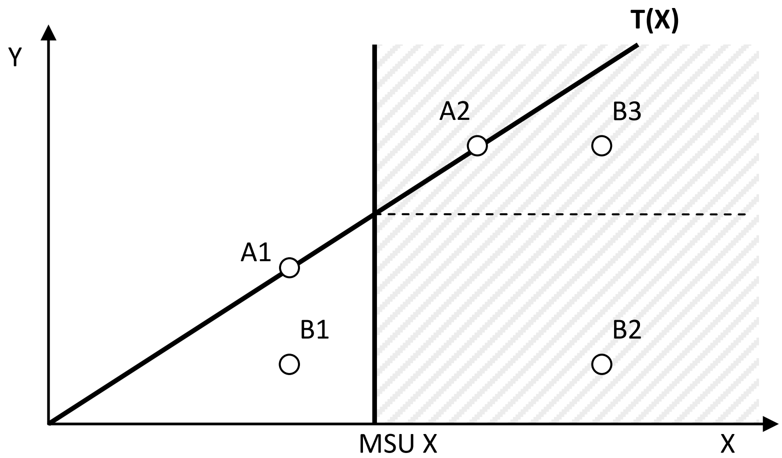


Figure 10.1. Sustainable versus efficient resource use of an industry. T(X) reflects the production frontier and MSU X the maximum sustainable use of X. Following categories can be distinguished: A1: efficient and sustainable resource use; A2: efficient but unsustainable; B1: inefficient but sustainable; B2: inefficient and unsustainable, but removing inefficiency suffices to achieve sustainability; B3: inefficient and unsustainable, and efficiency improvement does not suffice to achieve sustainability

Depending on whether the production frontier is situated within the capacity constraint or not, the current technology is suited for sustainable production. The value of the classification is that relative efficiency and absolute sustainability are not competing but complementary criteria. Knowing the status of the system according to this classification is important for making appropriate policy decisions. Cases A1 and B1 are ok as far as sustainability is concerned. In case B2 it is possible to maintain the current level of output by improving efficiency of resource use. Cases A2 and B3 require downscaling of output level; in B3 this can be complemented with efficiency improvement.

Figure 10.1 reflects the industry composed of different economic entities. The possible positions of these entities in the figure can also be grouped in these 5 categories. It is thus very well possible that an industry is in sustainable equilibrium, with some firms breaching their proportional share of the MSU, as this is compensated by other firms who remain below their proportional MSU.

In the spirit of sustainable development, we aim to maximize an industry's value creation, while simultaneously meeting the capacity constraints. To this end following possibilities are available: we can reduce the technical inefficiency in the industry, we can change the industry's and hence the firms' input mix, to reach the capacity constraints at the lowest (shadow) cost possible, and we can change the output generated. By decomposing the aggregate 'sustainable inefficiency' into different parts, we can yield more information on which components of inefficiency are present both at industry and at firm level. The decomposition at industry level is important for policy making, while the decomposition at firm (versus industry) level reveals information with respect to the competitive positioning of firms in this industry.

10.4 Unsustainable and inefficient resource use

In figure 10.2, option A1 and B1 do not pose sustainability concerns. In both cases output can still be increased up to the point that the capacity constraint is met. In the case of A1 industry output can be expanded by consuming extra resources under an efficient technology regime. In the case of B1, this can be complemented with some efficiency improvement. B2 offers an interesting starting point for our discussion, because it is the most straightforward case (with exception of A1 and B1). In this case the economy is characterized by unsustainable and inefficient resource use, and removing inefficiency suffices to attain the sustainability constraint. The question is here how the sustainability constraint should be divided over the different firms.

In this paper it is the aim to obtain an index for a firm's sustainable profit inefficiency. In the static view employed in this paper, a firm is considered to be **sustainable profit efficient (SPE)** when it creates maximum economic value while sustainability constraints (at firm or supra firm level) are met. We will distinguish between **sustainable technical efficiency (STE)**, **sustainable allocative efficiency (SAE)** and **sustainable profit efficiency**, which is a combination of both other efficiency measures.

We distinguish between a bottom up approach and a top down approach. In the former all firms in the industry are maintained after the optimization, which means that the size of the industry remains unchanged. The advantage of this method is that a firm specific efficiency measure can be easily obtained. In the latter approach the number of firms in the industry, i.e. the industry size, is allowed to change to guarantee an optimal allocation of resources. This method shows the potential maximal output and profit of the industry. Obtaining a firm specific index is however more complicated.

10.4.1 Bottom up approach: the use of directional distance (DD) vectors

As depicted in Figure 10.2 below, an industry B2 can remove technical input inefficiency until its members jointly meet the capacity constraint. The remaining inefficiency can be removed to maximize output under the constrained regime. The removal of a certain amount of input and output inefficiency can be projected on a single vector (IE+OE in Figure 10.3). There is a stream of literature focusing on nonradial efficiency measures and directional distance vectors (see Chambers et al., 1996, Chung, et al., 1997, Chambers et al., 1998 and more recently Lee et al, 2002, Fare et al., 2004, McMullen et al., 2007, Murty et al., 2007, Briec and Kerstens, 2009, Kuosmanen et al., 2009), which is helpful for our case, as we want to define the necessary input contractions for each firm in the industry to jointly meet the capacity constraint as well as the possible output increases for these firms. A directional distance vector seems appropriate then.

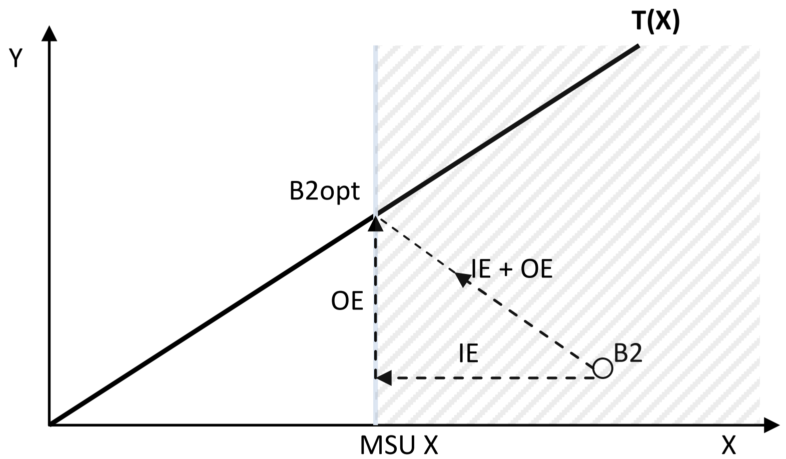


Figure 10.2. Input (IE) and output inefficiency (OE) removal potential for industry B2

In accordance to Fare et al. (2004), let $x \in R_+^N$ denote a vector of inputs and $y \in R_+^M$ a vector of outputs and the physical component of a technology denoted by T, where

$$T = \{(x, y): x \text{ can produce } y\} \quad (4)$$

T is assumed to be closed and convex with freely disposable inputs and outputs. The assumption of freely disposable outputs can be relaxed when bad outputs are present. Fare et al. (2004), in pursuit of Chambers et al. (1998), define the directional distance function on T as

$$\overrightarrow{D_T}(x, y; g_x, g_y) = max\{\beta: (x - \beta g_x, y + \beta g_y) \in T\} \quad (5)$$

where the nonzero vector $(g_x, g_y) \in R_+^N \times R_+^M$ determines the direction in which inputs are contracted and outputs are expanded.

Defining the appropriate directional distance vector is straightforward in the absence of sustainability constraints, because this boils down to measuring the output inefficiency, i.e. $g_x = 0$ and $g_y = y$. When sustainability constraints are present, we need a mechanism to define the optimal mix between g_x and g_y to ensure that output is maximized under the restriction of the capacity constraint. This will prove especially challenging for supra firm sustainability constraints, as we then need to find the optimal way of dividing the constrained input over the firms.

We can identify two types of directional distance vectors that are appropriate in our case:

1. a single directional distance vector (g_x, g_y) for all the firms in the industry
2. a directional distance vector ($g_{x,n}$, $g_{y,n}$) which is firm specific

Option 1, depicted in Figure 10.3, is appealing as it shows the general direction in which all the firms in an industry have to move to meet the capacity constraint and simultaneously improve output. It adequately solves the reallocation problem[32] which occurs when higher level capacity constraints need to be distributed over multiple firms. As all firms are evaluated in the same direction, the metric found can be easily interpreted. The single direction comes with a (minimal) cost, some potential industry output increase is lost compared to the case of the firm specific directional distance vector.

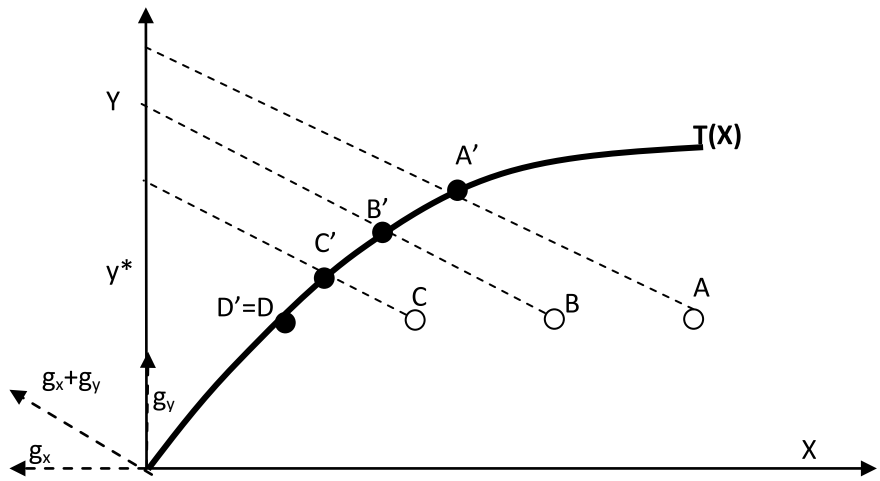


Figure 10.3. Improvement path for firms A, B, C and D in an industry when there is a single, industry wide directional vector (g_y; g_x)

Option 2, the firm specific directional distance vector ($g_{x,n}$, $g_{y,n}$), as depicted in Figure 10.4, is also appealing as it allows to maximize the potential industry output given the capacity constraint. We could specify the *x*-component of the directional distance vector of firm *n* as $g_x X_n$, and the *y*-component as $g_y Y_n$. This means that the vector is dependent on a firm's *x* and *y*-level, but also that each vector shares a common part with the vectors of the other firms in the industry. This makes the reallocation mechanism of the constrained resource *x* over the firms still behaviorally interpretable. The more inefficient a firm is in the constrained resource x_c the more its directional distance vector projects it in the g_x direction. The more inefficient a firm is in the output direction, all else equal, the more it is projected in this direction. Firms inefficient in not-constrained resources are, logically, projected in the same direction as their counterpart efficient in these resources, as the directional vector only depends on x_c and y.

[32] Imagine for example two identical firms and imagine that, given the capacity constraint, industry profit is maximized by reducing resource use of one of the two firms, keeping the use of the other constant. Although from an industry perspective it doesn't matter which firm's input use has to be reduced, from a firm perspective it does. The firm who's input use is reduced after optimization, receives a low efficiency score, opposite to the other. When the aim is to obtain a firm level inefficiency estimate, the firm's mirror should be the optimum from firm perspective, otherwise the micro level behavioral rule of private utility maximization is absent.

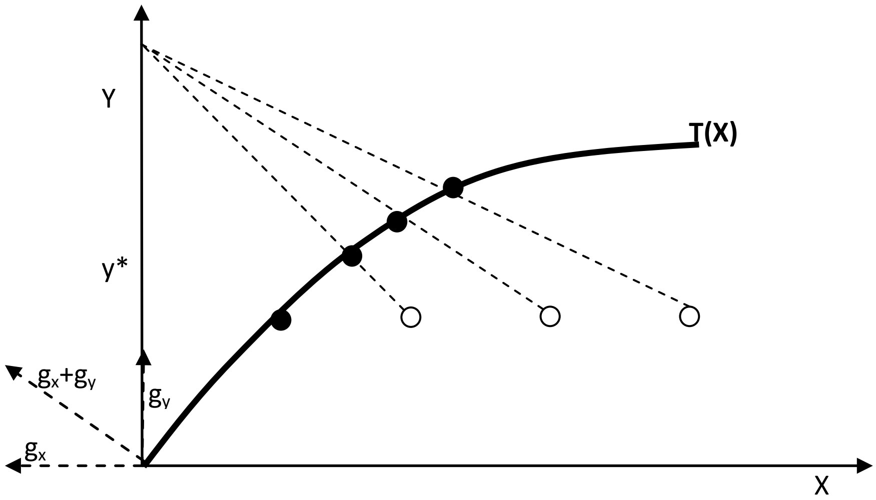


Figure 10.4. Improvement path for firms in an industry when the directional vector (g_yY; g_xX) is partly firm specific.

10.4.1.1 Sustainable technical inefficiency

In this section the aim is to determine the output inefficiency of the firms in a industry, corrected for the industry's unsustainable input use. This correction is achieved by removing part of the firm's input inefficiency to the extent that the MSU is met. As can be seen in option B2 in Figure 10.1, removing only part of the input technical inefficiency at firm level is sufficient to guarantee that the joint input consumption of the firms in the industry meets the industry MSU. The industry does not need to reduce its input use further, as this level of input consumption already guarantees higher (eco)system sustainability[33]. The remaining inefficiency can be used to optimize firm level output. As such we obtain a measure for technical output inefficiency corrected for (higher level) sustainability targets, which indicates how much the output can be expanded given sustainability constraints.

When multiple outputs are present, we suggest to maintain the current output mix, as the decision maker has some (unobserved) reasons to choose this mix. In the section on sustainable allocative inefficiency the input and output mix is optimized to generate maximum firm profit in the presence of capacity constraints. As the real prices for the constrained resources are unknown and therefore need to be approximated, an indication of technical output inefficiency, even for multiple outputs, is informative.

The necessary input contraction *at industry level* is straightforward, as this is reflected by the relative difference between the capacity constraint and the current resource use. This could be used as starting point for the capacity constraint component (g_x) of the directional distance vector. This choice of the directional distance vector however does not guarantee that the capacity constraint is met, as some firms already operate on the efficiency frontier (esp. in a non parametric setting) and therefore they do not contribute to input reduction. Furthermore, each firm has potentially a different input inefficiency for the constrained (and unconstrained) resources, uses a different amount of the constrained input and has a different firm size.

When a non parametric production model is used, the according piecewise linear production technology is formulated as (based upon Lee et al., 2002):

[33] at least in a static setting

$T(x) = \{(y): y \leq Y\lambda, x \geq X\lambda, e^T\lambda \leq 1, \lambda \in \mathcal{R}_+^i\}$ (6)

The (nonlinear) nonparametric models below guarantee that industry output (as a sum of firm inefficiency corrected outputs) is maximized, while simultaneously meeting the sustainability target.

In the first model, the individual firm is projected on the efficiency frontier based upon vector ($g_x x$, $g_y y$). θ_l provides a direct measure of how far (x, y) must be projected along ($g_x x$, $g_y y$) to reach the frontier of *T(x)* (Chambers et al., 1998). The directional vector in model 7 is firm specific, as it depends on x and y. Vector components g_x and g_y however are constant over the firms. The term ($1+g_y\theta_l$) indicates the remaining firm level output inefficiency after removal of a proportionate part of the input inefficiency ($1+g_x\theta_l$). As both indices relate to each other by means of θ_l, the technical output inefficiency can be used as a the efficiency measure. As there is only one direction that maximizes output given the capacity constraint, the constants g_x and g_y are not independent. Therefore, by fixing one, the complexity of the model below can be further reduced. If for example, g_x is set to -1 in the formula below, each firm's input $x_{c,l}$ is contracted with θ_l times $x_{c,l}$, while the output is expanded with g_y times θ_l times y_l. This approach assures that firms contribute to the capacity constraint according to their inefficiency.

$Max\ Y = \sum_{l=1}^{L}\theta_l$ (7)

s.t. $\sum_{k=1}^{K}\lambda_{k,l}\, y_k \geq \left(1+g_y\theta_l\right)y_l$ for each k (7a)

$\sum_{k=1}^{K}\lambda_{k,l}\, x_{k,c} \leq (1+g_x\theta_l)x_{c,l}$ (7b)

$\sum_{k=1}^{K}\lambda_{k,l}\, x_{k,u} \leq x_{u,l}$ (7c)

$\sum_{l=1}^{L}(1+g_x\theta_l)x_{c,l} \leq \alpha\sum_{l=1}^{L}x_{c,l}$ (7d)

$e^T\lambda \leq 1$

$\lambda, \theta \geq 0$

with Y= industry output, l= firm index, k=also firm index, θ_l=firm distance parameter, g_y=output component of directional distance vector, g_x=capacity constraint component of directional distance vector, λ=weight of peer, y=output, x_c=constrained input, x_u=unconstrained input, e^T= matrix of 1's

By solving this model, the optimal vector and the firm directional distances are found. These distances, which reflect technical inefficiencies (Fare et al., 2004), indicate the maximal output achievable under the constrained regime. Based upon the right hand side of equations 7a and 7b, an output and capacity constraint related efficiency measure can be obtained, $\left(1+g_y\theta\right)$ and $(1+g_x\theta)$ respectively. As they are inextricably linked through vector (g_x, g_y), reporting the sustainable output technical inefficiency is sufficient as a measure for a firm's sustainable technical inefficiency.

