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Food Regulation when Food Safety and Healthy Diet are in Conflict - the Case of Baltic Herring

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Abstract. Food safety and nutritional issues are most often studied separately. In this paper, we bring the two aspects together. We examine regulators' decision making and policy trade-offs in the EU dioxin regulation. Using an economic model we evaluate how and why the regulation has been designed differently in the Scandinavia than in other EU countries. In our case study of Baltic herring, fish has two important, although contradictory, health aspects. Firstly, it is an important part of a healthy diet but, secondly, it is known to contain carsinogenic dioxins. In the model, the policy maker has a dual-objective: how to account for both food safety and nutrition issues in health regulation. The challenge in policy design is to recognise that when avoiding one risk, even greater risk may appear. In addition, better knowledge on consumer profiles and risk groups is needed to enable more efficient regulation design.

Keywords: food safety, nutrition, healthy diet, regulation, fish consumption, Baltic herring

Introduction

The food economy is facing new challenges, both in the fields of food safety and diet. According to a Eurobarometer study conducted by the European Commission, 67,9 % of consumers were concerned about the safety of foodstuffs (European Commission, 2000-2001). Food safety regulation aims at protecting the public health, and the regulatory challenge is to restore and maintain consumer confidence in the safety of food, and thus create a reliable safety regulation.

Ensuring the protection of public health is not, however, restricted to chemical, biological, and physical safety of food. A healthy diet is at least as important as food safety since nutritional imbalances account for over one hundred times more premature – yet preventable – deaths than food-borne infections in Europe (Core Report, 2000). In Europe, the need to address both food safety and nutrition in public health promotion has recently been advocated by WHO (2001). Caswell (2001) recognises this importance among consumers in the U.S., as she argues that "*if the goal is consumer health, then diet is a key and probably paramount issue in the US. Thus food safety priorities must encompass nutrition.*"

Although food safety and nutrition have attracted much attention among researchers, surprisingly, they are commonly studied separately and the connection or trade-offs between them have seldom been discussed[1]. Therefore, it is difficult to assess the overall impact of different health risks and regulatory policies on public health (Tuomisto, 2002). The problem

[1] For food safety, see Food Policy 24 (6), 1999, and for nutrition and diet, see Food Policy 24 (2-3), 1999. One example where nutrition and food safety are discussed together is in Asp (1999), where the author recognises food safety as one of the barriers when selecting food items for a healthy diet.

becomes obvious when nutrition and food safety are contradictory. In this paper, we bring food safety and nutrition together and construct a model for regulatory decision making and policy trade-offs. Subsequently, we take Baltic herring as an example, where a specific food item is an important part of a healthy diet but, on the other hand, it is also known to contain dioxins which are suspected to cause for instance cancer (Tuomisto, 2002). As a result, recommendations for fish consumption from the point of view of health and dietary aspects may end up being contradictory.

The European Commission set up a European fish promotion campaign in 1997. The purpose of the campaign was to inform European consumers, particularly young people, about the dietary qualities and the nutritional value of fish. As a separate issue, in November 2001, the Council of the European Union adopted measures establishing maximum levels of dioxins in human food (Council of the European Union, 2001). In practice, this means that all food (fish included) exceeding certain limits will be withdrawn from the food chain. These policies, contradictory in their recommendations, might cause confusion among consumers: should they or should they not eat fish?

These kinds of policy trade-offs in dietary choices and food safety have prompted growing demand for information assisting decision-makers on the development of current and future policies. In this particular study, the question is posed as follows: i) what are the regulative trade-offs in promoting a healthy diet and consumption (and supply) of safe food, and ii) what are the concerns when constructing a homogeneous food safety policy on a largely heterogeneous consumer population.

When creating a regulatory action promoting two potentially competing objectives, the regulator is required to assess the effects of the regulatory action on both of the objectives. The effects have to be then weighted according to an agreed (scientific, political) procedure, and the regulatory action has to be adjusted in order to reach a balanced outcome. Alternatively, the regulator may decide to create relatively more relaxed rules for the use of the food item, and thus leave broader decision making power to a consumer. In such a case, the regulatory action has to be complemented with information, which allows a consumer to make an informed decision suiting his/her specific needs and risk preferences.

This brings up the second question concerning the homogeneity of the policy. In practise, either a unified policy can be constructed ruling similarly over all individuals or alternatively a differentiated policy can be constructed. Consumers may be segmented according to their risk characteristics (health status, age, etc) and policy measures can then be differentiated for each segment. A somewhat similar effect can be reached if consumers have more information and are allowed to make a large part of the decisions by themselves.

The question of policy differentiation in the case of a heterogeneous population is actually independent of the dual-objectiveness or the regulation. However, a dual-objective underlines the importance of differentiation as in the situation, where consumers may differ in their abilities/preferences relative to two objectives, not only relative to one. Naturally, this is not an "either-or" question, rather it is a question of levels: the stricter the regulation is (e.g. forbidding a food item outright v.s. just requiring the food to fulfil certain quality requirements) the more difficult it may be to reach another objective of the two.

Besides the health status, this same question comes up when regulating very diverse cultural populations, whose traditional diets differ considerably. It is difficult, if not impossible to create such a non-differentiated policy that could serve as an efficient regulation for a heterogeneous population. This has become important as markets have been increasing in their geographic size effect and as tastes of consumer populations have become increasingly varied.

The paper emphasises the importance of considering both aspects of public health simultaneously, the dual-objectiveness and the heterogeneity of modern consumption. A case of Baltic herring consumption is taken as an example in order to highlight the relevance of the question.

In the next section, we present some health issues in the EU and our case study of fish consumption and dioxin regulation. After this, we will introduce a decision framework for the policy maker and some model implications. Finally, we will discuss the role and implications of public policy interventions in the field of nutrition and food safety.

