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The economics of HACCP: farm-to-table analysis

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Introduction

Risk analysis seems to be one of the basic principles for the food-safety policies in the EU. According to the EU White Paper the food policy should be based on the three elements in risk analysis, that is risk evaluations (scientific consultancy and data analysis), risk management (regulation and control) and communication of risk factors (*Food safety - a worldwide public health issue* 2000). However, it is remarkable that nothing explicitly is said about the role of economics in the EU White Paper on Food Safety. Does this reflect that the EU politicians and authorities reject to include economists in the risk-analysis process in considering the appropriate food policies to adopt and the policy regulations to deploy?

By arranging a workshop with the title "New Approaches to Food-Safety Economics" it is once again stressed that we need to readdress the role that economics might and can play in policies and strategies for food-safety improvement. One renewed approach might be to adopt a system methodology in order to ensure an enhanced integration of cost-benefit evaluations into risk analyses. In what follows, I will attempt to discuss the benefits and challenges of such a system methodology by using an ongoing Danish research project concerning the economics of food quality and safety as an example.

Background and aim of the Danish project

The project (Food quality and safety – Consumer behavior, food supply chains and economic consequences) was initiated in 2001 by the Danish Research Institute of Food Economics. The motivation for starting the project was a need to improve our general knowledge about quantitative relationships and behavioral parameters related to quality and safety attributes in Danish food products, not least seen under the changing policy regulations that Danish producers, manufacturers and consumers are facing.

The project has three major aims. Firstly, the purpose is to investigate consumers' attitudes towards food quality and safety, including the effects of labeling, marketing and product identity for consumer behavior. Secondly, the aim is to quantify and evaluate the consequences of changing consumer requirements for the downstream food chain. This will be accomplished by case studies where selected food products are analysed and central issues are identified through the different stages in the chain, i.e. from the consumer via retailers and distribution to processing and primary production. Thirdly, by using generated price and cost information holistic scenario

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analyses are carried out in order to evaluate the economic perspectives for production and marketing of food products with specific safety and quality attributes.

The research efforts in the project are mainly directed towards executive managers in the food industry and policy regulators, who are all involved in strategic decision-making concerning the formulation of future quality and safety strategies related to the production and distribution of food products to Danish and foreign consumers.

The contents of the project

The project will be carried out in five subprojects as shown in figure 1:

I. Establishment of the project
II. Consumer behavior and marketing
III. Quality and safety in the supply chain
IV. Holistic scenario analyses
V. Recommendations and perspectives.