For the single industry wide directional distance vector the model becomes:

$Max\ Y = \sum_{l=1}^{L}\theta_l$ (7bis)

s.t. $\sum_{k=1}^{K}\lambda_{k,l}\, y_k \geq y_l + g_y\theta_l$ for each k

$\sum_{k=1}^{K}\lambda_{k,l}\, x_{k,c} \leq x_{c,l} + g_x\theta_l$

$\sum_{k=1}^{K}\lambda_{k,l}\, x_{k,u} \leq x_{u,l}$

$\sum_{l=1}^{L}\left(x_{c,l} + g_x\theta_l\right) \leq \alpha\sum_{l=1}^{L}x_{c,l}$

$e^T\lambda \leq 1$

$\lambda, \theta \geq 0$

with Y= industry output, l= firm index, k=also firm index, θ_l=firm distance parameter, g_y=output component of directional distance vector, g_x=capacity constraint component of directional distance vector, λ=weight of peer, y=output, x_c=constrained input, x_u=unconstrained input, e^T= matrix of 1's

The index for sustainable technical output inefficiency is now calculated as $\frac{y_l+g_y\theta_l}{y_l}$.

Whether option 1 or option 2 is chosen will not change the ordering of firms based upon their sustainable technical inefficiency. Option 1 yields a slightly higher overall output. There is a minor change in the obtained sustainable technical inefficiency scores, whereby firms which are most inefficient receive a better score in the model with firm specific directional distance vectors, at the cost of the more efficient. In the latter model, the difference in sustainable technical efficiency is thus less pronounced.

10.4.1.2 Sustainable allocative efficiency

The former procedure allows us to meet the capacity constraint and to optimize output generation at firm level. Given this, there is still potential to increase profit generation, by optimizing the input mix in function of input and output prices and as such removing the allocative inefficiency still present. Chambers et al. (1998) show the duality between the profit function and the directional technology distance function. We refer to their reading for a formal derivation. As shown in Figure 10.5, the inefficiency of a firm in an industry can be decomposed into a technical (TE) and an allocative part (AE, Chambers et al., 1998):

$$TE = \overrightarrow{D_T}\left(x, y; g_x, g_y\right) \quad (8)$$

$$AE = \frac{[\pi(p,w)-(py-wx)]}{(pg_y+wg_x)} - \overrightarrow{D_T}\left(x, y; g_x, g_y\right) \quad (9)$$

with $\pi(p,w)$ = maximal feasible profit; $py - wx$ = actual profit; $pOE + wIE$ = price normalization to avoid effect of proportional price changes; $\overrightarrow{D_T}(x, y; IE, OE)$ = directional distance function.

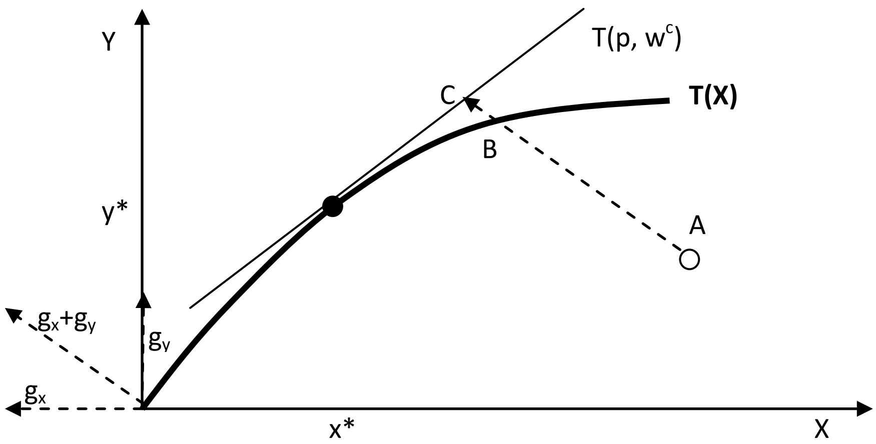


Figure 10.5. Technical and sustainable allocative efficiency measure in a directional distance framework (adapted from Chambers et al., 1998)

Specific for our case of MSU's is that the input price vector *w* (and potentially the output price vector) will change due to the introduction of a MSU. The point (*x**, *y**) is determined by the tangency between the frontier of *T(x)* and the line segment whose slope is given by an adjusted input price w^c.

The fact that the MSU is exceeded indicates that the constrained resource is not appropriately priced, i.e. the price does not reflect the real scarcity of the resource, or the real (external) cost, otherwise the industry would not be in this equilibrium. A possible explanation is given by Lawn (2007, p82), who argues that resource prices reflect reasonably well the relative scarcity of various resource types, but they do not adequately reflect the absolute scarcity of a resource type. The stock will determine the total inflow over time, but not the inflow at a particular point in time. Ecological economists argue that relative prices are mainly based upon flow based forces generated by the interacting market supply and demand forces. Oil is a good example. While oil stocks decrease over time, in particular periods prices can also decrease due to a drop in demand. We argue that the correct price is unknown due to absence of some information and/or the institutions to determine and enforce the exact price. This can both relate to absolute scarcity of a resource and external costs generated by exploiting a resource.

In an industry in which all firms are economically (i.e. technically and allocatively) efficient under an unconstrained regime (i.e without capacity constraint), the firms are (sustainable) allocative inefficient[34] under the constrained regime, as depicted in Figure 10.6. With sustainable allocative inefficient we mean allocative inefficient when the MSU is respected. As shown in Figure 10.7, introducing the MSU constraint will influence the supply and demand equilibrium and hence the prices. The industry's shadow price for the constrained resource can be used as a proxy for the real unknown market price, as suggested by Li and Ng (1995). Firms with a higher shadow price for this resource will be willing to pay for extra units of this resource while firms with a lower shadow price are interested to sell some units, until all firms reside in the new economic optimum.

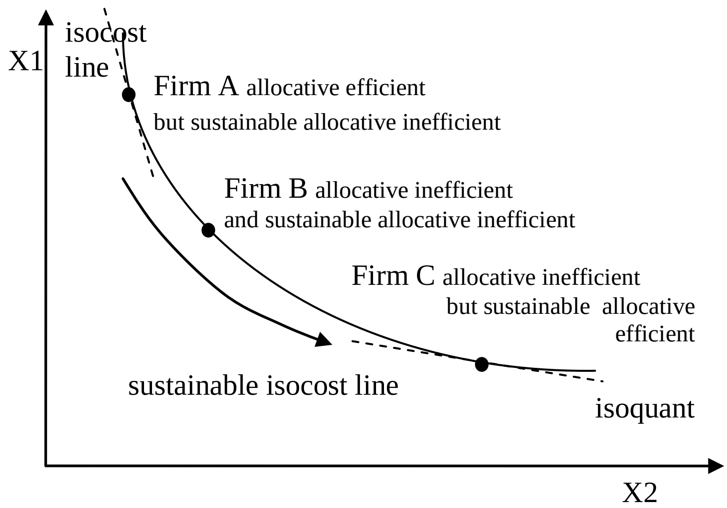


Figure 10.6. Allocative inefficiency when X1 is not constrained and sustainable allocative inefficiency when input X1 is constrained

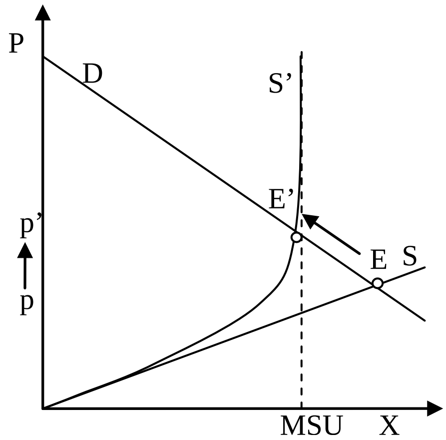


Figure 10.7. Input price change when MSU is introduced. S= supply function, S'= supply function with MSU constraint, D=demand function, E=equilibrium, E'=new equilibrium

Introducing the new sustainable price for the constrained resource will change the slope of the isoprofit line so that the capacity constraint at industry level is met. By defining the Kuhn-Tucker conditions of the industry profit function, we can obtain the shadow price which can serve as the new market price, see formula 12 and formula 13 further in the text. The dual of restriction 13g indicates the potential increase in market price for the constrained resource. This price can be used to reconstruct the new sustainable isoprofit line (see Figure 10.5)[35]. However, to apply this approach the industry technology has to be known. When both prices and technology are unknown, we can build further on the approach developed by Kuosmanen et al. (2009). To obtain shadow prices, they propose to minimize the sum of firms' profit inefficiencies, whereby the prices enter the inefficiency measure as decision variables of the optimization problem and the profit function is empirically determined. This industry distance function gives the lower bound for the true but unknown industry profit inefficiency:

[34] In this example, every firm will have (the same) sustainable allocative inefficiency score.
[35] For simplicity, we ignored the influence of introducing the MSU on the prices of the unconstrained inputs and the outputs (and hence assumed a partial equilibrium model). This could however be accommodated by introducing constraints for the other inputs, and allowing for a flexible output price.

$$IPE = \min_{w,p,\rho} \sum_{n \in \nu} \rho_n \quad (10)$$
$$\text{s.t. } \rho_n \geq (pY_m - wX_m) - (pY_n - wX_n) \qquad \forall m,n \in \nu$$
$$pg^y + wg^x = 1$$
$$p, w \geq 0$$

with IPE = estimated industry profit efficiency; w=unknown input price, p= unknown output price; ρ_n=profit inefficiency of firm n

When only one price is known, f.e. input price W_n, Kuosmanen et al. (2009) suggest to set input vector g_x equal to *1/*W_n and all other elements of the directional vector equal to zero. We have no price information for the above problem, as all prices might vary given the introduction of the capacity constraint, but we know the industry directional distance vector (g_x, g_y) for the DD fixed at industry level, which we can use as normalization constraint in equation 10. This will allow us to determine the prices that minimize industry profit inefficiency. For the DD which varies at firm level, we can also isolate the fixed (g_x, g_y) component of the DD and use these for the normalization constraint (see formula 7). Given the obtained shadow prices, a firm's maximal profit relative to T can, in a nonparametric setting, be defined as:

$$\pi(p, w^c) = \max_{x,y,\lambda} p_c y - w_c x \quad (11)$$
$$\sum_{k=1}^{K} \lambda_k y_k \geq y_m \quad m = 1, \dots, M$$
$$\sum_{k=1}^{K} \lambda_k x_k \leq x_n \quad n = 1, \dots, N$$
$$\lambda_k \geq 0 \quad k = 1, \dots, K$$
$$\sum_{k=1}^{K} \lambda_k = 1$$

With the exception of the adapted prices p_c and w_c, this is the standard profit maximization model as also defined by Fare et al. (2004). Introducing the shadow prices p_c and w_c allows to calculate the expected maximum profit and the allocative inefficiency under the constrained regime, by applying formula 9.

Based upon the prior two sections, we can determine a firm's **sustainable allocative inefficiency** (SAE), its **sustainable technical inefficiency** (STE) and its **sustainable profit inefficiency** (SPE). Furthermore, with classic efficiency techniques, we can determine a firm's allocative inefficiency and technical inefficiency, in the absence of sustainability constraints. Comparison of both metrics will allow us to classify firms with respect to current resource use and sustainable resource use. It is possible that a firm is currently termed allocative inefficient, while it is at the same time sustainable allocative efficient.

10.4.2 Top down approach: firm specific directional distance vector and the optimal size of the industry

The decomposition proposed above might not guarantee maximal profit at the industry level (or equally, that the capacity constraint is met when all firms in the industry reside at their respective sustainable allocative efficient point). Maybe it is better that some firms use more of the resource while others use less or even disappear, in order to maximize industry profit. Li and Ng (1995) introduce the notion of group reallocative inefficiency, which refers to some remaining inefficiency even if firm technical and allocative inefficiency are removed. It compares the group maximum potential total revenue, after technical and allocative inefficiencies at firm level have been removed, with the actual total revenue when these inefficiencies have been removed. The industry could potentially gain more when a fewer number of firms applies a more profitable input mix while other firms would have to face out. To this end, the following industry profit function can be maximized under the constrained regime, as shown in formula 13, to obtain the optimal firm size:

$$Max\ \psi = \sum_{k=1}^{K}\left(p_y y_k - \sum_{i=1}^{n} w_i\, x_{k,i} - w_j^c x_{k,j}^c\right) + \sum_{k=1}^{K} \lambda_{1,k}\left(T\left(x_{k,1}, \dots, x_{k,n}, x_{k,j}^c\right) - y_k\right) + \lambda_2\left\{X_c - \sum_{k=1}^{K} x_{k,j}^c\right\}$$

(12)

with K= number of firms in the industry; y_k=output of firm k; p_y=output price; n=number of unconstrained inputs; $x_{k,i}$=unconstrained input i; w_i=price of unconstrained input i; x^c_j=constrained input; w^c_j=(shadow) price of constrained input; T(.)=production frontier, estimated prior; X_c=MSU for the industry; λ_1=lagrange multiplier of the production function constraint and λ_2=lagrange multiplier of the capacity constraint

The corresponding linear programming model maximizing industry profit can be formulated as:

$$\max_{g_{yl}, g_{xl}} \sum_{l=1}^{L}\left[p_y\left(g_{yl} y_l\right) - w_x\left(g_{xl} x_l\right)\right] \quad (13)$$

$$\text{s.t. } \sum_{k=1}^{K} \lambda_{k,l}\, y_k \geq g_{yl} y_l \qquad \forall l, \forall y \quad (13b)$$

$$\sum_{k=1}^{K} \lambda_{k,l}\, x_k \leq g_{xl} x_l \qquad \forall l, \forall x \quad (13c)$$

$$g_{xl,c} x_{l,c} \leq x_{l,c} \qquad \forall l, \forall x_c \quad (13d)$$

$$g_{yl} y_l \geq y_l \qquad \forall l, \forall y \quad (13e)$$

$$\sum_{k=1}^{K} \lambda_{k,l} = 1 \qquad \forall l \quad (13f)$$

$$\sum_{l=1}^{L} g_{xl,c} x_{l,c} \leq \alpha \sum_{l=1}^{L} x_{l,c} \quad (13g)$$

$$\lambda, \theta \geq 0$$

with g_{yl}=firm relative output change, g_{xl}=firm relative change in input, l=index for firm, L=number of firms in the industry, k=also index for firm, K= number of firms in the industry, λ=weight of peer, y=output, x_c=constrained input, x=unconstrained input, α= relative amount of constrained resource we want to maintain at industry level

Variable g_{yl} is a measure for the firm level output change, given the capacity constraint, while $g_{xl,c}$ indicates the necessary firm level input contraction to guarantee that the industry capacity constraint is met. There is no longer an inefficiency component linked with the firm specific directional distance vector, so the direction is only determined by the industry profit maximization.
The above model is very flexible, as it also allows input use to decrease or increase[36] at firm level, (f.e. by relaxing restrictions 13d and 13e) in order to maximize industry profit, given the capacity constraint. Removing restriction 13f introduces the assumption of CRS, which is probably unrealistic. Restriction 13g is the capacity constraint.

The choice is then for the policy maker to either allow some profit loss but to maintain all firms in the industry or to reduce the number of firms in the industry. This number depends on the consumption of constrained resource by the optimal firms:

$$K' = \alpha \cdot \sum_{k}^{K} x_k / x_{opt}^c \quad (14)$$

with K'=optimal size of industry, α= relative amount of constrained resource we want to maintain at industry level, $\sum_k^K x_{1,k}$=current resource use at industry level, x_{opt}^c=optimal consumption of constrained resource at firm level.

The difference in industry profit generation in the case of the optimal versus the actual number of firms can be used to pay off those who have to face out. In order to obtain a firm level sustainable development efficiency score, the optimal firm can be used as mirror.

[36] Firms in this situation experience increasing returns to scale.

10.5 Unsustainable but efficient resource use

Consider situation A2 in Figure 10.1, where all firms, and thus the industry (Fare and Zelenyuk, 2003), are operating on the efficiency frontier, and input consumption still exceeds the MSU. We can distinguish between 2 cases. First, if the use of substitute products can be expanded, we can attain the MSU without physical loss of output (see Figure 10.8 below). This will however come at a monetary cost because the price of the constrained resource will increase to better reflect the MSU, as well as the cost of using the unconstrained resources. In this situation the changes in supply and demand functions of the constrained and unconstrained inputs have to be taken into account, as well as the substitutability. Second, if substitution is impossible, the MSU can only be attained by sacrificing some (physical) output (see Figure 10.9 below).

Under the assumption that all firms in the industry are economically efficient, the introduction of the MSU will render the firms sustainably allocative inefficient. By reformulating the isocost line (see Figure 10.5), the new economically efficient point can be found, as well as the sustainable allocative inefficiency of the firms.

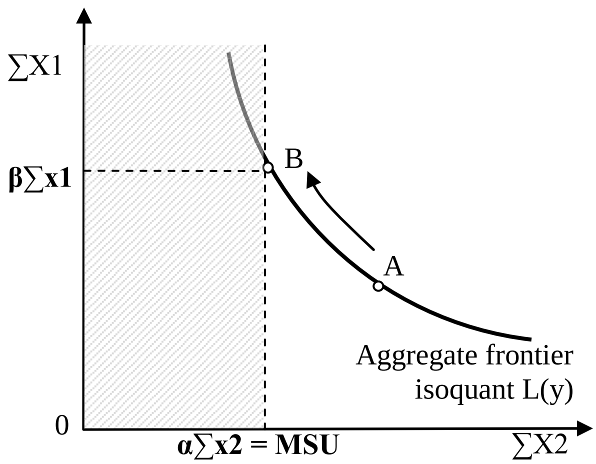


Figure 10.8. Group sustainable allocative inefficiency when a MSU is introduced. B reflects the optimal point for the group, A the current resource allocation.