EU contemporary health issues and food safety regulation for fish

Together, dietary choices and food safety play a major part in determining the health. In Europe, an unhealthy diet may be responsible for: (i) between 30-40 % of cancers, (ii) at least one third of premature deaths from cardiovascular diseases (CVD), and (iii) prevalence of obesity and overweight (the pan-European "epidemic"), which in turn is linked to increased risks of CVD and certain cancers, and premature death (Core Report, 2000).

In the EU Member States, cardiovascular disease represents the main cause of mortality: in 1998, 45% of deaths in women and 38% of deaths in men were attributed to circulatory diseases and thousands of others remained disabled by them (European Commission, 2002). According to the Eurostat data, the problem of being overweight and severely overweight affects the health about 26% of males and about 21% of females in EU countries (Eurostat, 2000). Health risks, notably cardiovascular diseases, increase considerably when people become overweight.

Should authorities promote or regulate fish consumption?

Recent studies suggest that fish consumption is associated with reduced risk of blood clotting or sticking to the artery walls, a condition that could result in CVD, heart attack, and stroke (WHO/FAO, 2002). It is also well known that fish have great nutritional value, containing certain vitamins (D) and good quality fatty acid (omega 3) (Tuomisto, 2002). Since saturated fat intake is high in Europe, it would be advantageous to replace hard (saturated) fat with soft fat such as fish fat.

Promoting fish consumption, however, is not straightforward because of food safety risks. One problem in fish consumption is that fish may contain dioxins (Tuomisto, 2002). Dioxins are a group of chemicals, PCDDs, PCDFs and dioxin-like PCBs, which have a broad series of toxic and biochemical effects. Some of them are classified as known human carcinogens (SCF, Scientific Committee on Food, 2000). For example, in laboratory animals they have been linked to developmental and neurobehavioral effects (learning disabilities) as well as immunotoxic effects (European Commission, 2001a).

The impact of dioxin regulation and promotion of fish consumption on public health is unforeseeable. Regulating food safety and promoting a healthy diet in this case may have just the opposite effects on fish consumption. On the one hand, promoting fish consumption may lead to hazardous doses of dioxins. On the other hand, if food safety standards of dioxin levels are very stringent, it may lead to a decrease in fish consumption and, as a result, possibly to an unhealthy diet. Thus, separating nutritional and food safety aspects may lead to an unexpected and undesired outcome (Tuomisto, 2002).

Baltic herring consumption and EU dioxin regulation in the Nordic countries

An interesting example of such a dual-objective health regulation, where both nutrition and food safety are considered, is dioxin regulation and the consumption of Baltic herring (Clupea harengus membras) in Finland. There are considerable geographical differences in the level of dioxin contamination of the various fishing grounds from which fish originate. The Baltic region, for example, is a highly polluted area and fish caught in the Baltic Sea have high concentrations of dioxins (SCOOP, 2000.). When the maximum dioxin rates were established in the EU, there was a notable exception in the regulation: Sweden and Finland were granted a derogation, up to 31 December 2006, on tolerable dioxin levels in the Baltic region fish. Derogation authorises the sale on their domestic markets of fish caught in the Baltic region with dioxin in excess of the maximum EU-rates. (Council of the European Union, 2001).

When approaching the dioxin regulation exclusively from the food safety viewpoint, the derogation seems questionable. Finns receive 80 per cent of their dioxins from fish due to the high pollution of the Baltic Sea. For instance, Baltic herring accounts for 35 per cent of fish dioxins (Kiviranta *et al.*, 2001). Given that the intake of dioxins in Finland mainly comes from fish, is it reasonable to allow the level of dioxins to exceed the maximum rates?

According to Finnish officials, the quest for derogation was based on a fact that the total dioxin intake of Finns differs, from other EU nationals: generally, the total exposure of Finns does not exceed the dioxin recommendation despite the elevated concentrations in fish from the Baltic (SCOOP, 1999). Besides the fish, Finns receive the rest of their dioxins from milk and meat products. As the concentrations in them are found to be lower in Finland than in other EU countries on average (SCOOP, 2000), the total exposure remains in an acceptable range.

When accounting for these differences, the answer to seek regarding impact on food safety is unclear. If effects of fish consumption are to be examined more comprehensively accounting also for dietary aspects, the indirect effects of the regulation must also be assessed (Tuomisto, 2002).

From the viewpoint of diet, some arguments can be pointed out which refer to derogation. Without the derogation, the maximum dioxin rate regulation would have had a great effect on Baltic herring consumption in Sweden and Finland since a large share of fish from the Baltic region might have been eliminated from the food chain (Council of the European Union, 2001). The exclusion of fish from the diet may have had a significantly negative health impact in Sweden and Finland, since fish consumption is associated with reduced risk of a condition that could result in CVD, heart attack, and stroke. In addition, there is a risk of vitamin D deficiencies in these two countries, as this vitamin is normally absorbed through exposure to sunshine and eating fish (Council of the European Union, 2001; Fishing in Europe, 2002). Therefore, the derogation can be seen as an example of a dual-objective health regulation where both nutrition and food safety are considered.

This would clearly affect the consumption of food in Finland in general since Baltic herring has traditionally been part of the Finnish cuisine and diet. Besides the dietary and culinary aspects, the domestic fish market would have been heavily affected. According to the Finnish Game and Fisheries Research Institute (2002), after rainbow trout, Baltic herring was the most important fish in Finnish domestic fish consumption in 2000 and 2001. In particular, rainbow trout and Baltic herring represent 41 % of Finnish domestic fish consumption. Banning the use of Baltic herring would most likely have resulted in people transferring from fish consumption to other fish and meats (and maybe vegetables) and in decreased domestic fish production and increased fish imports.

