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Vertical Product Differentiation and Adverse Selection:

An Experimental Note

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Abstract - In three identical laboratory markets, sellers possess products whose quality is both exogenously and endogenously determined. Buyers can observe products' quality only in the last session of each experiment. It is also assumed an uneven distribution of income among buyers. We study whether a separating equilibrium arises in such a context, as in traditional models of vertical product differentiation, thus reducing adverse selection outcomes.

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1. Introduction: theoretical literature on prices, quality, and asymmetric information

In his seminal paper, Akerlof (1970) showed that in certain markets quality uncertainty on the part of consumers could lead to market failure in the form of an insufficient supply of high quality products, or even to a market breakdown, in the sense that no trade takes place at all. To illustrate this point, Akerlof focused on second hand car markets. More generally, in all markets in which one side of the market is less informed than the other about the properties of the goods and services being traded, it is possible for adverse selection to arise. The markets Akerlof relates to are markets in which buyers are unable to ascertain the quality of the goods before they purchase, the information about that is unavailable at any price, and the sellers are aware of the quality but have no way of making buyers believe them. Examples of markets where the adverse selection phenomenon can arise are the markets of new as well used durable, markets for professional and skilled services, the labor market, the credit market and the insurance market. Information about the performance of the market in such a setting is essential to evaluate a wide variety of regulatory initiatives. With his paper, Akerlof opened a new line of research which led to many new developments; many papers in fact proceeded to examine more closely the explicit or implicit assumptions made by that author.

Among the others assumptions, Akerlof supposes that the less informed part of the market has no way of getting information, with the implication that there are no costs and that the price is the only variable the agents may use to distinguish quality; besides, the better informed side of the market makes no effort to transmit relevant information to the other side. However in many markets there are third parts providing the relevant information and selecting the better quality; also, both sides of the markets take steps to solve or reduce the adverse selection problem. In addition, consumers can obtain information at costs, with this cost differing among consumers because of differences in prior information, location, or information processing ability. Consumer can also purchase the product repeatedly and obtain product specific information through experience. If we

introduce some of these items in the original model we expect the effects of adverse selection to be reduced.

There is another strong assumption made by Akerlof: goods of different quality are all traded at the same price, that is a single price makes total demand equal to total supply at equilibrium. In other words, the equilibrium implies a single price rather than a distribution of prices. Under perfect information all quality differences would be reflected in the prices, and each quality of good sold would have a distinct price. The equilibrium allocation would be such that the highest quality goods are allocated to consumers with the highest marginal rates of substitution of quality for price. Wilson (1980) shows that in a market with asymmetric quality information the possible equilibria are different from the one described under perfect information, but may have some of its properties, even if the uninformed cannot acquire information and the informed cannot use signals. The important assumption made by Wilson is that each agent (not each group of agents, as in the paper of Akerlof) is given an individual utility function: in particular, consumers differ with respect to their willingness to pay for quality.

Wilson (1980) supposes there is a given set of durable goods with a random quality distributed over the interval $[q_0, q_1]$ with density $f(q)$, and that each agent has the utility function $u = c + tq$, where c is consumption of other goods, q is the quality of the good it buys, and t is a parameter that reflects its willingness to pay for quality. The nonowners are therefore characterized by a positive utility index t, distributed on the interval $[t_0,t_1]$ with density $h(t)$; nonowners are risk neutral with respect to quality. The higher t the higher their reservation value for a given quality, so non owners with a higher t will buy cars at least as expensive as those bought by nonowners with a lower t, if higher prices imply a better average quality. The owners have the same utility index t, which lies between the highest and the lowest nonowner's valuation to simplify the computations. Note that t can be interpreted as the marginal rate of substitution between income and quality, so that a higher t corresponds to a lower marginal utility of income and therefore a higher income (Tirole,

1988, pag. 97). Under this interpretation, the model proposed by Wilson (1980) is the analogue to the models where consumers differ by their incomes rather than by their tastes[1].

