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Abstract

With credence goods consumers cannot judge actual quality neither before purchase (*ex ante*) nor after purchase (*ex post*). Trust has to replace own examination and verification. Applying Choquet-Expected Utility theory, a general model of credence goods is developed which takes the problem of trust explicitly in its view and generalizes the problem of quality uncertainty on the 'market for lemons' of Akerlof (1970) to 'quality ambiguity' with credence goods. The model shows the market mechanism only performing well in providing credence goods when consumers' trust in given information is not too low. With trust too low, sellers of credence goods will be driven out of the market by *trust induced adverse selection*. In market equilibrium prices will always be lower compared to equillibrium prices for experience goods.
Journal of Economic Literature Classification Numbers: C72, D81, D82.

Key words: credence goods, asymmetric information, quality ambiguity, quality uncertainty, adverse selection, ambiguity, choquet expected utility

Contents

1 Introduction

Since Akerlof (1970) has given a theoretical understanding of adverse selection the market mechanism under asymmetric information caused by quality uncertainty has constituted a main focus of research in economics of information (for an comprehensive overview see textbooks on industrial organization e.g. Tirole (1988), Carlton and Perloff (1994), Shy (1995).) However, all models introduced so far refer to markets for goods with a quality distribution assumed to be known or to be deducible from former experience, i.e. quality itself must be verifiable at least after purchase. In economics of information goods satisfying this condition are classified either as *search goods* or as *experience goods* (Nelson (1970), Nelson (1974)). Beside many goods which fall into this categories (e.g. canned food), there is a growing range of goods for which quality is not known even after purchase, e.g. goods with quality specified in terms of the production process like the good's country-of-origin, the welfare of producing animals, or the use of hormones in keeping animals. According to Darby and Karni (1973) a good for which actual quality cannot be verified neither before purchase (*ex ante*) nor after purchase (*ex post*) is called *credence good* (cf. table 1).

quality is verifiable		type of good
ex ante	*ex post*	
yes	yes	search good
no	yes	experience good
no	no	credence good

Table 1. Asymmetric Information and types of goods

This paper is about asymmetric information with credence goods. With credence goods a specific new aspect of asymmetric information arises which is not yet captured by the models dealing with quality uncertainty. Since consumers cannot verify any given information on their own even after purchase with credence goods it is trust in received information which has to replace own examination and verification.

Whereas empirical studies have shown consumers' awareness of credence goods (Lynch and Schuler (1991), Arnthorsson et al. (1991)), there is only a small theoretical literature dealing with credence goods. The models presented so far mainly differ along two dimensions. Firstly, the models capture a good's credence component in different ways. On the one hand, the credence component is assumed to arise from so called expert services. With expert services an expert both provides the service and determines the amount of treatment so that the customer cannot verify the service provided at all (Darby and Karni (1973), Pitchik and Schotter (1997), Taylor (1995), Wolinsky (1995), Emons (1997), Emons (2001)). On the other hand, the credence component is assumed to be caused by aspects of the production process, which cannot be observed by consumers. (Schmutzler (1992), Feddersen and Gilligan (2001)). Secondly, the models make different assumptions on how information, which consumers cannot determine on their own, is provided. Provision of information is either modeled by additional sources of information which replace consumers' own evaluation (Schmutzler (1992), Feddersen and Gilligan (2001)) or by the ability of consumers in getting the information indirectly (Wolinsky (1995), Emons (1997), Emons (2001)). Beside all differences, in all frameworks existence of a market equilibria for which a transaction takes place is only made possible by a portion of trust coming along either by the trustworthiness of the seller himself or by a guarantee of a third party which can be trusted. However, this aspect of trust is assumed only implicitly and cannot be made explicit in the assumptions for any of these models. As a consequence, the specific dimension of credence goods has not yet captured and the influence of trust in market performance cannot be analyzed directly.

type of good		decision situation
search good	$\longrightarrow$	certainty
experience good	$\longrightarrow$	risk
credence good	$\longrightarrow$	uncertainty

Table 2. Typ of good and decision situation

To overcome the lack of the models developed so far this paper presents a model which considers the specific decision theoretic conditions given with credence goods.[1] The three types of goods differ in the way beliefs about a good's actual quality are deduced (Steenkamp (1990)). With search goods quality can be deduced by pure inspection before consumption with certainty leading to decisions under certainty. For experience goods quality can be verified at least after consumption. Thus, beliefs are given by a probability distribution over quality and are known ex ante or can at least be deduced from own experience after consumption. Decisions concerning experience goods therefore correspond to decisions under risk. Quality of credence goods is not known even after consumption. There is no basis for beliefs represented by probabilities (Caswell and Mojduszka (1996, p. 1250)) and decisions with credence goods therefore are based on uncertainty.

Considering the given characterization (cf. table 2) the formal analysis of credence goods amounts to the question how to formalize decisions under uncertainty arising from credence goods within decision theory. The leading theory to model decisions under uncertainty is subjective expected utility theory (SEU) as firstly developed by Savage (1954). Within SEU subjective probabilities can always be deduced from revealed decisions (Savage (1972, p. 51)) and include all aspects of uncertainty, i.e. both the impreciseness and the uncertainty of decision makers' knowledge about the uncertainty of the event itself (Savage (1972, p. 3)). Taking subjective probabilities generally as a basis for formalization of decision situations, there is no sense in distinguishing risk from uncertainty or experience goods from credence goods, respectively, since, in this case, probabilities are never unknown to the decision maker (Camerer and Weber (1992, p. 326)).

However, uncertainty given with credence goods is just characterized by the lack of any information about a good's quality and beliefs or probabilities, respectively. Thus, for a adequate representation of credence goods within decesion theory a equal-treating of uncertainty and risk according to SEU is not appropriate. The distinction between risk and uncertainty, i.e. between known and unknown probabilities, has already been stressed before axiomatization of SEU (Knight (1921)), but has been widely discussed in decision theory only since the direct attack on the axioms of SEU by the *Ellsberg-Paradoxa* (Ellsberg (1961)). Together with subsequent experimental studies (for a broad overview cf. Camerer and Weber (1992), Payne et al. (1992), Camerer (1995)), the Ellsberg-Paradoxa show that SEU is not sufficient to represent decision situations for which clear cut information is missing. It is just the lack of precise information relevant to a decision which contradicts the representation of decision makers' beliefs by probabilities both in the Ellsberg-paradoxa and with credence goods. In the given context, decision situations are uncertain for which no probabilities can be deduced because of a lack of information. This are just the situations for which Knight (1921) uses the term *uncertainty* and Ellsberg (1961) introduced the term *ambiguity*. It is then just the distinction between risk and ambiguity which captures the essential aspect of the difference between experience goods as decisions under risk and credence goods as decisions under ambiguity. As a consequence, we suggest to use the term *quality ambiguity* when considering credence goods. Then, refering to situations with experience goods, it would be more precisely to speak of *quality risk* instead of *quality uncertainty*.

Different approaches to cope with ambiguity in formal models have been given (Camerer and Weber (1992)). Our paper presents a model of quality uncertainty with credence goods which utilizes *Choquet Expected Utility theory* (Gilboa (1987), Schmeidler (1989)) and its application to game theory (Dow and Werlang (1994), Eichberger and Kelsey (1994), Eichberger and Kelsey (1999)). The model extents the lemons' market of Akerlof (1970) by referring to decisions concerning credence goods as decisions under ambiguity. Consumers' beliefs over sellers' behavior are represented by non-additive probabilities (*capacities*), and market behavior is modeled as a non-cooperative signalling game under ambiguity with equilibria given by the concept of *Dempster-Shafer equilibrium (DSE)* under uncertainty (Eichberger and Kelsey (1999), Ryan (2002)).

As a main result, the crucial role of trust in given information becomes obvious. For credence goods the lack of trust is an additional new source for market failure; with trust too low, sellers of credence goods will be driven out of the market by *trust induced adverse selection* even when this quality itself would be accepted if it could be judged after purchase, i.e. for experience goods. Even if a market for credence goods exists equilibrium prices always will be lower for credence goods than for experience goods.

The remainder of the paper is organized as follows. In section 2 our model of a market for credence goods is presented. Market behavior is modeled as a non-cooperative signalling game under ambiguity for which the aspect of trust is captured by representing consumers' beliefs over quality by non-additive probabilities (*capacities*). Section 3 summarizes the conclusions of the model.

2 Adverse Selection with credence goods

2.1 The model

Consider a market for a credence good for which quality is the only characteristic relevant for a buying decision. The transaction process between sellers and consumers is modeled as a signalling game between a sender (seller) and a receiver (consumer). Three different exogenous given qualities are offered on the market: A good can be of low (L), medium (M) or high (H) quality. Since only the seller knows the actual quality before a purchase there is asymmetric information with regard to quality. The only information available for the consumer is the distribution of quality which is given by the exogenous probabilities $\mu(H) = q_H$, $\mu(M) = q_M$, and $\mu(L) = q_L$ with $\sum_{t\in\{L,M,H\}} \mu(t) = 1$.

Throughout the section it is assumed that the good is a credence good, i.e. the consumer holds beliefs over the good's quality which are ambiguous.

