An Interdisciplinary Approach to White-collar Crime in the Food Sector

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Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006

Abstract: The probability that buyers are deceived with regard to the quality or safety of purchased products (moral hazard) increases with the profits which suppliers can earn through opportunistic behavior. It decreases with the probability and level of losses that result from disclosure of malpractice. It also decreases with protective factors rooted in the suppliers' social contexts – such as values, emotional bonds, etc. – which shield them from yielding to economic temptations. This paper describes how a systematic analysis of economic incentives and social context factors can be provided through an interdisciplinary approach which combines the analytical powers of microeconomics (game theory) and criminology (control theories). The approach is discussed with regard to food quality and safety threatened by moral hazard. Its essentials are illustrated through a case study of grain farmers who might be tempted to infringe upon production-related regulations.

Keywords: *asymmetric information, behavioral food risks, control theories, game theory, moral hazard, opportunistic malpractice*

JEL Classification*: A13, K32, K42*

1 Introduction: the problem of behavioral food risks

Food risks are often caused by *moral hazard*, i.e. by *opportunistic malpractice* of suppliers who exploit the fact that their production activities as well as resulting product properties cannot be directly observed by buyers (*asymmetric information*). Taking the buyers' point of view, asymmetric market information is often described by the term *credence quality*.

The probability that quality or health risks (here jointly referred to as "food risks") are caused by malpractice increases with the profits that can be earned through opportunistic behavior (*white-collar crime*). While the probability of white-collar food crime (and thus the imminence of *behavioral food risks*) can be conceptualized as varying with its expected economic benefits, there are different reactions to identical economic temptations. This is due to the fact that, in different social contexts, there are different levels of *protective factors* – such as values, emotional bonds, peer groups, scenes etc. – that shield actors from deviant behavior.

Despite a growing societal awareness of behavioral food risk, a systematic research program has not yet been developed for its analysis. Thus, substantial knowledge gaps persist both

regarding the *early identification* of behavioral risks and the design of adequate *preventive measures*. Effective prevention requires an *interdisciplinary systems approach* which takes the complexity of human decision-making into consideration and which has the capacity to provide situational intelligence concerning the economic incentives and the social context factors. Up to now, efficient systems analyses of behavioral food risks are impeded by the predominance of unilateral disciplinary approaches. Consequently, a full understanding of what it is that makes food business operators break (or not break) rules is still lacking.

The approach outlined in this paper aims to mitigate this problem by combining the analytical powers of *microeconomics* (*game theory,* moral hazard approach) and *criminology* (*control theories*, protective factor approach). While differing widely in their toolboxes, the two disciplines are related streams of research in that they both resort to *methodological individualism*. This common conception facilitates cooperation across the disciplines without jeopardizing the benefits of specialization. It enables analysts from both disciplines to avoid the pitfalls of unilateral approaches, i.e. the undervaluation of the impact of social context factors that are intrinsically hard to quantify (on the part of economic analysts), and the undervaluation of the power of economic incentives that can be quantified (on the part of criminological analysts).

2 The interdisciplinary approach to behavioral food risks

2.1 The economic state of the art: game theory and moral hazard

Hennessy et al. (2003), taking a comprehensive view on food safety and providing a typology of different sources for the systemic failure in the provision of safe food, conclude that misdirected incentives and malpractice are a major source of food risk. That is, in numerous situations non-compliance with regulations and contractual agreements is more profitable for sellers than compliance. This is the reason why preventive measures aimed at eliminating misdirected incentives are an important field of action for public authorities who act on behalf of consumers as well as for downstream food business operators who purchase inputs. Interested parties need to *assess behavioral food risks* (positive analysis) in order to identify those food chain activities where deviance is a viable proposition to food business operators. They then need to *manage behavioral risks* (normative analysis), e.g. by designing *incentive-compatible contracts*. Such contracts (if available at reasonable costs) work independent of moral atti-

tudes because they eliminate the temptations to infringe rules (misdirected incentives) and replace the need for *character trust* by *situational trust* (cf. Noorderhaven, 1996).

