Reduction of Behavioural Food Risks: An Analysis of Economic Incentives and Social Context Factors in the German Poultry Chains

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Abstract

This paper describes an interdisciplinary research project carried out on behalf of the Federal Ministry of Consumer Protection, Food and Agriculture. The project combines the knowledge of food experts with decision-orientated approaches from microeconomics and the social sciences. It examines what it is that makes food business operators (from the feed industry to the retail trade) break (or not break) rules. Through the analysis of both economic incentives and social context factors, the project aims at contributing to an adequate design of prevention measures. Four offence-prone regulations identified in the course of the ongoing project are exemplarily examined with regard to the present incentive situation.

Keywords: asymmetric information, moral hazard, opportunistic malpractice, poultry

1 Introduction

The probability that food quality and health problems or other undesired outcomes of food production (here jointly referred to as “food risks”) are caused by malpractice increases with the profits that can be earned through opportunistic behaviour (moral hazard). While the probability of malpractice on the part of food business operators (behavioural risk) can be conceptualized as varying with its expected economic benefits, there are different reactions to identical economic temptations because of different levels of “protective factors” in social contexts - such as values, emotional bonds, peer groups, scenes etc. - that shield actors from deviant behaviour.

Despite a growing societal awareness regarding behavioural food risks, little empirical research has been done on the conditions of compliance with the food law and, even more important, on human malpractice (Hennessy et al., 2003). Consequently, substantial knowledge gaps persist concerning suitable methods for the early identification of food risks that might (re-) emerge due to malpractice as well as concerning an adequate design of proactive measures (prevention). The trust that can be reasonably put in food producers despite information asymmetries depends on the effectiveness of two types of trust factors: (i) those reducing the economic payoffs that can be reaped through the behavioural strategy “non-compliance with rules”, and (ii) those enhancing utility-relevant social context factors that make food producers comply despite contrary monetary incentives (Hirschauer and Scheerer, 2004).

From a contract design perspective, incentive-compatible contracts are desirable which "get the incentives right" (cf. e.g. Akerlof, 1970; Stiglitz, 1987). Economic incentives depend on parameters such as action-outcome linkages, compliance costs, the probability of being caught, reputation and the risk of future market losses, sanctions etc. Available contracts are often neither enforceable nor incentive-compatible. That is, misdirected economic incentives may persist because they cannot (at least not with reasonable costs) be reduced to zero. In this context, it will be important to consider how incomplete inspection and incomplete tracing influence the incentives in force. The capability of tracing is relevant in situations where the qualities of food products purchased from multiple suppliers are only checked at downstream control points. A systematic generation of trust and the prevention of opportunistic behaviour require systems analysis approaches, implying that the pay-off relevant economic factors as well as the non-economic factors that motivate human behaviour are analysed (cf. Ostrom, 2005). In brief, attacking the problem requires answering the following questions:

- Where are food business operators and their employees exposed to economic temptations for breaking the rules, i.e., are there misdirected incentives in the present decision environments?
- What is the actual behaviour of different actors in the light of misdirected economic incentives? Are there protective factors in the actors' social contexts such as bonds to norms and the like which shield actors from yielding to economic temptations?
- What are the adequate prevention measures for interested parties who have less information, e.g. downstream buyers in the chain who are faced with credence qualities, and finally consumers and food safety and environmental protection authorities?

2 The Scientific Approach of the German Poultry Project

The project analyses behavioural risks in the poultry chain by using an interdisciplinary approach which combines the knowledge of food technologists with the analytical powers of microeconomics (game theory, moral hazard analysis) and criminology (control theories, protective factor analysis). The conception of human decision-making shared by the participating economists and criminologists is that purposive action, in conjunction with the individual's social context factors are responsible for his or her behaviour. Despite this shared conceptual framework, economists and criminologists focus on different aspects of the actors' attributes and decision frameworks due to their respective disciplinary background. That is why we combine the microeconomic and the criminological analysts' perspectives, capacities and toolboxes. Synthesising the disciplinary findings is to facilitate the reconstruction of the behaviour of food business operators along the poultry chain. A comprehensive understanding of how various actors assess their decision environment facilitates, in turn, the identification of critical (offence-prone) activities according to the rationale that offences are most imminent if their technological viability coincides both with a high level of economic temptations and with missing protective factors. In economic terms, protective factors (or bonds to norms) can be seen as restrictions that limit the freedom of "homo oeconomicus" to violate rules, regulations and contracts whenever it fits his subjective expected utility (Tittle, 2000).