The seller and the consumer differ from each other by their valuation of different qualities. With parameters a_S and a_C $(a_S, a_C \in I\!R)$ the consumer values the quality $t \in \{L, M, H\}$ at $a_C \cdot t$ and the seller at $a_S \cdot t$. It is assumed that the consumer does not value a specific quality level higher than the seller values the next higher quality level, i.e. $\frac{a_C}{a_S} < \frac{M}{L}$ and $\frac{a_C}{a_S} < \frac{H}{M}$. Additionally, the consumer values a given quality always higher than the seller, i.e. $a_S < a_C$. Thus, a purchase would be desirable if the consumer was knowing true quality.

The different qualities are represented by seller types, i.e. the set of seller types is given by $T_1 = \{L, M, H\}$. Each seller type can offer the good and ask for a price $p \in I\!R^+$ or can withdraw from the market (n_p), i.e. the seller's strategy set S_1 is given by $S_1 = I\!R^+ \cup \{n_p\}$. The consumer observes the prices and can reject or accept the offer, i.e. his strategy set S_2 is given by $S_2 = \{yes, no\}$.

If the consumer rejects an offered price p he yields zero utility and the seller yields a utility of $a_S \cdot t$ $(t \in T_1)$. Given a quality t, accepting an offer the consumer yields an utility of $a_C \cdot t - p$ and the seller receives the price p. By withdrawing from the market at a quality t, the consumer always gets zero utility and the seller yields a utility of $a_S \cdot t$.

The consumer's beliefs about the behavior of the seller and the quality of the offered credence good, i.e. the seller's type, are represented by a capacity $\nu^1 : S_1 \times T_1 \longrightarrow [0,1]$ (Eichberger and Kelsey (1999)). Since only the consumer has got incomplete information the seller's beliefs about the behavior of the consumer are represented by additive probabilities, i.e. $\nu^2(yes) \in \{0,1\}$ and $\nu^2(no) \in \{0,1\}$ with $\nu^2(yes) + \nu^2(no) = 1$.

Within our model there are two reasons for representing the beliefs by a *simple capacity* (Eichberger and Kelsey (1994)), i.e. a capacity whose value for an event is given by the product of an additive probability for this event and a weighting parameter γ. On the one hand, by representing trust in given information by a parameter γ it is possible to analyze the impact of trust in the behavior of the players directly. On the other hand, analyzing the resulting game is more manageable and the results can be compared with results given by models for experience goods straight forwardly: In equilibrium the probabilities of the game in additive probabilities can be used in the definition of simple capacities (Eichberger and Kelsey (1996)), i.e. the additive probabilities of the capacities are given by the corresponding game under risk for experience goods (cf. appendix A). By utilizing simple capacities credence goods and experience goods differ in the weighting parameter γ as a measure of trust in the given probabilities. With credence goods γ lies in the half-open interval $[0, 1)$, and the situation with experience goods is given by $\gamma = 1$.

With an additive probability distribution $\pi : S_1 \times T_1 \longrightarrow [0, 1]$ and a parameter $\gamma \in [0, 1]$ the consumer's beliefs ν^1 are given

$$\nu^1(A) = \begin{cases} \gamma \cdot \pi(A) & A \subset S_1 \times T_1 \\ & \text{if} \\ 1 & A = S_1 \times T_1 \end{cases} \tag{1}$$

Additionally, it is assumed that $\pi(\{(s_1, t) : s_1 \in S_1\}) = q_t$ $(t \in T_1)$, i.e. the marginal distribution of π is equal to the distribution over types. Since the probabilities π are given by the corresponding game with additive probabilities in equilibrium they are determined by the additive distributional strategies played in equilibrium. As a measure of trust in the probabilities π, the parameter γ also represents trust in the given information about the distribution of types, i.e. the quality distribution.

2.2 The equilibrium conditions

Equilibrium strategies can be distinguished according to the seller's types playing same prices (*pooling or semi-pooling equilibrium*) or playing different prices (*separating equilibrium*). However, separating equilibriums can be disregarded: If the seller plays a different price $p_{\hat{t}}$ for every type $\hat{t} \in \{L, M, H\}$ the updated beliefs are given by

$$\nu^1(t|p_{\hat{t}}) = \begin{cases} \dfrac{\gamma \cdot q_t}{1 - \gamma \cdot (1 - q_t)} & \text{if } t = \hat{t} \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

For $\gamma > 0$ the consumer can distinguish the seller types and would accept a high price. Thus, there is an incentive for the low and medium seller type to play a high price as well. Analysis therefore will be restricted to pooling and semi-pooling price offers of the seller.

So far, the buying decision of the consumer depends on the beliefs for receiving a certain quality after observing a price offer. If he rejects an offered price p he receives zero utility. Thus, he rejects if this price offer is greater than the (choquet-expected) utility of the quality which is offered on the market, i.e.

he chooses his strategies according to the decision rule given by

$$\begin{aligned} &\text{accept } (yes) \iff p \leq a_C \cdot CE_p[t] \\ &\text{reject } (no) \iff p > a_C \cdot CE_p[t] \end{aligned} \tag{3}$$

with

$$\begin{aligned} CE_p[t] = &\ \nu^1(H|p) \cdot H + [\nu^1(t \in \{H,M\}|p) - \nu^1(H|p)] \cdot M \\ &+ [1 - \nu^1(t \in \{H,M\}|p)] \cdot L) \end{aligned} \tag{4}$$

2.2.1 Pooling equilibrium

By decision rule (3) the consumer accepts a pooling price offer p if[2]

$$p \leq a_C \cdot CE_p[t] \tag{5}$$

For the seller a price offer is only optimal if the price leads to a higher utility for all quality grades than withdrawing from the market, i.e. if

$$p \geq a_S \cdot H \tag{6}$$

With updating rule for capacities (Eichberger and Kelsey (1999)) and an offered price p satisfying (5) and (6) the beliefs of the consumer are given by

$$\begin{aligned} \nu^1(H|p) &= \frac{\nu^1\left((p,H) \cup \neg p\right) - \nu^1(\neg p)}{1 - \nu^1(\neg p)} \\ &= \frac{\gamma \cdot \pi(p,H)}{1 - \gamma \cdot \pi(\neg p)} \end{aligned} \tag{7}$$

$$\begin{aligned} \nu^1(t \in \{H,M\}|p) &= \frac{\nu^1\left(\{(p,t) : t \in \{H,M\}\} \cup \neg p\right) - \nu^1(\neg p)}{1 - \nu^1(\neg p)} \\ &= \frac{\gamma \cdot (\pi(p,H) + \pi(p,M))}{1 - \gamma \cdot \pi(\neg p)} \end{aligned} \tag{8}$$

In equilibrium the additive probability distribution π equals the distributional strategy played in equilibrium of the game with additive distributional strategies. With behavioral strategies $b_t^*(p^*) = 1$ and $b_t^*(p) = 0$ for $p^* \in S_1$ and $p \neq p^*$ $(t \in \{L, M, H\})$ according to equilibrium conditions (A.8) (cf. appendix A) in equilibrium updated beliefs (7) and (8) are given by

$$\nu^1(H|p^*) = \gamma \cdot q_H \tag{9}$$

$$\nu^1(t \in \{H, M\}|p^*) = \gamma \cdot (q_H + q_M) \tag{10}$$

and the choquet-expected-utility is

$$CE_{p^*}[t] = \gamma \cdot (q_H \cdot H + q_M \cdot M + q_L \cdot L) + (1 - \gamma) \cdot L \tag{11}$$

Thus, with an offered price p^* following beliefs constitute a pooling equilibrium:

$$\nu^1(S, T) = \begin{cases} 1 & S = S_1, T = T_1 \\ & \text{if} \\ \gamma \cdot \sum\limits_{s_1 \in S} \sum\limits_{t \in T} b_t^*(s_1) \cdot q_t & S \subset S_1, T \subset T_1 \end{cases} \tag{12}$$

$$\text{with } b_t^*(p^*) = 1 \text{ and } b_t^*(p) = 0 \ (p \neq p^*) \ \ \forall t \in T_1$$

$$\nu^2_{p^*}(yes) = \begin{cases} 1 & a_S \cdot H \leq p^* \leq a_C \cdot CE_{p^*}[t] \\ \text{if} & \\ 0 & a_C \cdot CE_{p^*}[t] < p^* \leq a_C \cdot H \end{cases} \tag{13}$$

$$\nu^2_{p^*}(no) = 1 - \nu^2_{p^*}(yes) \tag{14}$$

In equilibrium expected quality for a credence good is not given by average quality $\bar{t} = q_H \cdot H + q_M \cdot M + q_L \cdot L$ as with a experience good. Rather, expected quality always lies between minimum quality L and actual average quality $\bar{t}$. Only for full trust in information ($\gamma = 1$) the consumer's quality expectation equals average quality.

Out off equilibrium, i.e for an offered price $p \leq a_C \cdot H$ with $p \neq p^*$, updated beliefs are $\nu^1(H|p) = 0$ since $\pi(p, H) = b_H^*(p) \cdot q_H = 0 \cdot q_H$.[3] Such an offer is only accepted if $p \leq a_C \cdot L$ by condition (5). In this case, only the low seller type wants to sell and this price offer is not played in a pooling equilibrium.