We address the behavioral source of food risks by analyzing incentives and contracts from an operational-level moral hazard perspective. The context is that of a supplier (agent) and a buyer (principal) of a raw material or (semi-) processed food product. Processing decisions made by suppliers affect the probability distributions of the product properties relevant for buyers (be they food business operators or consumers). Buyers, however, cannot contract contingent on actual actions because they cannot observe them (asymmetric information). Moreover, they cannot directly observe the product quality either.

While moral hazard models, which have also become known as principal agent *(PA-) models*, have the capacity to provide valuable insights into the structure of real-life incentive problems (cf. Akerlof, 1970; Stiglitz, 1987), empirical estimates of parameters such as prices, costs of compliance, frequency of control etc. are needed to facilitate practical conclusions. That is, we need to answer the question which methods should be used to obtain realistic estimates for the parameters that define the players' payoffs and which kind of models should be specified. In most empirical contexts expert opinion is the only source of information for quantifying model parameters. Consequently, general PA-model formulations as found in the scientific literature (cf. e.g. Kreps, 1990; Fudenberg and Tirole, 1991) need to be modified into "leaner" models (cf. Hirschauer, 2004) which are able to account for the limited availability of data.

A significant knowledge gap exists with regard to the impact of *inspection intensity* and *traceability*. While a few authors consider partial inspection and *multiple agents* (c.f. e.g. Demski and Sappington, 1984; Fox and Hennessy, 1999; Starbird, 2005), two essential characteristics of behavioral risks are still to be incorporated into applicable and relevant models in the food context: (i) the fact that quality can usually only be observed through random inspections, and (ii) the fact that products cannot always be traced.

2.2 The criminological state of the art: control theories and protective factors

Since Sutherland coined the expression of "white-collar criminality" (cf. Sutherland, 1940), the question why respected members of the professions violate the law has become an integrated part of the criminological discourse. The search for answers has produced a consider-

able body of knowledge on *elite deviance*, *crimes of the powerful*, *repressive crime, crimes of the middle class* and especially *organizational* as well as *occupational crime* (Geis et al., 1995; Friedrichs, 2003). One major consequence of this work has been what may be termed a kind of reversal of the burden of proof. Whereas earlier theorists used to see crime and deviance as a minority phenomenon more or less confined to specific groups, economic situations and/or psychic disorders, more recent approaches assume an image of the human actor based on the rational choice paradigm as specified by the so-called RREEMM model. That is, the human actor is being conceptualized as "resourceful, restricted, expecting, evaluating and maximizing man" (cf. Esser, 1999 pp. 237-239). This fits the empirical finding that just about every member of any human society is sufficiently inclined towards rule-breaking behavior at various occasions; and it justifies a turn-around of the criminological perspective away from the question why people *break* to why people *obey* the law (Tyler, 1990; Hess and Scheerer, 2004). The so-called "control theories" conceptualize deviance as a social fact the emergence of which is due to the inevitability of gaps within the system of formal and informal social control (Gottfredson and Hirschi, 1990). In this context the criminological discourse has become aware of different means of social control and their relative merits, and the decisive relevance of situations and, correspondingly, of situational crime prevention. This implies to use the largely untapped resources of "smart controls" and "soft means" of corporate regulation (cf. e.g. Clarke, 1992; Braithwaite, 2003). The fact that people "with strong bonds to conventional social groups or institutions will be less likely to violate the law because they have less freedom to do so" (Tittle, 2000 p. 65), can also be rephrased: (1) people are in principle prone to develop a motivation for deviance and to act accordingly whenever it fits their subjective expected utility; (2) in spite of a prima facie utility, deviance can be prevented by "protective factors" like emotional attachment to law-abiding family, religious affiliations etc. To find out why people obey the law in spite of contrary economic temptations, one therefore has to investigate the nature and extent of social bonds working as protective factors.

The specific potential of control theories, i.e. to look for effective bonds to norms still has to be activated with regard to white-collar crime. This applies especially with regard to white-collar delinquency in food business operations. There seems to be no systematic empirical research to speak of that addresses this issue from an explicit control theories perspective.