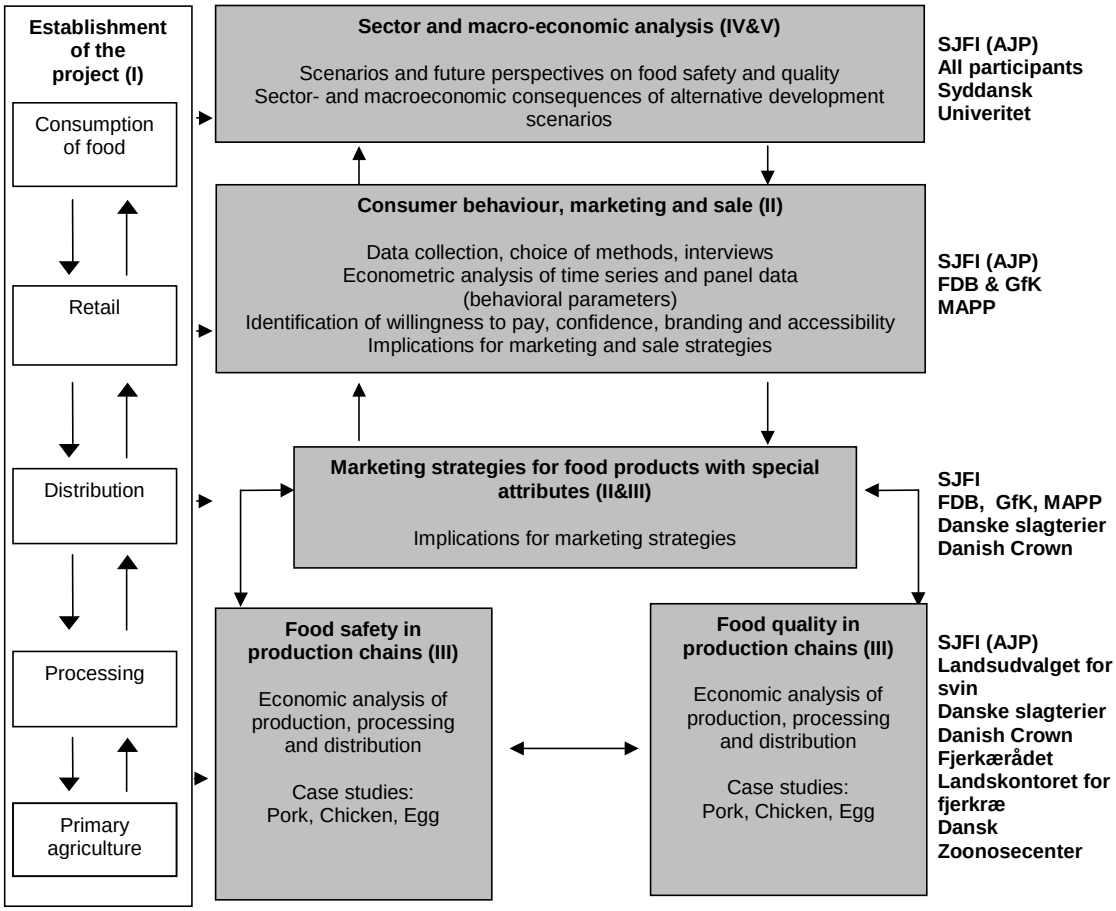

Figure 1. The Danish project concerning the economics of food quality and safety

I. Establishment of the project

The project is designed as a cooperative project between the Danish Research Institute of Food Economics (SJFI) and a range of other institutions, including a data-survey institute (GFK), a center for research on customer relations in the food sector

(MAPP), a surveillance center for zoonosis (Dansk Zoonosecenter), an institute for human-health economics (Syddansk Universitet), a major food retailer (FDB), the biggest Danish slaughterhouse (Danish Crown) and several development and extension associations (Danske Slagterier, Landsudvalget for Svin, Fjerkrærådet and Landskontoret for fjerkræ).

The aim of subproject I is to establish a general conceptual framework for the total project and to identify the working tasks of the individual participants and their collaborative relationships.

II. Consumer behavior and marketing

The aim of the subproject is to perform quantitative analyses on the behavior of Danish consumers with respect to the demand of food products. The analyses include the division of the food consumption into different product groups and different categories of quality and safety as well as estimates of the sensitivity of the consumption patterns with respect to price and income changes for different product groups and levels of quality. The subproject includes four parts:

- Establishment of a database for consumer data and characteristics, food prices, etc.
- Estimation of parameters for consumer behavior
- Analyses of the impact of information asymmetries, credence, accessibility, etc.
- Evaluation of alternative marketing strategies.
- Econometric methods are employed to estimate consumer behavior and willingness to pay for high-quality foods by formulating alternative demand systems that will include variables such as income, prices and safety and/or quality indicators.

III. Quality and safety in the supply chain

The purpose of the subproject is to identify and evaluate strong and weak points in existing supply chains and on this basis specify minimum standards for safe food products. A second objective is to estimate the costs associated with the production, distribution and marketing of specific food products characterized by high levels of safety and quality. As indicated in the figure, analyses will be performed for three case studies, including pork, eggs and chickens. These three food products should represent different degrees of integration in the food supply chains and different strategies to comply with food-safety regulations.