With equilibrium conditions (12), (13) and (14), a price offer leads only to a successful transaction if the combination

$$\bar{t}_\gamma := CE_p[t] = \gamma \cdot (q_L \cdot L + q_M \cdot M + q_H \cdot H) + (1 - \gamma) \cdot L \tag{15}$$

of average quality and minimum quality is valued high enough by the consumer. The less the consumer trusts in information about quality, i.e. the probability distribution over types, the more pessimistic is the consumer and the decision will be based only on the minimum quality L.

For a successful transaction the price offer must be adequately adapted. With $\gamma \in [0, 1)$ one yields $CE_p[t] < E_p[t]$ and the equilibrium price for a credence good is always lower than the equilibrium price for an experience good of equivalent quality. Full confidence in information ($\gamma = 1$) yields $CE_p[t] = E_p[t]$ and the price offer can be maximal, i.e. $p^* = p^*_{EG} := a_C \cdot E_p[t]$, with p^*_{EG} the price offer for an experience good (cf. appendix A).

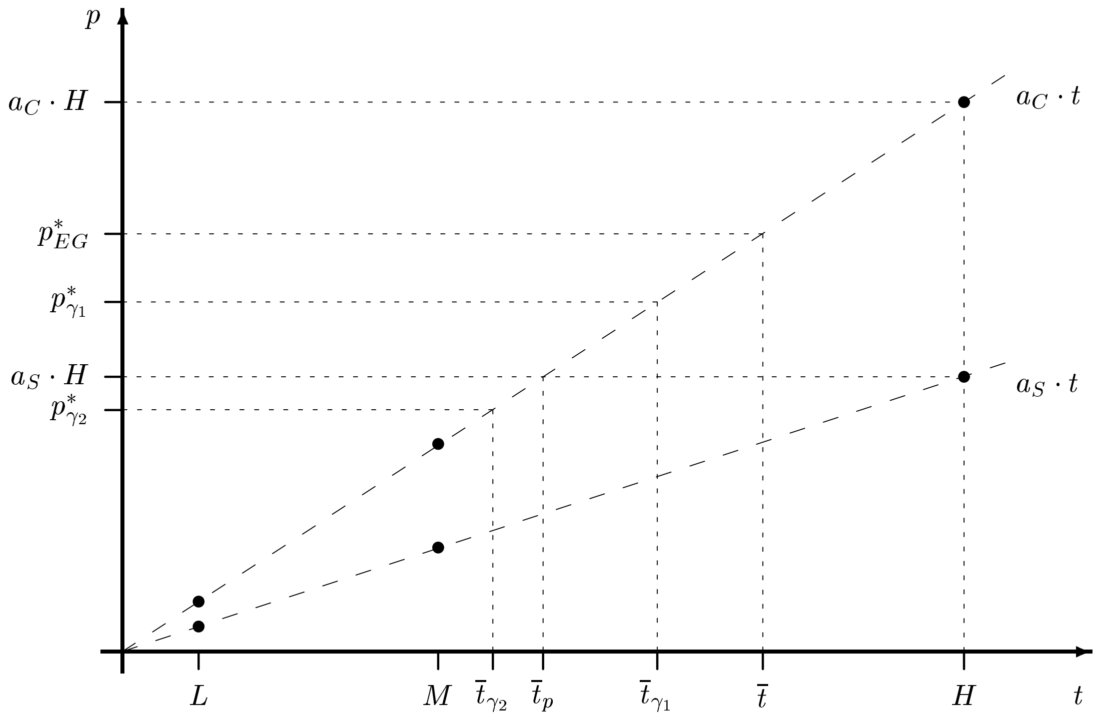

Fig. 1. Pooling equilibrium with credence goods

Figure 1 illustrates the equilibrium conditions. A transaction is only possible if the price p, which is offered for a credence good, is not higher than the consumer's value for actual average quality $E_p[t]$, i.e. if $p \in [a_S \cdot H, p^*_{EG}]$. For trust in information large enough, i.e. $\gamma = \gamma_1$, according to condition (13) there exists an intervall $[a_S \cdot H, p^*_{\gamma_1}]$ in which a price p can lie to enable a transaction. To yield maximal possible utility the seller demands a price $p^*_{\gamma_1} > a_S \cdot H$. If trust in information is too low, i.e. $\gamma = \gamma_2$, one yields $p^*_{\gamma_2} < a_S \cdot H$. Hence, there is no intervall of possible prices, which leads to a transaction since in equilibrium according to (13) an accepted price satisfies $p \geq a_S \cdot H$.

2.2.2 Semi-pooling equilibrium

If the seller's types do not choose same decisions two equilibrium situations arise:

(1) *Low and medium seller type pooling*: The low and medium seller type are pooling with a price p, and the high seller type is choosing n_p, i.e. he withdraws from the market.

(2) *Medium and high seller type pooling*: The high and medium seller types are pooling with n_p, i.e. they do not offer their good, and the low seller type plays a price offer p.

Low and medium seller type pooling. A price for which high quality is not offered must lead to zero utility for the high seller type, i.e. the price must satisfy

$$p < a_S \cdot H \tag{16}$$

Since only low and medium quality is offered such a price is accepted if

$$p \leq a_C \cdot M \quad \text{and} \quad p \leq a_C \cdot CE_p[t] \tag{17}$$

A price offer is optimal for the seller if it is optimal for both types L and M, i.e. if $p \geq a_S \cdot L$ and $p \geq a_S \cdot M$ and therefore

$$p \geq a_S \cdot M \tag{18}$$

As before, in equilibrium updated beliefs are based on the equilibrium strategies of the game with additive probabilities. Since only sellers of low and medium quality want to sell this equilibrium strategies are given by $b_H^*(p^*) = 0$ and $b_H^*(n_p) = 1$ and $b_L^*(p^*) = b_M^*(p^*) = 1$ for $p^* \in [a_S \cdot M, a_C \cdot M]$ (condition A.13, appendix A). Updated beliefs and choquet-expected-utility then are given by

$$\nu^1(H|p) = 0 \tag{19}$$

$$\nu^1(t \in \{H, M\}|p) = \frac{\gamma \cdot q_M}{1 - \gamma \cdot q_H} \tag{20}$$

$$CE_{p^*}[t] = \begin{cases} E_{p^*}[t] & \gamma = 1 \\ & \text{if} \\ L & \gamma = 0 \end{cases} \tag{21}$$

Thus, following beliefs constitute an equilibrium in which sellers of low and medium quality are offering their good for a price p^*:

$$\nu^1(S,T) = \begin{cases} 1 & S = S_1, T = T_1 \\ & \text{if} \\ \gamma \cdot \sum_{s_1 \in S} \sum_{t \in T} b_t^*(s_1) \cdot q_t & S \subset S_1, T \subset T_1 \end{cases} \tag{22}$$

with $b_t^*(p^*) = 1$ if $t \in \{L, M\}$ and $b_t^*(n_p) = 1$ if $t = H$

$$\nu_{p^*}^2(yes) = \begin{cases} 1 & a_S \cdot M \le p^* \le a_C \cdot CE_{p^*}[t] \\ \text{if} & \\ 0 & a_C \cdot CE_{p^*}[t] < p^* \le a_C \cdot M \end{cases} \tag{23}$$