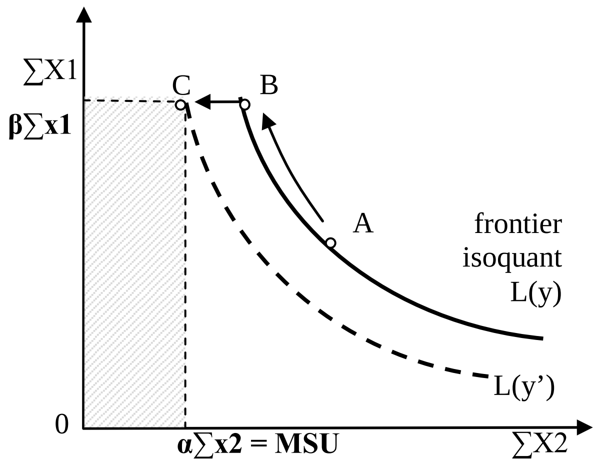


Figure 10.9. MSU cannot be met by only changing the input mix. Some output must also be sacrificed (y → y'). C reflects the optimal point, A the current state of the industry

When the substitution potential is exhausted, the MSU can only be attained by output contraction. As all firms are economically efficient (point B in Figure 10.8), i.e. both technically and sustainable allocatively efficient, and the MSU is still not met, the necessary output contraction can be obtained by a rather straightforward non linear programming model:

$$\max_{g,x} \sum_{k=1}^{K} g y_k \qquad (15)$$

$$\text{s.t. } y_k = f\left(x_{ik}, x_{jk}^{c}\right)$$

$$MSU \geq \sum_{k=1}^{K} x_{jk}^{c}$$

Note that the reduction in output (by a factor g) is distributed equally over the K firms, as they are all assumed technically and allocatively efficient, hence the reduction should be divided equally over the firms.

The objective of this paper is to come up with metrics for the SPE, SAE and STE. In model 7 we can allow g_y to take a negative value, which will reduce the output as well as the input simultaneously. For the rest the models for sustainable technical and allocative efficiency remain equal.

10.6 Multiple resource constraints or outputs

From a sustainability perspective, it is likely that more than one of the inputs is constrained. Figure 10.9 is illustrative as it shows an industry A confronted with two higher level capacity constraints $\beta\sum x1$ and $\alpha\sum x2$. In the case of 2 constraints, the directional distance vector should now also expand in the direction of the second capacity constraint. To come up with a unique solution, we again calculate the size of the output component of the directional distance vector by maximizing the industry's output under the capacity constraint regime. The directional distance function $\vec{D}$ can then be computed by the following linear programming for the *i*th plant, and by iterating over g_{x1} and g_{x2}. Under assumption of CRS, this model becomes:

$$Max\ Y = \sum_{l=1}^{L}\left(1 + g_y\theta_l\right)y_l \tag{16}$$

$$\begin{aligned}
\text{s.t. } & \sum_{k=1}^{K}\lambda_{k,l}\, y_k \geq \left(1 + g_y\theta_l\right)y_l \quad \text{for each k}\\
& \sum_{k=1}^{K}\lambda_{k,l}\, x_{k,c} \leq (1 + g_{x1}\theta_l)x_{c1,l}\\
& \sum_{k=1}^{K}\lambda_{k,l}\, x_{k,c} \leq (1 + g_{x2}\theta_l)x_{c2,l}\\
& \sum_{k=1}^{K}\lambda_{k,l}\, x_{k,u} \leq x_{u,l}\\
& \sum_{l=1}^{L}(1 + g_{x1}\theta_l)x_{c1,l} \leq \alpha\sum_{l=1}^{L}x_{c1,l}\\
& \sum_{l=1}^{L}(1 + g_{x2}\theta_l)x_{c2,l} \leq \beta\sum_{l=1}^{L}x_{c2,l}\\
& e^T\lambda \leq 1\\
& \lambda, \theta \geq 0
\end{aligned}$$

with Y= industry output, l= firm index, k=also firm index, θ_l=firm distance parameter, g_y=output component of directional distance vector, g_{x1}=capacity constraint 1 component of directional distance vector, g_{x2}=capacity constraint 2 component of directional distance vector, λ=weight, y=output, x_c=constrained input, x_u=unconstrained input, e^T= matrix of 1's

As in the case for a single resource constraint, we can fix the output component of the directional distance vector to one. The directions for the input components can then be calculated, by means of a non linear programming model.

For the case of multiple outputs, the researcher has to make some normative decision on how the output inefficiency is distributed over the different outputs. One way would be to keep the output mix constant, as this mix reflects best what is perceived optimal from the private decision maker's perspective. To that end $g_{y,i}$ should be set equal to $g_{y,j}$ for output *i* and *j*. Optimization of the output mix is achieved when the sustainable profit efficiency is calculated.

10.7 Undesirable outputs

Undesirable outputs are treated in a similar way as constrained inputs, as they both need to be minimized. We could define a MSA (maximum sustainable abuse) level that meets our sustainability goal. The directional distance function $\vec{D}$ can then be computed by the following linear programming for the *i*th plant, by iterating over g_z:

$$Max\ Y = \sum_{l=1}^{L}\left(1 + g_y\theta_l\right)y_l \tag{17}$$

$$\begin{aligned}
\text{s.t. } & \sum_{k=1}^{K}\lambda_k\, y_k \geq \left(1 + g_y\theta\right)y\\
& \sum_{k=1}^{K}\lambda_k\, z_{k,c} \leq (1 + g_z\theta)z_c\\
& \sum_{k=1}^{K}\lambda_k\, x_{k,u} \leq x_u
\end{aligned}$$

$$\sum_{l=1}^{L}(1+g_z\theta_l)z_l \leq \gamma \sum_{l=1}^{L} z_l$$
$$e^T\lambda \leq 1$$
$$\lambda, \theta \geq 0$$

with θ=distance parameter, OE='desired output' component of directional distance vector, g_z=undesired output component of directional distance vector, λ=weight, y=desired output, z_c= undesired output, x_u=unconstrained input, e^T= matrix of 1's

10.8 Firm level resource constraint

It is very well possible that a capacity constraint relates directly to the firm level. Excess nitrogen surplus can serve as an example. When this capacity constraint is breached, the firm can be termed unsustainable. The case develops in a similar fashion as explained above, with the exception that the aggregated constraint is now simply replaced by the firm level constraint. Some degree of input inefficiency has to be removed to attain the firm level MSU. The remainder inefficiency can be removed to expand the output. The directional distance vector can again be obtained by iteration. When inefficiency removal is insufficient to attain the MSU, the output will have to be contracted. The individual firm model for a firm level resource constraint becomes:

$$Max\ \theta \qquad (18)$$
$$\text{s.t.} \sum_{k=1}^{K}\lambda_k\, y_k \geq \left(1+g_y\theta\right)y$$
$$\sum_{k=1}^{K}\lambda_k\, x_{k,c} \leq (1+g_x\theta)x_c$$
$$\sum_{k=1}^{K}\lambda_k\, x_{k,u} \leq x_u$$
$$\alpha x_c \geq (1+g_x\theta)x_c$$
$$e^T\lambda \leq 1$$
$$\lambda, \theta \geq 0$$

with θ=distance parameter, g_y=output component of directional distance vector, g_x=capacity constraint component of directional distance vector, λ=weight, y=output, x_c=constrained input, x_u=unconstrained input, αx_c=capacity constraint, e^T= matrix of 1's

10.9 Uncertainty about the correct MSU

In the above settings, it is very well possible that the MSU cannot be calculated with full certainty. When a confidence interval for the MSU is available, scenario analysis, based upon repeated application of the procedures outlined above, can be used to construct a confidence interval for the inefficiency scores.

The ecosystem sustainability depends on the choice of the MSU. As there are many unknowns, there is no guarantee that the chosen MSU corresponds to the real MSU. Furthermore, in a dynamic setting, exogenous and endogenous system changes might call for a new MSU. To accommodate both, we can introduce a probability function for the occurrence of certain MSU level. The (normative) choice of this probability function, which could be based upon environmental scientists' predictions, is beyond the scope of this article. For each MSU level we can calculate a firm's sustainable technical inefficiency score and sustainable allocative inefficiency score. By integrating over the MSU's probability distribution we can obtain a firm's average inefficiency scores:

$$\overline{STE} = \int_{MSU=x1}^{MSU=x2} P(x)\, STE_x\, dx \qquad (19)$$
$$\overline{SAE} = \int_{MSU=x1}^{MSU=x2} P(x)\, SAE_x\, dx \qquad (20)$$

To determine which firms are insensitive to changes in the MSU, i.e. firms with a low variation in efficiency score over the range of MSU's, we can apply following formula:

$$Var(\overline{STE}) = \int_{MSU=x1}^{MSU=x2} P(x)\,[STE_x - \overline{STE}]^2 dx \quad (21)$$

10.10 Illustration

10.10.1 Dairy farming under 1 MSU

The sample data used in this example consist of 271 Belgian dairy farms in 2004 and are derived from EU FADN. We assume that this sample is representative for the Belgian population of dairy producers. Physical output is measured as total milk production (in 1000 l) while inputs are concentrates (in ton), forage crops (in ha), labor use (in 100 hours), farm capital use (in 100€) and dairy cows (number). Some data conversions were necessary to construct these physical inputs from the costs reported in FADN. A stochastic frontier analysis revealed that these variables influence total milk production. We emphasize that this example is developed for an illustrative purpose.

For sake of simplicity, assume now that the global warming problem demands a 10% cut back in total number of (Belgian) dairy cows, as these are an important group of methane producers. The 90% remaining cows than acts as the capacity constraint or the MSU. Currently the sample livestock consists of 14.203 cows.

When all the radial output technical inefficiency would be removed, the total production of milk could be increased from 83.637.801 liter to 102.549.026 liter, which is a relative increase of 22,6%. When all input inefficiency is removed, the total number of cows drops back to 11.065, which is below the capacity constraint of 12782 cows, for a total output of 83.637.801 litre. By maintaining a stock of 12.782 cows (or 90% of the current stock), more output can be generated. The directional distance vector will help us to determine how much more. As explained in the text, we have two options for the directional distance (DD) vector: fixed at industry level (model 7) or firm specific (model 7bis). In this example we apply the firm specific DD vector.

For the model with firm specific DDs, the g_x and g_y component of the DD's are -0,4871 and 1, respectively. The total output generated by the industry under this scenario is 96.844.516 liter milk. Figure 10.10 below shows the obtained sustainable technical output inefficiencies (STE) under the MSU regime, for variable DD. The closer to unity, the more sustainable efficient the firm is.

With respect to sustainable allocative inefficiency, we first have to determine the industry shadow prices, by applying formula 10. The prices for labor, farm capital use, concentrates, forage crops, cows and milk might change due to the introduction of the MSU. We used normalization constraint $p+g_x w=1$, with p the shadow price for milk, w the shadow price for cows and g_x defined earlier in the example (-0.4871). Remember that g_y was arbitrarily set to 1. Shadow prices obtained are given in Table 10.2.

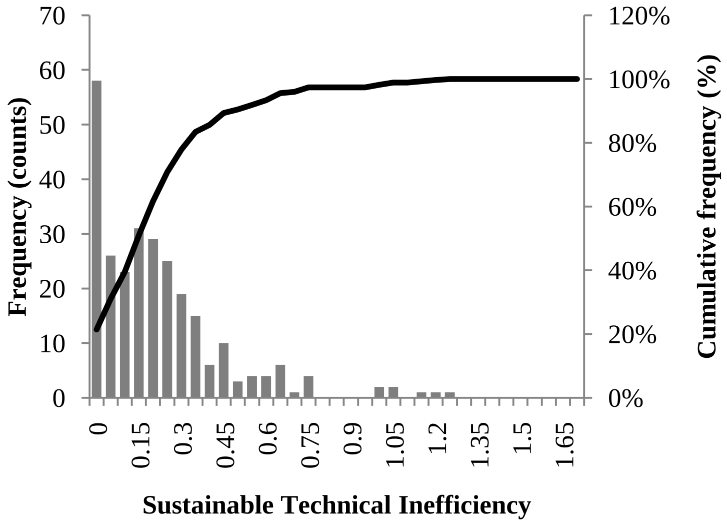


Figure 10.10. Histogram of Sustainable technical output inefficiency (STE) of the firms when the DD-vector varies over firms (STEv). Grey bars indicate count frequency, black line indicates cumulative frequency in %.

Table 10.2. Normalized shadow prices for the model with variable DD vector and average normalized shadow prices for the model with variable DD vector

	Milk output (in 1000l)	Cows	Labor (100h)	Capital (in 100€)	Concentrates (ton)	Fodder (in ha)
Shadow price variable DD	0.7544	0.5042	0.0138	0.0087	0.0192	0.0610

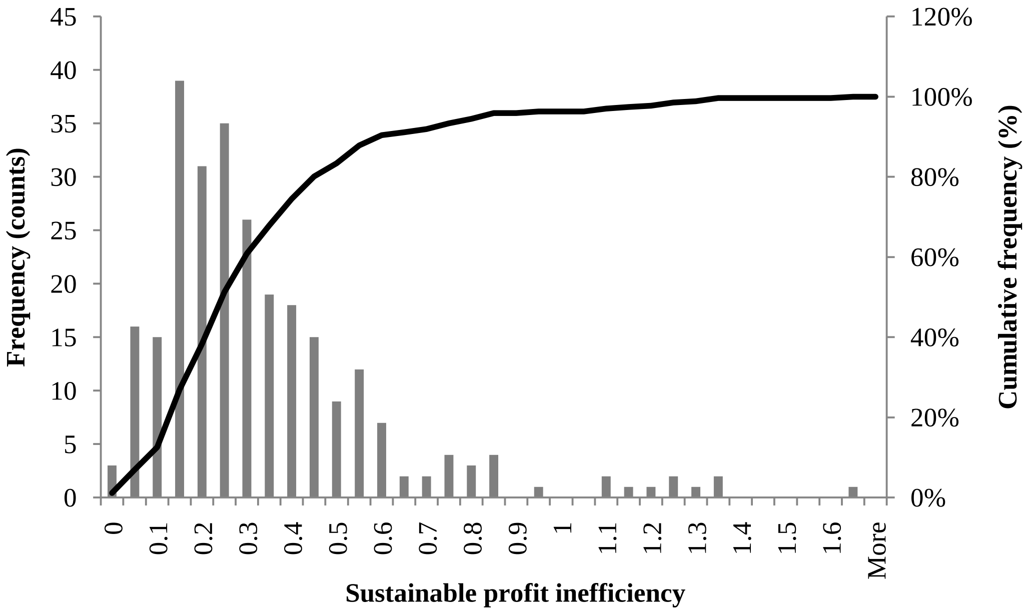


Figure 10.11. Histogram of Sustainable profit inefficiency (SPE) of the firms. Grey bars indicate count frequency, black line indicates cumulative frequency in %.

Based upon these prices we can now calculate the sustainable profit efficiency (SPE) and the sustainable allocative efficiency (SAE), according to formula 8, 9 and 11. Figure 10.11 shows the sustainable profit efficiency. The sustainable allocative inefficiency is simply obtained by subtracting STE from SPE. According to formula 9, and taking into account that our DD vectors vary per firm, a firm *i*'s sustainable profit efficiency is normalized by $pg_y y_i + wg_x x_i$, which gives it a straightforward interpretation. A SPE of 0.1 indicates that sustainable profit can be raised by 10% by improving sustainable technical and sustainable allocative inefficiency. A histogram with SPE-values is given in Figure 10.12. The bars show the count frequencies (on a total of 271 farms), while the black line is the cumulative frequency percentage. The majority of farms has an SPE below 0.5, indicating that they can improve their sustainable profit up to 50% of the profit they now would attain under the sustainability scenario.

What is now the potential of the industry given the capacity constraint? To know this we can insert the shadow prices obtained earlier (Table 10.2) in formula 13. Figure 10.12 combines the firm SPE and SAE (and hence also the STE, as this is the difference between both), in one figure. The values are ranked in increasing order of SPE.

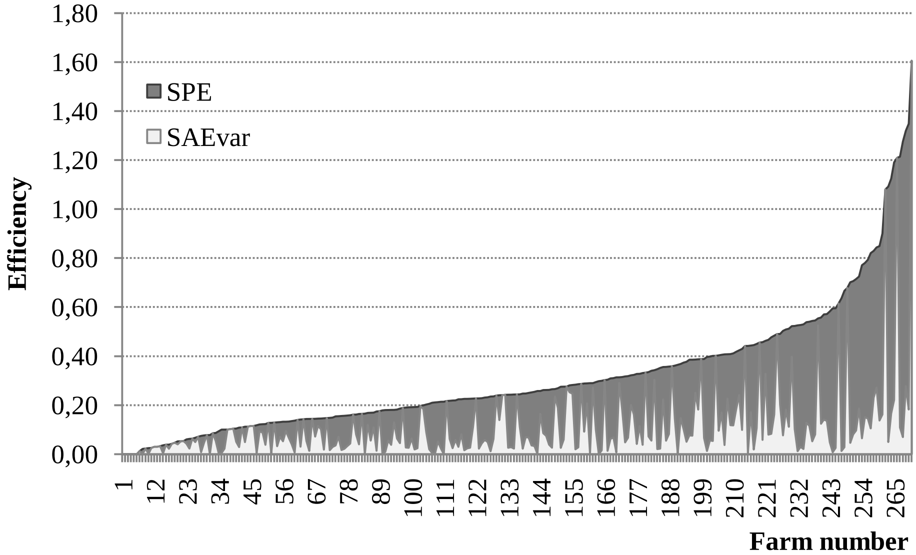


Figure 10.12. SPE and SAE-values for the firms in the sample, ranked in order of increasing SPE. The difference between SPE and SAE is the STE. The higher the SPE the lower the profit efficiency

10.10.2 Dairy farms under more than one constraint

In their quest for more energy efficiency and reduction in greenhouse gas emissions, it is very well possible that the public authorities also impose reduction targets on the non renewable energy use on farms. In EU FADN costs for energy use are reported. We can express this cost in crude oil-equivalents by dividing it through the cost per litre of crude oil. This EU FADN proxy is not very accurate given that energy costs relate to the farm as a whole and not only to the dairy production. Farmers producing own forage crops and concentrates are likely to consume more energy than those who do not. The latter however consume this energy indirectly through their suppliers of forage crops and concentrates. This energy is not accounted for in the model. The main aim of this section is therefore to illustrate the potential of the method.

