MEASURING THE COSTS OF FOODBORNE DISEASES: A REVIEW AND CLASSIFICATION OF THE LITERATURE

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Abstract

The food scandals and foodborne disease outbreaks in recent years have increased the demand for food safety and have led policy makers once more to tighten the safety regulations in the food supply chain. Obviously, an adequate balance between the costs of foodborne diseases and the costs and benefits of improved food safety is not static but time-varying and depends very much on specific situations. Given the complexity of an economic assessment of food safety, it is not surprising that the literature in this field mainly analyses particular stages but not the complete food supply chain from the farm to the consumer. This paper focuses on the costs of foodborne diseases and aims to review and classify the existing literature along a set of certain evaluation criteria. Our main findings are that most studies so far have been conducted in the USA and the UK. The reviewed studies consider mainly the consumption level of the supply chain, focus on tangible costs, examine budgetary costs and costs of individuals, and make use of the cost-of-illness approach.

Key words: food safety, food scandals, costs of foodborne diseases, food supply chain

Zusammenfassung

Die jüngsten Lebensmittelskandale haben die Nachfrage und auch das politische Angebot nach mehr Regulierung in der Warenkette erneut gesteigert. Demnach ist ein „angemessenes" Gleichgewicht zwischen den Kosten von lebensmittelbedingten Erkrankungen und den Kosten sowie dem Nutzen einer verbesserten Lebensmittelsicherheit nicht statisch, sondern verändert sich im Zeitablauf und hängt von vielen Faktoren ab. Aufgrund der Komplexität im Hinblick auf die ökonomische Bewertung von Lebensmittelsicherheit ist es nicht verwunderlich, dass in der Literatur zu diesem Thema häufig nur einzelne Stufen und nicht ganze Lebensmittelwarenketten vom Landwirt bis zum Konsumenten analysiert werden. Der vorliegende Beitrag hat zum Ziel, die bestehende Literatur zu den Kosten von lebensmittelbedingten Erkrankungen auszuwerten und zu klassifizieren. Zu unseren wichtigsten Ergebnissen zählt, dass der größte Teil der betrachteten Studien in den USA und in Großbritannien durchgeführt wurde und meistens der Fokus auf den Kosten für die Konsumenten lag. Zudem wurden in den Studien überwiegend die so genannten messbaren Kosten sowie staatliche Kosten und Kosten der einzelnen Individuen untersucht und dabei der Krankheitskostenansatz angewendet.

Schlüsselwörter: Lebensmittelsicherheit, Lebensmittelskandale, Kosten von lebensmittelbedingten Erkrankungen, Lebensmittelwarenkette

1 Introduction

Due to a growing number of food scandals[1] as a consequence of foodborne disease outbreaks in both developed and developing countries in recent years, the issue of food safety and associated health concerns is again in the focus of public interest. Recent trends, including large-scale production practices, globalization of the food supply and distribution at larger geographic distances have been, without doubt, catalysing factors for foodborne disease outbreaks (NYACHUBA, 2010). Be-

[1] It should be noted that when the term "food scandal" is used in our paper, we refer to a particular event which takes place as a consequence of a foodborne disease outbreak.

sides, the occurrences of such outbreaks[2] as bovine spongiform encephalopathy (BSE) and foot-and-mouth disease virus (FMDV) have shown the direct link between livestock and foodborne diseases (BENNETT, 2003). In the case of food scandals related to foodborne diseases the social and economic consequences can be disastrous. This fact was again made clear by the events surrounding the issue of dioxin-contaminated feedstuffs and the outbreak of Escherichia coli (EHEC) in Germany and Europe in 2011, although the food contamination with dioxin did not cause any foodborne diseases.

Since the structure of global food chains is becoming more and more complex, the scope of possible foodborne diseases and scandals has long been a matter of international food safety concern. The contamination of food in one country may also seriously affect the public health and the economic situation in other countries. Such phenomena as the concentration of food production and globalization of food supply seem to increase the risk of a food scandal and make its occurrence even more large-scale and difficult to control (MØRKBAK et al., 2011). Moreover, due to the growing preparedness for bioterrorism attacks, both unintentional as well as intentional contaminations in the food and feed chain are now at top of the global food safety agenda. If unintentional food contaminations could already affect many consumers and cause damage to various economies, the consequences of a deliberate contamination, especially with intentionally selected aggressive pathogens, could be devastating (CFSAN, 2003).