$$\nu_{p^*}^2(no) = 1 - \nu_{p^*}^2(ja) \tag{24}$$

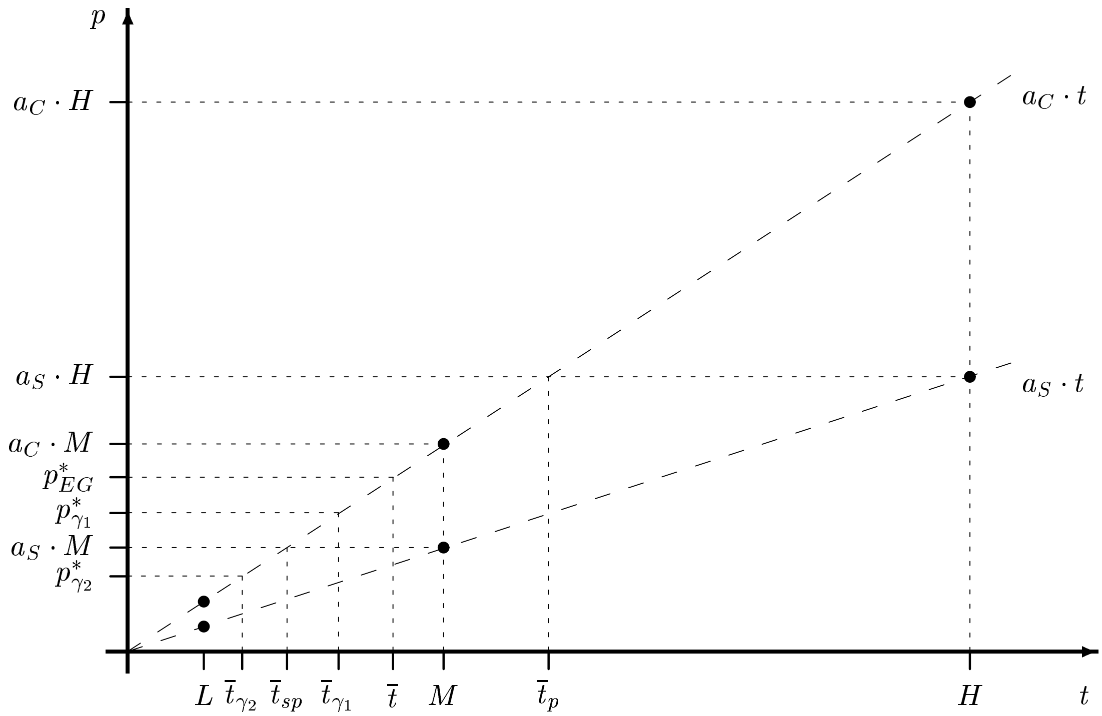

Fig. 2. Semi-pooling equilibrium with two seller types

A price $p \neq p^*$ out off equilibrium ($p < a_S \cdot H$ not satisfying equilibrium conditions (22), (23), and (24)) leads to $\nu^1(t \in \{H, M\}|p) = 0$. This price only is accepted if by (17) $p \leq a_C \cdot L$. However, this price is not offered by the medium seller type and therefore is not played. For $p \geq a_S \cdot H$ the price can be accepted if conditions (12), (13) and (14) for a pooling equilibrium are satisfied.

Figure 2 illustrates the equilibrium conditions. A price $p < a_S \cdot H$ is part of an equilibrium only if p is less or equal than the consumer's value of offered average quality $\bar{t} = \frac{1}{q_L + q_M}(q_L \cdot L + q_M \cdot M)$, i.e. if p satisfies $p \in [a_S \cdot M, p^*_{EG}]$ with p^*_{EG} the equilibrium price for an experience good.

If trust in information is sufficiently large ($\gamma = \gamma_1$, cf. figure 2) with condition (23) there is an interval $[a_S \cdot M, p^*_{\gamma_1}]$ of price offers leading to a transaction. To enforce the maximum in possible profit the seller plays $p = p^*_{\gamma_1} > a_S \cdot M$. However, if trust in information is too low ($\gamma = \gamma_2$, cf. figure 2), $p^*_{\gamma_2} < a_S \cdot M$. Since an equilibrium must satisfy $p \geq a_S \cdot M$ according to (23) there is no equilibrium with such an price offer.

Medium and high seller type pooling. Low quality is exclusively offered if withdrawing is optimal for the medium and high seller type, i.e. if a price p satisfies $p < a_S \cdot M$. The consumer rejects this price offer, if $p > a_C \cdot L$. He accepts if $p \leq a_C \cdot L$ and $p \leq CE_p[t]$. The price offer is optimal for the remaining seller type if $p \leq a_C \cdot L$.

For an equilibrium price offer p^* beliefs in the game with additive beliefs satisfy $b^*_L(p^*) = 1$ and $b_M(p^*) = b^*_H(p^*) = 0$ and $b^*_M(n_p) = b^*_H(n_p) = 1$ (cf. condition A.18, appendix A). Thus, consumer's beliefs are given by

$$\pi(\neg p^*) = b^*_H(n_p) \cdot q_H + b^*_M(n_p) \cdot q_M \tag{25}$$

As a consequence, updated beliefs are given by ($p^* \in [a_S \cdot L, a_C \cdot L]$)

$$\begin{aligned} \nu^1(H|p^*) &= 0 \\ \nu^1(q \in \{H, M\}|p^*) &= 0 \end{aligned} \tag{26}$$

The (choquet-)expected-utility then is given by

$$CE_{p^*}[t] = [1 - \nu^1(t \in \{H, M\}|p^*)] \cdot L = L \tag{27}$$

Thus, following beliefs and price offer form an equilibrium, in which only low quality is offered:

$$\nu^1(S,T) = \begin{cases} 1 & \text{if } S = S_1, T = T_1 \\ \gamma \cdot \sum\limits_{s_1 \in S} \sum\limits_{t \in T} b_t^*(s_1) \cdot q_t & \phantom{\text{if }} S \subset S_1, T \subset T_1 \end{cases} \tag{28}$$

with $b_t^*(p^*) = 1$ if $t = L$ and $b_t^*(n_p) = 1$ if $t \in \{H, M\}$

$$\nu_{p^*}^2(yes) = 1 \quad \text{if} \quad a_S \cdot L \leq p^* \leq a_C \cdot L \tag{29}$$

$$\nu_{p^*}^2(no) = 1 - \nu_{p^*}^2(ja) \tag{30}$$

Independently from trust a price offer $p^* \in [a_S \cdot L, a_C \cdot L]$ is always accepted (cf. figure 3 on page 20). To enforce maximum profit the seller plays $p^* = a_C \cdot L$.

An offer $p \neq p^*$ with $p < a_S \cdot M$ not satisfying equilibrium conditions (28), (29) and (30), is not accepted. However, an offer $p \geq a_S \cdot M$ is accepted if conditions (12), (13), and (14) for a pooling equilibrium or conditions (22), (23), and (24) for a semi-pooling equilibrium are satisfied.

2.3 Discussion of the equilibrium conditions

In the conditions for pooling and semi-pooling equilibria deduced so far the parameter γ represents the influence of consumer's trust in given quality information about credence goods. Thus, by varying the parameter γ it can be taken advantage of comparing the well known situation for experience goods with the situation for credence goods reaching from full trust in information with experience goods ($\gamma = 1$) to the situation of complete mistrust only possible for credence goods ($\gamma = 0$).

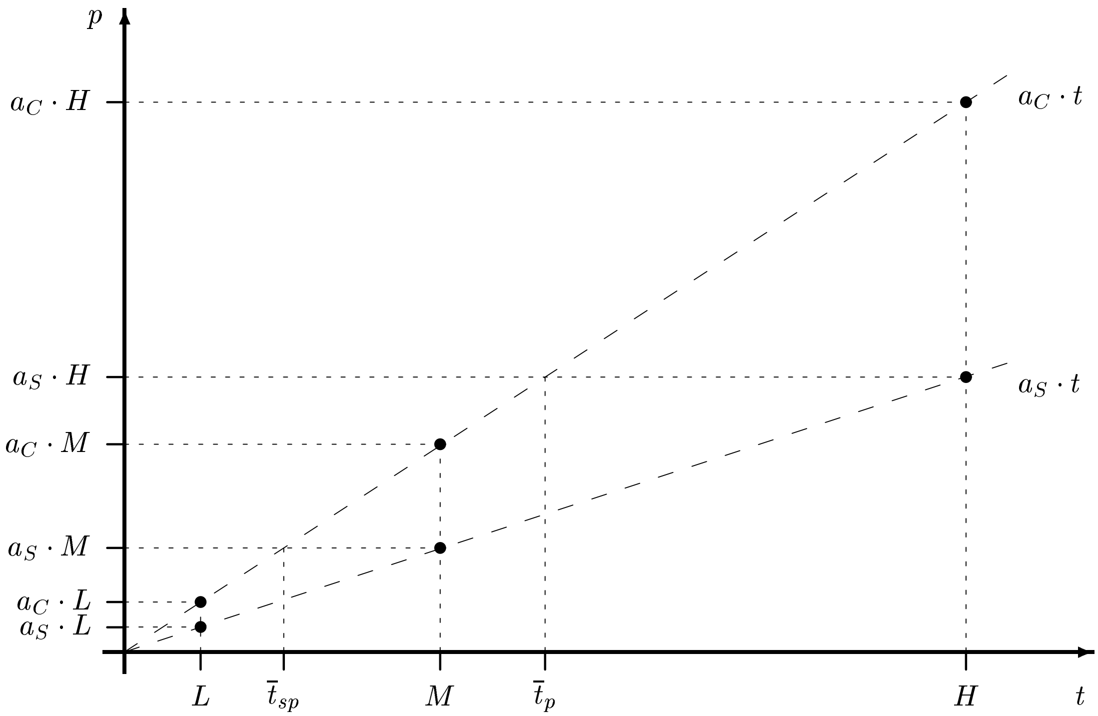

Fig. 3. Semi-pooling equilibrium with one seller type

Complete trust in information ($\gamma = 1$). If the consumer trusts in the given quality information the beliefs in our model for credence goods amount just to the additive beliefs of the model for experience goods. Expected quality then is given by the actual average quality offered on the market and the equilibrium conditions of both models are identical. In this case, on the market for credence goods the usual problem of adverse selection without any problem of trust occurs: If the actually offered average quality $\bar{t}$ for a given price offer is too low in equilibrium no transaction takes place.