Conceptualising trade-offs in regulating food safety and nutrition

In this section, we present a decision framework for health regulation where the objective is twofold: to promote public health by increasing the consumption of fish while at the same time regulating fish related health risks (here dioxin) by setting safety standards. The approach follows studies by Neven and Thisse (1990) and Lombardini-Riipinen (2002), and is based on a vertical differentiation model. In those models, all consumers are in agreement where the preference order is concerned: at equal prices there is a natural ordering over the characteristic space (Neven & Thisse, 1990; Tirole, 1990). In our case, this translates simply to the following: "commonly better safety is preferred".

For the sake of reality, consumers are assumed to be heterogeneous. With heterogeneity we mean that consumers have a different appreciation for the safety of food, i.e. consumers have different opinions on *how much* better the safer food is, although they agree that safer food is better. A decision-maker in turn is interested in two different aspects when launching regulation: (i) both direct and indirect consequences from fish consumption and (ii) consumer heterogeneity and preferences. The first aspect means that the policy maker does not only try to avoid food safety hazards of fish (direct health consequences, dioxin intake and subsequent cancer), but is also interested in a healthier, fish-abundant diet (indirect health consequences, obesity and cardiovascular diseases due to high fat intake) (Tuomisto, 2002). The second aspect simply states that consumers appreciate different things in food consumption.

Differentiated fishery products and the demand for fish

Consider a case of a differentiated market of fishery products. There are two categories of fishery products that are similar but not perfect substitutes. Categories are differentiated by their safety, and in our example the level of dioxin measures the safety of fish. However, the safer the category is, the more restricted it is. It has less diversity, which means that in that category, there are fewer different alternatives (fishery products) available. Safety of both categories is regulated by the safety standards and the standards guarantee that some exogenous health risk target will not be exceeded.

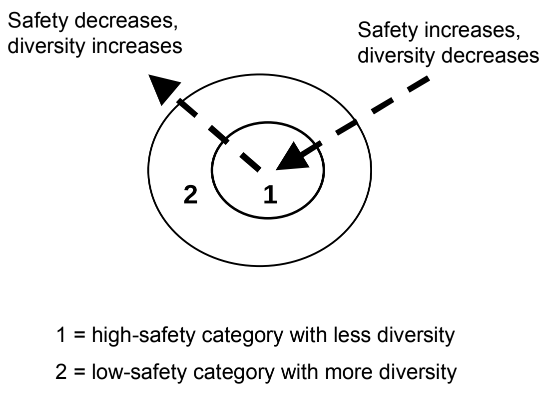

Figure 1. Two categories of safety

In figure 1, there are two categories of fishery products. Circle sizes refer to the extent of diversity, not to the volume of the categories. Category 1 (the inner circle) is safer, but has less diversity. Category 2 (the outer circle) has a larger diversity, but at the cost of safety. In our example, the first category reflects fish in which the dioxin level is not in excess of the maximum EU-rates, and the second category includes Baltic herring in which dioxin can be in excess of the maximum rates. The second category thus allows more diversity. Increasing safety implicitly means decreasing diversity. As consumers value both, there exists a trade-off between safety and diversity in regulation design.

In setting up an economic model, each consumer is assumed to buy either one or zero units of fish and choose fish either from a high-safety category *H* (low diversity) or a low-safety category *L* (high diversity). Consumers' type is identified by θ and is uniformly distributed over [0,1]. A consumer with high θ has a higher willingness-to-pay for obtaining high safety and therefore may give up some more diversity in turn, when compared to a consumer with low θ, although both types agree that safer fish is better. Consumer type θ is assumed to include all notable components of consumer characteristics such as taste, consumption habits, age, health status, and vulnerability to dioxin.

Consumers have full information on the two categories, which means consumers can distinguish the high- and low-safety categories from each other prior to purchase. They cannot, however, perceive exactly the safety of a particular fishery product, i.e. how much dioxin a fish in a category contains. Instead, they only know which category the particular product belongs to.

The number of consumers is normalised to unity, so that the market share of both product categories refers to the proportion of people buying from that category. A consumption decision (and thus demand) of a consumer of type θ buying fish from category *i*, can be described by the following (indirect) utility function:

$$U = y + \theta s_i - p_i - \beta r_i(s_i) + \alpha\ (s_H - s_L)^2,\ i = H, L \tag{1}$$

where y is income, s_i is the safety of category *i*, and p_i is the exogenous price of fish. For the sake of simplicity, it is assumed that all consumers have the same income. Further, it is assumed that fish in a high-safety category costs more than fish in a low-safety category.

The health risk from eating dioxin tainted fish is assumed to be unknown to consumers: $\beta r_i(s_i)$ is the health risk from consuming fish from the category s_i, where β is the exogenous probability of an adverse health effect and $r_i(s_i)$ is the potential damage (severity or extent of damage) of category *i*. As in Smallwood and Blaylock (1991), the health risk encompasses all aspects of potential health damage from mild short-term illness to chronic, long-term effects that may be associated with some cancers, and to a shortened life span. It does not, however, include the risk of an unhealthy diet which is due to not consuming fish and may lead to, for example, obesity and cardiovascular disease potentially resulting from it. For simplicity, only consuming from the low-safety category is assumed to include the health risk, thus $\beta r_H(s_H) = 0$. The potential damage r_L is assumed to increase as safety decreases, $r_L'(s_L) < 0$ and $r_L''(s_L) < 0$.

The last term in the equation, $\alpha_i(s_H - s_L)^2$, describes the (additional) utility gained from thr diversity of a fish category. The notation is adopted from Neven and Thisse (1990) and is common in horizontal differentiation models. In those models, it is assumed that there is some variety that is "most preferred" and a consumer derives disutility when he has to choose some other variety, other than his most preferred one. We use the same notation but the interpretation is modified. α_i is a parameter, and $\alpha_L = 1$ and $\alpha_H = (-1)$. When choosing from the low-safety category, a consumer has many different fishery products available to choose from, and a consumer gains utility from the subsequent diversity. We denote this "additional diversity" by $(s_H - s_L)^2$, and a parameter α_i gets a positive value, $\alpha_L = 1$. On the other hand, a consumer choosing from the high-safety category has a smaller selection, and thus foregoes some of her utility derived from diversity, $(s_H - s_L)^2$; thus, a parameter α_i gets a negative value, $\alpha_H = (-1)$.