Each foodborne disease outbreak and food scandal certainly increases the demand for more food safety and leads policy-makers to tighten the safety regulations in the food supply chain (MARETTE et al., 2003). However, creating such policy regulations is a two-sided coin. On one side, such regulations aim to reduce health risks for consumers and to decrease the economic burden of possible foodborne diseases by improving the level of food safety. On the other side, additional regulations often come at the expense of the agri-food sector. Besides, governmental programs fostering food safety also require budgetary expenses. An adequate balance between the costs of foodborne diseases, and costs and benefits of improved food safety, is obviously not static but time-varying and depends very much on specific situations.

There is a variety of methodological approaches in the literature which measure the economic impacts of foodborne diseases, each with specific strengths and weaknesses. These approaches include both the assessment of the consequences of foodborne diseases as well as the cost-benefit evaluation of quality and safety improvement measures in order to avoid them. However, despite the existing concepts and suggestions to systemize the approaches to the economic assessment of food safety (e.g., ANTLE, 2001; VALEEVA et al. 2004; BAERT et al., 2011) a thorough classification of the numerous empirical studies is, to our knowledge, missing in the literature. Most studies dealing with the economic assessment of foodborne diseases are also restricted to a small number of contaminants and countries (OTTE et al., 2004). Many authors analyse the costs related to medical expenses of infected patients and only a few of them focus on industry costs limited to either a single company level (JACXSENS et al., 2010; LUNING et al., 2010) or to specific stages of the chain (JENSEN and UNNEVEHR, 2000; MORTLOCK et al., 2000).

This paper focuses on the costs of foodborne diseases and aims to review and classify the existing literature. In the next section, we present an overview of the empirical scope of the selected studies and group them according to a set of evaluation criteria. The latter include, besides to the

[2] The World Health Organization (2008) provides a very specific definition of a foodborne disease outbreak: "i) the observed number of cases of a particular disease exceeds the expected number; ii) the occurrence of two or more cases of a similar foodborne disease resulting from the ingestion of a common food". It should be mentioned that we use the term "outbreak" in the sense of occurrence and not in the sense of an epidemic.

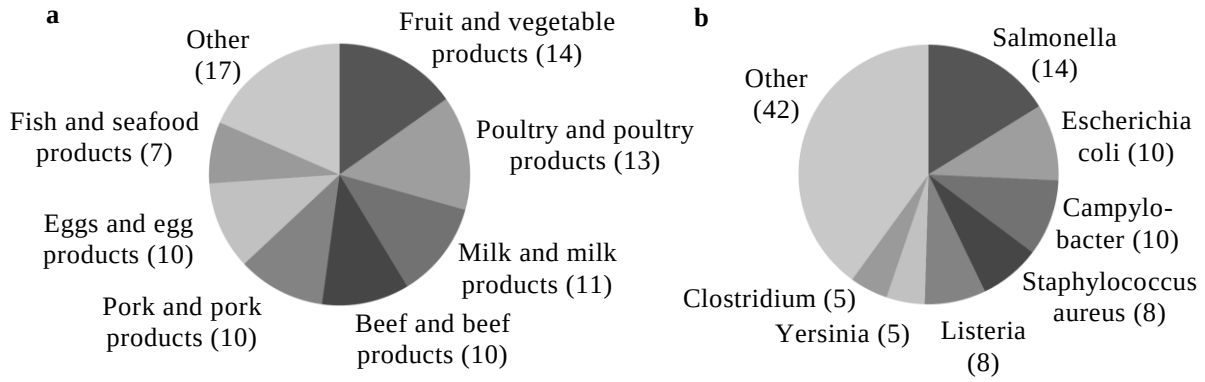
products and contaminants analysed, the kind of cost components considered and the methodology used. In the last section, we summarize our main findings.