The main results obtained by Wilson are the following:

1) if the price is set by an auctioneer who equates supply and demand, the markets with adverse selection may be characterized by multiple stable equilibria: if such equilibria exist, they can always be ranked accordingly to the Pareto criterion in order of ascending price, in the sense that both buyers and sellers always prefer higher price equilibria to lower ones;

2) if buyers or sellers set the price, Wilson shows that although there is a pattern of expectations that are consistent with a "walrasian" equilibrium, there is also always another pattern of expectations that are consistent with a continuous distribution of prices.

Rose (1993) discusses the first result, and shows theoretically that the existence of multiple equilibria depends critically on the distribution of quality (for example, in the model of Akerlof the distribution of quality among used car owners is uniform). Then he illustrates, using computationally intensive numerical techniques, that multiple equilibria are highly unlikely if quality follows some standard distribution, and he concludes that there is no evidence to change the result of a unique equilibrium in markets with adverse selection. However Rose (1993) does not discuss the possibility of an equilibrium characterized by a dispersion of quality-price pairs.

The problems which may occur in markets where consumers are uncertain on the quality of goods or services being sold have been studied by a number of authors[2]. Wolinsky (1983) examines a situation in which all consumers differ in their willingness to pay for

[1] These models are described in the literature of strategic product differentiation, where two approaches prevail, horizontal and vertical differentiation. Two products are horizontally differentiated when there is no ranking among consumers based on their willingness to pay for the products. Horizontal differentiation is normally associated with the presence of product varieties. Two products are vertically differentiated when there exist such a ranking of consumers, and vertical differentiation is associated with the existence of product qualities. Examples of the first case are the models by Hotelling (1929) and D'Aspremont, Gabszewicz, Thisse (1979); examples of the second type of product differentiation models are the ones by Mussa, Rosen (1978) and Shaked, Sutton (1982). In general, firms have an incentive to avoid head-to-head competition by differentiating their product from those of their competitors. This is a sort of common sense intuition which inspires the principle of maximum differentiation of D'Aspremont, Gabszewicz, Thisse (1979), and, even if in an attenuated form, the model of Shaked, Sutton (1982, 1983), who show that firms use vertical differentiation to relax price competition.

[2] In addition to the works cited in the text, see also Bagwell, Riordan (1991), Kim (1985), Riordan (1986) and Rogerson (1988). Leland (1979) provides a general framework of the Akerlof's lemons' market, showing that in markets with asymmetric information the adverse selection problem is a general phenomenon. He also discusses what are the markets which could benefit from the adoption of minimum quality standards, and shows that if quality standards are set by the profession (or industry) itself, it is likely that the standards will be too high.

quality, and the sellers can produce any quality they like, but higher qualities are more costly to produce[3]. Consumers are not completely uninformed: in the course of a visit to a firm, but before purchase, each consumer gets some information on the quality he obtains, and this costlessly, as by-product of the shopping process. This information is represented by a signal which depends on quality of the product and on random factors. Clearly, the results of the model (if prices serve or not as signals which differentiate the available quality levels) depend critically on the assumption that receiving the signal does not involve any cost beyond the cost of visiting the firm, which must be incurred anyway if a consumer wants to buy the product.

Others, for example Cooper, Ross (1984) and Chan, Leland (1982), have investigated the behavior of competitive markets in which some but not all consumers are uninformed about the quality of goods being offered. Cooper, Ross (1985) extend this kind of models to the monopoly case, and show that when the firm sells to more than one taste type of buyer, randomization of quality may be useful as a tool to relax binding self-selection constraints.

An important distinction among these kind of models is made by Shapiro (1982). As he points out, to understand the problems arising when consumers cannot observe product quality before purchase, it is fundamental to distinguish the case in which sellers choose product quality from the case in which there is an exogenous supply of products of different qualities. The incentive to produce high quality items is that higher quality today will cause the demand curve to shift out in the future; therefore product quality choices by sellers are fundamentally a dynamic problem. Besides, if the incentives to provide goods of above minimum quality depend on consumer learning, the process by which consumers get information is crucial. In particular, Shapiro (1982) analyzes the phenomenon of reputation, which can induce firms to produce high quality products. To do that, he excludes advertising and potential signals of quality such as warranties, because advertising may suffer from credibility problems and signals often cause adverse selection and moral hazard problems.