A consumer will choose fish from category *i* that provides her with the largest utility. Given (1), the demands for fish from the high- and low-safety categories are

$$q_H = 1 - \theta_H = 1 - \frac{p_H - p_L - \beta r_L(s_L) + 2(s_H - s_L)^2}{s_H - s_L}$$

and

$$q_L = \theta_H - \theta_L = \frac{p_H - p_L - \beta r_L(s_L) + 2(s_H - s_L)^2}{s_H - s_L} - \frac{p_L + \beta r_L(s_L) - (s_H - s_L)^2}{s_L},$$

respectively.[2] The critical point at which a consumer is indifferent between buying fish from the high- or low-safety category is identified by θ_H, and the critical point at which a consumer is indifferent between buying fish from the low-safety category or not buying at all is identified by θ_L. Consumers, whose type θ exceeds the critical point θ_H, choose fish from the high-safety category, and consumers whose type θ is lower than the critical point θ_H but exceeding the critical point θ_L, choose fish from the low-safety category. The others choose not to buy fish at all. Consumers with high θ (exceeding the critical point θ_H) could also be regarded as a "risk averse group" since they prefer high-safety products. Figure 2 provides an example of the critical points and the demands for both categories.

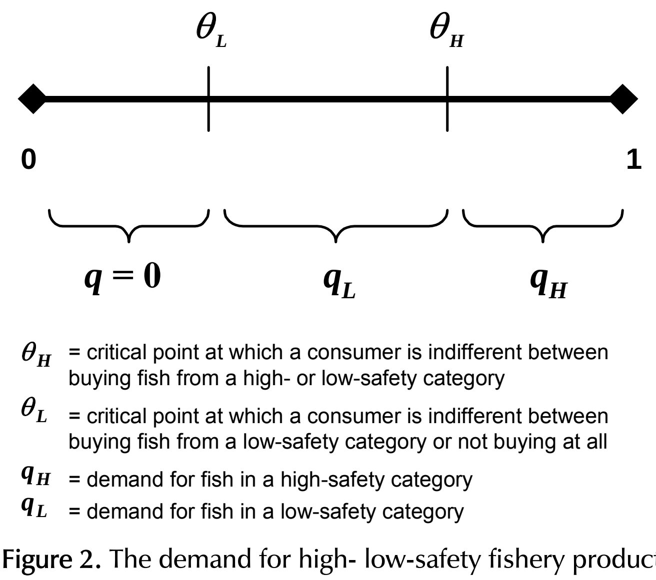

Figure 2. The demand for high- low-safety fishery products

[2] For details, see Demand functions in Appendix.

The regulator's objective is to provide a consumption environment, which is both safe and promotes a healthy diet. In our current example, the objective is to increase the consumption of fish, while regulating the intake of dioxin. When setting the safety standards, it is important that the regulator provide the consumers with information, which allows them to distinguish between the two categories.

As can be seen from figure 2, the standards can be set in such a manner that some consumers (with type θ lower than θ_L) choose not to buy fish at all. The regulator's ability to affect the demand of the two categories and the resulting consumers' actions can be investigated with standard comparative statics techniques.

Results of the model – affecting the consumption patterns

The regulator can change the safety of the two categories by changing the two standards. By comparative statics results we can derive how consumer behaviour is affected by these regulation changes. Note that prices are assumed to be exogenous, thus they are not affected by the changes in the safety of the two categories. It is, however, presumable that in reality, prices are affected, but since our prime interest is in consumer behaviour and regulation design, we will not make any assumptions concerning firm behaviour and price change.

By differentiating the demand functions with respect to the two safety standards, we get the following results[3]. First, we analyze the effects of changing the high-safety standard. An important and unambiguous result is that when the high-safety category becomes safer, the overall consumption of fish increases. This is due to the increases of demand for high- and/or low-safety categories. In the low safety category, there will be new consumers, who previously chose not to consume fish at all. Despite the fact that the safety of the low-safety category remains unchanged, the low-safety category is now relatively more attractive than before. The diversity difference between the two categories becomes larger and consumers derive utility from that additional diversity.

However, we do not know how the increased demand for fish will be divided into two categories but we can identify two possible cases according to their outcomes. Figure 3 represents the two possible outcomes.

Case 1: Fewer consumers prefer fish acceptable by maximum EU-rates

If the critical point θ_H moves closer to unity, the demand for fish in the high-safety category decreases and the demand for fish in the low-safety category, including Baltic herring, increases. This can happen if the diversity loss is large compared to the difference in prices.

Case 2: More consumers prefer fish acceptable by the maximum EU-rates

If the critical point θ_H moves closer to θ_L, the demand for fish in the high-safety category increases. In this case, a higher number of consumers are willing to pay a price p_H of high-safety fish than before, and thus, the demand for fish in the high-safety category increases. The demand in the low-safety category can either increase or decrease. Whether or not demand for low-safety fish increases or decreases, depends on the parameter values. If increased safety of the high-safety category is relatively more important to consumers than diversity, then the

[3] For details, see Comparative statics results in Appendix.

change in θ_H is greater than the change in θ_L, $\Delta\theta_H > \Delta\theta_L$. As a result, the demand for fish in the low-safety category decreases as the safety of high-safety fish increases, and vice versa.