The project is carried out on behalf of the German Federal Ministry of Consumer Protection, Food and Agriculture (BMVEL). It is funded by the Federal Agency for Agriculture and Food

(BLE) and implemented in co-operation with the Department of Social Sciences (University Hamburg). Within its course (04/05 - 01/2006) three major working steps are carried out:

Step A comprises a **positive analysis** of the economic and social determinants of human behaviour in conventional and ecological poultry chains. We identify practical and relevant opportunities for disregarding existing regulations or contract agreements by collecting and systematising partial data stocks available at scattered places and by gathering knowledge from various food experts who are familiar with production processes. Following this exploratory investigation, we collect data for the actors' decision parameters such as prices, sanctions, expected controls and tracing probabilities etc. through questionnaires. We then analyse the economic incentive situations on different chain levels and for various activities by inserting the collected data into a formal moral hazard model. This facilitates the identification of problem spots where profit-maximising food business operators are most tempted to break the rules. Additionally, the social settings and value systems of food business operators and their effects on compliance with rules in the light of contrary economic temptations are investigated. This includes situations of high and low norm internalisation. Examples of the latter may be a low acceptance of rules being perceived to be "bureaucratic rubbish", or the existence of "clubs" whose members commonly reject the legitimacy of public authorities.

Step B involves **a normative analysis** from a "societal" point of view. That is, we investigate preventive measures which reduce or eliminate moral hazard in the poultry industries. On the one hand, this refers to measures that change the economic environment in that they reduce economic temptations for malpractice by changing the underlying determinants such as intensities of control, control points, traceability, sanctions etc. Restrictions such as upper admissible sanction levels, the costs of different control technologies, and the current food legislation (including EU regulations operative from 2006) are accounted for. On the other hand, this relates to measures that change the social environment in that they enhance protective factors by trying to influence the value system, norm acceptance and self-assessment of different (groups of) actors. When making recommendations, we consider economic and social findings simultaneously in order to derive a consistent set of complementary measures. Search for consistency implies the attempt to avoid that progress in one field (e.g. reduction of misdirected economic incentives through increased controls) is thwarted by drawbacks in others (e.g. dysfunctional effects of controls caused by a decrease in the social acceptance of rules).

Step C focuses on the **methodical conclusions** that can be drawn with regard to future fact-finding activities in other chains. While there is clearly no general methodical approach valid for all circumstances, structural regularities of decision environments can be systematically assessed and broken down into categories. This facilitates a classification into problem types featuring common characteristics. Thus, prudent methodical generalisations may be made, laying the groundwork for a manual which gives step-by-step guidance of how to gather economic-criminological intelligence in different contexts of the food sector in general.

3 Preliminary Findings with regard to Offence-prone Regulations

Carrying out empirical moral hazard analyses, one will soon realise that, due to lacking hard data and evidence, expert opinion and knowledge is an indispensable source of information to understand the decision environment as well as the decision-makers' calculi. In the early stages of the project we tentatively assessed offence-prone activities through exploratory interviews with more than 40 poultry experts from different domains. These include the control field and law enforcement agencies (e.g. public veterinaries, public food surveillance, public prosecution, customs), agricultural administration and extension services, consumer and environmental protection agencies, poultry businesses on various chain levels (from the feed industry to the retail trade), lobbying groups (e.g. Zentralverband der deutschen Geflügelwirtschaft), food scientists, consultant veterinaries, quality assurance systems and corresponding organisations (e.g. QS-Fleisch, ökologische Anbauverbände) etc.

In this paper we use the available evidence from these exploratory interviews and exemplarily subject selected activities to a formal moral hazard analysis. It is to be noted that using limited data sets such as those derived from exploratory expert interviews provides only preliminary hints regarding the regularities of the decision environment and of decision-making. It should also be noted that, in this paper, we do not present the results of the criminological analysis regarding protective factors. Thus, even if we reveal economic temptations to break the rules, the actual behaviour of food business operators in the light of such temptations is not known. For demonstration purposes we examine hereafter the incentive situation in four exemplary situations which reflect different structural characteristics in that they are related to different types of regulations and relevant outcomes as well as in that the economic decision parameters include different components and exhibit widely different levels.