2 Overview of studies dealing with the economic assessment of food safety

We performed the bibliographic search of empirical studies dealing with the economic assessment of food safety using electronic databases (Google Scholar, ScienceDirect, JSTOR, SpringerLink, EconLit, AgEcon). In order to select the empirical studies for our review we applied the following filter. First of all, we looked only at those studies which consider the economic impacts, i.e., the costs, of foodborne diseases.[3] This criterion is an important one, since there is a large strand of literature dealing, for example, with the economic assessment of environmental pollution or other health risks which are not caused by foodborne contaminants. Then, we excluded all studies considering the economic assessment of general food safety improvements and analyses based on the willingness-to-pay (WTP) approach. We did not make any specifications to the kind of food included into our search, which can be attributed to the limited number of such studies. We also did not limit the studies to a certain region or the type of contaminants for similar reasons. In order to guarantee that the information is at least to some degree up-to-date we included all works published after 1984. In the end, we selected 38 empirical studies and analysed their main characteristics.[4]

The general criteria for classification of the studies included author, year of data collection, region, contaminant and product. We examined the structure of the studies according to these general classification criteria and made the following observations. 17 of the reviewed studies were published after the year 2000, 13 in the 1990s and 8 in the 1980s. With regard to the region under consideration, the majority of the studies were conducted in the USA (about one-fourth) and UK (about one-sixth). The Netherlands as a location of study was ranked third and Australia and Sweden fourth. It should be noted that only two studies conducted their research in Germany.

Figure 1: Frequency of products and contaminants analysed in the reviewed studies[5]



Source: Own illustration.

[3] According to ADAMS and MOTARJEMI (1999) a foodborne disease can be defined as: "any disease of an infectious or toxic nature caused by or thought to be caused by the consumption of food or water".

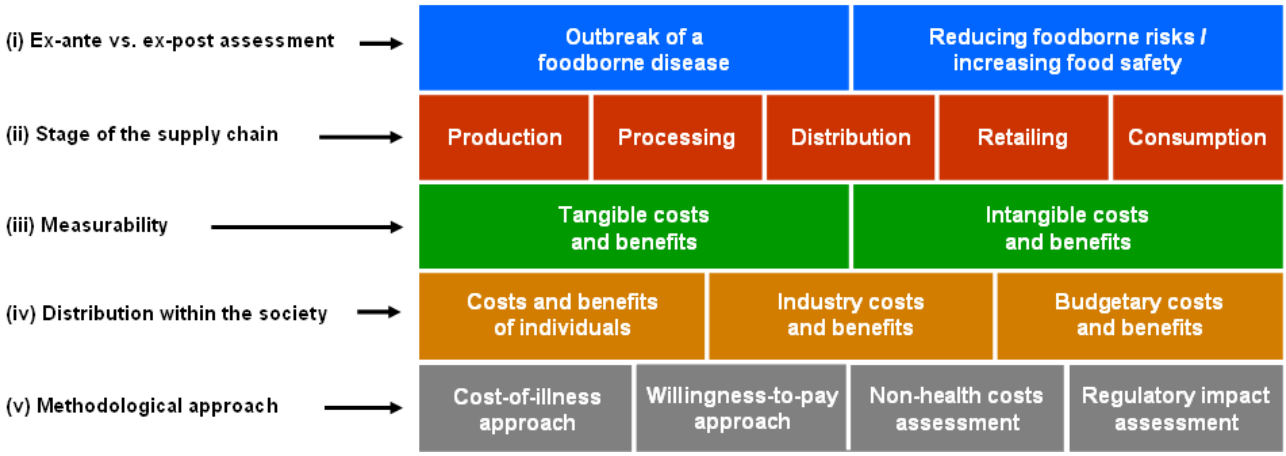
[4] A complete classification of the 38 studies could not be included in this paper due to space limitations, but can be provided upon request. Authors written in bold letters in our references refer to the studies which we have selected in our review.

[5] The figure shows absolute numbers of products and contaminants considered in the studies.

Figure 1a shows that among the contaminated products examined, the top six were fruit and vegetable products (14), poultry and poultry products (13), milk and milk products (11), beef and beef products (10), pork and pork products (10) and eggs and egg products (10). Among the most often studied contaminants were Salmonella (14), Escherichia Coli (10), Campylobacter (10), Staphylococcus aureus (8) and Listeria (8) (Figure 1b).