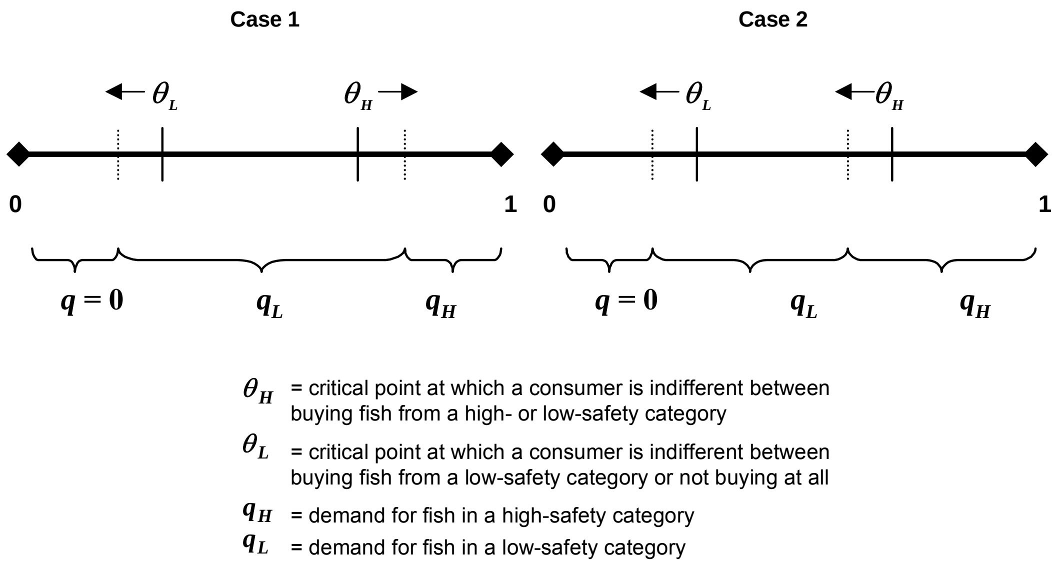

Figure 3. More stringent high -safety standard and increased demand for fish

Second, we analyze the effects of changing safety of the low-safety category. When the low-safety category becomes safer the effects are ambiguous, but again two possible cases can be derived. The sign of all results depends crucially, but not exclusively, on the size of the change in health risk $\beta r_L'(s_L)$. Figure 4 depicts the two possible outcomes.

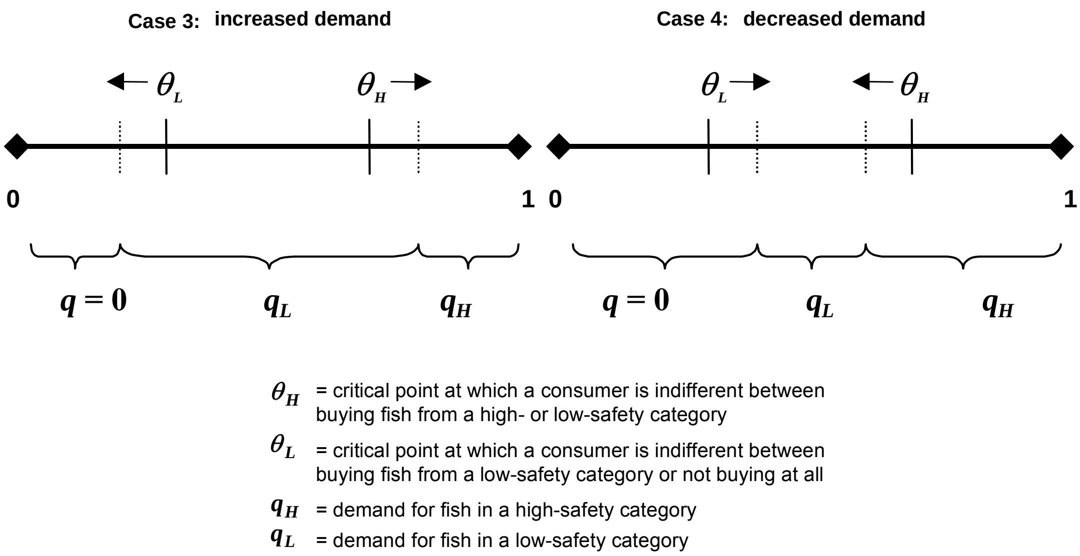

Figure 4. More stringent low-safety standard and changed demand for fish

Case 3: More consumers prefer the category where Baltic herring is allowed

Some consumers switch from the high-safety category over to the low-safety category since the health risk in the low-safety category has decreased while the price in this category is lower and diversity greater than in the high-safety category. Also, because of the decreased health risk, some consumers who previously chose not to buy fish at all will now choose to buy from the low-safety category. The increased demand for low-safety fish, where Baltic herring is allowed, outweighs the loss in the demand for high-safety fish, and as a net result, the overall demand for fish can only increase.

Case 4: Fewer consumers prefer the category where Baltic herring is allowed

The increased safety in the low-safety category does not decrease the health risk enough in order to compensate the loss in diversity (the difference between S_H and S_L gets smaller as S_L increases). As a result, some consumers previously choosing fish from the low-safety category will no longer buy at all. In addition, some consumers who previously purchased from the low-safety category, will now switch over to the high-safety category, because the disutility from diversity loss has decreased and the high-safety category has better safety. As a result, the overall demand for fish decreases.

Implications – possibilities of the policy maker

We can now establish how the regulator can affect the demand of fish in both categories in order to alter overall demand and promote a healthy diet. We can also establish what kind of information the regulator needs in order to be able to predict consumer behaviour and the consequences of the regulation.

By increasing the consumption of fish, the regulator can improve the quality of the general diet and public health. The first action to be taken towards achieving this goal is to tighten the high-safety standard, and thus the high-safety category will become even safer. As a result, the overall demand increases, although the distribution of increased demand into low- and high-safety categories is not clear. The second possibility is to alter the low-safety standard, i.e. affect the safety of the low-safety category. The question, however, of whether to tighten or loosen the low-safety standard, is ambiguous. Because of this ambiguity, the regulator needs information on whether consumers prefer diversity over safety in order to recognise which one of the two possible cases prevails.