1. **Illegal manure disposal:** A permission to operate a poultry production unit is only granted if legal manure disposal is assured. All big producers are specialised firms without significant acreage of own farm land. Hence, they regularly contract farmers to take their manure. The contracts, confirming that farmers will dispose of the manure according to the rules, suffice to get the permission to operate. The problem is that the environmental authority does not re-check the contracts once a permission to operate has been granted. Thus, in the course of time, producers may be tempted to reduce costly disposal contracts.
2. **Non-compliance with waiting periods after application of drugs:** Affected poultry are treated with drugs containing various active agents such as antibiotics, antiparasitics, anticoccidials etc. After medication periods of up to five days, a waiting period ranging from 2 to 18 days is prescribed before animals may be slaughtered and sold for human consumption. Not meeting the regular delivery date results in increased production costs (extra feeding costs, extra capacity use) and sales losses for overweight animals. Hence, producers may be tempted to infringe upon the costly waiting periods.
3. **Non-compliance with cooling temperatures:** Specialised transport enterprises deliver fresh meat to processors. Due to negligence and/or an insufficient state of cooling equipments, the load may be transported at excessive temperatures. Even in case of negligence on the part of the employee (truck driver), the problem can be seen as a moral hazard problem on the firm level: it would cause some costs (of compliance) to instruct and motivate

the truck driver sufficiently to prevent negligent malpractice. If there are virtually no consequences to be expected, however, the transport enterprise may be well tempted not to spend these compliance costs.

4. **Putting spoilt produce on the market:** Wholesalers storing frozen meat with expired best-before use dates may be tempted to sell this meat to processors who are ready to take it at reduced prices even if it is clearly objectionable. From a wholesaler's point of view, temptations result from the chance to obtain some sales revenues and from the chances to save disposal costs.

4 A Tentative Investigation into the Profitability of (Non-) Compliance

4.1 The Calculus of Decision-makers in Competitive Markets

Understanding which incentives decision-makers face in competitive markets requires that we reproduce their calculi. We need to examine whether it is more profitable to comply or not to comply in various circumstances and according to the decision-makers' perception. From a principal-agent perspective, this can be seen as a check of the incentive-compatibility constraint. The context is that of a less informed principal (the buyer of a product with credence qualities, or a public authority responsible for food safety or environmental issues) and a better informed agent (supplier, food producer). While the principal and the agent have conflicting interests and maximize their respective objective function, the principal aims at designing an incentive-compatible contract that takes account of the agent's expected actions.

In order to do examine the incentives in force, we hereafter adopt a binary perspective in that we assume that the food producer has two available actions (**compliance, non-compliance**). Compliance causes **compliance costs *K*** which usually comprise different components, ranging from a direct cost increase of various inputs to opportunity costs caused by a reduction of sales. There are two expected outcomes (desired, undesired). Modelling a stochastic environment, we use ***q* (*r*)** to represent the **probability of the desired (undesired) outcome** conditional on compliance (non-compliance). Stochastic action-outcome linkages (equivalent to values $q < 100$ % and $r < 100$%) arise if a physical (biochemical, hygienic etc.) product quality is regarded as the relevant outcome. Whenever the very way of behaviour is seen as the relevant outcome (e.g. production with ecologically or socially desirable standards) the linkage is deterministic and q and r can be equated to unity. Corresponding to outcome, there are two payoffs. The **payoff *P* for the desired outcome** may result from market sales as well as from subsidy payments. The **payoff *P-L* for the undesired outcome** may result from losses in sales, damage compensation, fines, long-term market losses due to a deterioration of reputation etc. We furthermore consider that an outcome irregularity is only found with a **detection probability *s* 100 %**. Sometimes, this probability solely reflects the inspection intensity (cf. e.g. Starbird, 2005). In pooling situations, however, where products are commingled before being inspected, it reflects the joint effect of dilution and incomplete inspection. Finally, a **tracing coefficient *z* 100 %** is considered. This is important if physical product qualities are checked at downstream control points and if there are multiple suppliers. In this case, there will be regularly only a certain probability $z < 100$ % that the responsible supplier is traced as the originator of a product irregularity. Incomplete tracing may be due to an insufficient performance of documentation and traceability systems. It may also be caused by high costs of tracing activi-

ties which prevent buyers from **actual tracing** even if a complete **traceability** (ability to trace) is assured through the system in place. In contrast, whenever the observed signal is directly attached to the agent, the coefficient *z* can be equated with unity.