Suppose that the government issues a quota on energy use reducing the overall consumption to 90% of the current consumption. The model now contains one extra production input, energy consumption. The directional distance vector will now consist of three components: g_y relating to the output, $g_{x,cow}$ to the capacity constraint on livestock numbers and $g_{x,en}$ to the capacity constraint on farm energy consumption. Capacity constraint related DD vectors have values $g_{x,cow}$ =-0.575 and $g_{x,en}$=-0.564, while g_y=1, as explained before. This combination ensures that both the capacity constraints are met and that industry output is maximized. For each firm the associated STE is calculated. To calculate the sustainable profit efficiencies, the shadow prices are first derived, applying formula 10. Table 10.3 shows the shadow prices for the model with and the model without the energy capacity constraint.

An interesting question is how the introduction of an extra capacity constraint influences the sustainable technical efficiencies of the firms. Due to the extra constraint, the frontier becomes more restricted, resulting in an increase or a status quo in sustainable technical efficiency estimates for the firms in the sample, as efficiencies are relative measures. Total maximum industry output drops from 95.623.708 litre to 94.805.359 litre, which is still more than the initial production (83 million litre).

Table 10.3. Average normalized shadow prices for the models with one or two capacity constraints

Shadow price	Milk output (in 1000l)	Energy (100 l oil)	Cows	Labor (100h) *	Capital (in 100€)	Concentrates (ton)	Fodder (in ha)*
Livestock constraint	0.7405	0.0778	0.4888	/	0.0091	0.0188	0.0037
Energy and livestock constraint	0.7071	0.1223	0.3893	/	0.0100	0.0172	/

* zero as the observed unit is projected to the weakly efficient subset of the DEA frontier

10.11 Application on a PIoS: organic versus conventional dairy farming

In the above set of 271 dairy farms, 13 adhere to the organic principles (see chapter 6). The share of organic farms in our sample is thus only 4,8%, which corresponds reasonably well to the share of organic dairy farms in the overall dairy farm population. In what follows we document on potential differences in sustainable technical efficiency and allocative efficiency between organic and conventional dairy farms. We are aware that due to the limitations of the FADN data w.r.t social and ecological capital forms, as well as due to the limited observations for organic farms, our analysis can only be considered as exemplary for what could be measured with the technique developed in this paper. We will restrict our analysis to the capital forms defined above (with the exception of energy use).

The directional distance vector, which is defined at the macro level, remains the same compared to example one. All firms are supposed to move in the same direction, i.e. the direction that maximizes output while guaranteeing that the livestock number capacity constraint is met. The sustainable technical efficiency is therefore calculated considering all firms jointly.

The firm with the best sustainable performance is the one that maximizes output (or value) creation while respecting the sustainability constraints. Figure 10.13 and 10.14 depict possible scenarios. Figure 10.13 shows how the technical production frontier of the conventional system potentially envelops the technical production frontier of the organic system, due to the restrictions in the organic standard. Conversely, Figure 10.14 shows how both frontiers might intersect. This occurs when the organic standard stimulates the use of a production technology which is more efficient in the use of the constrained resource when small amounts of this resource are used. The latter is in line with the sustainability considerations made while devising the organic standard, as it steers farms towards lower consumption of the constrained resource.

All farms are considered jointly to estimate the sustainable technical efficiency frontier, as the sustainability target is defined at the macro level. The frontier that envelops both organic and conventional frontier represents the best technology available for meeting the sustainability constraints with the highest economic performance. What really matters are the sustainability constraints, the targets, not the differences in designed private standards. When the organic standard is well designed to contribute more to sustainability compared to conventional farming practices, organic farms should be closer to the sustainable efficiency frontier (under the assumption that the technical efficiency of both organic and conventional farms is equal). Graphically this is the situation presented in Figure 10.14.

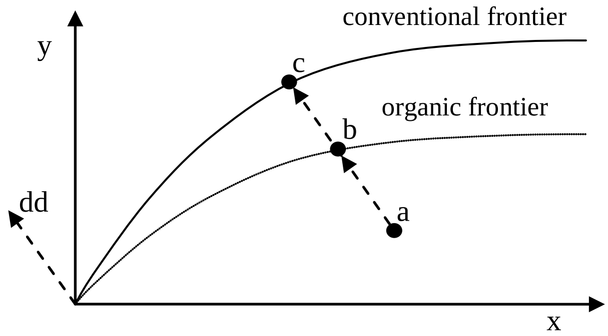


Figure 10.13. Difference in sustainable technical inefficiency between organic and conventional farming in the direction *dd*, when the organic frontier is enveloped by the conventional frontier. The peer for firm *a* is firm *c*. If firm *a* is an organic farm, its best performance is *b*, due to the restrictive organic production function.

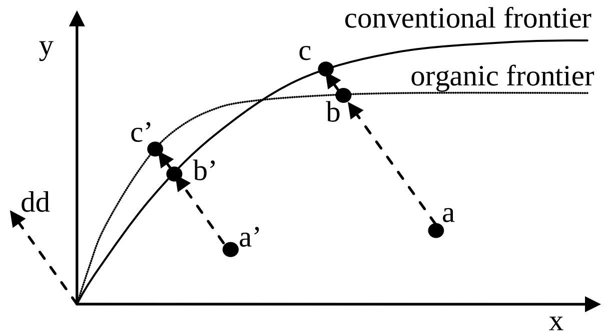


Figure 10.14. Organic and conventional frontier intersect. The peer for firm *a* is firm *c*. If firm *a* is an organic farm, its best performance is *b*. If *a'* is an organic farm, its best performance is *c'*. If farm *a'* is conventional, its peer is also *c'*, an organic farm

We can distinguish between two situations: 1) either the capital forms used in organic and conventional farming have equal physical properties or 2) they have different physical properties. The organic farming standard prescribes that only a limited list of conventional inputs can substitute organic inputs, and this only to a limited extend. As said in chapter 1, organic farming renounces the use of chemical pesticides and fertilizers, amongst other rules.

10.11.1 Assuming inputs with the same physical properties

For the different capital forms studied we can assume that there are no physical differences between the organic and conventional inputs and outputs. One hectare of organic fodder is equal to one hectare of conventional fodder with respect to physical quality attributes such as nutritional value, dry matter content, crop types, internalized externalities etc. The same applies for concentrates, labour, dairy cow breeds used, and litre milk produced.

Fare and Zelenyuk (2003) propose a way to aggregate (Farrell) firm inefficiencies. We can use their approach to calculate average efficiencies for organic and conventional farming. The weighting across firms in the aggregation process is based upon the farm's share in total farming system's output. As such size differences between firms are taken into account. When the arithmetic mean is taken, each firm has the same weight in the overall efficiency estimate. Table 10.4 shows the output weighted and arithmetic mean sustainable technical efficiency (STE), sustainable allocative efficiency (SAE) and sustainable profit efficiency (SPE) for organic and conventional farms. The STE can be interpreted as the potential relative output expansion. The STE is also proportional to the constrained input contraction. Interestingly, differences between organic and conventional farming are generally small, in the scenario of one sustainability constraint. The (output weighted) average organic firm can expand milk production with 17% (and simultaneously contract the number of cows with 8,4%, i.e. g_x times STE), without other input changes. The (output weighted) average conventional firm can expand milk production with 16% and contract the number of livestock units with 7,6%. When the arithmetic mean is taken, the average STE changes considerably. For conventional farms we can note an increase in STE and for organic farms a slight decrease, indicating that conventional farms with a higher output are also more sustainable technical efficient. For organic farms the opposite case is true. The high output organic farms are less sustainably efficient compared to the smaller organic farms. SAE increases both for conventional and organic farms when the arithmetic mean is taken, indicating that farms which produce more are more sustainable allocative efficient. The average sustainable allocative efficiency is about 0.10. Profit efficiency of conventional farms is higher when the output weighted average is taken (i.e. 0.25<0.29). When the arithmetic mean is taken, it is lower.

Table 10.4. Output weighted average sustainable technical efficiency, sustainable allocative efficiency and sustainable profit efficiency for organic and conventional farms

		STE		SAE		SPE	
		Mean	s.e.	Mean	s.e.	Mean	s.e.
Output weighted Mean*	organic farming	0.1725	0.1576	0.1206	0.1098	0.2930	0.1593
	conventional farming	0.1572	0.2327	0.0993	0.1697	0.2565	0.2716
Arithmetic mean	organic farming	0.1629	0.1572	0.1358	0.1087	0.2987	0.1592
	conventional farming	0.2024	0.2283	0.1132	0.1691	0.3156	0.2651

* one way Anova indicates no difference between groups

Another interesting question is whether the organic farms already reach the sustainability target of 10% reduction in overall livestock units, as the organic standard prescribes a restriction in livestock equivalents of two per hectare. When taking the arithmetic mean for conventional farms, the reduction in livestock units amounts to 10%. For organic farms this is on average 8%.

Interesting is also to know whether the conventional production technology envelops the organic (see Figure 10.13) or opposite. Given the directional distance vector, we can calculate the STE scores for organic farms when the only production technology considered is the organic. Figure 10.15 is illustrative. The organic frontier is composed of 11 of the 13 organic farms in the sample (only firm 8 and 13 not), which is typical for DEA-estimates when a small number of observations is used. More interesting is that 4 out of the 13 farms are part of the metafrontier as well (farm 1 to 4). For the remainder of farms the metafrontier is composed of conventional farms. We can therefore conclude that Figure 10.14 is the appropriate representation of the two frontiers. The metafrontier itself is composed of 58 farms (or 1 out of 5 farms).

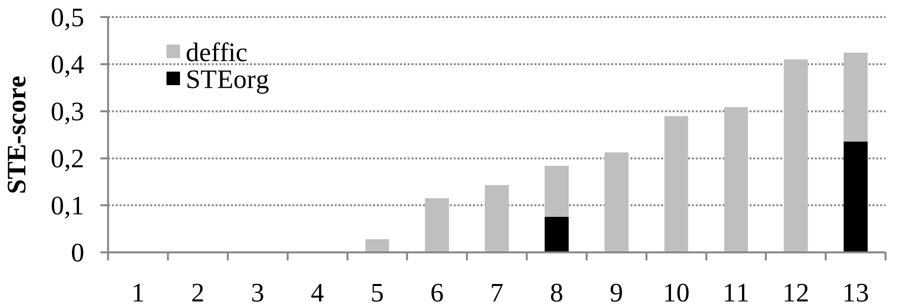


Figure 10.15. Comparison of STE-score of organic farms when the metafrontier is applied (grey+black) versus when the organic frontier is applied (black)

10.11.2 Assuming inputs with different physical properties

The assumption that organic and conventional inputs and outputs have the same properties can be considered too restrictive, given the set of rules in the organic certification manual. The market values organic inputs and outputs differently compared to conventional inputs and outputs. We can use this value difference as proxy[37] for the difference in quality between organic and conventional inputs and outputs. To make organic and conventional capital forms comparable, we can multiply the physical inputs with the actual market prices for these inputs. As such, the single meta-frontier model with an industry-wide capacity constraint can still be applied. Price differences between organic and conventional in- and outputs are reported in Table 10.5. Capital and labour are equally costly in organic and conventional agriculture. Concentrates and fodder are more costly in organic farming, due to the specific requirements with respect to breeds, pest treatments, organic fertilizer application and associated costs in organic farming. At farm level, one litre of organic milk is nearly 20% more expensive compared to conventional milk.

Table 10.5. Farm input and output prices for conventional and organic farming in 2004

	Milk output (in €/l)	Cows*** (€/cow/year)	Labour (€/h)	Capital (in €)	Concentrates (€/ton)	Fodder (in €/ha)
Conventional farm price	0.3*	195.7*	8.5*	1	165**	507.5
Organic farm price	0.3588**	210**	8.5*	1	280**	684.5

* = based upon FADN
** = based upon KWIN (2007)
*** = cows can be maintained productive for 5 years

Apart from the reconversion of the physical inputs into monetary inputs, the calculations can remain the same. Physical input 'cows' is not changed as it is assumed that both conventional and organic dairy cows contribute equally to greenhouse gas emission[38]. The DD measure defines the direction in which each firm has to evolve to jointly meet the industry wide capacity constraint and attain industry level maximum output (which is revenue now). Note that the monetary inputs are only proxies for the physical inputs. The introduction of the capacity constraint will change the optimal mixes of the different inputs and will therefore affect the shadow prices of the inputs, even when these are expressed in monetary values, as these monetary values express the input value prior to the introduction of the capacity constraint. Following shadow prices are obtained (Table 10.6):

Table 10.6. Average normalized shadow prices for the model with variable DD vector for organic and conventional farms

	Milk output (in 1000l)	Cows	Labor (100h)	Capital (in 100€)	Concentrates (ton)	Fodder (in ha)
Shadow price	0.4766	1.056	0.0884	0.1683	0.1564	0.1672

Table 10.7 reports the revenue weighted and arithmetic mean STE, SAE and SPE of organic and conventional farms in the sample. SAE measures are similar. The mean STE is

[37] We are aware that price differences may also result from non quality related differences such as differences in market structure. Even then the price differences still reflect different values attributed to the inputs.
[38] When difference in greenhouse gas emissions between conventional and organic livestock units are quantifiable, the capacity constraint can be adapted to account for this difference. Currently there is no reason to assume a differential emission per cow in organic and conventional farming. In chapter 3 it is reported that the methane emission per hectare in organic farming is approximately 66% of the conventional emission. This is mainly due to the lower livestock density in organic farming.

considerably smaller for organic farms, indicating that organic farms are on average more sustainable technical efficient when the resources are transformed based upon market prices.

Table 10.7. Revenue weighted average sustainable technical efficiency, sustainable allocative efficiency and sustainable profit efficiency for organic and conventional farms

		STE		SAE		SPE	
		Mean	s.e.	Mean	s.e.	Mean	s.e.
Revenue weighted Mean*	organic farming	0.1022	0.1132	0.1201	0.0909	0.2223	0.1503
	conventional farming	0.1576	0.2312	0.1074	0.1581	0.2650	0.2581
Arithmetic mean	organic farming	0.0975	0.1131	0.1274	0.0905	0.2249	0.1503
	conventional farming	0.2024	0.2268	0.1181	0.1577	0.3205	0.2521

* one way Anova indicates no difference between groups

10.12 Conclusions

What can we learn from this decomposition of the firm's inefficiency into different components? The directional distance component indicates in which direction the firm should improve the management of its inputs in order to reduce the use of the constrained input to a sustainable level and to increase the output. The variable directional distance vector is extremely helpful to determine how much constrained input inefficiency should be removed to guarantee that the capacity constraint, and thus the sustainability target, is met. The remainder inefficiency can then be removed at the output side to increase output generation and as such increase the development side of 'sustainable development'. The sustainable allocative inefficiency on its turn indicates to what extend input substitution can increase the firm's profit.

The main question is however whether it is defendable to compare the firm with its peer on the frontier based upon the directional distance vector. There are different pathways for individual firms that still guarantee that the higher level capacity constraint is met. The main advantage of using the directional distance vector to determine a firm's reduction in constrained input use is that the decision rule is not arbitrarily imposed but based upon differences in efficiency between firms. From a sustainable development perspective, 100% efficiency guarantees that most value is created for a given input use. Therefore, more efficient firms are entitled to more of the constrained resource. The directional distance can be interpreted in a similar way as technical inefficiency. By improving the management of the resources, some constrained input and some output 'inefficiency' can be removed, keeping the non constrained inputs constant. The vectors shown in Figure 10.3 are a weighting between technical input and output efficiency. The weighting thereby depends on the size of the capacity constraint. If we want to steer the economy towards sustainable development, i.e. growth with sustainable resource use, it is helpful to have an overall direction. The directional distance vector gives this direction. From a sustainability perspective it is only relevant that the MSU is not exceeded. From a micro-economic perspective it might be interesting to know what the sustainable allocative inefficiency is, to maximize profit in monetary terms, ceteris paribus.

The method developed also allows to compare PIoS with other systems when additional sustainability constraints are introduced. PIoS claim to internalize externalities, and to contribute to sustainable development. By including these externalities as resources (or outputs) in the analysis, the sustainability contribution of PIoS can be measured. If the claim is legitimate, the conventional farms will have a lower sustainable profit efficiency compared to PIoS. In the example, the comparison of organic and conventional farms shows no difference when the inputs are assumed to have similar physical properties. When the inputs are adapted for physical differences, organic farming clearly has a higher sustainable technical and sustainable profit efficiency.

Conclusions

Chapter 11. **Conclusions**

Lessons learnt from the different chapters combined with insights from literature gives a comprehensive overview of the contribution of PIoS to sustainable development. To conclude on the key determining features of PIoS, we use a description of two extreme types of PIoS, the premium private spot market and the private firm strategy. Next, we revisit the hypotheses tested in this PhD-dissertation. Finally, we focus on the potential role for the public regulator (third section), the methodological and contextual limitations of the study (fourth section) and some suggestions for future research (fifth section).

11.1 A continuum of PIoS-types

As explained in the introductory chapter, PIoS prevail in the presence of externalities, which relate to the misuse of public or private goods, due to ill defined property rights or wrong pricing. In the conceptual framework we introduced farm certification schemes as private institutions of sustainability, building further on Hagedorn's Institutions of Sustainability-framework (2005, 2008). He distinguished between four determining aspects that come together to form IoS: the actor, the transaction, the institution and the governance structure. The primary actors involved in farm certification schemes as PIoS are the value chain members that participate in the *certification network*. The object of transaction on its turn is the *certified product*. The private institution, or the rules of the game, is the *certification standard*. The governance structure established to facilitate the implementation of these rules is the *certification organisation*. This organisation governs the incentive mechanisms, support services and the administrative controls associated with the certification standard. When multiple actors are involved, a hybrid configuration emerges which is an intermediate between the regular spot market organization and an intra firm hierarchy.