Market for one quality ($q_t = 1$ *for exact one* $t \in \{L, M, H\}$ *and* $\gamma \in (0, 1)$). If there is only one quality offered in the market ($q_t = 1$ for exact one $t \in \{L, M, H\}$) with full trust in given information ($\gamma = 1$) the consumer accepts

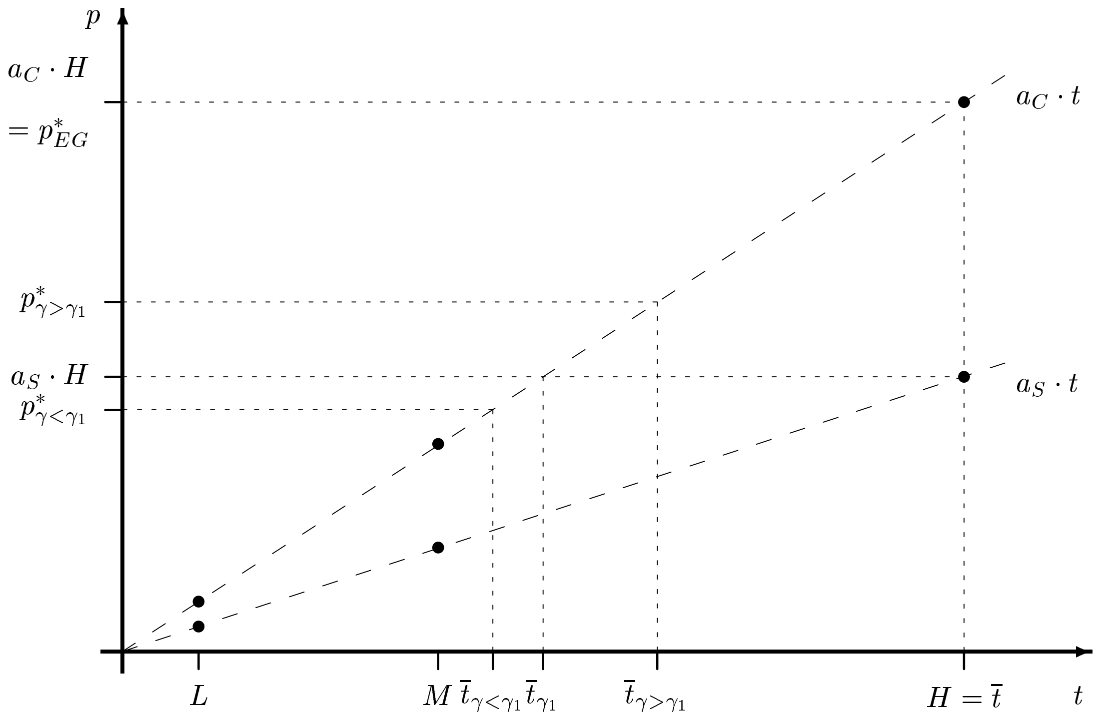

Fig. 4. Adverse selection with a credence good of only high quality

a price $p^*_{EG} = a_C \cdot t$, which is equal to the maximum price offer for a experience good. A transaction always takes place since neither there is an information problem nor a problem of trust (cf. figure 4).

However, for $\gamma < 1$ a new source of market failure arises from the problem of trust.[4] In equilibrium a transaction takes place if there is a price p^* with $\gamma \in [0, 1)$ satisfying ($t \in \{M, H\}$)

$$a_S \cdot t \leq p^* \leq \bar{t}_\gamma = a_C \cdot (\gamma \cdot t + (1 - \gamma) \cdot L) \tag{31}$$

With γ_1 as the minimum level of trust enabling such a price offer, one yields

$$\gamma_1 = \frac{a_S \cdot t - a_C \cdot L}{a_C \cdot t - a_C \cdot L} \tag{32}$$

For $\gamma \in [0, \gamma_1)$ there is no price p^* for which a transaction takes place (cf. figure 4 on page 21), i.e. the consumer only accepts a price p^*, if[5] $\gamma \in [\gamma_1, 1]$. Conversely, this means if trust in given information is too low no transaction takes place and a kind of market failure arises relevant only for credence goods (*market failure by trust induced adverse selection*).

To maximize profit the seller asks for a price $p^* = a_C \cdot \overline{t}_\gamma$, i.e. profit increases with increasing trust in information.[6] Conversely, for a transaction to be taken place trust in information must be the much higher, the smaller is the difference between the consumers' value for a given quality and the seller's value for this quality.[7]

The connection between trust in information and consumer's value of quality is most clearly shown for $a_S = const$. In this case increasing consumer's value leads to an increase of the interval $[a_S \cdot t, \gamma \cdot a_C \cdot t + (1-\gamma) \cdot a_C \cdot L]$, in which an accepted price offer can lie. Thus, the minimal trust γ_1 for a successful transaction can be smaller:[8] the higher value of quality leads even for low trust to positive consumer's utility, i.e. the higher value compensates a loss of trust in the information.

Market for all qualities ($0 < q_t < 1$ for $t \in \{L, M, H\}$ and $\gamma \in (0,1)$). If all qualities are offered with probability $q_t \neq 0$ ($t \in \{L, M, H\}$) with full trust ($\gamma = 1$) the usual problem of adverse selection for experience qualities occurs. However, for $\gamma \in (0,1)$ transaction only takes place under two conditions.[9] On the one hand, there is a pooling equilibrium if all qualities are offered and the price offer p^* satisfies

$$a_S \cdot H \leq p^* \leq a_C \cdot [\gamma \cdot (q_H \cdot H + q_M \cdot M + q_L \cdot L) + (1-\gamma) \cdot L] \tag{33}$$

On the other hand, there is a semi-pooling equilibrium if high quality is not offered and the price offer p^* satisfies

$$a_S \cdot M \ \leq p^* \leq a_C \cdot \left[\gamma \cdot \left(L + q_M \cdot \tfrac{M-L}{1-\gamma \cdot q_H}\right) + (1-\gamma) \cdot L\right] \tag{34}$$

Defining γ_2 as the minimum level of trust, leading to a transaction with $q_t \neq 0$ ($t \in \{L, M, H\}$) for a given quality distribution, in a pooling equilbrium γ_2 satisfies

$$\gamma_2 = \gamma_2^p := \frac{a_S \cdot H - a_C \cdot L}{a_C \cdot (q_H \cdot H + q_M \cdot M + q_L \cdot L) - a_C \cdot L} \tag{35}$$

and in a semi-pooling equilibrium γ_2 satisfies

$$\gamma_2 = \gamma_2^{sp} := \frac{a_S \cdot M - a_C \cdot L}{(a_C \cdot M - a_C \cdot L) \cdot q_M + (a_S \cdot H - a_S \cdot L) \cdot q_H} \tag{36}$$

As shown in figure 5 on page 24, a *pooling* price offer for all seller types only exists if [10]

$$\gamma \in [\gamma_2^p, 1] \tag{37}$$

Compared to a market with only high quality offered (cf. figure 4 on page 21) condition (32) with $t = H$ and (35) leads to

$$\gamma_2^p > \gamma_1 \tag{38}$$

Thus, in the situation with all quality levels offered on the market trust in information must be higher for a successful transaction than in the situations with only high quality offered. Conversely, in the situation with all quality levels offered and the level of trust not high enough to enable a transaction a low level of trust can be compensated and a transaction can take place if

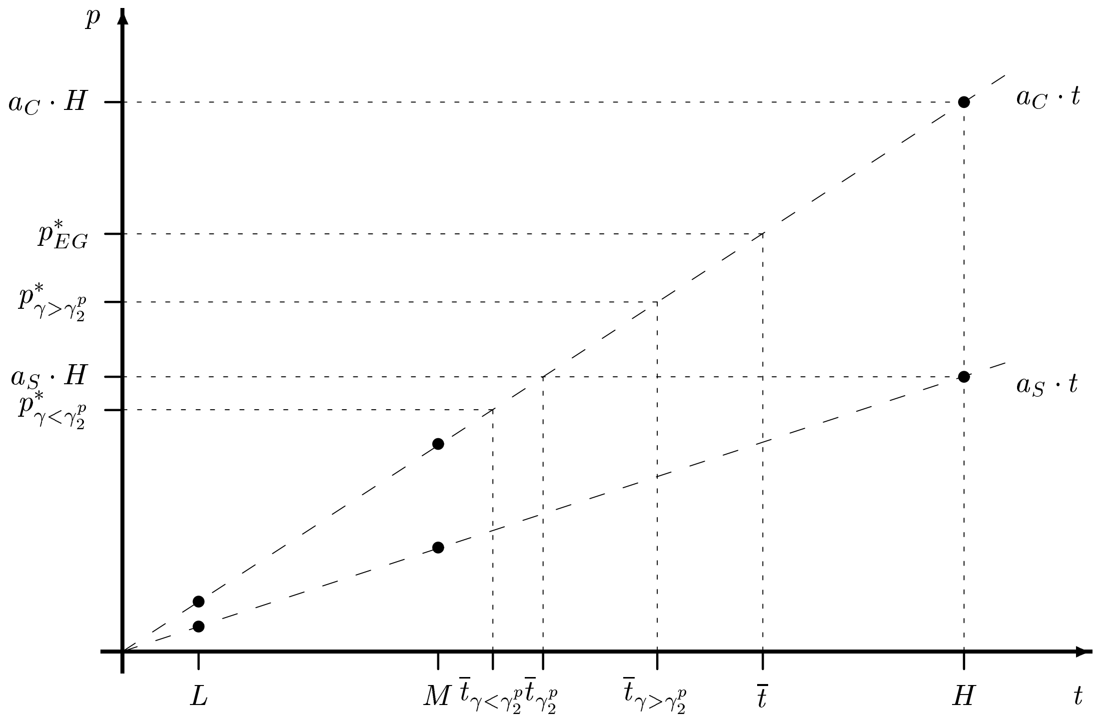

Fig. 5. Adverse selection with a credence good of different qualities

an adequate high quality is guaranteed, i.e. guaranteeing only quality t with $t = H$. This means, actions of guaranteeing a certain quality can enforce or even substitute actions of gaining or increasing trust.