Using the above-mentioned symbols and abstracting first from the effects of incomplete inspection and incomplete tracing, we can reproduce the decision-maker's calculus as follows:

expected payoff for compliance – expected payoff for non-compliance = incentives to comply

$$qP + (1-q)(P-L) - K \quad - \quad \big(r(P-L) + (1-r)P\big) \quad = \quad \textit{incentives to comply}$$

After some simple mathematical manipulations we get:

$$(q + r - 1)L - K \quad = \quad \textit{incentives to comply} \tag{1}$$

Eq.(1) demonstrates that we do not need to know the payout level *P* for the desired outcome, but only the balance *L* of both payout levels. A negative result of Eq.(1) implies that the "incentives are not right". A positive result, in contrast, means that it is more profitable to comply than not to comply. Eq.(1) shows that, with complete inspection and tracing (i.e. if the outcome is fully observed and if it is unambiguously attached to the agent), the outcome probabilities conditional on non-compliance and for compliance coincide with the payoff probabilities. In contrast to that, including a control intensity $s < 100$ % as well as a tracing coefficient $z < 100$ % in the model changes the expected payoff for non-compliance and for compliance. This reflects the fact that, independent of the (unknown) outcome, the payoff *P* is to be paid whenever the outcome is not ascertained through an inspection. But even if an irregular (undesired) outcome is found through random controls, offenders face only a probability $z < 100$ % of being traced. Considering these effects leads us finally to the following incentive formulation:

$$sz \cdot (q + r - 1)L - K \quad = \quad \textit{incentives to comply}, \quad \textit{with } 0 < sz \leq 1 \tag{2}$$

4.2 Parameter Values according to Expert Opinion

The economic determinants represented in Eq. (2) by single parameters may comprise widely differing components in different contexts. In empirical research, the researcher's main task is to identify these components and realistically estimate their values or, at least, magnitudes. Table 1 indicates the parameter values for the selected activities according to gathered expert opinion. For the sake of easy understanding, we will briefly comment on these parameters.

Table 1. Economic decision parameters*

	1. manure dis-	2. waiting period	3. trans- port	4. spoilt produ- cee
action-outcome linkages *q* and *r*				
probability of desired outcome in case of compliance (*q*)	**100%**	**100%**	**100%**	**100%**
probability of undesired outcome in case of non-compliance (*r*)	**100%**	**50%**	**100%**	**100%**
detection probability *s*				
probability that an undesired outcome is detected	**0.1%**	**0.01%**	**0.1%**	**0.5%**
compliance costs *K* (€)				
costs arising from compliance with the rules	**3 300**	**756**	**5**	**6 500**
losses *L* (€)				
inflicted losses if non-compliance is proven	**1 500**	**25 190**	**35**	**58 000**
thereof: - sales losses	0	20 790	0	5 000
- short-term sanctions (fines, compensations)	1 500	500	35	1 500
- disposal costs	0	3 900	0	1 500
- capitalized long-term market losses	0	0	0	50 000
tracing coefficient *z*				
the responsible actor's probability of being traced	**100%**	**100%**	**100%**	**100%**

* All values are related to the offences as specified below.