2.3 Synergies and joint conceptual background

Micro-economists, while focusing on economic goals and individual choice, have adopted the concepts of imperfect information, bounded rationality, opportunism and multi-goal decision-making. Criminologists who can be seen as social psychologists in the field of delinquency understand deviance on the micro-level as behavioral strategies of coping with personal goals (Kaplan, 1995) and strain (Agnew, 1999). While adopting the concept of choice, they focus on the individual's behavior depending on his social settings and value systems.

The overall conceptions of modern economists and criminologists are quite similar in that they resort to methodological individualism and assume that purposive action in conjunction with the individual's social context factors are responsible for his behavior. The fact that the two approaches focus on different aspects may nonetheless lead to a different perception. This may be enhanced by their respective affinity to quantitative vs. qualitative methods. Focusing on monetary incentives and treating social factors merely as constraints or subordinate objectives, economists may undervalue the impact of social factors. The reverse, i.e. the risk to undervalue the power of monetary incentives may arise in criminological approaches.

It seems that a lot of knowledge could be gained by combining the analytical power of economics with that of criminology: the PA-model facilitates a quantitative analysis of misdirected economic incentives. The criminological facilitates a qualitative reconstruction of protective social factors which make actors comply despite contrary economic incentives. The diverse forms of social control resist their representation in formal models. Thus, *we deliberately exclude the social determinants of human behavior from the economic model. It seems that more knowledge can be gained by explicitly leaving them to a qualitative criminological analysis*. Synthesizing the disciplinary results follows the rationale that offences are imminent if misdirected economic incentives coincide with missing protective factors.

3 A case study of grain farmers' incentives and social contexts

Conventional European grain farmers regularly apply a last dose of fungicides five to six weeks before harvesting. Applied products are labeled for control of fungal infections which could reduce the grain quality. Farmers might be tempted to breach the minimum waiting period of 35 days if, a few days before expiration, ripeness and weather are ideal for harvesting.

Three farmers provided expert opinion for the case study. They sell their wheat to a grain dealer who takes and stores samples from all individual trailer loads, tests them for their technological qualities (humidity, protein etc.) and differentiates prices for different quality categories. Before testing for pesticide residues, the grain dealer blends the individual "loads" into "batches" according to technological specifications. Thus, infringements are only detected if the blended batch exceeds the tolerance limits. This happens only if a critical number of farmers simultaneously break the rule. Otherwise, residues are "sufficiently" diluted and free-riders stay undetected. Free-riding "moves the residue distribution to the right". It arises precisely because the group appears trustworthy on the whole, but is (morally) heterogeneous.

3.1 Economic incentive analysis

The model

With a view to the empirical application, we resort to a general discrete PA-model as described, for instance, by Kreps (1990 p. 577). The model assumes that a risk-averse agent has opportunity costs (reservation utility) μ for accepting a contract. After accepting, he has the choice between discrete actions a_n (n = 1,2,…,N) and corresponding deterministic efforts $k_n < k_{n+1}$. In a stochastic environment, these actions result – with given probabilities π_{nm} – in discrete outputs $y_m < y_{m+1}$ (m = 1,2,…,M). For these outputs the principal defines output-dependent remunerations $w_m < w_{m+1}$. The agent's utility depends on his remuneration and effort ($u(w_m) - k_n$), where $u(w_m)$ represents a von Neumann-Morgenstern utility function. If the principal is risk-neutral, his design problem can be stated as follows:

Step 1: determine the minimum wage costs $w_{min}(a_n)$ for each possible action

$$\underset{w}{Min} \sum_{m=1}^{M} \pi_{nm} w_m = w_{min}(a_n) \tag{1}$$

$$s.t. \quad \sum_{m=1}^{M} \pi_{nm} u(w_m) - k_n \geq \mu \qquad \text{(participation constr.)} \tag{2}$$

$$\sum_{m=1}^{M} \pi_{nm} u(w_m) - k_n \geq \sum_{m=1}^{M} \pi_{n'm} u(w_m) - k_{n'}, \quad n' = 1,...,N \qquad \text{(incentive compatibility constr.)} \tag{3}$$