If the change in health risk is large enough when tightening (loosening) the low-safety standard, the proportion of non-consuming consumers decreases (increases). This is quite intuitive, since one would expect that when the safety increases, the health risk decreases, and as a result of this, consuming becomes more attractive. It is not, however, always the case. An interesting result would be the case when the change in health risk is "too small" or insignificant from a consumer's point of view, the proportion of non-consuming consumers increases (decreases) as a result of tightening (loosening) the low-safety standard. The diversity matters more than the decrease (increase) of health risk, since the change in health risk is not large enough. Consumers, who chose fish from the low-safety category prior to the more stringent low-safety standard will now choose not to consume fish at all since diversity has diminished. Diversity outweighs the health risk in this case. The consumer preferences could be further explored in order to tailor policies to fit better in consumer profiles.

Also the changes in prices and the exogenous probability of adverse health effects have an impact on the demand of both categories. However, one may assume that the regulator cannot or does not want to affect the prices since prices are determined in the market. Also, the exogenous probability of health risk can be out of reach if we think the probability represents the exogenous conditions in the food market, e.g. a sudden exposure to dioxin due to an environmental disaster or accident.

Discussion

Food safety and nutrition are crucial determinants of overall health and well being. This paper emphasises the importance of a dual-objective health regulation, which considers both of these aspects and also accounts for the heterogeneity of consumers. Our model shows how the regulator can promote public health by adjusting the consumption of fish while taking into account the health risks related to dioxin exposure. The regulation policy should consider both the risks and benefits of consuming and of not consuming. The challenge in policy design is to recognise that when avoiding one risk, an even greater risk may appear (Tuomisto, 2002).

The EU dioxin regulation and the derogation in Finland is an interesting example of such a dual-objective regulation. Food-related dioxin exposure in Finland, excluding fish, is lower than in the EU in general and total exposure of Finns to dioxin does not exceed the recommendations. On the other hand, the role of herring in the nutritionally healthy diet as well as in the traditional Finnish cuisine is very important. Due to these two reasons, it can be said that there were strong reasons for Finns to attempt to modify the general EU dioxin policy applied in Finland.

If the viewpoint of food safety is considered and subsequently a strict dioxin regulation is set, the nutritional quality of the general diet may suffer. It is preferable that food safety and healthy diet are addressed together and regulation is designed such that it takes into account health issues more comprehensively and food safety risks from different foodstuff, e.g. dioxin concentration in fish as well as in milk and meet.

Besides health issues per se, one may also assess this policy setting from the viewpoint of applying a unified policy on the heterogeneous population. It can be presumed that a unified, non-differentiated (dioxin) regulation will not lead to an effective outcome when it is applied to a demographically (age, gender, health status) and culturally heterogeneous population (different nations in the EU). A consumer choice may be significantly altered and narrowed when traditionally or otherwise preferred food items are forbidden or viewed as unsafe.

In our framework, health regulation could be improved by providing information for consumers in order to move consumers from a non-consuming group to either of the two categories. Further, information may be used in order to better inform consumers about their nutritional needs. This information is especially useful for risk groups (e.g. pregnant women, people with obesity) so that they become aware of the possible risks of not consuming fish or of consuming fish from a low-safety category.

Information plays an important role in dioxin regulation and the derogation in Sweden and Finland as well. When granting the derogation, these two countries were obligated to acquire scientific information on dioxin as well as provide clear information for consumers on the possible harmful effects of fish with dioxin in excess of the maximum EU-rates, particularly for pregnant women (Council of the European Union, 2001; Tuomisto, 2002). Also, the better the knowledge the regulator has about consumer profiles and risk groups, the more efficiently information can be distributed to consumers. Similarly, the foodstuff can be classified and categorised in more detail in order to suit to needs of different consumer groups.

However, dioxin regulation in the EU and the derogation in Sweden and Finland is just one example of regulation where nutritional issues are considered together with food safety. The problem in this kind of dual-objective regulation is the same as in any regulation. Health risks and consumer behaviour are difficult to assess beforehand, and due to this there is uncertainty involved in policy design. We have not yet seen the effects of derogation in dioxin regulation, so the effects of the policy have not been yet thoroughly assessed. It is, however, possible to study potential alternatives and their outcomes, which could be expected from different policy actions.

A better understanding is needed of the connections and trade-offs between food safety and nutrition policies. Additionally, more effective and comprehensive health regulations require a better understanding of the effects of consumer habits and traditions on their behaviour with respect to food safety regulation. The matter of population heterogeneity will further grow in importance as present accession countries will become EU-members. The rationale and implications of the general harmonisation of standards in the EU should be brought into this discussion.

References

[1] Asp, E.H., 1999. Factors affecting food decisions made by individual consumers. Food Policy 24 (2-3), 287-294.

[2] Caswell, J.A., 2001. Food safety and the U.S. consumer. Invited paper presented at the European Association of Agricultural Economists Seminar "The food consumer in the early 21st Century", April 19-20, Zaragoza, Spain.

[3] Core Report, 2000. EuroDiet: Nutrition and diet for healthy lifestyles in Europe, Science and policy implications. Health and Consumer Protection. Supported by the European Commission (DG SANCO) and co-ordinated by University of Crete School of Medicine.

[4] Council of the European Union, 2001. Council Regulation (EC) No 2375/2001 of 29 November amending Commission Regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs. Official Journal L 321, 06/12/2001. p. 1-5.

[5] European Commission, 2002. World heart day. Press release by European Commission, Public Health Issues. Consumer Affairs, Health and Consumer protection Directorate General. Available at: http://europa.eu.int/comm/dgs/health_consumer/library/press/press_health_en.html.

[6] European Commission, 2001a. Fact sheet on dioxin in feed and food. Brussels, 20 July 2001.

[7] European Commission, 2001b. Communication from the Commission to the Council, the European Parliament and the Economic and Social Committee Community - Strategy for Dioxins, Furans and Polychlorinated Biphenyls. COM/2001/0593 final. Official Journal C 322, 17/11/2001. p 2-8.