Besides these general criteria, we worked out a set of additional classification criteria which seemed to us very important when comparing the various studies (Figure 2). They include (i) the distinction between an ex-ante vs. ex-post assessment, (ii) the stage of the supply chain concerned, (iii) the measurability of costs arising from a foodborne disease, (iv) the distribution of costs within the society and (v) the methodological approach used for the economic assessment. In the next subsections we define the additional criteria in more detail and describe the characteristics of the selected studies according to these criteria.

Figure 2: Classification criteria of studies dealing with economic assessment of food safety



Source: Own illustration.

(i) Ex-ante versus ex-post assessment

First of all, it is necessary to clarify the time perspective of the economic assessment, i.e., whether it is an ex-ante or ex-post analysis. According to ABELSON et al. (2006) there are two main groups of business costs related to the provision of safe food: the costs of complying with regulations and the costs of disruption when a food contamination occurs. A similar classification is offered by PERVIN et al. (2008) who state that studies can generally be divided into prevalence-based or incidence-based reports. The first group of costs is caused by the estimates of present and future costs resulting from potential diseases and measures designed to reduce foodborne risks or to increase food safety (ex-ante or prevalence-based assessment). These costs are usually used to evaluate the cost-effectiveness of public policies, which aim to decrease microbial contamination of the food supply (ANTLE, 1999) and are useful for planning and budget decisions.

Ex-ante assessment is usually done by conducting cost-benefit analyses based on the preliminary assessment of the situation. The costs of food safety regulation measures include the costs of preventive measures that are carried by the industry and by taxpayers. Most retailers impose their own private food safety guidelines and standards based on specific criteria such as appearance, grading, ripening, maximum residue limits/levels, packing, labelling, and phytosanitary specifications (WILLEMS et al., 2005). The benefits of food safety regulation measures may include a reduction of morbidity and mortality risks associated with the consumption of potentially contaminated foods.

The second type of assessment (ex-post or incidence-based) is done after the outbreak of a foodborne disease. In our literature review we focus only on those studies which conduct such an ex-post assessment. The latter involves calculating the economic losses caused by the outbreak as well as the costs of intervention measures in order to stop or decrease the spread of contamination. Therefore, industrial companies and policy-makers face a trade-off: investing into prevention measures and reducing the risks of an outbreak, or taking the responsibility for the consequences of an outbreak in case of insufficient investments into the preventive activities (ABELSON et al., 2006).

(ii) Stage of the supply chain

Since contamination may occur at any point in the food or feed chain, all stages of the supply chain can be directly involved. Depending on the stage at which the outbreak may occur and on the severity and the duration of the outbreak, some stages of the supply chain can also be affected indirectly. For example, if the contamination was detected on the farm level and measures were undertaken to stop the spread of the food crisis, consumers would not directly suffer from the contamination (e.g., by eating the contaminated products and getting sick). Nevertheless, indirect effects are possible, as, for example, product recalls may temporarily alter food consumption habits or lead to adjustments in the processing, distribution or retailing stage of the supply chain.

The majority of studies reviewed in this paper focus on the economic estimation of costs resulting at a specific stage of the supply chain. In about 50 per cent of them the economic impact on consumption as a stage of the supply chain was considered. Particularly medical expenses and losses in terms of infected and dead persons as a result of an outbreak were estimated by many authors (e.g., ROBERTS and MARKS, 1995; BUZBY et al., 1996; SPEARING et al., 2000). Overall, almost one-third of the reviewed studies dealt with the economic assessment of food safety within the distribution, processing or retailing stages of the supply chain. The production or farm level was the scope of examination in about one-fifth of the studies. For example, CARPENTER et al. (2011) illustrate the economic assessment of a foodborne outbreak at the farm level and posit that the main costs arise in this case from slaughtering and disposing of livestock, the associated cleaning and disinfecting of premises and administration costs.

In the Appendix of this paper we grouped the various cost components analysed in the selected studies according to the stage of the supply chain. It becomes apparent that a large variety of costs has been or might be taken into consideration when conducting an economic assessment of food safety. The costs may range from the costs of control measures at the farm level to the income losses of ill persons at the consumption level.