Step 2: determine the maximum payoff over all actions a_n

$$\underset{a}{Max} \left(\sum_{m=1}^{M} \pi_{nm} y_m - w_{min}(a_n) \right) \tag{4}$$

Since expert opinion is *the* source of information for quantifying the model parameters in our case (and many other related food risk contexts), we adjust the general model to the type and availability of data by making the following modifications: **(1)** We apply a binary perspective and consider only two possible actions (a_1 = non-compliance; a_2 = compliance), two corresponding effort levels ($k_1 < k_2$), two outcomes ($y_1 < y_2$), and two remunerations ($w_1 < w_2$). This enables us to use expert estimates in the form of binomial distributions for variables such as outcome and remuneration. **(2)** Instead of accounting for risk aversion endogenously, we assume risk neutral principals *and* agents in model calculations. Therefore, optimal risk sharing will not be our concern here. **(3)** We assume a reservation utility $\mu = 0$. This reflects a situation with binding regulations where the agent has to refrain from production if he does not officially "participate". **(4)** We assume that the principal is pre-determined to induce compliance and only strives to do so at minimum (budgetary) costs. Hence, the second step of the optimization can be omitted and the problem is reduced to cost minimization. **(5)** We take into account that observation can only take the form of random sampling inspections carried out with a control intensity $s \leq 100$ %. **(6)** We consider the fact that identified properties cannot always be retraced to a single upstream supplier by incorporating a traceability (tracing probability) coefficient $z \leq 100$ % into the model.

Instead of simply reformulating the Kreps-model for the above-mentioned modifications we now use the handier notation from table 1. Contrary to complete inspection and traceability where output probabilities coincide with remuneration probabilities, partial inspection and traceability generate modified remuneration probabilities. That is, both a control intensity $s < 1$ and a traceability $z < 1$ change the expected remuneration for non-compliance $w(a_1)$ as well as for compliance $w(a_2)$: independent of the product quality, the principal has to pay P whenever the quality is not ascertained or cannot be ascribed to a single agent. The agent can only be made to pay a sanction S if the undesired quality y_1 is evidently his making.

Table 1: Notation for the binary food risk model

		s	intensity (frequency) of random product inspection ($0 < s \leq 100$ %)
		z	probability that responsible suppliers are traced ($0 < z \leq 100$ %)
w_1	=	$-S$	sanction (loss) inflicted on the agent if the undesired/hazardous quality y_1 is detected
w_2	=	P	regular price paid for a product of the desired quality y_2
k_2-k_1=k_2	=	K	agent's cost of compliance with regulations
π_{11}	=	r	probability of undesired quality y_1 conditional on action a_1 (i.e. non-compliance)
		szr	remuneration probability for $-S$ conditional on action a_1 (i.e. non-compliance)
π_{12}	=	$1-r$	probability of desired quality y_2 conditional on action a_1 (i.e. non-compliance)
		$1-szr$	remuneration probability for P conditional on action a_1 (i.e. non-compliance)
π_{22}	=	q	probability of desired quality y_2 conditional on action a_2 (i.e. compliance): $q > 1-r$
		$1-sz(1-q)$	remuneration probability for P conditional on action a_2 (i.e. compliance)
π_{21}	=	$1-q$	probability of undesired quality y_1 conditional on action a_2 (i.e. compliance)
		$sz(1-q)$	remuneration probability for $-S$ conditional on action a_2 (i.e. compliance)

We replaced k_2-k_1 by the costs K of compliance. It is unrealistic to assume that food business operators produce the unauthorized quality at cost $k_1 = 0$. For the sake of simplicity we normalize k_1 to zero and avoid having an extra variable without impeding the insights of the analysis.