Industrial organization theory and new institutional economics will be applied to evaluate the performance of the existing supply chains, while the best methods to estimate the costs in the different stages of the chains yet have to be decided.

II & III Evaluation of marketing strategies

Based on the knowledge generated in subprojects II and III, a number of different marketing strategies will be evaluated under due consideration to, for instance, the design of relevant labeling schemes. Thus, the aim of the analysis is to identify the opportunities and limitations of alternative marketing strategies for food products with specific quality and safety characteristics such as *Salmonella*-free products. Organizationally, the analysis of the marketing strategies is considered as a part of subproject II.

IV. Holistic scenario analyses

The aim of this subproject is to integrate the results from the other subprojects into holistic economic analyses. Thus, to estimate the total benefits and costs related to an improved level of food quality and safety and to evaluate the future economic perspectives for the production and marketing of Danish food products with enhanced quality and safety. The subproject contains three parts:

- Overall social evaluations related to food-borne diseases
- Construction and evaluation of a baseline scenario for the future development of the Danish food industry
- Construction and evaluation of alternative scenarios for the future development of regulatory polices, changing consumer preferences etc.

The scenario evaluations will be performed by use of a Danish general equilibrium (CGE) model with the nickname "Aage", which by construction can simulate the interactions between different economic sectors and markets in the Danish economy. However, in the project no considerations are explicitly taken into account with regard to the international trade effects of potential changes of the Danish and/or the EU food policies.

V. Recommendations and perspectives

The objective of this latter subproject is to summarize the results and experiences from the four subprojects and to formulate policy recommendations in relation to the:

- marketing strategies of the food industry
- formulation of future food policies
- new research and development activities related to food quality and safety.

By using this project as an example, I will attempt to address the key questions as formulated in the workshop program under the headline "Farm-to-table Risk Analysis and HACCP".

How can cost-benefit analysis be integrated into farm-to-table risk analysis?

In a framework as shown in Figure 1 it is in principle possible to integrate cost–benefit analyses into farm-to-table risk analysis. Since, food economics is all about determining the point where the marginal costs spent on e.g. food safety just balance the marginal benefits gained from the resultant increase in food safety. Such economically optimal solutions also imply that no change in reallocation of resources from e.g. environmental protection to food safety could increase overall human welfare.

In practice, the integration is of course much more difficult. One major problem we are facing is the problem of valuing the benefits of an increase in food safety. These benefits are normally assumed to be the reduction in suffering and an improvement in life expectancy, which are intangible and uncertain by nature and therefore difficult to measure. However, when governments for example decide to construct new roads rather than building a new hospital, they are also implicitly valuing human life.

In my opinion one major challenge in order to integrate cost–benefit analysis into farm-to-table risk analysis is to establish a much better cooperation between researchers from the natural and social sciences and also between research communities, private companies and the public authorities. For example, in recent

years animal diseases and production losses due to these diseases have been investigated to a greater extent. However, most of this information has not been utilized in a holistic manner to evaluate the total impact on animal production and on the related industries. The experiences from our Danish project are that it requires a lot of time and effort to establish and maintain such types of networks.

What lessons can we learn from modeling animal-disease risks?

Obtained experiences indicate that a number of important lessons can be learned from modeling animal-disease risks. First, we know that traditionally decisions on control strategies at the herd level have been based on the farmer's or herd advisor's subjective judgement, intuition, experience, attitudes to risk and presumed economic costs and benefits of control strategies. Therefore, we should not expect practical decision-makers to make important decisions on the basis of cost–benefit studies alone. The challenge is of course to prove that the economist's framework to think and make analyses can and should be an important contribution to the decision-making process (Houe et al. 2001).

Secondly, experiences with decision-support systems in animal-health management show how difficult it is to construct real integrated models for practical decision-making. We normally agree that biological and economic modeling should be integrated in order to provide improved decision support to farmers, but often this is not the case. Frequently, the economic model is just an appendix to the technical/biological model; the reason may be that the model builders from natural sciences and social sciences have no common training, experiences or professional working fields (McInerney 2001).