In analogy with Williamson's distinction between spot markets and hierarchies (1979), in PIoS, we can identify two extreme configurations, based upon a number of characteristics. The first, spot market like, configuration is a sector wide meta-certification scheme while the second is a single firm initiative. In between all kinds of configurations can be found, in analogy with the hybrid configuration of Ménard (2005). Table 11.1 lists different characteristics that can be associated with these two extreme types. We will use these key determining issues to reintroduce the important features of PIoS.

Table 11.1. Types of PIoS and characteristics

Sector wide meta-systems	Intermediary hybrids	Single firm strategy
Premium spot market	← →	Hierarchy
Semi-public character	← →	Private character
Quasi-obliged	← →	Voluntary
Absence of strong public regulation	← →	Presence of public regulation
Centralized institutions	← →	Decentralized PIoS
Higher to global level	← →	Local level
Standardizing functions	← →	Differentiating functions
Generic	← →	Restrictive
Homogeneity in preferences	← →	Heterogeneity in (consumer) preferences
Seggregative	← →	Integrative
Static	← →	Dynamic
Certainty about claim	← →	Uncertainty about externality

The premium spot market can be considered as a regular spot market, with the exception that the contract law is not public but privately designed and organized. Giraud-Héraud et al. (2005) explained the phenomenon for food safety issues, where retailers voluntarily impose minimum quality standards that surpass the legal requirements. Codron et al. (2005) describe the presence of private minimum quality standards, comparable to premium spot market, and premium private labels, comparable to single firm strategy. They notice that, when the definition and monitoring of minimum quality standards is difficult and costly, public authorities leave it to private parties to organize the private minimum quality standards. The classic distinction between hierarchies and markets is based upon the incentive and control mechanisms applied. In the case of the market, prices provide all relevant information and competition is the main safeguard, while in hierarchies (firms), risk is mitigated but the incentives to maximize profits are weak and additional bureaucratic costs occur (Van Huylenbroeck et al., 2008). Similar distinctions can be made between premium spot markets and single farm strategies. We will identify additional reasons why some PIoS are organized by single firms and other are market covering.

As also concluded after part 1, a PIoS can occur either as a voluntary proactive private strategy or as a quasi-obliged reactive private strategy, to pre-empt a more stringent regulation. The premium spot market closely resembles a public minimum quality standard, with the exception that costs for organizing and monitoring are borne by the private parties. The single firm strategy can be considered similar to any quality differentiation strategy, with the exception that the quality claim relates to the environment and not to the product itself. In accordance to Codron et al. (2005), we could term this a premium private label strategy. The semi-public character of premium spot markets is also reflected in the collective acceptance of the standard as the basis for competition. As explained in the conceptual framework, Ménard (2004) identifies three key features describing hybrids: 1. the pooling of resources, where activities are organized through interfirm coordination; 2. the use of more or less formal contracts; and 3. competition both within the hybrid and with other hybrids. In the case of premium private spot markets, a firm’s private authority with respect to the environmental issue is transferred to the level of the collective hybrid spot market. The environmental issues are completely organized by interfirm coordination and competition does not relate to these issues, as they are non-discriminatory for all participants. For the single firm strategy, no pooling of resources takes place and coordination rests fully within the firm. Competition can be based upon the environmental issue. In reality we will see that even in the case of a single firm strategy some authority is transferred to a third party, as third party certification is used for monitor and control, to guarantee credibility of the environmental claim. The premium private spot markets are typically organized when no strong public regulation is present. We see this for example when retailers sourcing globally enter developing markets. As it is too costly for each retailer to organize and enforce a separate environmental certification strategy, they pool resources and impose the standard jointly for all producers, leaving the monitoring and control to third parties. When public regulation and monitoring for an environmental issue is strong, private actors have no incentive to jointly organize a premium private spot market, as it already exists. A single firm environmental strategy surpassing the public spot market requirements might however pay off. When public regulation is largely absent but liability rests with the private actors, the incentive to organize the premium spot market increases.

We now come to the reasons why the choice is made for either a collective or an individual strategy. The more a coordination institution is organized at the collective level, the higher the degree of centralization. As explained in chapter 7, under centralization economies of scale, scope and learning can be realized. It also allows the exhibition of market power over other private and public institutions. Arguments against centralization relate to the divergence of individual preferences from the collective, leading to free riding and defecting behaviour, triggering the need for increased monitoring. The possibility that a small but powerful group within the PIoS misuses the PIoS to exert market power over a larger group is also imminent. There is also a hidden danger that this will have adverse effects on the environmental contribution of the PIoS, as this group can have another agenda.

In the introduction and in chapter 10 we portrayed the ecosystem as a system in which many subsystems are embedded. Sustainability can be defined at each of these systemic levels. Higher system sustainability issues need more centralized institutions while lower system sustainability issues are better organized decentrally. As an example, global warming requires a global strategy while nitrate leaching in Flemish rivers requires a local strategy. In chapter 5 the heterogeneity in environmental states urged us to conclude that environmental certification rules need to be goal driven and be defined in relation to the proper systemic level.

The more centrally an institution is organized, the more its standardizing functions increase. Opposite, the more decentrally the more its differentiating functions increase. As explained in chapter 7 and 9, inside a PIoS the standardizing functions are important as these reduce transaction costs, as they facilitate handling, packaging and control and guarantee uniform product quality. Between PIoS's the differentiating functions are important as these reduce the transaction costs, which mainly relate there to the costs for signalling the difference with other PIoS to buyers. Related to this is the implementation cost of the environmental claim. The more restrictions an environmental issue demands, i.e. the more costs need to be made to attain the environmental claim, the more decentrally the institution is organized, as less value chain members and consumers are willing to bear these costs. Signalling costs will however be lower as it is not so difficult to prove the difference with other PIoS (or with the legal minimum). PIoS with strong differentiating functions are therefore often communicated to consumers while PIoS with standardizing functions are mainly communicated to PIoS value-chain members.

Another related issue is the degree of homogeneity of consumer preferences. As indicated in chapter 3, some consumers are more sensitive to the incorporation of environmental issues compared to other. In that light we also explained the consumer-citizen trade-off, where a consumer has to choose between free riding, with the danger that the environmental issue is not met when many people act similarly, or paying premiums, with the danger that he pays while other free ride. The more homogenous the preferences of buyers (and consumers), the more centrally the institution can be organized, as differentiating functions (towards the consumer) have no added value there.

The above distinction between premium spot markets over clusters of firms to single firm strategies can also be related to the dichotomy of integrative and seggregative institutions as explained by Hagedorn (2005) and operationalised in chapter 8. The more integrative institutions are, the more the actors, who make decisions on transactions, can profit from beneficial effects, but are simultaneously held responsible for adverse effects. This means that they can reap the benefits from the integration while simultaneously having to bear the additional costs. Hagedorn (2005) also distinguishes between the transaction costs and the opportunity costs of additional integration.

An up to now ignored but important issue is the uncertainty about the existence of an externality. Above we explained the difference between the voluntary proactive strategy versus the semi-obliged reactive strategy. The latter occurs when the public authority transfers the burden of organizing the environmental strategy to the private actors. The voluntary proactive strategy focuses on (perceived) externalities not addressed by public regulation. Different reasons can be appointed for this lack of governmental action. First, there can be uncertainty whether the externality is really a concern or not. As an example, even today not everybody is convinced of the contribution of human activity to global warming. Likewise, the impact of GMO on plant and human health is still question of debate. This uncertainty opens up possibilities for private actors to set own standards going beyond these legally required. It is possible that future developments show that the path chosen by the PIoS is wrong. A good example is the production of bio-ethanol from the first generation, which, as a sustainable substitute for non-renewable energy sources, was questioned for its competition with regular food production. A second reason relates to the slow process of establishing legal frameworks. Private actors can take progressive steps and profit from this by anticipating public action. There is some similarity between this strategy and the process of 'arbitrage', as contemporarily advantage is taken from the absence of a regulatory framework and the presence of consumer concern. A good example is Certus, a certification scheme which advertised its watertight traceability measures. Currently these are obliged by the General Food Law (Regulation (EC) 178/2002). Ceteris paribus, the more certain an externality is the more the PIoS will be organized as a central institution and in the end it will be incorporated in the legal framework.

Associated but not synonymous to this is the credibility of the environmental claim. Several reasons can be appointed why environmental claims might lack credibility:

1. Uncertainty about the real existence of an externality;
2. Externality is well identified but the technology to address the externality is poorly designed or not yet existing;
3. Wrong level of centralization of the institutions, such as local issues addressed at higher levels and vice versa;
4. Underdeveloped governance system making that the actual implementation of the rule cannot be guaranteed.

Lack of credibility makes the appropriability, or the ability to extract economic benefits from the environmental claim, difficult. Contrary, to make the claim more credible, more resources (costs) need to be invested, which brings us back to more integrative versus seggregative institutions.

Finally, we can make a distinction between static and dynamic character of institutions. There is some analogy with Williamson (2000)'s four levels of institutions and Ostrom's multiple levels of nested institutions (1990), as introduced in the conceptual framework. Centralised institutions evolve slowly compared to decentralised institutions. It takes a long time before they are established and they are not easily changed. Their acceptance evolves progressively, as an increasing number of actors adhering to it make it a force to be reckoned with. Switching costs become higher as outside options reduce. Simultaneously, the centralised institution is criticized for its rigidity and new PIoS-strategies emerge. Figure 11.1 shows the development trajectory of simple certification schemes to higher order certification schemes. The deming-circles represent continues cycles of planning, doing, checking and acting. A simple PIoS starts with registration of the actions taken. A more complex form also sets reduction targets. Certification schemes than evolve to optimize the farm management. Higher order certification schemes considers the individual farm as part of a higher system and optimizes these jointly.

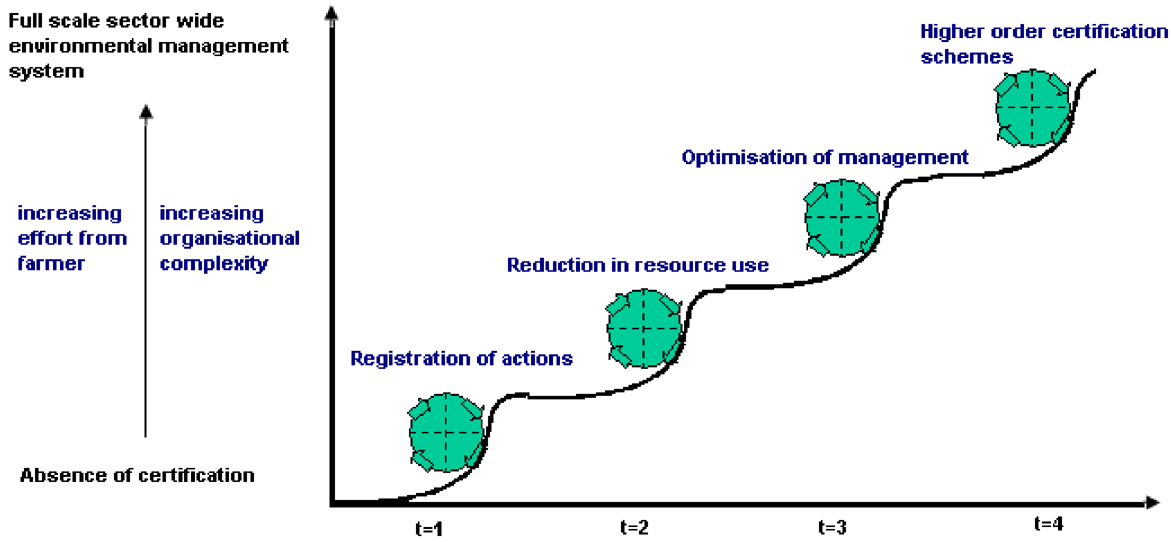


Figure 11.1. Evolution from simple certification schemes to complex higher order schemes

We can now conclude from these observations that, to make PIoS well targeted, a combination of centralised and decentralized institutions and associated governance systems is required. PIoS should consist of different nested levels of institutions of which the higher levels are rigid and well established and much alike public regulations while the lower levels are more flexible, less homogenous and form the main basis for competition. With this is mind we can now revisit the hypotheses tested in chapters 5 to 10.

11.2 Hypotheses revisited

The general objective of this research was to measure and optimize the performance of PIoS. Following hypotheses were therefore developed in the conceptual framework and tested throughout the dissertation. The first three hypotheses measure the current environmental, economic and social performance of PIoS, while the last three focus on the optimization.

Hypothesis 1. Firms participating in Private Institutions of Sustainability contribute more to ecosystem sustainability than firms who do not

Hypothesis 2. Firms participating in Private Institutions of Sustainability create more ‘sustainable value’ than firms who do not

Hypothesis 3. Private institutions of Sustainability can lead to more equity among value chain members

Hypothesis 4. Improving the environmental performance of PIoS will change the private actors’ desired pay-off structure

Hypothesis 5. Institutional changes in PIoS can simultaneously improve the equity among value chain members

Hypothesis 6. Farms participating in PIoS are more sustainable efficient than farms who do not when new sustainability targets are introduced

In what follows we recapitulate the lessons learnt from the chapters testing these hypotheses.

11.2.1 H1: Firms participating in PIoS contribute more to ecosystem sustainability than firms who do not

Given the focus of PIoS on ecosystem sustainability themes, it was expected that this hypothesis, tested in chapter 5, would be confirmed. In chapter 5 the case of organic farming is studied, as it is the most telling example of PIoS. Chapter 5 also reports results from other environmental certification schemes. From the meta-analysis we could conclude that the environmental state on organic farms is generally better than the environmental state on comparable conventional farms. Soils in organic farming systems have on average a higher content of organic matter, organic farming contributes positively to agro-biodiversity (breeds used by the farmers) and natural biodiversity (wild life) and nitrate leaching, phosphorous leaching and greenhouse gas emissions are lower per unit area. Hypothesis 1 seems confirmed.

Two question marks need to be placed. First, the land use efficiency was considerably lower compared to conventional farming, leading to non-significant differences in environmental efficiency indices between organic and conventional farming for some of the other sustainability themes. This has two important, albeit totally different, implications.
First, if land scarcity is a sustainability issue, organic farming can be termed less sustainable for this issue compared to conventional farming, as it needs more land, ceteris paribus. To know which system to choose, we have to consider whether it is better to use more land for extensive production or less land in an intensive way. The choice may be different in different regions, and also depends on increasing pressure from both non agricultural human activities, non food agricultural production and nature.
The second implication is more from a conceptual nature. The organic and conventional farming systems are for these environmental themes seemingly located on the same isoquant, as shown in figure 11.2 below. This could indicate that for these issues there is no technological progress made when shifting from conventional production to the PIoS-production, as we move along the same isoquant instead of shifting to another isoquant. The significant difference per hectare mainly originates from a difference in input intensity (less fertilizer use, lower animal density, no chemical inputs).

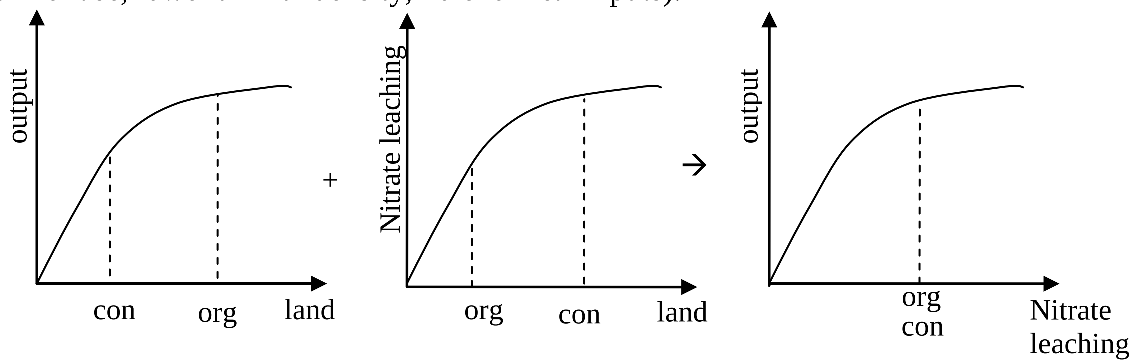


Figure 11.2. Similar relation between output and sustainability themes in organic and conventional farming systems

The meta-analysis in chapter 5 also reports high levels of heterogeneity between studies, due to different reasons. Important for PIoS is that this finding confirms that the same institutions can have totally different effects in different regions and institutional settings, which argues for choosing the proper level of decentralization of the institution and the related governance structure, as explained in the previous section.

11.2.2 H2: Firms participating in PIoS create more 'sustainable value' than firms who do not

The previous study shows opposing indices at a disaggregated level. This calls for the use of an aggregated indicator to assess the overall contribution to sustainability of the PIoS. As explained in chapter 6, the Sustainable Value (SV) method developed by Figge and Hahn (2004) is an interesting starting point for analyzing and comparing the overall sustainability performance of firms or systems, especially because it offers a value oriented perspective. As a methodological contribution to the literature, chapter 6 critically analyzes and extends the traditional Figge and Hahn sustainable-value method by redefining the opportunity costs of the benchmark. Several complementary benchmark definitions are proposed, each having a different economic interpretation. These benchmarks are then used in an empirical analysis to compare the Belgian organic and conventional dairy production system. From this empirical analysis we can conclude that the organic system currently produces the most sustainable value.

So, when the ecological and economic objectives are combined in one single index, the sustainable value index, farms participating in PIoS outperform conventional farms. By taking the full production function into account, the trade-offs between the different resources are now properly accounted for. These results indicate that investing in PIoS is socially more desirable, as more value is created for the same overall environmental impact.

11.2.3 H3: PIoS lead to more equity among value chain members

Under section 1 of this chapter we already explained the possible existence of premium private spot markets. Chapter 7 of this dissertation exemplifies, by means of a Belgian case study, the transition of multiple certification schemes currently employed in the food sector towards a single retail driven higher end spot market. The chapter furthermore argues that the dynamics of certification schemes are characterized by processes of contraction (mergers) followed by relaxation (diversification).