Additionally considering the control costs depending on the intensity $c(s)$ and the costs of imposing sanction $c(S)$, the principal's design problem is to be restated as follows:

$$Min\left(w(a_2) \; + \; c(s)+c(S)\right) = Min\left(P - sz\cdot(1-q)\cdot(P+S) \; + \; c(s)+c(S)\right) \tag{1'}$$

$$s.t. \;\; w(a_2) - k_2 = P - sz\cdot(1-q)\cdot(P+S) - K \geq 0 \tag{2'}$$

$$w(a_2) - k_2 - w(a_1) = sz\cdot(q+r-1)\cdot(P+S) - K \geq 0 \tag{3'}$$

$$0 < sz \leq 1$$

While there are only few parameters to be considered in the model, their empirical estimation still represents a formidable task. It is not trivial, for instance, to define different control alternatives and to provide their cost estimates (let alone intensity-dependent control cost functions $c(s)$ for different control systems and technologies). In our case study, we therefore solely assess the current incentive situation and tentatively investigate incentive-compatible

alternatives through variant calculations. That is, we determine the parameters *K, q, r, s, z, P,* and *S*, and then use equation (3') to quantify resulting incentives.

Farmers' economic decision parameters and incentives

Since only a limited number of discrete data can be gained in expert interviews, the farmers were asked to assess the economic parameters for three discrete types of weather, implying, in turn, three different "technologically optimal" harvest dates: 6 days and 2 days prematurely as well as an optimal harvest date after expiration of the waiting period. The term "technologically optimal" implies that, in the absence of a prescribed waiting period, farmers would harvest because they expect quality losses and increased harvesting costs for any posterior date.

Table 2: Economic decision parameters if it is technologically optimal to harvest 6 days prematurely

	parameter	Farmer A	Farmer B	Farmer C
1) probability that the farmer exceeds the residue limit in his individual load if he harvests 6 days early	***r***	**5 %**	**50 %**	**20 %**
2) probability that the farmer is detected if his individual load has exceeded the residue limit	***s***	**5 %**	**50 %**	**5 %**
3) losses (€/ha) if the farmer complies with the waiting period despite contrary technological weather conditions	***K***	**100**	**130**	**100**
4) losses in sales (€/ha) if non-compliance is proven	***P***	**984**	**984**	**984**
5) "sanctions" (€/ha) if non-compliance is proven	***S***	**1 100**	**20 750**	**13 375**
thereof: - short-term sanctions (fines, damages, …)		350	20 000	13 000
- capitalized long-term losses in the market		750	750	375
6) probability that the farmer can be traced	***z***	**100 %**	**100 %**	**100 %**

Ad 1): farmers agreed that there is no risk of exceeding the residue limit if they comply. Trusting that a safety margin had been built into the prescribed 35 days, they also agreed that harvesting two days early would still involve a zero probability of exceeding the limit. According to this perception, a 2-days-infringement of the waiting period has the same outcome as compliance ($r = 1\text{-}q = 0$ %). For the 6-days-infringement farmer A (B, C) estimated the probability of exceeding the limit to rise to $r = 5$ % (50 %, 20%).

Ad 2): in the considered case, the probability *s* results from the joint effect of two factors: (i) the control intensity and (ii) the dilution effect caused by the fact that individual loads are blended before tests are made for residues. All farmers ignored the actual percentage of batches that are controlled. They likewise ignored the determinants of the dilution effect such as their own share in a batch, or the behavior of other farmers. They provided ad hoc estimates, however, regarding the overall effect of these factors (i.e. the probability that an infringement is detected if their individual load exceeds the limit): 5% (A and C), and 50% (B).

Ad 3): the compliance costs *K* arise from two sources: if it is technologically optimal to harvest 6 days early, all three farmers expected a 50%-threat of degradation from food to feed quality, resulting in an expected loss of 87.5 €/ha (A and C) and 105 €/ha (B). Furthermore, farmers A and C (B) estimated machinery costs to increase by 12.5 €/ha (25 €/ha).

Ad 4): farmers are convinced that they would completely loose their income from wheat sales (including EU-subsidies) of P = 984 €/ha if non-compliance was detected.