Thirdly, we have learned how difficult it is to obtain knowledge about all risk factors and their causal relationships, and how difficult it is to gather sufficient and reliable data on the effects of these risk factors.

Fourthly, it is increasingly realized that modeling animal diseases should be done in a wider context. As noted by Dijkhuisen (Dijkhuisen 1998), a more integrated chain approach is necessary in order to provide fast and reliable tracing of animal diseases to meet safety requirements. A system perspective seems to be appropriate as farms are consolidated into fewer, but larger production units that are operating with an industrial mentality, which creates the opportunity for supplying differentiated agricultural products into the food chain (Downey 1996).

How does a system approach differ from examination of stages of the food chain separately?

Food products are produced and consumed through a series of stages from farm production to the end consumer as illustrated in Figure 1. Understanding the competitiveness of all the stages is important, not only in terms of determining how the total chain performs, but also in understanding the appropriate role of e.g. public regulation. Most economic studies, however, have only considered selected parts of the food supply chain.

The term "system" might better describe the business challenges faced by food and agribusiness firms than the term "chain". The term "chain" is associated with a linear understanding that is insufficient to understand really all the interactive and dynamic business games that are increasingly taking place among firms in the battle for gaining competitive advantages and control in the food markets. Furthermore,

food supply chains often involve many interconnected stages and inputs, and failure at any point in the chain may require the product to be condemned. Several examples of serious food contamination by pathogens in different countries have illustrated these interconnections, and high costs associated with such food scares have been reported in the literature. Thus, it seems that the most serious food-safety problems can be characterized as systemic by nature. According to Hennessy, Roosen and Miranowski (Hennessy, Roosen and Miranowski 2001), two of the most important aspects of systemic failure are interconnectivity, which provides the technological potential for systemic failure, and the incentive problems, which provide the economic potential for systemic failure.

Measures to prevent food-safety problems from recurring are more likely to be successful if these interconnectedness and incentive aspects are understood from a systemic perspective. One example might be the understanding the total effect of supply management (Downey 1996). Another highly relevant example might be an improved understanding of the investment incentives in the chain and the problems concerning the division of the economic surplus among the actors in the supply chain. Thus, a systemic approach may have the potential to avoid sub-optimal solutions.

Does a system approach provide lower cost solutions?

At least, by adopting a system approach it is easily recognized that different measures can be taken to improve the safety of the food supply. Many regulatory alternatives are available along the chain from the farm to the table that might implement changes in production, processing, distribution and consumption in order to reduce the health risks associated with food-borne diseases. Among these are (Crutchfield et al. 1997):

- Improving the meat and poultry inspection system;
- Educating consumers, retailers, and food-service workers, and promoting safe food handling;
- Irradiating meat and poultry products; and
- Using market-oriented approaches to food safety: labeling, branding, legal incentives, and providing food-safety information about products or production methods.

All such options could help improve the safety of meat, poultry and other food products, but to make optimal choices among these alternatives requires estimation of the costs and benefits of each policy followed by a ranking of the available alternatives. Some sort of a system approach will also be necessary in order to evaluate all the distributional consequences of implementing new regulatory policies for farmers, food processors, retailers and consumers.

What will be the implication of the proposed HACCP directive from the EU that will apply to most of the food chain?

Governments, public agencies and international organizations (WHO, FAO) are increasingly recognizing HACCP as one of the most effective means to provide safe food. The basic idea of HACCP systems is to keep control by identifying the critical control points (CCPs) in the food production and distribution processes that are most important to monitor (Mortimore and Wallace 2001). As noted by Unnevehr and Jensen (Unnevehr and Jensen 1999) there is, however, some disagreement concerning

the consequences of mandatory imposition of HACCP. Among other issues they mention disagreement regarding how effectively HACCP will be to control or eliminate some food-safety hazards, the controversy regarding whether it improves or reduces regulatory oversight and whether it allows firms to meet food-safety objectives in the most efficient manner or it is overly prescriptive.