In this chapter, the hypothesis that PIoS lead to more equity among value chain members was qualitatively tested by comparing the position of participants in the hybrid PIoS (the FlandriaGAP-standard) with their position in the resulting premium private spot market (the GlobalGAP-standard). The chapter indicated several sources of mutual gains and losses from cooperation within PIoS-hybrids. Gains at the PIoS-level mainly relate to economies of scale, scope and learning that are transaction cost minimizing. As an example, the harmonization of different certification manuals reduces the administrative burden for farmers. A hidden danger is that the initiative is 'captured' by strong stakeholder groups, opening the doors for buyer or supplier power. As asset specificity increases due to an increasing standard, dependency might also increase. Another danger is the fact that more centralized institutions are less individually adapted, creating higher personal transaction costs. With increasing standards, barriers to entry rise and exclusion of actors is more likely. Henson and Reardon (2005) argue that the risk exists that, as private standards that surpass regulatory requirements come to predominate, broad swathes of the supply chain that are driven by regulatory compliance can be excluded. A key concern is thus that the process of vertical coordination through certification will exclude a large share of farmers, and in particular small farmers. The most important reasons are transaction costs favouring larger farms in supply chains, small farms are more constrained in their financial means for making necessary investments and small farms typically require more assistance from the company per unit of output (Swinnen, 2005). Especially the actors from developing countries are vulnerable, as these are often most isolated from markets and are the smallest and least powerful actors in the chain (FAO, 2003).

The chapter concludes that the retail sector are the primary beneficiaries of the shift towards a single premium spot market. For the remainder of the food chain members, it is less clear whether the overall effect is positive.

11.2.4 H4: Improving the environmental performance of PIoS will change the private actors' desired pay-off structure

Another conclusion from chapter 4 was that the environmental performance of PIoS can still improve, as for example indicated by the multicriteria-analysis. The main objective of chapter 8 is to illustrate how the opportunity cost of more integrative institutions can be assessed. When the certification institution, as a set of rules, becomes more restrictive, f.e. in its pesticide policy, it evolves in the direction of an integrative institution, triggering higher transaction and opportunity costs for the participants, but simultaneously allowing them to reap some reputational gains from the institutional change. This opportunity cost is approximated by the monetary compensation private actors expect for the introduction of extra sustainability rules. As such hypothesis 4, that changes in institutions influencing the environmental performance of PIoS will change the private actors' desired pay-off structure, is tested.

Some theoretical lessons can also be drawn from the experiment. When the farmers' perceived utility increases or remains status quo, the integrative rule can be introduced without additional compensation. This is the case when the ecological performance improvement also improves the economic performance. When the perceived utility decreases, a trade-off has to be made between ecological and economic performance. The proposed method than gives an indication of farmers' desired compensation for the environmental change. Given this information, some new issues arise. First, a costly new rule is not necessarily the cheapest way to obtain the desired environmental effect. As becomes clear from the experiment, different rules contribute to the same pillars of ecological sustainability, at a different cost. First the pareto-efficient rules should be selected, i.e. rules that increase ecological performance and not decrease economic performance. A second issue is whether the environmental performance increase is worth the economic price and whether we as a society are willing to pay for this. If not, maybe there are cheaper ways to organize the environmental performance increase, such as end of pipe technologies or other abatement strategies that not reside within PIoS. Finally, if we agree that the environmental performance increase is worth the extra price, the question remains who will take the burden. We could apply the 'polluter pays'-principle and leave the cost to the farmer. Or we could subsidize the change and bear the cost as citizens through increased taxes. Another option is to let the PIoS signal the change to green consumers and let those pay a price premium. The choice will depend on the costs of organizing the environmental policy under these different scenarios, and more specifically the transaction cost differences. When changes are made to the institutional structure of PIoS, associated transaction costs will also change. The next hypothesis focuses on the transaction cost changes that can be associated with a change in the purpose of the standard.

11.2.5 H5. Institutional changes in PIoS can improve the equity among value chain members

Hypothesis 3 highlighted that there is a hidden danger that PIoS are captured by powerful stakeholder groups. In chapter 9 a method is presented to assess ex ante what the perceived opportunity costs and transaction costs are associated with changes in the governance structure, the bargaining position of farmers and the purpose of a PIoS-standard. This chapter provides a measure for institutional equity from the farmers' point of view, as it estimates their desired pay-off when institutions change. The methodology is tested on the FlandriaGAP certification system, the major fresh fruit and vegetable standard in Flanders (and Belgium).

The reaction of the farmers in our experiment can be summarized in one term: change averseness. The current certification institution reflects an equilibrium between the interests of buyers and sellers. The producers' primal fear is the gradual weakening of their power, shifting the equilibrium in favour of the retailers. The farmers' change averseness can also be explained when considering the new pay-off structure, which should be satisfactory to make change sustainable. However, for those entering the new scheme this pay off structure remains unchanged, apart from a temporary price increase to motivate conversion. The pay-off structure does change for those who decide not to implement the new changes, because they are then excluded from the preferential sales channel.

11.2.6 H6. Farms participating in PIoS are more sustainable efficient than farms who do not when new sustainability targets are introduced

Chapter 6 assumes that current resource use is sustainable, which is questionable. In chapter 10 this restrictive assumption is abandoned. In this chapter a static view on sustainability is employed, by introducing capacity constraints as the boundaries above (or below) which the system cannot maintain its stable state. Currently these capacity constraints are often breached. The methodology developed builds upon the potential to simultaneously increase sustainability of the earth system and economic development by removing inefficiencies currently present both at the production input and output side. In this chapter it is shown how the efficiency improvement pathway of an industry and the firms within it can be calculated to come to a sustainable, profit maximizing state, given the existence of these capacity constraints. In the practical example it is shown that organic farming as example for the PIoS performs better than the conventional counterpart when overall sustainability targets are introduced. Organic farming thus operates closer to the efficiency frontier compared to conventional farming.

11.3 Role for the public regulator

As indicated in chapter 2, public authorities have an important role to play in guaranteeing the transition towards a more sustainable society. According to the stakeholders consulted in this chapter, the three ecologically most advantageous strategies to improve the environmental performance are training and advice for farmers, more governmental control and adapted legislation. These strategies can be positioned in the public policy sphere, aiming at an optimisation of the current policies. The two economically and ecologically most beneficial systems (training and control) do not require major financial adaptations from the market players, instead, the government bears the extra costs. The implementation process for both strategies is also quite uncomplicated, and they result into a direct pay-off. The most important role of a public regulator is of course to set the legal framework under which production and competition can take place. This not only relate to the allowed processes and products but also to the legitimacy of the claims made.

In the first section of these conclusions, we already explained why PIoS can occur additional to the legal framework. The main reason why public authorities give room to private actors for self regulation is to transfer associated costs to the private players. As Codron et al. (2005) say, government action is conditioned by how it will affect the distribution of costs and benefits over actors. They argue for setting an intermediate public minimum quality standard as this will still allow private actors to develop products differentiated from this standard, while simultaneously guaranteeing that a minimum level of environmental quality is met. When designing and implementing environmental policies, public authorities also experience transaction costs. Falconer and Whitby (1999) indicate that the most important public transaction costs are the costs of the administrating agencies. These result from a set of administrative activities including (OECD, 2003): designing a policy, which can be determining the modalities of payments (e.g. amounts, selection criteria, etc.) or defining cross compliance conditions; obtaining consensus on the policy; collecting revenues to pay the policy; selecting which areas fall under the policy; implementing the policy by payment of the private actors; monitoring whether the condition required by the policy is met and enforcing the policy when the condition is not met. The public transaction costs should be set against the effectiveness of the policies, in order to improve the value for money of the public expenditure on the environmental policy (Falconer & Whitby, 1999). The lower the public minimum quality standard, the lower the public design and monitoring costs, but the higher the environmental damage.

In Chapter 10 we saw that there are consumption levels for resources (Maximum Sustainable Uses, MSU or Minimum Sustainable Abuses) that guarantee long term sustainability. As depicted in the Figure 11.3 below, there are two ways to attain these levels. Either the MSU ($EnvP_{ideal}$) or the technology to reach it ($PIoS_B$) is imposed by the public regulator, triggering high public transaction costs for the design and monitoring of the standard and high private transaction costs as private actors are constrained by the rules laid out in the public regulation. In the end, the consumer (and tax payer) has to bear these costs. The second possibility is to set a lower environmental target (f.e. $EnvP_{market}$). As Figure 11.3 shows, the different technologies employed in the market can reach this level. Public and private transaction costs are low and private actors have the possibility to differentiate based upon the environmental issue. Graphically this is represented by the market curve, $PIoS_A$- curve and $PIoS_B$-curve reaching the same level of economic performance (point F, A and N). The problem under this scenario is that there is uncertainty whether the MSU will be met.

The public regulator should thus help in the transition of market players towards the more environmentally sound production technologies of PIoS, which can be done by the different instruments explained in chapter 2. Demand driven instruments are for example the creation of consumer awareness or lower end product prices through subsidies, taxes, more freedom with respect to monitoring and control etc. Figure 11.4 shows how the PIoS under such a scenario can attain a higher economic performance compared to the market, either through the stimulation of consumer interest or direct government incentives. The market actor now has to make the trade-off to produce at a lower economic performance level or to bear the switching costs to the better performing PIoS.

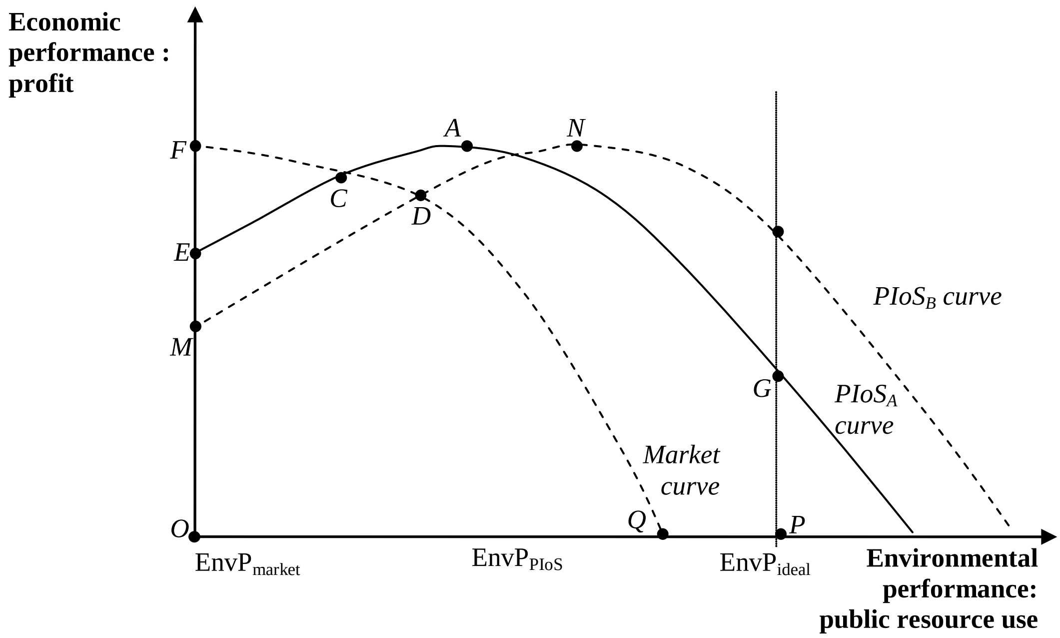


Figure 11.3. Economic and environmental performance for participant in the market and in A $PIoS_A$ and $PIoS_B$

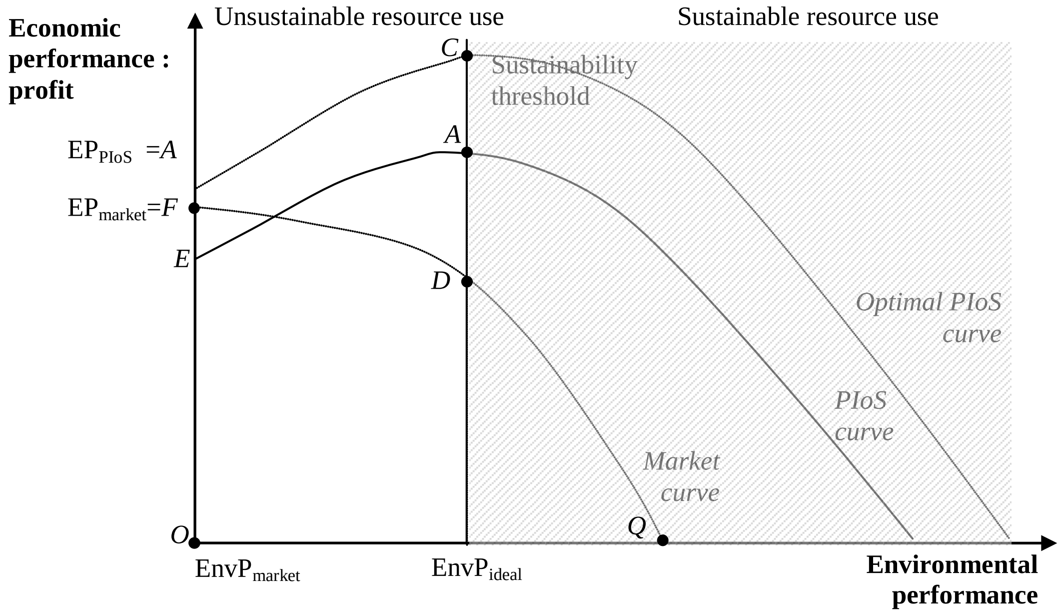


Figure 11.4. Economic and environmental performance for participant in the market and in A $PIoS_A$ and $PIoS_B$ when environmental performance is rewarded

Also with respect to equity issues, the government has a role to play. The public regulator has to outweigh the costs for avoiding equity issues versus the potential welfare gains. The monitoring of social issues is extremely costly as these are difficult to define and measure. As explained in chapter 7, the threat of market power abuse and exclusion is a reality in PIoS. A recent apparent shift in PIoS is however the increased focus on social issues. Chapter 9 for example tests the farmers' acceptance of extra social measures. The government can further stimulate the inclusion of social issues into the PIoS certification manuals, with the instruments outlined above. These certification manuals offer a rather uncomplicated way for monitoring and control of these social issues. In a similar sense internal social sustainability issues, such as the division of rents and duties across participants, can be framed into the PIoS.

An increasing role is currently played by non-governmental pressure groups who influence both the behaviour of private actors (consumers and producers) and the public regulator. They partly take over the monitoring and control function of the public authorities and can therefore also be considered as PIoS. We however did not specifically focus on these institutions in this dissertation.

11.4 Strengths and weaknesses of the methods applied and developed

In this section a description is given of the main strengths and weaknesses of the applied and developed methods. Table 11.1 distinguishes the different quantitative methods based upon their use of single or multiple indices and their descriptive or prescriptive nature.

Table 11.1. Characteristics of the different quantitative methods in this dissertation

	Descriptive	**Prescriptive**
Single index	Sustainable Value modified	Sustainable efficiency Choice preference Multi-Criteria Analysis
Multiple indices	Meta-analysis	Choice Preference

11.4.1 Stated choice preference, nested logit and latent class models

In chapter three, eight and nine the technique of stated choice preference is used. The advantages are manifold. Opposite to conjoint analysis (which is often erroneously used as a synonym), stated choice preference has a solid theoretical basis, which rests upon Random utility theory.
Opposite to contingent valuation methods, which assess utility for a good or a service as a whole, it allows to decompose goods or services into their main characteristics and to obtain utility estimates for these characteristics separately. The different experiments in this dissertation made specific use of this ability. As a choice option consists of multiple attributes, strategic behaviour of respondents, typical for contingent valuation, is reduced. The disadvantage is however the complexity of the experiment, both for the designer and the respondent.
Opposite to revealed preference methods, the method of stated choice preference allows to make ex ante assessments, enabling to test hypothetic options which cannot be readily observed in the market. This possibility is extremely helpful when new modifications are explored. In addition, it also captures non use values, which enables to incorporate attributes which are currently not marketed, such as biodiversity.

In chapter three, the basic multinomial model was extended with more advanced models such as the nested logit model and the latent class model, which enabled to incorporate preference heterogeneity into the experiment. As such underlying preference structures could be revealed that suggest to reinterpret the results of traditional multinomial logit models. The application of a combined nested latent class choice model has not been performed as the technique is up to now not developed.

The advanced techniques used in chapter three indicate that within the general preference structure of a sample, divergent preference structures can be identified. As the sample size of chapter three is sufficiently large, this decomposition was possible. This is at the same time the drawback of the applications in chapter eight and nine, where the classic multinomial logit model was applied. This choice was inspired by the small sample size, which prohibits more in depth analysis. A non significant coefficient for a new rule can be the result of all farmers being indifferent, or one group of farmers, f.e. the laggards, being opposed while another group of farmers, f.e. the innovators, being in favour. The non significant coefficient does not allow us to make a distinction.

Another issue in the current study is the use of orthogonal designs, which guarantee that each attribute in an experiment is considered independent from other attributes. The disadvantage is the loss of some efficiency. The same estimates could have been obtained with more precision (i.e. lower confidence intervals) when efficient designs would have been used, albeit at the expense of introducing some degree of collinearity.