1. Illegal manure disposal: Besides food safety legislation, poultry producers face environmental legislation which regulates the maximum amount of manure to be spread on farm land. Having provided enough manure disposal contracts when setting up business, an interviewed producer could, according to his own as well as to other expert opinion, reduce the amount of contracted acreage in subsequent years. Obviously, he would then end up over-fertilising his own limited farm land. Considering legal disposal itself as the relevant outcome (alternatively, one could look at physical outcomes such as nitrogen soil levels or nitrogen drains that depend also on stochastic effects from the environment), action-outcome linkages amount to $q = r = 100$ %. The producer expects that the buyer of the poultry is not interested in any information about compliance with environmental rules because it does not affect the product quality. He therefore thinks that the detection probability solely reflects the probability that the competent environmental authority controls contracted acreage in the years after the permission to operate has been granted. The perception of an extremely low detection probability $s = 0.1$ % is partly due to the producer's experience of not having been subjected to any manure controls since setting up production in 1998. Public veterinaries (responsible for animal health issues) only checked conditions in and next to stables, but did not cross-check with the conditions imposed by the environmental authority. Furthermore, the producer has heard no stories of any such controls being made at all. Assuming that, with a capacity of 30 000 turkeys, a realistic offence might be to provide no legal disposal for 300 tons of manure, cost savings of $K = 3\,300$ € per year would arise. In case of detection, no losses of sales are expected. However, he expects EU-subsidies to be cut by 15 % due to cross-compliance regulations. In his case, this would result in an effective loss of $L = 1\,500$ € . Finally, the detection of an offence automatically implies that the offender is detected. Thus, z amounts to 100 %.

2. Non-compliance with waiting periods after application of drugs: The conventional production period for light-weight chicken (1.5 kg) is 32 days. Chickens affected by parasites are regularly treated with the agent "Levamisol" which requires a waiting period of 14 days to prevent residual drug metabolites from persisting in poultry meat (q = 100 %). If the five-day treatment encompasses, e.g., day 15 to 20 of the production cycle, the producer cannot legally meet the regular delivery date. If a producer infringes upon the waiting period by two days, poultry meat is expected to contain residual metabolites with a probability r = 50 % due to stochastic influences. Given the fact that, according to the national food monitoring report, only 10 tests have been made for Levamisol in one year, the probability that an existing irregularity is detected is estimated to amount approximately to s = 0.01 %. While facing additional costs, producers have the opportunity to extend the production period to 37 days and deliver heavy-weight chicken (1.9 kg). However, the additional variable costs (mainly for feeding) and the opportunity costs of capacity use are not fully compensated by increased sales since prices are down by 0.1 €/kg due to the change of product category as well as due to the producer's not meeting the regular delivery date. The resulting costs of compliance amount to K = 756 € per production lot of 18 000 chicken. In a rare case of detection, all sales would be lost and disposal costs would amount to 3 900 €. While having heard no stories of producers being fined for not complying with the waiting period, the interviewees expect the fine to amount to 500 €. The probability of being traced if residual metabolites are detected amounts to z = 100 % because different lots are clearly attributed to individual producer through accompanying documents.

3. Non-compliance with cooling temperatures: We consider the case of a food transport firm which delivers truck loads of 20 tons of poultry meat to processors. During transport, the load must be constantly kept at 4°C (core poultry temperature). Negligence and/or an insufficient state of cooling equipments may cause the load to be transported and delivered at 5°C or more. In some cases, enterprises may even increase the probability of negligent malpractice by replacing experienced personnel by low-cost and ill-trained temporary staff. Abstracting from (the monitoring of) quality consequences and considering the very way of transport as the relevant outcome, we can equate the action-outcome linking probabilities q and r with unity. According to expert opinion, in most cases no controls of transport temperature are made by the processor due to the attitude of those in charge that *"The hygienic quality of goods is not really affected by slightly exceeding transport temperatures for a short while"*. If so, the detection of negligence will only occur if the public food surveillance authority carries out one of its very rare random on-site controls. The detection probability s = 0.1 % simply reflects this minor control intensity. Compliance on the part of the transport enterprise implies spending money (compliance costs) on improving the maintenance of cooling equipments as well as on human resource management in that the firm's truck drivers are regularly instructed and motivated to prevent negligence. The proportional compliance costs per load are estimated to amount to K = 5 €. The caution issued for such minor offences amounts to L = 35 €. Again, the observed activity is directly attached to the offender and z = 100 %.