Of course, it is possible to implement HACCP systems in the whole food chain, although HACCP is originally developed as a food-safety management tool to be used in individual firms. Currently it is probably most widespread in the food-processing industry. If the HACCP principles have to be implemented throughout the whole food chain, the requirements will be different and all the direct and indirect consequences will be difficult to predict. All the potential hazards in the chain should be identified and all scientific information needed for systemic risk assessments should be provided. It also raises the question about who should set the food-safety standards and critical limits of the CCPs and who is assumed to carry out all audit and verification activities.

If HACCP is applied to manage food safety in every stage of the food system from farm to table, we furthermore have to investigate if the total system is designed to provide enough feedback to make appropriate corrective actions. One of the characteristics of the response to food-safety issues is that it should be rapid because food safety may be an emotive issue among consumers; and when it comes to real food scares, HACCP systems seem to be of limited value, because the system works by negative-feedback mechanisms. In dealing with food scares there may instead be a need for crisis management, which requires use of other mechanisms such as “crisis teams”.

There may also be some concern that mandatory application of HACCP in the whole food chain will make it more difficult to coordinate public regulation with private incentives for using quality-control systems. Private systems include self-regulation and various forms of certification by other parties (Henson and Caswell 1999).

How can we measure the costs and benefits of alternative interventions or systems of prevention?

The main problem with measuring the costs and benefits of such regulations is that food safety itself is very difficult to measure. This is also the case in our Danish project, where we have to estimate both the benefits and costs of alternative safety regulations in the food chains. As noted by Antle (Antle 1999), information about the various quality and safety attributes of food products is not perfectly known by consumers, producers, government regulators and researchers. Microbial pathogens cannot easily be identified in the production process and their health effects are often difficult to recognize. This is reflected in the reported empirical cost–benefit analyses, which indicate that the existing data can only provide us with highly uncertain estimates of the benefits and costs associated with new food-safety regulations (Crutchfield et al. 1997).

As already noted, the benefits of food-safety regulation are reductions in risks of suffering and mortality associated with contaminated foods. A number of methods have been developed to measure health risks and risks of dying. The most simple method to value health risks is the cost-of-illness method (Kenkel 1994), but although it is simple to use, it lacks a theoretical foundation. A more proper theoretical approach is adaptation of the willingness-to-pay methods, which will be used in the

Danish project. There seems, however, to be some controversy about their validity and their ability to produce sufficiently general results (Antle 1999).

There are three well-known approaches available to estimate regulatory costs. The first one is the accounting approach, which is rather straightforward to use, but also has a number of limitations. The most important is that it is not possible to measure the overall efficiency of any changes in input variables such as quality control. The second is the economic-engineering approach by which it is possible to get a rather detailed description of the cost structure and whereby it is also in principle possible to derive the cost function. The economic-engineering approach is, however, rather time-consuming to apply. The last approach is to estimate cost functions by use of econometric methods. Traditional econometric estimation methods generally require greater data sets compared to the two other methods, but the advantages of the econometric methods are that it is possible to study actual cost behavior and that statistical tests concerning the underlying production structure and behavior can be carried out.

Final remarks

I have no doubt that much can be gained from adopting a systemic perspective in cost-benefit assessments of food-safety regulations, but I do not think that it is possible to point out the best economic tools. The choice of methods will always be dependent on the specific circumstances. But a general future research challenge in measuring the benefits and costs of food-safety regulations is – in my opinion – to develop methods that can make the best use of the available data, which are limited and imperfect (Antle 1996; Antle 1999). Another important potential research area is to study the implementation costs associated with new forms of regulations. Depending on the time frame given to implement new regulations, firms will have more or fewer opportunities to learn how to handle new routines, and these may have important impact on their adjustment costs.

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