11.4.2 Multi-Criteria Analysis

A second quantitative technique referred to in chapter three is Multi-Criteria Analysis. There are some similarities and dissimilarities with the stated choice preference method outlined above. First, both methods are prescriptive, i.e. they say something about a wanted but unexisting situation. In both methods different alternatives are compared with respect to multiple criteria. The applied method is however totally different. While stated choice preference rests upon the random utility theory with a single utility maximizing choice per respondent, Multi-Criteria Analysis compares alternatives two by two for each criterion. As such the MC method shares some similarity with traditional conjoint analysis where alternatives are artificially ranked and rated. As this does not link directly to behavioural theory, it is opposed to real life situations where a single, actual choice between alternatives is made. This poses a first criticism. The MC-procedure's main advantage is the possibility to distinguish between alternatives based upon different, sometimes totally unrelated, criteria. An important drawback relates to the use of weights which exhibit the potential danger of being subjective. First, to determine the preference of one alternative over another for a given criterion, a preference function is constructed. The choice of a preference function should be carefully considered, as this will influence the alternatives' scores. Second, to end up with a single index, the scores for different criteria are aggregated. To do so, a weighting is chosen which is again open for subjectivity. In the reported study, weights for the different certification book chapters and scores of PIoS on these chapters were determined by experts. It is assumed that these have the appropriate knowledge and objectivity to guarantee reliable results. Given that multiple experts were consulted to construct the scores, the objectivity was further improved.

11.4.3 Meta-analysis

Chapter 5 uses a meta-analysis, which, as opposed to the previous methods, does not aggregate the scores of an alternative into a single index. It is also not a prescriptive method, as it is reports the existing situation. As Arnqvist and Wooster (1995) explain, meta-analysis refers to a specific set of statistical quantitative methods that are designed to compare and synthesize the results of multiple studies. In many ways, the procedures involved are analogous to those of standard statistical methods, but the units of analysis are the results of independent studies rather than the independent responses of individual subjects.

The use of the meta-analysis technique is interesting for two main reasons. First, it allows to calculate an overall, site-unspecific effect, which makes it possible to generalize findings over different study sites. Second, it indicates whether it is allowed to combine different studies into a single effect measure or not, depending on the heterogeneity between studies.

Given these advantages, it was interesting to use the meta-analysis in this study, especially because proponents of PIoS and of conventional production keep falling back on different studies to build up their argumentation. The application presented in chapter 5 is the first meta-analysis comparing organic and conventional farming for different environmental issues in a single study. The holistic study of Hansen et al. (2001) is for example from a qualitative nature, while the study of Bengtsson et al. (2005) only focuses on biodiversity. The disadvantage is however, as in standard statistical analysis, that sufficient independent observations are necessary to guarantee unbiased results. When a small number of studies are used, effect sizes of the opposed systems will probably not differ, due to broad confidence intervals. In our study, this is the case for greenhouse gas emissions. Extra studies are needed there to make the findings more robust.

11.4.4 Sustainable value analysis

Chapter 6 reports another single index method. In this chapter the sustainable value method of Figge and Hahn (2004) is further improved. To determine the opportunity costs, the original method uses a specific and restrictive weighting between firms and between resources, which makes it akin to Multi-Criteria Analysis. The adaptations presented in chapter five depart from this in two ways. First, it is proposed to base the weighting between resources upon the production functions of the firms. This is behaviourally more appealing, as it takes the interdependency between resources and value creation into account. It also allows to incorporate firm level substitution between resources. Second, Figge and Hahn’s specific weighting between firms in the overall benchmark is made more generic by proposing a formulation with different possible weights, each of them having another economic interpretation and hence a different potential use.

To operationalize the method, non parametric production frontiers were used. In such a case, the production function is not subject to a predefined functional form. The drawback is that no correction is made for outliers when defining the benchmark. Parametric benchmarks do take noise into consideration, but they impose a restrictive functional form. The stochastic frontier models attribute the difference between the benchmark and a particular firm partly to random noise and partly to inefficiency. When using either parametric or non parametric production functions, assumptions are made which can be contested.

The empirical application in chapter 6 is based upon EU FADN data. As these data are primarily meant for accountancy purposes, some physical and social resources are not very well approximated. Nutrient balances cannot be derived, pesticides and fertilizers are only expressed in costs, labour is not divided over the different farm activities, information on knowledge, education, satisfaction, networks and so on is absent. Currently, proxies were constructed to overcome this problem. To obtain more accurate data, it is necessary to conduct farm level surveys.

11.4.5 Sustainable efficiency

In chapter 10 recent advancements in efficiency analysis, relating to the use of directional distance vectors instead of radial distance measures, were used to develop a new methodological extension. This extension enables to approximate the profit inefficiency of firms or systems in the presence of newly defined sustainability constraints. Introducing new constraints alter the prices of inputs and outputs. Under this scenario it is interesting to know which firm or system applies the best hypothetic technical input and price mix, as this can indicate the future direction of the best technology available. The application potential is manifold. A particularly interesting one relates to the incorporation of non commodities which are not priced at all in the market.

As the method rests upon a non parametric efficiency approach, the limitations of the latter also apply to this method (see above). Furthermore, the method uses existing firms and systems, although the capacity constraint can be normative (as in the examples of chapter 10). The use of existing data opposes to the use of an 'ideal' system, which can be constructed based upon expert knowledge. The latter is however also not free of limitations. Another drawback relates to the fact that sustainability is not a static concept. Hence, identifying a single direction in which the industry should move to come to a profit maximizing and sustainable state is potentially dangerous. As a suggestion for future research we propose to maintain a certain degree of heterogeneity in production functions to guarantee resilience to shocks in the system.

As the application presented in chapter 10 also uses EU FADN data, the limitations of these data identified earlier also apply here.

11.4.6 Qualitative research in this dissertation

In chapter two, four and seven qualitative research techniques have been used. For chapter two and seven, a combination of in depth interviews, a questionnaire and focus group sessions provided the relevant data. Objectivity and triangulation are the main issues when performing qualitative research. They were guaranteed both across these data sources and within the focus groups. As an example, the results of the first five focus groups were presented and rediscussed with all focus group members in a final focus group. During each focus group one moderator and two observers were present. The process was also videotaped.

Qualitative research can be descriptive, explorative or testing hypotheses (Mortelmans, 2007). In chapter two the focus groups were used to explore stakeholders' attitude towards different sustainability approaches. In chapter seven the focus groups, in combination with other sources, were used for descriptive research, explorative research and, indirectly, to test the main hypothesis. Focus group four for example focused on the construction process of the certification standard, which resulted in purely descriptive research. Focus group one and two focused on the advantages and disadvantages of certification and the costs and benefits for farmers, which is explorative research. By linking this with the transaction cost theory and Porter's theory on competitive forces, the hypothesis could be tested.

11.5 Limitations of the study

The research presented here is of course not free of limitations. We here identify some of the theoretical, conceptual, methodological and empirical limitations.

With respect to applied theories, focus in this dissertation rests heavily upon institutional economics. Recent advancements in network theory, supply chain management, new business economics, contingency and resource dependency theory amongst others, could also have been considered. We are however convinced that this theory offers the best lens for the analysis of PIoS.

Conceptual limitations in this dissertation might relate to the narrowing down of environmental performance to an analysis of the environmental effectiveness, economic performance to resource use efficiency and social performance to inter supply chain equity.

These issues are more complex and additional measures could be developed to fully take into account these concepts. Within the frame of this dissertation, it was not possible to construct more composite indicators.
Furthermore, the analyses of performance and the optimizations rests upon the comparison with a benchmark. In this dissertation we mainly worked with an existing benchmark, as opposed to a normative benchmark. The benchmark mainly used is the conventional farming system. This benchmark can be question of debate as all kinds of firms can be encountered in the conventional spot market. All benchmarks have always been constructed to guarantee maximum representativeness possible.

The main empirical limitations relate to the case study approach and the data used. The theoretical and conceptual findings of this dissertation are illustrated mainly by two case studies. The first one, the organic, represents an environmental quality niche approach, while the other, Flandria, is more widespread and less environmentally restrictive. Generalizing the findings from one of these PIoS-types to the other or to other PIoS should be done with great caution, as each type uses its own set of endogenous institutions of sustainability. The principles identified in this dissertation should however allow to identify which institutions should be analyzed in what way to assess the environmental, social and economic contribution of the PIoS under study. Data related limitations were already explained in the previous section 11.4.

11.6 Alleys for future research

While answering questions, new questions arise. Below we list some of the many possible arrays. Chapter 6 showed indications for the potential of exhibition of market power. In future research it could be interesting to operationalize the measurement of this market power. Chapter 7 compares the sustainable value creation of PIoS at farm level with the sustainable value creation of conventional farms. PIoS are however defined over a value chain, therefore it would be interesting to calculate the sustainable value at the product level. Chapter 10 developed a static view on sustainability as ‘attaining capacity constraints’. This view could be made more dynamic. Throughout the dissertation the potential role of public authorities was indicated. It could be interesting to empirically determine which policy instruments are necessary to support PIoS, to attain maximum social welfare.

11.6.1 Measurement of market power in PIoS

The choice preference method applied in chapters 3, 8 and 9 can potentially be used to measure the difference in market power between participants in PIoS (or more generally in the supply chain), by comparing participants’ willingness to pay for changed contract attributes, with the current situation. In the ideal case the current PIoS is preferred by all participants, indicated by the highest utility estimates for the current PIoS attributes. In this case market power is unobserved. When for one participant in the PIoS low or negative utilities are found for the current PIoS attributes, and positive utilities for another participant, there is an indication of opposing stakes. High negative utilities for one actor combined with low positive utilities for another actor (or vice versa) then indicates that the latter party possesses market power, as this party was able to influence the current state more. The difference in distance between the preferred situation and the current situation could be a measure for market power. Figure 11.5 shows this graphically.

It is furthermore also possible that the current contractual arrangement between the parties is suboptimal and that value creation in the chain could be increased. When the willingness to accept a certain change, expressed in euro, is lower than the willingness to pay of the other party, changing the contract in this direction leads to a win win for both parties. Identification of these contract attributes can lead to optimized contracts for all PIoS parties.

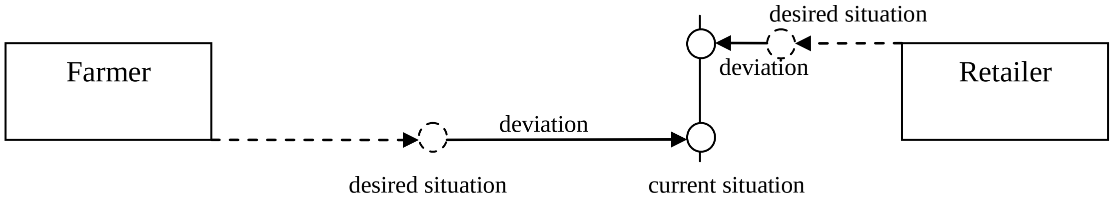


Figure 11.5. Difference between current and desired market situation, for example for product quality. While retailers want a higher quality level, the farmers desire a lower level, given the current prices. In the negotiation process the farmer has less market power as the current situation deviates more from his desired situation compared to the retailer.

11.6.2 Sustainable value at chain and product level

In this dissertation an adapted version of the sustainable value method has been applied at farm level. As PIoS are typically hybrid configurations, it could be interesting to come to calculations of Sustainable value creation over the total value chain. In the ideal case the sustainable value of end products is calculated, as this can have a high communicative power. This necessitates aggregation of sustainable value scores at different stages in the supply chain, which also bears some resemblance with life cycle costing. As such the most 'sustainable' product and supply chain can be determined. The main difficulty is the determination of the benchmarks for each actor in the value chain. Another option would be to calculate the sustainable value for all value chain members jointly. As explained in chapter 7, also here the production technologies should be taken into account to calculate the value that a benchmark value chain would have created with the resources of the value chain under study. It is clear that this will not be straightforward.

11.6.3 Dynamic sustainability: resilience

In the static perspective developed in the chapter 10, all firms are projected towards a single point on the frontier, i.e. the sustainable profit efficient point. This would work well when there are no (unforeseen) changes in the system. As there are many known and unknown unknowns, in a dynamic perspective this outcome can't be a guarantee for sustainability.

The concept of resilience could therefore be used to take uncertainty and risk into consideration when assessing sustainability. Carpenter et al. (2001) define resilience as the magnitude of disturbance that can be tolerated before a socio-ecological system moves to a different region of state space controlled by a different set of processes[39]. We are interested in economic system resilience, knowing that economic resilience is conditional upon ecosystem resilience. A lower level system cannot survive when the higher level collapses. We are currently uncertain whether the capacity constraints defined in chapter 10 reflect the real maximum sustainable uses. We can thus define a two stage two level game (see figure 11.6 below) when the ecosystem is under threat due to an external shock. The consequence of the shock is a change in the use of a resource (or the production of a bad output) at the economic system level, if not the ecosystem goes into disequilibrium. The most topical example is

[39] In contrast, **sustainability** is an overarching goal that includes assumptions or **preferences about which system states are desirable**.

global warming. Not changing current resource consumption results into the undermining of the ecosystem's resilience, which leads to a switch to a new ecosystem state. Assuming that we do not want that, as this will impact heavily on our societal system, cutting resource consumption is the alternative. The question we could pose ourselves is whether our economic system is resilient to such a change in resource consumption.

Economic resilience can be defined as the degree to which an economic system is able to maintain its current level of value creation given a shock in a resource x. A system disposes of 3 mechanisms to rebuild this value creation after a shock: it can improve the technical efficiency of its subsystem units; it can reallocate resource x from allocative inefficient to allocative efficient firms and it can make technological progress.

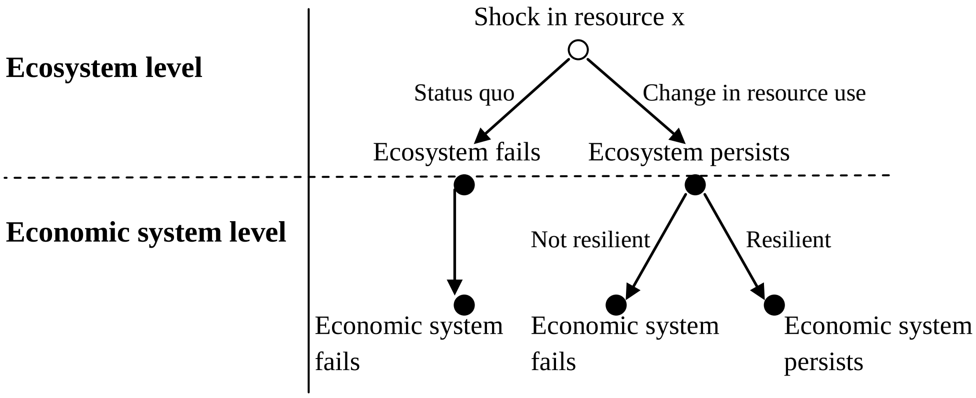


Figure 11.6. reaction of ecosystem and economic subsystem to an external shock

The procedure in chapter 10 shows how sustainability targets at the higher level and output increase at the firm level can be achieved jointly by simultaneously removing technical inefficiency at the input and output side. We also showed how profit can be maximized by applying the sustainable allocative efficient combination. Technical efficiency relates to the production function, the efficient conversion of physical inputs into outputs. Sustainable allocative efficiency occurs when the production function is applied that generates maximum profit, given prices for inputs and outputs. Remarkably, firms (radial) technically inefficiency score is independent from a system shock t_1, while the allocative inefficiency score is shock-dependent. An allocative efficient firm in t_0 can become allocative inefficient after shock t_1 and vice versa. A technical inefficient firm remains as inefficient after the shock.

It is not because the technical inefficiency is shock independent that it does not impact on a system's resilience. By becoming technical efficient an inefficient firm can set free some units of resource x to help absorb the shock. Thus, the more inefficient firms in the system, the more adaptive capability a system has to external shocks, ceteris paribus. However, the more technical inefficiency the less value is created in the system, ceteris paribus.

To objectively measure a system's resilience, i.e. its adaptive capability to shocks, we have to focus on the allocative inefficiency in the system. As explained above, the allocative inefficiency is shock-dependent, because a system shock in one resource changes the relative amounts of resources and therefore also the relative prices. There exists a direct relation between allocative inefficiency and an economic system's value creation potential under uncertain conditions. The more allocative inefficiency present in t_0, the more value can still be produced in the short run after a shock t_1[40]. When there is no allocative inefficiency in t_0, i.e. only the optimal production technology for regime t_0 is in use, a sizeable shock may imbalance the whole system. Accordingly, switching costs to a new system configuration are high, as the optimal technology is not yet in use. When different production technologies are in use, some allocative inefficient firms in t_0 become allocative efficient in t_1. The switching costs for the system will be considerably lower. Even more, in the short run some system elements will still be able to generate positive value. There is thus a tradeoff between present value creation and the potential to create value under uncertain conditions.

In Figure 11.7, the probability density function pdf(t_0) reflects the distribution of technologies f(x_1) across the firms in a system around $f(x^{opt}_{1,t0})$, which is the technology that creates most value in regime t_0. From efficiency theory, we know that several technologies can generate the same output, but that in a steady state only one maximizes profit, i.e. the allocative efficient combination. A change in the stock of the resource at ecosystem level creates a new most valuable point $x^{opt}_{1,t1}$, i.e. the new allocative efficient point. We can calculate how much value is destroyed in the short run due to the shock t_1, how much value remains, how much value can be regenerated in the longer run by reallocating x_1 across firms with existing technologies and how much of the initial value can only be restored after new technologies are introduced. The distribution of technologies in system 2 in Figure 11.7 is characterized by a much wider spread compared to system 1. As a consequence, less value is created in system 2 under regime t_0. On the other hand, given a shock t_1, less of its original value is destroyed. System 2 is thus more resilient to shocks compared to system 1.