Ad 5): farmers estimated that they would have to pay an equivalent of 350 - 20000 €/ha in direct sanction payments such as fines, damage compensations etc. Farmer B's and farmer C's perception of comparably high sanctions is mainly due to their understanding that they could be forced to pay damage compensations for large quantities of grain if these were contaminated by their individual load. Furthermore, farmers assumed that their capitalized future losses on the market would amount to 375 - 750 €/ha.

Ad 6): farmers agreed that the traceability *z* amounts to 100 % due to the fact that samples are taken and stored from their individual loads according to EU-regulations.

Table 3 demonstrates the incentive situation which results from the farmers' perception of the relevant parameters in force. Only farmer A perceives an economic reason to infringe upon the waiting period if it is technologically optimal to harvest 6 days prematurely. His actual behavior in the light of such a temptation is not known.

Table 3: Economic inferiority (–) / superiority (+) of complying with the waiting period if it is technologically optimal to harvest 6 days prematurely (€/ha)

Farmer A	Farmer B	Farmer C
– 95	+ 5 304	+ 44

Resorting to (3') a critical value analysis reveals which changes (sanctions, controls) would ceteris paribus ensure/maintain incentive-compatible contracts. It should be noted that, in the case under consideration, the participation constraint (2') does not need to be accounted for in such a critical value analysis. It is possible to design "boiling-in-oil-contracts" (cf. Rasmusen, 1994 p. 180) since the probability of the desired product quality is $q = 1$ for complying farmers. Thus, they are neither affected by increased sanctions nor by intensified controls.

Table 4: Incentive-compatible contract alternatives

	Farmer A	Farmer B	Farmer C
critical sanction with retention of the present system of batch controls (s = 5 %)	39016 €/ha	no sanction needed	9016 €/ha
critical sanction after introduction of complete individual controls (s = 100 %)	1016 €/ha	no sanction needed	no sanction needed
critical individual control intensity with present sanctions: A: 1100 €/ha, B: 20750 €/ha, C: 13375 €/ha	96.0 %	1.2 %	3.5 %
critical individual control intensity with assumed sanctions: A: 2200 €/ha, B: 41500 €/ha, C: 26750 €/ha	62.8 %	0.6 %	1.8 %

If mixed batch controls are maintained, the sanction perceived by **farmer A** needs to increase from its present level of 1100 €/ha to 39016 €/ha in order to eliminate his 95 €/ha-temptation to break the rule. Since it seems unrealistic that the principal succeeds in making the farmer believe in such a sanction, we consider replacing the downstream control point "blended batch" by the upstream control point "individual load", thus eliminating the dilution effect. With complete individual controls (s = 100 %), a sanction of 1016 €/ha would suffice to eliminate misdirected economic incentives for farmer A. Alternatively, with the presently perceived sanction of 1100 €/ha, controlling 96 % of individual loads would be sufficient.

Considering **farmer B and C** reveals that, due to information uncertainties, the incentives "in force" are in the eyes of the beholder. Farmer B, for instance, clearly perceives no temptation whatsoever to break the rule. After switching over to individual controls, a control intensity of 1.2 % (3.5 %) would generate incentive compatibility for farmer B (C).

The **grain dealer's** view of the incentive situation is that a shirking farmer's risk of being detected is almost zero due to the dilution effect, and that situational incentives are indeed not "right". However, he states to rely on character trust with regard to his farmers. This statement triggers the question whether he is really motivated to act as a "responsible principal". Responsible principals would indeed act on behalf of the downstream chain by trying to identify optimal control points and to design incentive-compatible contracts. The "making of responsible principals" requires that they are forced to internalize societal costs resulting from downstream diseconomies and finally from consumers' exposure to increased residue levels.

Abstracting from individual particularities, we can finally generalize from the last row of table 4 that increasing the sanction level allows for a decrease of the control intensity without compromising the incentive compatibility. With a given sanction level, increasing the price (and thus the threat of sales losses in case of disclosure) would equally allow for a decrease of the control intensity. If we knew the control costs depending on the control intensity and the costs for imposing different levels of sanctions an optimal combination of price, sanction and control intensity could be formally derived (Hirschauer, 2004) by using equation (1') to (3').