The seller yields maximum profit by demanding a price $p_\gamma = a_C \cdot t_\gamma$ with $p_\gamma < p^*_{EG}$. The higher is consumer's trust in the given probabilities of quality distribution, the higher this price will be, i.e. a price offer and the resulting possible profits are lower than with full trust in given information ($\gamma = 1$).

Conversely, as with the situation of only one quality level, for a relative increase of a_S the consumer's trust in the distribution of quality must increase if a transaction should take place. Additionally, the trust in the quality distribution must be the higher, the lower is the probability of only high quality on the market.[11] If average quality on the market is decreasing already a small deviation from full trust makes transaction impossible.

A *semi-pooling* price offer with which only sellers of low and medium quality offer only exists if[12] $\gamma \in [\gamma_2^{sp}, 1]$. For only one quality condition (32) with $t = M$ and (36) yields

$$\gamma_2^{sp} > \gamma_1 \tag{39}$$

Thus, for a transaction to take place a higher level of trust in information is needed. Conversely, as in the situation of a pooling price offer, this leads to a possible compensation of actions of producing trust by actions of guaranteeing higher quality. For the given situation this actions are actions of guaranteeing only quality $t = M$.

Complete mistrust ($0 < q < 1 \wedge \gamma = 0$). If the consumer does not trust in the seller at all ($\gamma = 0$), a transaction with offered quality other than L will never take place (cf. figure 3 one page 20): The consumer would accept a price offer p only, if the seller demands a price $p^{\gamma=0} \leq a_C \cdot L$. But with this price for sellers of medium and high quality, respectively, withdrawing from the market is optimal. Thus, only an equilibrium exists with the seller only offering low quality. As a consequence, there is a complete failure of the market with offering medium and high quality caused solely by the problem of trust given with credence goods.

3 Conclusions

Previous research on credence goods has not yet given a theoretical basis for analyzing asymmetric information given with credence goods. In contrast, our paper has presented a framework which integrates quality ambiguity with credence goods and the given problem of trust into economics of information in an adequate way.

Our model shows clearly the consequences of quality uncertainty with credence goods for market behavior. On a market for credence goods a transaction does not solely depend on the quality offered by a seller, but trust in the given information about the quality distribution plays the crucial role. With experience goods only average quality offered on the market determines whether a transaction takes place or not. In contrast, for credence goods consumers' quality expectation which consumers are using for the decision, always is lower than the actual average quality because of the specific problem of trust. As a consequence, a new source of market failure only given with credence goods arises: If trust in quality information is too low only seller types of the lower qualities have got an incentive to offer their good and higher quality is driven out off the the market (*market failure by trust induced adverse selection*). Even if transaction takes place in equilibrium possible prices for a credence good are always lower than prices for an equivalent experience good.

Generally, the framework suggests a difference in the specific causes for market failure with credence goods and experience goods. With credence goods it is not only the lack of information which leads to inefficiency or even market failure. As a entirely new factor, it is the degree of trust in given information, represented by the ambiguity of own beliefs (parameter γ in our model) about the existence of the relevant quality, which emerges for credence goods. Even if quality of a credence good and an experience good is in fact the same quality expectation for a credence good is lower than for an experience good. This lack of trust can lead to market failure with credence goods even if with experience goods there would be a transaction. Only if consumers have full trust in information quality expectations are identical for credence goods and experience goods, and causes for market failure are identical.

With the influence of trust becoming obvious, the model also gives hints to overcome the problem of trust. If high quality is driven out off the market because of lack of trust trust building actions can be replaced by actions of guaranteeing quality: As well on markets, on which higher quality is guaranteed,[13] as on markets on which consumers value quality higher a lower trust in information about quality is needed for a transaction to take place.

Notes

[1]For a first attempt to exploid the decision theoretic conditions of search, experience and credence goods cf. Becker (1997).

[2]An offer with $p < a_C \cdot L$ is always accepted and an offer with $p > a_C \cdot H$ is never accepted.

[3]With updating rule for capacities, beliefs can be determined out off the equilibrium path, too (Eichberger and Kelsey (1999)).

[4]Since with $t = L$ the equilibrium conditions are independent of quality information this is only valid for $t \in \{M, H\}$.

[5]With $a_C \cdot t - a_C \cdot L > 0$ for $t \in \{M, H\}$ and $\frac{a_C}{a_S} \geq \frac{H}{L}$ it follows $0 \leq \frac{a_S \cdot t - a_C \cdot L}{a_C \cdot t - a_C \cdot L} \leq 1$.

[6] With $a_C \cdot \bar{t}_\gamma \leq a_C \cdot \bar{t}$ for $\gamma \in [0,1]$ and $t_{\gamma=1} = \bar{t}$ profit is maximal for $\gamma = 1$.

[7]For $a_C = a_S$ one yields $\gamma_1 = 1$.

[8] $\frac{\partial}{\partial a_C}\left(\frac{a_S \cdot t - a_C \cdot L}{a_C \cdot t - a_C \cdot L}\right) < 0$.

[9] Since with $t = L$ the equilibrium conditions are independent of trust in information only qualities $t \in \{M, H\}$ are relevant.

[10] $\gamma_2^p \leq 1$ for $\frac{a_S}{a_C} \leq \frac{\bar{t}}{H}$.

[11] $\frac{\partial\left(\gamma_2^p\right)}{\partial q_H} < 0$.

[12] $\frac{a_S}{a_C} \leq \frac{L + q_M(M-L)}{M - q_H(H-L)} \Longrightarrow \gamma_2^{sp} \leq 1$.

[13]In fact, a private guarantee of the seller would suffer from the same problem of trust and would therefore not be sufficient. Only a guarantee given by an independent third party would solve this problem.

Appendix

A Adverse selection with experience goods

Consider a market with a consumer and a seller for goods of three different qualities:[14] With probabilities q_t ($t \in \{L, M, H\}$) a good is of quality t with $L, M, H \in I\!R^+$; $L < M < H$. Since the good is an experience good only the seller knows the quality before purchase. The consumer has to use the price as the only signal for quality.

For the consumer valuation of quality t is given by $a_C \cdot t$ ($a_C \in I\!R^+$) and $a_S \cdot t$ ($a_S \in I\!R^+$, $a_S < a_C$) for the seller. It is assumed that the consumer does not value a specific quality level higher than the seller values the next higher quality level, i.e. $\frac{a_C}{a_S} < \frac{M}{L}$ and $\frac{a_C}{a_S} < \frac{H}{M}$. Additionally, the consumer values a given quality always more than the seller, i.e. $a_S < a_C$. Thus, a purchase would be desirable if the consumer was knowing the true quality.

Each seller type either can offer his good on the market and ask for a price $p \in I\!R^+$, or can withdraw from market (n_p), i.e. the strategy set S_1 of the seller is given by $S_1 = I\!R^+ \cup \{n_p\}$. The consumer observes the prices and can reject or accept the offer, i.e. the strategy set S_2 of the consumer is given by $S_2 = \{yes, no\}$.

If the consumer rejects an offered price p he yields zero utility and the seller yields a utility of $a_S \cdot t$ ($t \in T_1$). Given a quality t, accepting an offer the consumer yields an utility of $a_C \cdot t - p$ and the seller receives the price p. By withdrawing from the market at a quality t, the consumer always gets zero utility and the seller yields a utility of $a_S \cdot t$.