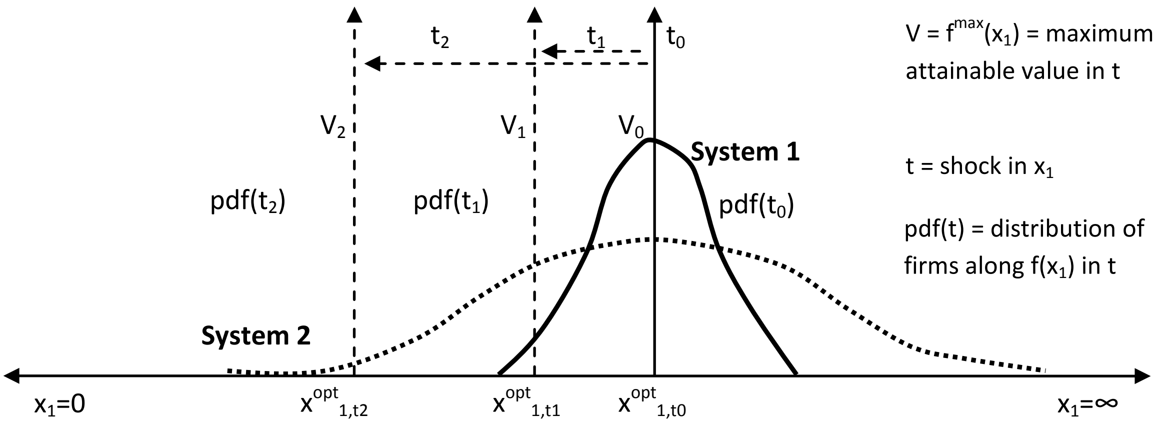


Figure 11.7. Distribution of firms in 2 systems around the value maximizing technology. When a shock in one of the resources occurs, only part (or none) of the technologies are still usable to rebuild the system. Some combinations are redundant while other have become more important to restore value creation. A shock of size t_2 brings system 1 in total disequilibrium, while system 2 can still partly use existing technologies to rebuild its value creation and resilience

We therefore argue that a good measure for an economic system's resilience is the amount of value that can be created under uncertain conditions, which relates to the amount of allocative inefficiency present in the system. The above concepts could be further operationalized into a calculation method.

11.6.4 Public-private interaction and social optimum

Both in chapter 2 and in the conclusions the important role of the public regulator was highlighted. A very strict regulatory framework inhibits the proliferation of PIoS, while a very

[40] under the assumption that the shocks are random and allocative inefficiency is not unidirectional

unregulated market might result into the creation of premium spot markets. The question is now where the social optimum is located and how costs and benefits are then distributed over the different stakeholders. Different papers, such as Giraud-Héraud et al. (2005), Roe and Sheldon (2001), Ben Youssef and Abderrazak (2009), Bougherara and Piguet (2009) develop theoretical models to address this. It would however also be interesting to see this confirmed in empirical analyses, where the assumptions underlying these theoretical models can be relaxed.

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Summary

The demand for an ecologically and socially more responsible production has increased dramatically. Traditionally, public authorities intervene by means of regulations and economic stimuli, but also private market parties integrate social and ecological concerns into their business objectives. As such they hope to create added value. Consequently, this can result into a win-win for both the private actor and the society.

To operationalize these private initiatives in the farm sector, certification schemes with private standards and labels are used. These certification schemes can be considered as an example of Private Institutions of Sustainability, which are sets of rules voluntary followed by private market actors to reach a sustainability target.

The doctoral thesis investigates whether these certification schemes and labels, as examples of Private Institutions of Sustainability, are a promising instrument to realize sustainable development.

The introductory part focuses on why market actors are interested in these Private Institutions of Sustainability. A first descriptive analysis places PIoS between other sustainable development initiatives. According to different market actors PIoS are promising both from economic and ecological perspective. An important condition for the success of these schemes is consumer interest. By means of 'choice preference'-modelling it is shown that there are strong consumer preferences for some sustainability claims. Moreover, different types of consumers perceive the same claims differently. A second important precondition for the success of these schemes is retail interest. In a qualitative analysis different retail strategies for sustainable production were identified.

The second part of the thesis focuses on whether these private systems deliver what they promise, which is effectively contributing to ecological, economic and social sustainability. First the contribution of PIoS to ecological sustainability is investigated by means of a meta-analysis. The contribution is confirmed, although some question marks can be placed. To assess the economic performance of these systems the sustainable value method is further optimized. The analysis reveals that firms participating in PIoS create more added value by using ecological resources more efficiently. The social performance was investigated by means of a qualitative analysis of social equity within the value chain. PIoS are not automatically a guarantee for social equity within the value chain.

In part three of the dissertation changes are modelled in the PIoS to further improve sustainability. By means of 'choice preference'-modelling the cost experienced by market actors for ecological changes in the certification scheme is estimated. This enables us to estimate the private cost for further ecological sustainability. In a following step it is shown how the 'choice preference'-methodology can be used to estimate the desired compensations for institutional changes within the certification scheme. This allows to reduce the information asymmetries during negotiations between participants in the value chain. Finally, a methodology is developed to assess the sustainable efficiency of firms and certification schemes when new sustainability targets are introduced. From the analysis it became clear that firms participating in certification schemes have a higher sustainable efficiency compared to firms who do not.

The research shows that there is still room for further ecological and economic improvement by removing current inefficiencies in the systems. Given that these institutions are private, a trade off is made between private and social objectives. Although the role of public authorities has shifted from initiator to monitor, it is important that these give the necessary impulses for further improving PIoS' sustainability. Finally, the contribution of PIoS to internal value chain social sustainability depends on whether specific rules have been incorporated that safeguard the equity between participants.

Samenvatting

De vraag naar een ecologisch en sociaal meer verantwoorde productie klinkt steeds luider. Traditioneel stuurt de overheid bij door middel van wetgevingen en economische stimuli, maar ook private marktdeelnemers nemen proactief sociale en ecologische thema's in de bedrijfsobjectieven op. Op die manier hopen ze meerwaarde te creëren en kan een mogelijke win-win situatie voor de private marktdeelnemer en de maatschappij ontstaan.

Om dergelijke private initiatieven te operationaliseren gebruikt men certificatieschema's met private standaarden en labels. Deze certificatieschema's kunnen gezien worden als een voorbeeld van Private Instituties van Duurzaamheid. Dit zijn sets van regels die een private marktdeelnemer vrijwillig volgt om een duurzaamheidsobjectief te behalen.

In de doctoraatsthesis wordt onderzocht of deze certificatiesystemen en labels, als voorbeeld van Private Instituties van Duurzaamheid, een veelbelovend instrument zijn om duurzame ontwikkeling te realiseren.

In het inleidende deel wordt bekeken waarom marktdeelnemers geïnteresseerd zijn in deze Private Instituties van Duurzaamheid. Een eerste beschrijvende analyse plaatst deze Private Instituties van Duurzaamheid tussen andere initiatieven die een duurzamere ontwikkeling beogen. Volgens de verschillende marktdeelnemers zijn Private Instituties van Duurzaamheid zowel vanuit economisch als ecologisch perspectief veelbelovend. Een belangrijke conditie voor het welslagen van deze private systemen is interesse van de consument. Door middel van 'keuzepreferentie'-modellering wordt aangetoond dat er duidelijke consumentenvoorkeuren zijn voor bepaalde duurzaamheidsclaims. Bovendien reageren verschillende types consumenten anders op dezelfde claims. Een tweede belangrijke voorwaarde voor het welslagen van deze private systemen is interesse vanuit de grootdistributie. In een kwalitatieve analyse werden verschillende strategieën binnen de grootdistributie voor duurzame productie geïdentificeerd.

In het tweede deel van deze thesis wordt nagegaan of deze private systemen doen wat ze beloven, namelijk effectief bijdragen tot ecologische, economische en sociale duurzaamheid. Eerst wordt aan de hand van een meta-analyse onderzocht of deze certificatiesystemen ecologische duurzaamheid bevorderen. Dit blijkt zo te zijn, met inachtneming van enkele kanttekeningen. Om de economische performantie van deze systemen in te schatten werd de duurzame waardemethode verder geoptimaliseerd. Uit de analyse blijkt dat deze private systemen meer toegevoegde waarde creëren door een efficiënter gebruik van ecologische middelen. De sociale performantie wordt vervolgens onderzocht door een kwalitatieve analyse van sociale gelijkheid binnen de waardeketen. Deze certificatiesystemen blijken niet automatisch een garantie voor sociale gelijkheid binnen de waardeketen te zijn.

In deel drie van de thesis worden veranderingen in de Private Instituties gemodelleerd die de duurzaamheid verder bevorderen. Aan de hand van 'keuzepreferentie'-modellering wordt nagegaan welke kost de private marktdeelnemers ervaren voor ecologische veranderingen in het certificatieschema. Op die manier wordt een inschatting gemaakt van de private kost voor een verdere ecologische verduurzaming. Een volgende stap beschrijft hoe de 'keuzepreferentie'-methodologie kan gebruikt worden om de gewenste compensaties voor institutionele veranderingen binnen het certificatieschema in te schatten. Zo kan de informatieasymmetrie tussen de verschillende deelnemers van de waardeketen tijdens

onderhandelingen gereduceerd worden. Tenslotte wordt een methodologie ontwikkeld om de duurzame efficiëntie van bedrijven en certificatiesystemen in te schatten wanneer nieuwe duurzaamheidsdoelstellingen worden geïntroduceerd. Uit de analyse blijkt dat bedrijven die deelnemen in certificatiesystemen een hogere duurzame efficiëntie hebben dan bedrijven die dit niet doen.

Het onderzoek toont dat er nog ruimte is voor ecologische en economische vooruitgang door het verwijderen van huidige inefficiënties in de systemen. Gegeven dat deze instituties privaat zijn, wordt er bovendien een afweging gemaakt tussen private en sociale objectieven. Hoewel de rol van publieke autoriteiten verschoven is van initiator naar monitor, is het belangrijk dat deze de nodige impulsen geven zodat deze systemen verder verduurzamen. Tenslotte hangt de bijdrage tot interne sociale duurzaamheid af van het feit of specifieke regels die de gelijkheid tussen ketenpartners verhogen, worden opgenomen in de Private Instituties van Duurzaamheid.

Curriculum Vitae

1. Personalia

Name: Mondelaers
First name: Koen Karel Johan Paul
Date of birth: 4 october 1979
Place of birth: Gent
Gender: M
Nationality: Belg
Marital state: married
Cell Phone: 0032 479 614 995

2. Diplomas

Master: Ghent University, Faculty of Bioscience Engineering
Master of Bioscience Engineering: agricultural sciences, option tropical agriculture, with distinction (1997-2003)
Master thesis: Rural microfinance: impact of saving and credit initiatives on the rural communities of Guntur, India; case study in India, Promoter: Prof. dr. ir. P. Van Damme

Additional master: Ghent University; Faculty of Economics
Complementary Studies in Economics and Business Administration - Option: Business Economics, with great distinction (2003-2004)
Additional master thesis: Land Reform in South Africa: a research program to determine the extend of land transfers to black South Africans outside the official Land Reform Program
Proposal for VLIR Eigen Initiatieven
Promoter: Prof. dr. ir. L. D'Haese

3. Professional record

3.1. Employment as doctoral student/researcher at Department of Agricultural Economics, Ghent University (September 2004 – December 2009)

Project title: Conversion to organic agriculture: scenario analysis of bottlenecks in the institutional and market environment (Omschakeling naar biologische landbouw: scenarioanalyse van knelpunten in de institutionele en marktomgeving).
Period: 01/09/2004 – 30/06/2005
Finance: IWT
Other partners: Brussels: Centre for Agricultural Economics
Personal contribution: See publications, chapters in book: Biologische landbouw: mens, markt en mogelijkheden

Project title: Sustainability of certified production systems – the example of labels in the agrofood sector (Duurzaamheid van gecertificeerde productiesystemen - het voorbeeld van labels in de agrovoedingssector)
Period: 01/09/2004 – 30/11/2005
Finance: Federal Science Policy
Other partners: UGENT – Department of Phytopharmacy
Tervuren: CODA/CERVA
University of Gembloux (Liège): SSED
Personal contribution: Internal functioning and willingness to change of participants in certification schemes

Project title: Surplus value of organic food and farming (Meerwaarde biologische voeding en landbouw)
Period: 01/04/2006 – 15/11/2007
Finance: ALT – ADLO

Other partners:	UGENT-FBW – Department of Food Safety and Quality UGENT-FBW - Department of Phytopharmacy UGENT - Faculty of Medicine
Personal contribution:	Surplus value of organic farming with respect to environmental aspects Choice experiments: consumers' willingness to buy organic

Project title: Sustainable Value Analysis of Policy and Performance in the Agricultural Sector (Duurzame waarde analyse van beleid en performantie in de landbouwsector)

Period:	01/03/2007 – 01/03/2009
Finance:	EC – DG Research
Other partners:	Consortium of 9 international partners - see website http://www.svappas.ugent.be
Personal contribution:	Management: assistant coordinator Scientific: Methodological improvements of SV

3.2. Employment as researcher at Institute for Agricultural and Fisheries Research, Social Sciences Unit (from January 2010 onwards)

4. Publications

A1:

Mondelaers, K. and Van Huylebroeck, G. (2008). Dynamics of the retail driven higher end spot market and its institutions. British Food Journal, 110 (4/5), 474 – 492.

Mondelaers, K., Verbeke, W. and Van Huylenbroeck, G. (2009). Importance of health and environment as quality traits in the buying decision of organic products. British Food Journal. 111 (10), 1120-1139.

Mondelaers, K., Aertsens, J. and Van Huylenbroeck, G. (2009). A meta-analysis of the differences in environmental impacts between organic and conventional farming. British Food Journal, 111(10), 1098-1119.

Aertsens, J., Mondelaers, K. and Van Huylenbroeck, G. (2009). Differences in retail strategies for marketing organic products. British Food Journal, 111 (2),138 – 54.

Aertsens, J., Verbeke, W., Mondelaers, K. and Van Huylenbroeck, G. (2009) . Personal determinants of organic food consumption: a review. British Food Journal. 111(10), 1140 – 1167.

Hoefkens, C., Verbeke, W., Aertsens, J., Mondelaers, K. & Van Camp, J. (2009) .The nutritional and toxicological value of organic vegetables: consumer perception versus scientific evidence. British Food Journal. 111(10), 1062 – 1077.

Verbeke, W., Van de Velde, L., Mondelaers, K., Kühne, B. and Van Huylenbroeck, G. (2008). Consumer attitude and behaviour towards tomatoes after 10 years of Flandria quality labelling. International Journal of Food Science and Technology, 43(9), 1593 – 1601.

Submitted to A1:

Mondelaers, K, Lauwers, L. and Van Huylenbroeck, G. (2010). Sustainable value creation by Private Institutions of Sustainability. Submitted to Ecological Economics.

Mondelaers, K., Kuosmanen, T., Van Passel, S., Buysse, J., Lauwers, L. and Van Huylenbroeck, G. (2010). Meeting industry sustainability targets by improving firm efficiency. Submitted to Journal of Environmental Management.

Chapters in book:

Mondelaers, K., Garreyn, F., Roussel, L., Louviaux, M., Mormont, M., Pussemier, L., Steurbaut, W. and Van Huylenbroeck, G. (2007). Certified production systems: a way forward towards sustainability? In: Towards a safer food supply in Europe. Eds. Van Peteghem, C., De Saeger, S. and Daeseleire, E. Belgian Science Policy, Brussels, ISBN 978-90-8756-032-4.

Mondelaers, K., Van Huylenbroeck, G. en Verbeke, W. (2005). Hoofdstuk 6: De markt en de consument van bioproducten. In: Biologische landbouw: mens, markt en mogelijkheden. Van Huylenbroeck, G., De Cock, L. en Lauwers, L. (eds.). Leuven: LannooCampus, 111 - 127.

Mondelaers, K. en Van Huylenbroeck, G. (2005). Hoofdstuk 7: Belgische bio: strijd om de binnenlandse markt. In: Biologische landbouw: mens, markt en mogelijkheden. Van Huylenbroeck, G., De Cock, L. en Lauwers, L. (eds.). Leuven: LannooCampus, 128 - 148.

Mondelaers, K. en Van Huylenbroeck, G. (2005). Hoofdstuk 8: Prijs voor groei. In: Biologische landbouw: mens, markt en mogelijkheden. Van Huylenbroeck, G., De Cock, L. en Lauwers, L. (eds.). Leuven: LannooCampus, 149 - 165.

Reports:
Van Huylenbroeck et al. (2005). Omschakeling naar biologische landbouw: scenarioanalyse van knelpunten in de institutionele en marktomgeving. IWT, p. 156
Author of the second part.

Van Huylenbroeck et al. (2006). Sustainability of certified production systems – the example of labels in the agrofood sector. Federal Science Policy, D/2006/1191/23, p. 199
http://www.belspo.be/belspo/home/publ/pub_ostc/MA/MA03_en.pdf
Author of Chapter 1(Introduction), Chapter 2, Chapter 6, Chapter 7, Chapter 9 (Conclusion)

Van Huylenbroeck et al. (2007) Surplus value of organic farming. ALT/ADLO.
Author of Part 2 Environmental aspects and co-author of Part 4 Consumer perceptions

International presentations:
Mondelaers, K. and Van Huylenbroeck, G. (2008). Farmers' preferences in evolving certification and labelling systems. Oral presentation, 8th International Conference on Management in Agrifood Chains and Networks, Ede, the Netherlands, May 28-30, 2008.

Mondelaers, K., Verbeke, W. and Van Huylenbroeck, G. (2008). Importance of health and environment as quality traits in the buying decision of organic products. Oral presentation, CREDA workshop, Castelldefels, Spain, July 3 – 4, 2008.

Mondelaers K. , Garreyn F., Steurbaut W., and Van Huylenbroeck G. (2008). Farmers' acceptance of further strengthening of private certification systems. Poster with oral presentation, EAAE 2008 Congress, Ghent, Belgium, August 26 – 29, 2008.

Aertsens , J., Mondelaers, K. & Van Huylenbroeck, G. (2006). Surplus Value of Organic Food and Farming. Poster, Joint Organic Congress, Odense, Denmark, May 30-31, 2006.

5. Co-promotor of Master Theses

2005 – 2006:	Economic analysis of bottlenecks and strengths of the organic label Biogarantie – Bart Van der Straeten
2006 - 2007:	Consumer perception of organic vegetables and profiling of the Flemish organic consumer – Jeen Van den Berg
2007 - 2008:	Meta-analysis of the full environmental costs of organic and conventional farming – Pieter Galle