[8] European Commission, 2000-2001. The 2000-2001 Food safety education campaign. Food Safety, Health and Consumer protection Directorate General.

[9] Eurostat, 2000. Key data on health: Health in the EU under microscope. A first statistical guide. News release, number 103/2000. European Commission, Eurostat. Available at: http://www.europa.eu.int/comm/eurostat/Public/datashop/print-product/EN?catalogue=Eurostat&product=3-08092000-EN-AP-EN&mode=download.

[10] Finnish Game and Fisheries Research Institute, 2002. Consumption of domestic fish by species in 2000 and 2001. Fish consumption, Fish market statistics, Fisheries and hunting statistics. Available at: http://www.rktl.fi/english/statistics/consumption/index.html.

[11] Fishing in Europe, 2002. Reducing dioxin content in human food and animal feed. A European Commission Publication No 11, Directorate General for Fisheries.

[12] Kiviranta H., Hallikainen A., Ovaskainen M.L., Kumpulainen J. and Vartiainen T., 2001. Dietary intakes of polychlorinated dibenzo-p-dioxins, dibenzofurans and polychlorinated biphenyls in Finland. Food Additives and Contaminants 18 (11): 945-953.

[13] Lombardini-Riipinen, C., 2002. Essays on environmental quality competition in a vertically differentiated duopoly model. Research reports, No. 92, Academic Dissertation, August 2002. Department of Economics, Faculty of Social Sciences, University of Helsinki.

[14] Neven, D., Thisse, J.-F., 1990. On quality and variety competition. In: Gabszewicz, J.J., Richard, J.-F., Wolsey, L.A. (Eds.), Economic decision-making: games, econometrics and optimisation. Elsevier Science, Amsterdam, Netherlands.

[15] SCF (Scientific Committee on Food), 2001. Opinion on the risk assessment of dioxins and dioxin-like PCBs in food. Update based on new scientific information available since the adoption of the SCF opinion of 22nd November 2000. Adopted on 30 May 2001. Health and Consumer Protection Directorate-General, European Commission.

[16] SCF (Scientific Committee on Food), 2000. Opinion on the risk assessment of dioxins and dioxin-like PCBs in food. Adopted on 22 November 2000. Health and Consumer Protection Directorate-General, European Commission.

[17] SCOOP (Scientific Co-operation on Questions Relating to Food), 1999. Annex 1: Country specific data on dioxins. Task 4 – Human exposure.

[18] SCOOP (Scientific Co-operation on Questions Relating to Food), 2000. Assessment of dietary intake of dioxin and related PCBs by the population of EU Member States. Report on Task 3.2.5 (Dioxins). Final Report, 7 June, 2000. Health and Consumer protection Directorate General, European Commission.

[19] Smallwood, D.M., Blaylock, J.R., 1991. Consumer demand for food safety: models and applications. In: Caswell, J.A., (Ed.), Economics of food safety. Elsevier Science, New York.

[20] Tirole, J., 1990. The theory of industrial organization. The MIT Press, Cambridge.

[21] Tuomisto, J., 2002. Eating fish - pros and cons. A presentation in the Finnish National Committee seminar: How safe is it to eat Nordic fish? Friday 23 August, 2002, Mariehamn, Åland Islands.

[22] WHO/FAO, 2002. Expert Consultation on diet, nutrition and the prevention of chronic diseases. Annex 4: The scientific basis for diet, nutrition and prevention of cardiovascular diseases. Background paper for the joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases, Geneva, 28 January – 1 February 2002.

[23] WHO, 2001. The first action plan for food and nutrition policy. WHO European Region 2000-2005.

Appendix

Demand functions

The consumer will choose to consume fish from category *i* that provides him with the largest utility. Given equation (1) in the text, the critical point θ_H at which the consumer is indifferent between buying from a high- or low-safety category can be derived as the solution to

$$y + \theta s_H - p_H - (s_H - s_L)^2 = y + \theta s_L - p_L - \beta r_L(s_L) + (s_H - s_L)^2$$

$$\theta_H = \frac{p_H - p_L - \beta r_L(s_L) + 2(s_H - s_L)^2}{s_H - s_L}.$$

The critical point θ_L at which the consumer is indifferent between buying from a low-safety category or not buying at all is derived from equation:

$$y + \theta s_L - p_L - \beta r_L(s_L) + (s_H - s_L)^2 = y$$

$$\theta_L = \frac{p_L + \beta r_L(s_L) - (s_H - s_L)^2}{s_L}.$$

Consumers whose type θ exceeds the critical point θ_H, i.e. $1 \geq \theta \geq \theta_H$, choose fish from the high-safety category, and those whose type θ is lower than the critical point θ_H but exceed the critical point θ_L, i.e. $\theta_H \geq \theta \geq \theta_L$, choose fish from the low-safety category. The others choose not to buy. Thus, the demand for the high-safety category is

$$q_H = 1 - \theta_H = 1 - \frac{p_H - p_L - \beta r_L(s_L) + 2(s_H - s_L)^2}{s_H - s_L},$$

and the demand for low-safety category is

$$q_L = \theta_H - \theta_L = \frac{p_H - p_L - \beta r_L(s_L) + 2(s_H - s_L)^2}{s_H - s_L} - \frac{p_L + \beta r_L(s_L) - (s_H - s_L)^2}{s_L}.$$

Comparative statics results

First, we evaluate the effects of changing the high-safety standard by differentiating the demand functions with respect to the high-safety standard:

$$\frac{d\theta_H}{ds_H} = \frac{\left[(4s_H - 4s_L)(s_H - s_L)\right] - \left[\left(p_H - p_L + 2(s_H - s_L)^2 - \beta r_L(s_L)\right)(1)\right]}{(s_H - s_L)^2} \gtrless 0$$

$$\frac{d\theta_L}{ds_H} = \frac{-(2s_H - 2s_L)}{s_L} < 0$$

$$\frac{dq_H}{ds_H} = -\frac{d\theta_H}{ds_H} \gtrless 0$$

$$\frac{dq_L}{ds_H} = \frac{\left[(4s_H - 4s_L)(s_H - s_L)\right] - \left[\left(p_H - p_L + 2(s_H - s_L)^2 - \beta r_L(s_L)\right)(1)\right]}{(s_H - s_L)^2} + \frac{(2s_H - 2s_L)}{s_L} \gtrless 0.$$

If setting the high-safety standard higher (e.g. more stringent dioxin regulation in high-safety category) the safety of fish in the high-safety category will increase. This is due to the increases of demand for high- and/or low-safety categories.