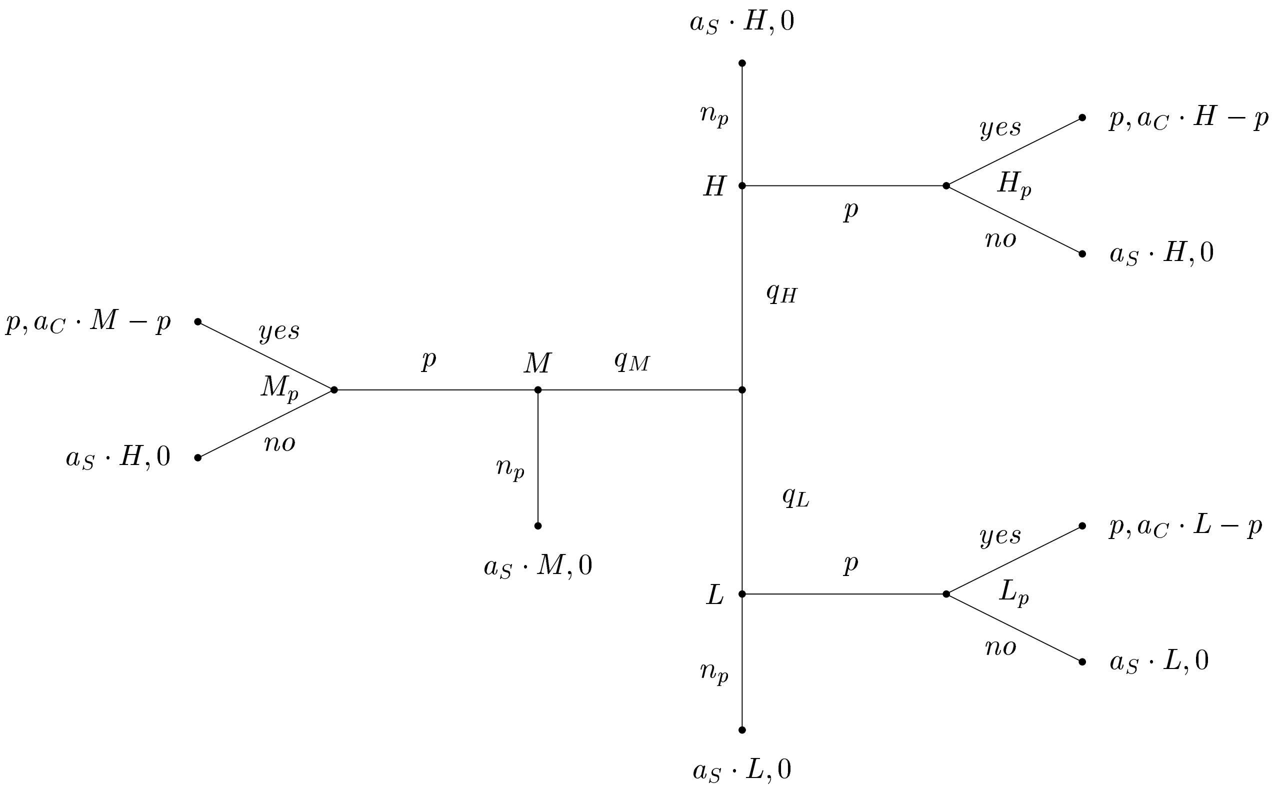

Fig. 6. Adverse selection as extensive form game

In the extensive form of the game (cf. figure 6) for each player i ($i = 1, 2$) $\mathcal{J}_i$ is the set of information sets with $\mathcal{J}_1 = \{J_1, J_2, J_3\}$ and information sets $J_1 = \{L\}$, $J_2 = \{M\}$ and $J_3 = \{H\}$ and $\mathcal{J}_2 = \{J_p : p \in I\!R^+\} \cup J_{n_p}$ with $J_p = \{H_p, M_p, L_p\}$. b_i are the behavioral strategies for each player i, i.e. $b_1 : \mathcal{J}_1 \to B$ with $b_1(J_1) = (b_L(p), b_L(n_p))$, $b_1(J_2) = (b_M(p), b_M(n_p))$ and $b_1(J_3) = (b_H(p), b_H(n_p))$, and $b_2 : \mathcal{J}_2 \to B$ with $b_2(J_p) = (b_p(yes), b_p(no))$ and $b_2(J_{n_p}) = (b_{n_p}(yes), b_{n_p}(no))$.

The consumer's decision depends on the conditional beliefs for receiving a good of a quality t given a price p. With $\mu(L) = P(t = L|p)$, $\mu(M) = P(t = M|p)$ and $\mu(H) = P(t = H|p)$, respectively, the consumer yields a expected utility of $\mu(L) \cdot 0 + \mu(M) \cdot 0 + \mu(H) \cdot 0 = 0$ if he rejects the offer. The consumer accepts a price if the price is greater than his valuation of expected quality, i.e. with the conditional expectation

$$E_p[t] := \mu(L) \cdot L + \mu(M) \cdot M + \mu(H) \cdot H \tag{A.1}$$

his decision rule is given by

$$\begin{aligned} \text{accept } (yes) &\iff p \leq a_C \cdot E_p[t] \\ \text{reject } (no) &\iff p > a_C \cdot E_p[t] \end{aligned} \tag{A.2}$$

Equilibrium strategies can be distinguished according to the seller's types playing same prices (pooling or semi-pooling equilibrium) or playing different prices (separating equilibrium).

A.1 Separating equilibrium

If each seller type asks for a different price $p_t = a_C \cdot t$ ($t \in \{L, M, H\}$) the behavioral strategies for which pay-offs are maximized are given by $b_L(p_L) = 1$, $b_M(p_M) = 1$ and $b_H(p_H) = 1$. For a price p the consumer's beliefs are updated to ($t \in \{L, M, H\}$)

$$\mu(t) = \begin{cases} 1 & p = p_t \\ & \text{when} \\ 0 & \text{otherwise} \end{cases} \tag{A.3}$$

Because the consumer can identify the seller's types due to prices he would always accept a price $p = p_H$. However, this would be a incentive for both the low and medium seller type not to play their price and to ask for the high price

p_H. As a consequence, a separating equilibrium with the consumer accepting the price offer does not exist.

A.2 Pooling equilibrium

With all seller's types playing the same price p behavioral strategies are given by $b_L(p) = 1$, $b_M(p) = 1$ and $b_H(p) = 1$. Such a price is only accepted if the price satisfies (A.1) and (A.2), i.e.[15]

$$p \leq a_C \cdot (\mu(L) \cdot L + \mu(M) \cdot M + \mu(H) \cdot H) \tag{A.4}$$

For the seller, playing price p is only optimal if all seller's types yield a higher utility than by withdrawing from market, i.e.

$$p \geq a_S \cdot H \tag{A.5}$$

An equilibrium price must satisfy (A.4) and (A.5) and for the quality in equilibrium $t' \in \{L, M, H\}$ beliefs are given by $(p \in [a_S \cdot H, a_C \cdot H])$

$$\begin{aligned} \mu(t') &= \frac{b_{t'}(p) \cdot q_{t'}}{b_L(p) \cdot q_L + b_M(p) \cdot q_M + b_H(p) \cdot q_H} \\ &= q_{t'} \end{aligned} \tag{A.6}$$

With (A.4) a pooling price $p \in [a_S \cdot H, a_C \cdot H]$ is only accepted if

$$p \leq a_C \cdot E_p[t] = a_C \cdot (q_L \cdot L + q_M \cdot M + q_H \cdot H) \tag{A.7}$$

For a price p^* a (perfect Bayes-Nash) equilibrium then is given by the following beliefs and behavioral strategies:

$$
\begin{aligned}
b_t^*(p^*) &= 1 \;\; t \in \{L, M, H\} \\
b_t^*(n_p) &= 0 \;\; t \in \{L, M, H\} \\
\mu(t) &= q_t \; t \in \{L, M, H\} \\
b_{p^*}^*(yes) &= \begin{cases} 1 & a_S \cdot H \leq p^* \leq a_C \cdot (q_L \cdot L + q_M \cdot M + q_H \cdot H) \\ & \text{for} \\ 0 & a_C \cdot (q_L \cdot L + q_M \cdot M + q_H \cdot H) < p^* \leq a_C \cdot H \end{cases} \\
b_{p^*}^*(no) &= 1 - b_p^*(yes)
\end{aligned}
\tag{A.8}
$$

If the seller is indifferent between playing a price and withdrawing from market the equilibrium conditions assume that he prefers playing the price. Out off equilibrium, for prices $p \in [a_S \cdot L, a_S \cdot H)$ beliefs must be $\mu(L) = 1$ to support equilibrium.

A.3 Semi-Pooling equilibriums

Because of the possibility to withdraw from market there are semi-pooling equilibria, in which the seller only separates for types in subsets of the entire set of types, i.e. neither all types demand the same price nor each single type demands a different price.

In the given game the structure of semi-pooling equilibria is determined by the willingness of the seller's types only to sell for prices equal to their valuation of the good. Additionally, it is assumed that each type of seller only prefers withdrawing from market if a price demand is lower than its valuation of the good; playing a price demand greater then its valuation is preferred if this price is not accepted. For a price p to be accepted only the types $t \in \{L, M, H\}$ remain on market for which $a_S \cdot t < p$. This price is played by all types and constitutes a pooling price strategy. A type t with $a_S \cdot t \geq p$ withdraws from market.

Possible equilibria are determined by the following combinations

(1) *Low and medium seller type pooling*: The L-type and M-type are pooling with a price p and the H-type plays n_p, i.e. withdraws from market. An equillibrium with the H-type and M-type pooling can be disregarde, because in this case the L-type would play this price, too.

(2) *Medium and high seller type pooling*: The H-type and the M-type are pooling with n_p and the L-type plays p.