It should be noted that a realistic model which tries to reconstruct human behavior needs to incorporate the relevant factors *as perceived by the decision-makers*. The essence of our incentive analysis can be pictured through a typology consisting of two extreme- and one mixed-type decision-maker. We arrive at these three types by distinguishing between "character trust" and "situational trust": (1) on the one extreme is the farmer whose character is utterly trustworthy. Because of his personal set of preferences he resists every perceived economic temptation to break the rules. (2) On the other extreme is the farmer who is only trustworthy if, given his exclusive objective of maximizing profits, the perceived situational incentives of the contract are "right". (3) Between these two extremes is the mixed-type farmer who accepts, for instance, a certain profit trade-off in exchange for a personal feeling of moral

integrity resulting from his decision to abide by the rules. He might yield to rule-breaking behavior, however, if the additional profits to be gained exceed his personal resistance.

3.2 Social context analysis

It is common sense to assume that real decision-makers are of mixed-type. They are likely to differ, however, with regard to their personal resistance to temptations, i.e. the level of protective factors that are individually effective. This is the reason why a systematic analysis of formal and informal mechanisms of social control is needed to understand actual behavior.

In the present case study, only farmer A's perception creates a temptation to violate the waiting period. If motivated solely by his expected monetary costs and benefits he would have to opt for deviance in order to maximize profits. This makes it necessary to find out about his actual choices and their motivation. To find out he was interviewed at two separate occasions. The first interview was conducted on the premises of the farm. Its purpose was to establish a working relationship and to gather general information about rules, practices and relationships in the farmer's work context. There was ample opportunity to speak with the farmer himself as well as (partly separated) with employees and colleagues of his. During a car tour of the area and a restaurant visit in the nearby village, a certain insight could be gained into farmer A's life-world and into the opinions of his relevant relations. Four weeks later, remaining questions could be cleared by a focused (20-minute) phone interview with farmer A.

The basic finding was that A – according to his own convincing affirmation as well as supportive testimonies of "relevant Others" – would rather take a financial loss than break the rules. He is also being seen this way: as a highly respectable and at the same time highly successful farmer. Asked for the reasons for this "uneconomic" attitude, A responded that he obeyed to something like "a sense of honor" which made him "want not to be one of those". "Those", it was understood, being "those who do not earn their living by honest work, but rather by cheating and concealing". Asked if he knew anybody of this "bad" kind, he denied any personal knowledge, but non-verbal evidence gathered at the first meeting told us the contrary.

As far as farmer A himself was concerned, we were convinced that he was sincere in his statement regarding his own behavior: there was something inside of farmer A which in effect limited his subjective freedom to commit unlawful acts. To find out more about the protective

factors at work, he was asked about his emotional attachment to relevant Others. In spite of his (deceased) parents' strict adherence to religion and especially his father's active Catholic Church practice, A said that his actions were not governed by religious motives. Asked with regard to whom he would feel most ashamed if a hypothetical rule violation transpired, he mentioned his wife and (also farming) son and his friends in the village community and colleagues who might "point fingers" at him. With his wife being a teacher and belonging to a different social milieu, where such farming details would hardly get to, the most relevant Others were obviously his farming environment including his own staff. Rather than fear of being found out, it was a sense of honor that attached farmer A to his personal community and – indirectly – to the rules that this community expected to be respected.