(iii) Measurability

In the economic assessment of food safety, some authors further group costs into tangible and intangible (e.g., SOCKETT, 1991; HENSON and TRAIL, 1993). Tangible costs are usually costs which can be measured in monetary terms. They include, for example, medical costs, costs of lost production or surveillance costs. Besides tangible costs, a large variety of intangible costs also exist. They may comprise costs associated with pain, grief, suffering and loss of life (RICE et al., 1985; ROBERTS, 1989; BUZBY et al., 1996). Intangible costs may also include such costs as lost goodwill (ROBERTS and SOCKETT, 1994), stress and emotional difficulties caused to farmers (THOMPSON et al., 2002), loss of product confidence by consumers (SOCKETT, 1993), deterioration in quality of life, illness, etc. (RICE et al., 1985) or loss of leisure time (ROBERTS, 1989; TODD, 1989; PERSSON and JENDTEG, 1992; BUZBY et al., 1996). Due to the difficulty of estimation and requirement of additional data, such costs have often been excluded from many studies.

Among the reviewed studies in this paper about 40 per cent of the authors examined intangible costs (see, among others, GADIEL, 2010; CASPARI et al., 2007; FRENZEN et al., 2005).

The most researched cost category within the group of intangible costs was the assessment of human life. This could probably be explained by the fact that other cost categories within the group of intangible costs, such as costs due to the loss of reputation or image of a company as a consequence of a food crisis, would require conducting additional surveys. On the other hand, the assessment of human life (or to be more exact, its loss) could often be done on the basis of secondary data. Another explanation for this could be the fact that there are many well-established methodological approaches to value a human life, e.g., human capital estimates or people's willingness-to-pay or willingness-to-accept. We fully agree with the previous studies that the classification of costs into tangible and intangible is very important. Otherwise, intangible costs might be overseen as a cost category.

(iv) Distribution within society

The next important classification criterion for studies dealing with the economic assessment of food safety related to foodborne outbreaks refers to the question "Who bears the costs?" According to, among others, HENSON and TRAILL (1993), BUZBY et al. (1996) and BUZBY and ROBERTS (2009) the costs arising from a foodborne disease outbreak can be grouped into budgetary costs, industry costs and costs of individuals. Budgetary and industry costs generally involve several stages of the supply chain, whereas the costs of individuals mainly refer to the stage of consumption. It is necessary to mention that within each of these groups benefits from a foodborne disease outbreak are also conceivable. For example, firms which produce substitutes for the products concerned might benefit from an outbreak in case their competitors are affected. Almost half of the studies reviewed in this paper calculated the costs to individuals, while only about one-fifth of the studies considered industry costs. Budgetary costs were examined in about one-third of the studies.

(v) Methodological approach

With regard to the methodological approach applied, we distinguish among the four groups: cost-of-illness (COI) approach, willingness-to-pay (WTP) approach, non-health costs assessment and regulatory impact assessment (RIA). Among the reviewed studies, about two-third used the COI approach. This approach can be viewed as the most basic approach to value health in the case of a foodborne disease outbreak (KENKEL, 1994). According to RICE (2000) costs derived from the COI approach can be further distinguished into two major categories: costs resulting directly from the illness and other related costs. In general, this approach measures the medical costs combined with the forgone market income due to lost work time. The main advantage of this approach is the use of readily available and reliable data (Kenkel, 1994; BUZBY et al., 1996). Moreover, this method has been modified to approximate some intangible costs such as lost leisure time (VAN RAVENSWAAY, 1995) or the value of a human life. It should be mentioned that studies based on the COI approach can be prevalence-based or incidence-based (PERVIN et al., 2008). In our case, the reviewed studies focused on the incidence-based costs including all the economic effects of a foodborne disease outbreak.

However, this approach also has some shortcomings. According to LUPPA et al. (2007) COI studies have substantial methodical difficulties due to disparities in economic measurements related to the inclusion of cost components and monetary valuing applied. COI studies are conducted in various regions and countries with distinct social and health conditions and various accounting systems based on specific market prices, fees, etc. This leads to differences in monetary values, which makes a comparison of such studies rather difficult. Thus the interpre-

tation of the results of such studies should be done with care. Another critical argument against this methodological approach is the fact that it generally does not take into account the defensive or averting expenditures that individuals make to protect their well-being (HARRINGTON and PORTNEY, 1987).