Low and medium seller type pooling. The H-type does not offer on the market if the price satisfies $p < a_S \cdot H$. Because of no H-quality on the market a price p is accepted if

$$p \leq a_C \cdot M \quad \text{and} \quad p \leq E_p[t] \tag{A.9}$$

For the remaining types price is optimal if[16]

$$p \geq a_S \cdot M \tag{A.10}$$

With a price p satisfying (A.9) and (A.10) and strategies $b_L(p) = b_M(p) = 1$ and $b_H(p) = 0$ updated beliefs amount to

$$\mu(L) = \frac{q_L}{q_L + q_M} \tag{A.11}$$

and $\mu(M) = \frac{q_M}{q_L+q_M}$ and $\mu(H) = 0$ ($p \in [a_S \cdot M, a_S \cdot H)$), respectively. Expected utility then is given by

$$E_p[t] = \frac{1}{q_L+q_M} \cdot (q_L \cdot L + q_M \cdot M) < a_S \cdot H \tag{A.12}$$

Together with a price p^* the following behavioral strategies and beliefs determine a (perfect Bayes-Nash) equilibrium

$$\begin{aligned}
b_t^*(p^*) &= \begin{cases} 1 & t \in \{L, M\} \\ & \text{if} \\ 0 & t = H \end{cases} \\
b_t^*(n_p) &= \begin{cases} 0 & t \in \{L, M\} \\ & \text{if} \\ 1 & t = H \end{cases} \\
\mu(t) &= \begin{cases} \frac{q_t}{q_L+q_M} & t \in \{L, M\} \\ & \text{if} \\ 0 & t = H \end{cases} \\
b_{p^*}(yes) &= \begin{cases} 1 & a_S \cdot M \leq p^* \leq a_C \cdot (\frac{q_L}{q_L+q_M} \cdot L + \frac{q_M}{q_L+q_M} \cdot M) \\ & \text{if} \\ 0 & a_C \cdot (\frac{q_L}{q_L+q_M} \cdot L + \frac{q_M}{q_L+q_M} \cdot M) < p^* \leq a_C \cdot M \end{cases} \\
b_{p^*}(no) &= 1 - b_p(yes)
\end{aligned} \tag{A.13}$$

To maximize profit the seller plays $p^* = a_C \cdot (\frac{q_L}{q_L+q_M} \cdot L + \frac{q_M}{q_L+q_M} \cdot M)$. Out off the equilibrium path equilibrium is supported by beliefs $\mu(L) = 1$.

Medium and high seller type pooling. Only L-quality is offered on the market, if $p < a_S \cdot M$. The consumer accepts a price p if

$$p \leq a_C \cdot L \quad \text{and} \quad p \leq E_p[t] \tag{A.14}$$

If p satisfies

$$p \geq a_S \cdot L \tag{A.15}$$

the price is optimal for the only remaining type of seller. Because only the L-type offers on the market strategies are given by $b_L(p) = 1$ and $b_M(p) = b_L(p) = 0$. With a price satisfying (A.14) and (A.15) the consumer's beliefs are given by

$$\mu(L) = 1 \quad \text{if } p \in [a_S \cdot L, a_C \cdot L] \tag{A.16}$$

and $\mu(H) = \mu(M) = 0$ $(p \in [a_S \cdot L, a_S \cdot M))$. Expected utility is then given by

$$E_p[t] = a_C \cdot L. \tag{A.17}$$

An equilibrium is given by a price $p^* \in [a_S \cdot L, a_C \cdot L]$ and behavioral strategies with beliefs satisfying

$$
\begin{aligned}
b_t^*(p^*) &= \begin{cases} 1 & t = L \\ & \text{if} \\ 0 & t \in \{M, H\} \end{cases} \\
b_t^*(n_p) &= \begin{cases} 0 & t = L \\ & \text{if} \\ 1 & t \in \{M, H\} \end{cases} \\
\mu(t) &= \begin{cases} 1 & t = L \\ & \text{if} \\ 0 & t \in \{M, H\} \end{cases} \\
b_{p^*}^*(no) &= 1 - b_p^*(yes)
\end{aligned}
\tag{A.18}
$$

To maximize profit the seller plays a price $p^* = a_C \cdot L$. Out off the equilibrium path beliefs $\mu(L) = 1$ support the equilibrium.

References

Akerlof, G. A., 1970. The Market for 'Lemons': Quality Uncertainty and the Market Mechanism. Quarterly Journal of Economics 84, 488 – 500.

Arnthorsson, A., Berry, W. E., Urbarny, J. E., 1991. Difficulty of Pre-Purchase Quality Inspection: Conceptualization and Measurement. Advances in Consumer Research 18, 217 – 224.

Becker, T., 1997. Quality Policy and Consumer Behavior. In: Schiefer, G., Helbig, R. (Eds.), Quality Management and Process Improvement for Competitive Advantage in Agriculture and Food. Proceedings of the 49^{th} Seminar of the European Association of Agricultural Economics.

Benner, D., 2002. Qualitätsungewissheit bei Gütern mit Vertrauenseigenschaften. No. 40 in Hohenheimer Volkswirtschaftliche Schriften. Peter Lang, Frankfurt.

Camerer, C., 1995. Individual Decision Making. In: Kagel, J. H., Roth, A. (Eds.), Handbook of Experimental Economics. Princeton University Press, Princeton, pp. 587 – 683.

Camerer, C., Weber, M., 1992. Recent Developments in Modeling Preferences: Uncertainty and Ambiguity. Journal of Risk and Uncertainty 5, 325 – 370.

Carlton, D. W., Perloff, J. M., 1994. Modern Industrial Organization. HarperCollins College Publishers, New York.

Caswell, J. A., Mojduszka, E. M., 1996. Using Informational Labeling to Influence the Market for Quality in Food Products. American Journal of Agricultural Economics 78, 1248 – 1253.

Darby, M. R., Karni, E., 1973. Free Competition and the Optimal Amount of Fraud. Journal of Law and Economics 16, 67 – 88.

Dow, J., Werlang, S. R. d. C., 1994. Nash Equilibrium under Uncertainty:

Breaking Down Backward Induction. Journal of Economic Theory 64, 305 – 324.

Eichberger, J., Kelsey, D., 1994. Non-Additive Beliefs and Game Theory. Working paper, University of Saarbrücken.

Eichberger, J., Kelsey, D., 1996. E-Capacities and the Ellsberg Paradox. Working paper, University of Saarbrücken.

Eichberger, J., Kelsey, D., 1999. Signalling Games with Uncertainty. Working paper, University of Birmingham.

Ellsberg, D., 1961. Risk, Ambiguity and the Savage Axioms. Quarterly Journal of Economics 75, 643 – 666.

Emons, W., 1997. Credence Goods and Fraudulent Experts. Rand Journal of Economics 28, 107 – 119.

Emons, W., 2001. Credence Goods Monopolists. International Journal of Industrial Organization 19, 375 – 389.

Feddersen, T. J., Gilligan, T. W., 2001. Saints and Markets: Activists and the Supply of Credence Goods. Journal of Economics and Management Strategy 10, 149 – 171.

Gilboa, I., 1987. Expected Utility with Purely Subjective Non-Additive Probabilities. Journal of Mathematical Economics 16, 65 – 88.

Knight, F. H., 1921. Risk, Uncertainty and Profit. The Riverside Press, Cambridge.

Lynch, J., Schuler, D., 1991. Operationalizing Economics of Information Theory: Consumer Quality Judgements and Advertising Credibility. In: Gilly, M. C. u. a. (Ed.), AMA Educator's Proceedings - Enhancing Knowledge Development in Marketing. American Marketing Association, Chicago, Illinois.

Nelson, P., 1970. Information and Consumer Behavior. The Journal of Political

Economy 78, 311 – 329.

Nelson, P., 1974. Advertising as Information. Journal of Political Economy 82, 729 – 754.

Payne, J., Bettman, J., Johnson, E., 1992. Behavioral Decision Research: A Constructive Processing Perspective. Annual Review of Psychology 43, 87 – 131.

Pitchik, C., Schotter, A., 1997. Honesty in a Model of Strategic Information Transmission. American Economic Review 77, 1032 – 1036.

Ryan, M. J., 2002. Violations of Belief Persistence in Dempster Shafer Equilibrium. Games and Economic Behavior 39, 167 – 174.

Savage, L. J., 1954. The Foundations of Statistics. Jon Wiley & Sons, New York.

Savage, L. J., 1972. The Foundations of Statistics, 2. Edition. Dover Publications, New York.

Schmeidler, D., 1989. Subjective Probability and Expected Utility without Additivity. Econometrica 57, 571 – 587.

Schmutzler, A., 1992. On Incentives for "Green" Production - A Signalling Approach to the Problem of Credence Goods. Working paper, Alfred Weber Institute, University of Heidelberg.

Shy, O., 1995. Industrial Organization. MIT Press, Cambridge, Massachusetts.

Steenkamp, J.-B. E. M., 1990. Conceptual Model of the Quality Perception Process. Journal of Business Research 21, 309 – 33.

Taylor, K. A., 1995. Testing credit and blame attributes as explanation for choices under ambiguity. Qrganizational Behavior and Human Decision Processes 38, 128 – 137.

Tirole, J., 1988. Theory of Industrial Organization. MIT Press, Cambrige, Massachusetts.

Wolinsky, A., 1995. Competition in Markets for Credence Goods. Journal of Institutional and Theoretical Economics 151, 117 – 131.

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