Second, we evaluate the effects of changing the low-safety standard by differentiating the demand functions with respect to the low-safety standard:

(A1) $$\frac{d\theta_H}{ds_L} = \frac{\left[(-4s_H + 4s_L - \beta r_L'(s_L))(s_H - s_L)\right] - \left[\left(p_H - p_L + 2(s_H - s_L)^2 - \beta r_L(s_L)\right)(-1)\right]}{(s_H - s_L)^2} \gtrless 0$$

(A2) $$\frac{d\theta_L}{ds_L} = \frac{\left[(2s_H - 2s_L + \beta r_L'(s_L))(s_L)\right] - \left[\left(p_L - (s_H - s_L)^2 + \beta r_L(s_L)\right)(1)\right]}{s_L^{2}} \gtrless 0$$

(A3) $$\frac{dq_H}{ds_L} - \frac{d\theta_H}{ds_L} \gtrless 0$$

(A4) $$\frac{dq_L}{ds_L}=\frac{\left[(-4s_H+4s_L-\beta r_L'(s_L))(s_H-s_L)\right]-\left[\left(p_H-p_L+2(s_H-s_L)^2-\beta r_L(s_L)\right)(-1)\right]}{(s_H-s_L)^2}-$$
$$\frac{\left[(2s_H-2s_L+\beta r_L'(s_L))(s_L)\right]-\left[\left(p_L-(s_H-s_L)^2+\beta r_L(s_L)\right)(1)\right]}{s_L{}^2}\gtrless 0.$$

The effects of changing the low-safety standard are ambiguous, but again two possible cases can be derived. As we can see from equations (A1)-(A4), the sign of all four results depend crucially, but not exclusively, on the size of $\beta r_L'(s_L)$.

Case 3: More consumers prefer the category where Baltic herring is allowed

If $\left|-\beta r_L'(s_L)\right|>\left|-4s_H+4s_L\right|$ (and $\left|\beta r_L'(s_L)\right|>2s_H-2s_L$) then

(A1) $d\theta_H/ds_L>0$,

(A2) $d\theta_L/ds_L<0$,

(A3) $dq_H/ds_L<0$, and

(A4) $dq_L/ds_L>0$.

The increased demand for low-safety fish outweighs the loss in the demand for high-safety fish, and as a net result, the overall demand for fish increases.

Case 4: Fewer consumers prefer the category where Baltic herring is allowed

If $\left|-\beta r_L'(s_L)\right|<\left|-4s_H+4s_L\right|$ (and $\left|\beta r_L'(s_L)\right|<2s_H-2s_L$))

and $\left|(-4s_H+4s_L-\beta r_L'(s_L))(s_H-s_L)\right|>\left(p_H-p_L+2(s_H-s_L)^2-\beta r_L(s_L)\right)$

(and $\left[(2s_H-2s_L+\beta r_L'(s_L))(s_L)\right]>\left(p_L-(s_H-s_L)^2+\beta r_L(s_L)\right)$) then

(A1) $d\theta_H/ds_L<0$,

(A2) $d\theta_L/ds_L>0$,

(A3) $dq_H/ds_L>0$, and

(A4) $dq_L/ds_L<0$.

The increased safety in the low-safety category does not decrease the health risk enough in order to compensate the loss in diversity (the difference between s_H and s_L gets smaller as s_L increases). As a result, the overall demand for fish decreases.

Also the effects of changing exogenous probability β and the prices can be determined. From the comparative statics results, we can derive the effects when changing the probability of adverse health effect:

$$\frac{d\theta_H}{d\beta} = \frac{-r_L(s_L)}{s_H - s_L} < 0,$$

$$\frac{dq_H}{d\beta} = \frac{r_L(s_L)}{s_H - s_L} > 0,$$

$$\frac{d\theta_L}{d\beta} = \frac{r_L(s_L)}{s_L} > 0,$$

$$= -\frac{r_L(s_L)}{s_H - s_L} - \frac{r_L(s_L)}{s_L} < 0.$$

When the probability of an adverse health effect changes, it can be seen that when β increases, the demand for high-safety category increases and the demand for low-safety category decreases. This result is quite intuitive since when the health risk increases more consumers will choose high-safety category or some consumers choose not to buy at all.

We can also derive comparative statics results when changing exogenous prices. The change of high-safety category price p_H:

$$\frac{d\theta_H}{dp_H} = \frac{1}{s_H - s_L} > 0,$$

$$\frac{dq_H}{dp_H} = -\frac{1}{s_H - s_L} < 0,$$

$$\frac{d\theta_L}{dp_H} = 0,$$

$$\frac{dq_L}{dp_H} = \frac{1}{s_H - s_L} > 0.$$

The change of low-safety category price p_L:

$$\frac{d\theta_H}{dp_L} = -\frac{1}{s_H - s_L} < 0,$$

$$\frac{dq_H}{dp_L} = \frac{1}{s_H - s_L} > 0,$$

$$\frac{d\theta_L}{dp_L} = \frac{1}{s_L} > 0,$$

$$\frac{dq_L}{dp_L} = -\frac{1}{s_H - s_L} - \frac{1}{s_L} < 0.$$

From the price change we can see that both categories can be regarded as normal goods: increase in own price will decrease the demand of it.