Since studies using the COI approach also calculate the forgone market income due to lost work time, and, more recently, some intangible measures such as the value of a life, they are being criticized for their incorrect use of human capital theory. According to this criticism this method relies on earnings data in order to value productive capability, which may lead to an unavoidable ethical bias (SHIELL et al., 1987). Finally, BUZBY et al. (1996) see the disadvantage of the COI approach in being crudely "economic" because this method does not consider the value that individuals may place on (and pay for) feeling healthy, avoiding discomfort as a result of an illness or using their free time. Due to these disadvantages this approach tends to underestimate the actual costs of an outbreak.

Another methodological approach which is widely used in empirical studies dealing with the economic assessment of food safety is the WTP approach[6]. It should be mentioned that this method is mostly designed to capture the ex-ante valuation of costs. It can also be used as an additional technique combined with cost-of-illness or non-health estimations in order to determine the value of a hypothetical good such as intangible assets. According to RODRÍGUEZ et al. (2008) the term "willingness-to-pay" represents the monetary difference between consumers' surplus before and after adding or improving a given food product attribute. Since this approach represents the full value of food safety improvements based on individual consumer preferences, it is more "preferred" by scientists than the COI approach (VAN RAVENSWAAY, 1995). In other words, the WTP approach is very useful when the price of a specific good is not known.

In order to conduct WTP analyses hypothetical markets or scenarios have to be developed. However, since it is based on hypothetical estimations and opinions of various people on what they would be willing to pay for the good (in our case improved food safety), it is considered to be inaccurate. According to LATOUCHE et al. (1998), the possibility of biased responses exists due to the use of hypothetical survey techniques. KUCHLER and GOLAN (1999) state that the WTP method is designed mainly for the estimate of the benefits of public health programs. In this regard, it aims at valuing the life-threatening hazards with some degree of randomness in order to predict the possible effects of publicly financed health programs for the society (ibid.).

A further methodological approach for the economic assessment of food safety includes the so-called non-health costs assessments. We use this term to evaluate all of the costs which are not directly connected with illnesses or health improvement measures. Examples of such costs may include product recalls, plant closings and clean-up, product liability costs, reduced product demand, decontamination and disposal of biohazardous waste, disruptions in commerce (nationally and internationally), training and other skill maintenance costs, criminal investigations and court costs (ROBERTS, 1989; KAUFMANN et al., 1997). Non-health costs assessments were used only in one-fourth of the studies reviewed in this paper.

Finally, regulatory impact assessment (RIA) is based on the evaluation of the benefits of food safety regulations which are designed to prevent and control the level of pathogens in food, to reduce risks of morbidity and mortality and to improve overall food safety. RIA encompasses eco-

[6] The WTP approach involves several economic evaluation techniques, such as contingent valuation, conjoint analysis, experimental auction, hedonic pricing approach and averting expenditure approach. Due to the main aim of the WTP approach to conduct ex-ante economic analysis, we deliberately excluded empirical studies in this field from the review.

nomic approaches that have been developed in order to evaluate the efficiency of such food safety regulations. The main aim of such evaluation is to compare the social benefits and costs of different programs and prevention measures and to set priorities for applying the most efficient programs (BUZBY et al., 1996). In this context, a number of indicators has been developed which include, among others, years of potential life gained (YLG), healthy years of life gained (HYLG), disability adjusted life years gained (DALY), quality adjusted life years (QUALY), years lived with disability (YLD), etc.

3 Summary and conclusions

In this paper we reviewed 38 empirical studies from the field of the economic assessment of food safety. Our analysis is focussed on studies dealing with the ex-post economic evaluation of foodborne disease outbreaks published after 1984. Since the characteristics of studies vary widely, we use a number of classification criteria. These include, besides the region, product and contaminant under consideration, the distinction between an ex-ante vs. ex-post assessment of costs, the stage of the supply chain, the measurability of costs, the distribution of costs within the society and the methodological approach.

We found that the majority of the selected studies were conducted in the USA und UK. Relatively few studies deal with Europe, except the UK, and Germany in particular. One might think that the outbreaks occurred more often in those countries than in other parts of the world, but probably a possible reason for that could also be the fact that more scientists there were able to get access to data and funding from these countries. Another interesting fact is that the majority of studies estimated the costs at the consumption stage within the food supply chain. The most frequently used cost components included medical expenses and the losses in terms of infected and dead persons as a result of a foodborne disease outbreak. As for the distribution of the costs within the society, the majority of the studies examined the costs to individuals and budgetary costs. Only one-fifth of the studies estimated the industry costs. One can assume that this fact is also connected with the availability of data. It might be easier to obtain statistical information from the public health sector than from private industry firms.