On the other hand, while speaking with his son, farmer A became conscious of a transgression which he indeed had once committed. He had infringed upon the 35-day waiting period by two or even (less likely) three days. This transgression had escaped the farmer's memory (or even his conscious experience), and there was no indication that would have suggested a deliberate attempt at concealing this transgression. This episode – while prima facie contradicting the assumption of effective protective factors – can be helpful in terms of drawing attention to the nature and limits of those factors. Since farmers were bound by the common conviction that a transgression of two to three days was within the (assumed) safety zone already built into the 35-day period, these days were not completely covered by the reign of what they understood as "the rules". As a matter of fact, a criminologist is reminded of the difference between the "law-in-the-books" (the so-called "first code") and the "law-in-action" ("second code"). While the informal "second code" of the farming and village community basically supports the legal "first code" normative order, it evidently draws the line a little bit different from the official order, thus leaving a small strip of normative ground uncovered or only fragmentarily protected. It is within this "no man's land" where the infraction took place, rendering it much less important for A and innocuous in terms of his reputation, thus making this behavior eligible for being ranked down in relevancy and sent into oblivion. It could escape his consciousness, because it was considered a justified and innocuous exception to the rule of conformity, and that is why it had to be brought into it through the conversation with his son.

This little episode can be contrasted with a hypothetical aggravation of circumstances. If, e.g., there had been an obligation to put down the date of spraying and the date of the harvest in an official book, and if any entry in this book had had to be signed by the farmer in person, his sense of attachment to the community would have prevented a violation: to falsify and sign an official entry in a document would certainly have been regarded something anathema by A.

4 Outlook

Designing effective measures against behavioral food risks requires systems analysis approaches which consider all relevant factors that motivate human behavior. While expert opinion is often the only available source of information, game-theoretic PA-models are efficient means to process quantifiable information. Other factors such as diverse forms of social control and the actor's intrinsic motivation, however, resist their representation in formal models. Nonetheless, they may represent crucial determinants of human behavior. Our message is that we have a big chance to improve our understanding of what it is that makes people choose certain actions if economic and non-economic social science disciplines systematically combine the relative merits of their approaches and toolboxes. In a context such as the considered case, social factors which are intrinsically hard to quantify should be explicitly excluded from the economic model even though they are payoff (utility) relevant in principle. The complementary criminological analysis guarantees that – instead of being merely considered as constraints or subordinate objectives – social factors are not underestimated, but considered comprehensively by using an adequate toolbox and a different perspective.

The findings of our demonstration case study have illustrated the suitability of an economic-criminological approach for the analysis of behavioral risks. Adequate decision and policy support, however, requires further research revealing behavioral regularities: first, the case study of three selected farms needs to be complemented by a broad investigation of representative samples of farmers in different regions, with different farm sizes etc. Second, a nearly endless number of activities on all levels of different food chains may represent sources of behavioral risks and thus relevant objects of investigation. They all lend themselves to the above-described economic-criminological research. However, given budgetary constraints and the costs of investigations, one will first need to scan the food chains and to gain expert

knowledge in order to narrow down the number of in-depth investigations to the most imminent threats. Third, the positive analysis should be complemented by a normative analysis aiming to find the optimal mix of risk reducing measures. We know that the optimal mix is characterized by the expectation that gains from further efforts to reduce misdirected incentives and/or to enhance protective factors will be smaller than the costs caused by these efforts. One might add, however, that this is difficult since there is no universally optimal mix.

Instead, the optimal mix depends on the specific contingencies of the situation. Besides the parameters defining the agents' incentives, its identification requires informed expectations regarding the costs of control depending on the control intensity, the costs of imposing different sanctions, and, in the long run, even the costs for changing the overall structures of the chain. It also requires estimates concerning the costs of measures to enhance protective factors. Furthermore, the problem needs to be attacked of how to deal with groups of agents who are heterogeneous, both with regard to their costs of compliance and their level of protective factors. That is, one needs to consider the adverse selection aspect of the incentive problem.

Future work should also focus on the development of easy-to-apply tools and on how these can be combined most efficiently, e.g. by public authorities, for a systematic analysis and prevention of behavioral food risk on all levels of food chains. Extending efforts to a systematic analysis of food chains or the food sector at large may require that the structure of the above-described PA-model is developed further and extended with regard to its restrictive assumptions. It may also require to further develop the criminological approach, for instance by including ethnographic perspectives and concepts of comparative deviance and cultural criminology. However, before increasing the complexity of applied approaches it should always be critically checked whether informational gains justify additional costs.

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