4. Putting spoilt produce on the market: Food business operators, e.g. wholesalers, may legally sell food products even after the best-before use date if they ascertain - through appropriate controls - that they are still fit for consumption. However, a wholesaler commits an offence if, neglecting evidence, he sells products that are clearly not fit for human consumption. Assuming such a deterministic context, we can equate *q* and *r* with unity. According to expert opinion, there is only a minor detection probability *s* = 0.5 % (or less) since wholesalers can choose a time of delivery outside the public veterinary's regular inspection times. Referring to a situation where a processor would be willing to take 5 tons of spoilt frozen processing meat at a price of 1 €/kg, the wholesaler's compliance costs *K* comprise opportunity costs, i.e. loss of sales (5 000 €), and disposal costs (1 500 €). Inflicted losses in case of detection comprise sales losses (5 000 €), a fine (1 500 €), disposal costs (1 500 €), and future market losses (50 000 €). The observed activity is directly attached to the offender (*z* = 100 %).

4.3 Incentives

Part A of table 2 indicates the incentive situation resulting from the parameter values indicated in table 1. It is interesting to note that there is a very high temptation to break the rules in all situations according to the experts' perception of parameters.

Table 2. The incentive situation*

	1. manure disposal	2. waiting period	3. transport cooling	4. spoilt produce
A: economic inferiority (-) of compliance (€)	-3 299	-755	-5	-6 210
B: ceteris paribus critical level of *L* (€)	3 300 000	15 120 000	5 000	1 300 000
ceteris paribus critical level of *s*	non-existing	6.0%	14.3%	11.2%

* All values are related to the offences as specified above.

Comparing the presently effective parameter values from table 1 with the critical values given in part B of table 2 reveals which change of losses *L* (inflicted in case of detection) and which change of detection probability *s* would ensure incentive-compatible contracts. Ceteris paribus, the inflicted losses would need to be increased to very high levels in order to get the incentives right. This is mainly due to the minor detection probabilities in force. Increasing the detection probability to indicated levels would be an alternative to guarantee the incentive-compatibility of the system. In situation 1, however, even a detection probability of 100% would leave the producer with a 1 800 € temptation to break the rule. This is due to the low level of inflicted losses in case of detection relative to compliance costs.

5 Conclusions

This article describes and applies a practical tool which can be used as a basis for systematic analyses of moral hazard in various food production contexts. Its overall perspective is that one needs to identify those critical activities which exhibit the highest economic temptations for rule-breaking. Its binary moral hazard approach, while being simple enough to account for the limited availability of data, accommodates the crucial elements of many food risk problems in that it considers the incentive effects resulting from partial inspection and incomplete tracing.

It also accounts for the effects of reputation by incorporating long-term market losses into the inflicted losses that need to be considered in the case of detection (cf. e.g. Tirole, 1996, for more details on the effects of reputation). Going beyond this paper's positive analyses and trying to identify optimal contract and control systems in a normative analysis would require that the costs of different control and sanction regimes are considered. Furthermore, more reliable conclusions require that an enlarged data base is analysed which can be statistically evaluated and which provides significant information regarding the mean and the range of parameter values. In the course of the above-described project we will proceed from exploring expert opinion to addressing a larger number of experts through questionnaires.

While it is well known that the identification of critical points is a prerequisite to guide measures carried out, e.g., by public authorities in complex environments such as food production contexts, public surveillance is faced with two major shortcomings: first, the data as well as the expert knowledge that is already existent in various public agencies is by no means systematically collected and evaluated. Regularly, different authorities do neither compare nor make joint use of the data sets the dispose of. This is partly a problem of the distribution of competencies within a federal constitution. It is partly, however, also due to a remediable lack of cooperation between agencies which are simply responsible for different aspects (such as environmental issues or food safety issues). Often, the information flow is even disrupted between different stages of a process, and situations occur where the results of investigations are not even fed back to the control personnel who have initially reported an offence. Second, and equally disadvantageous, neither control intensities nor the definition of control points nor the sanctioning behaviour is based on a risk-based classification of firms and a sensible rationale which at least "tries to influence the incentives in the right direction". Instead, they are often purely incidental and a reflection of budgetary constraints, causing widely differing incentive situations depending on local coincidences. This is quite the opposite of what is necessary to prevent malpractice, namely to use available budgets for those measures which are most effective in that they are apt to reduce harmful and self-interested behaviour. Besides systematically trying to reduce misdirected incentives, prevention also requires that one looks at smart controls (Braithwaite, 2003) that consider trust factors rooted in the social context and social-psychological findings.

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