Most of the reviewed studies consider the tangible costs (and benefits) in order to assess the impacts of a foodborne disease outbreak. However, many of the intangible costs are rarely considered, since there is no market for them and their evaluation remains a rather complex task. Without a doubt, in order to make the economic assessment of food safety more complete, the consideration of intangible costs and benefits is also necessary. Therefore, an area of research which can be considered challenging in this respect is the quantitative estimation of these intangible costs.

4 Literature

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Appendix: Examples of cost components considered in the economic assessment of food safety grouped according to the stage of the supply chain

Production	Processing
• Morbidity and mortality of animals on farms • Costs of herd slaughter and disposal of contaminated animals on farms • Diagnostic costs (costs of veterinarian labour, sampling materials and test costs) • Costs of control measures (sterilized feed, extra testing of animals for export) • Costs of cleaning and disinfecting of premises • Costs of product recall, spoilt or lost production • Costs of reduced or lost productivity • Reduction in (perceived or actual) output quality • Costs of extra feed • Costs related to equipment replacement or cleaning • Investments in buildings • Costs of breeding and parent stock • Increased insurance premiums • Losses due to delay in returning to production • Changes in subsidy payments • Loss of revenue due to changed marketing pattern • Waste (or higher level of use) of inputs • Illness among workers due to handling contaminated animals or products • Lost market share • Price changes resulting from changes in supply and demand for live animals and products • Costs of lost goodwill • Stress and emotional difficulties caused to farmers	• New processing procedures • Beyond the farm-gate effects marked for auction markets, slaughterhouses and food processors, the activities of which were disrupted • Destruction, decontamination, reprocessing of products and disposal of biohazardous waste • Product recall • Plant closings and clean-up • Purchase of new equipment • Design change at plant • Educational programmes, training, etc. for staff • Hiring of new/extra staff • Costs for extra ingredients • Legal costs (fines, court costs, etc.) • Increased testing of products • Interest on loans and increased insurance premiums • Increased meat product spoilage due to pathogen contamination • Loss of product confidence by consumers Reduced product demand • Promotional campaigns and advertising to increase consumer demand • Disruptions in commerce (local, national, and international) and effects on related businesses • Price fluctuations due to disturbed supply and demand • Drop in share value • Possible bankruptcy
Retailing and distribution	**Consumption**
• New wholesale/retail practices (pathogen tests, procedures) • Destruction, decontamination, reprocessing of products and disposal of biohazardous waste • Product recall • Monetary compensation to consumers • Legal costs (fines, court costs, etc.) • Educational programmes, training, etc. for staff • Hiring of new/extra staff • Altered product transport conditions (time or temperature) • Costs due to loss or reduction of international trade volumes due to import bans, protective trade embargoes imposed by major external trading partners or other restrictions on trade • Price changes for products concerned • Increased testing of products • Interest on loans and increased insurance premiums • Increased meat product spoilage due to pathogen contamination • Disruptions in commerce and effects on related businesses • Reduced product demand • Drop in share value • Possible bankruptcy • Loss of product confidence by consumers	• Daily costs of hospitalization • Intensive medical care, operations, convalescence • Laboratory costs • Drugs and other medications • Ambulance or other travel costs (costs to visit ill persons, costs of transportation to health providers) • Income and productivity losses for ill persons • Costs of relocating, losses and alterations of property (such as elevators for invalids) • Expenditures for household help, special diets, etc. • Costs of vocational, social and family counselling services • Risk aversion costs • Child care costs • Loss resulting from pre-paid cancelled arrangements • Caregiver for ill persons • Extra cleaning/cooking time costs • Deterioration in quality of life, illness and death • Loss of a body part or sense • Disfigurement or (vocational) disability • Unwanted job changes • Loss of opportunities for promotion and education • Relocation of living quarters and other undesired changes in life plans • Pain, grief and suffering • Loss of leisure time

Source: Own illustration.