[3]In all models where is assumed a distribution of tastes for quality among customers, the sellers or the monopolist know the distribution of these immutable characteristics across agents, but the individual's type is not public information; so the sellers cannot perfectly discriminate between customers. Nevertheless it is profitable for the firms to offer a set of price-quality pairs that partially sort consumers.

Garella (1989) shows that in a market characterized by imperfect information about product qualities, if buyers and sellers trade not directly but through a middleman, goods of different qualities are not necessarily priced uniformly, because middlemen usually screen the goods they buy with some accuracy and differentiate the goods they resell. A separating equilibrium may emerge: the type of contract a customer chooses signals his quality. The general result is that intermediate exchange normally entails the occurrence of more than one price on the market, and it recalls the results of Wilson (1980) discussed above. This result holds even if neither signals nor quality screening are available to sellers and customers. In his model, Garella (1989) assumes that buyers have different incomes endowment, and this influences their willingness to pay for quality. The result of the model is obtained under the hypothesis that the middleman randomizes his price offers to the sellers of the units to be intermediated, and a seller can accept or refuse to sell at the proposed terms, but cannot change the terms.

In the paper of von Ugern Sternberg, von Weizsacker (1985), it is shown that asymmetric information on product quality does not necessarily produce a market failure characterized by the phenomenon of adverse selection. They show that if the seller is interested not only in the number of consumers who buy the product but also in the volume of total sales of each consumer, quality product choice will influence the equilibrium of the market, in the sense that the kind of market failure that will result could not necessarily imply an undersupply of quality, but could be represented by prices above marginal costs.

Bester (1998) presents the idea that imperfect information about the vertical quality characteristics of good reduces the sellers incentive for product differentiation: the equilibrium outcome may be characterized by minimum differentiation, so that sellers compete by offering homogeneous goods. This article focuses on the effects of quality uncertainty upon the choice of spatial or horizontal product characteristics, but the author affirms that the analysis could be also applicable to a framework of vertical quality selection. Anyway, the author does not show this point analytically. Besides, in his model, Bester (1998) does not assume a distribution of tastes for quality (or different incomes of consumers). Therefore the analysis developed in a horizontal differentiated framework does not seem to be directly applicable to a framework of vertical differentiation.

In this note we want to analyze, using laboratory markets, whether income differentiation is enough to avoid adverse selection outcomes, when information on quality is asymmetric (in the sense that sellers know the quality of products offered for sale and buyers do not). In the next section we briefly describe previous experiments on asymmetric information, product quality, and market simulations, while in section 3 we introduce the basic framework of the experiments conducted at the University of Siena. Section 4 summarizes the main results obtained in these experiments, and in section 5 some concluding remarks are drawn. Tables, figures, instructions and sheets used by participants are in the appendix at the end of the paper.

2. Previous experiments on asymmetric information and product quality

During the last twenty years, many experiments have been conducted in order to verify whether adverse selection outcomes arise in markets with asymmetric information on product quality.

Lynch et al. (1986) used a standard double auction and required each seller to choose a product quality level before the beginning of the trading process. The two goods were labeled Regulars and Supers: Supers cost more to produce, but they were more valuable to buyers. All units offered by a seller had to be of the same quality. The market consisted of six sellers and eight buyers. Each market lasted from seven to fourteen periods, and buyers and sellers were placed in separate rooms. After sellers made their quality decisions, bids and offers were transmitted from room to room over a radio. The bonuses and the endowment were introduced to offset the initial losses suffered by buyers, who ended to purchase Regulars at a Supers price in the first trading periods. The authors were able to identify conditions under which inefficient lemons-market outcomes are consistently generated. In portions of seven sessions, seller identities were not disclosed to buyers (in order to avoid the development of reputations), and sellers were prohibited from making quality disclosures. In the periods conducted under this treatment 96% of all units sold were regulars, and the presentation of sellers identities was not enough to avoid an inefficient

outcome. On the other hand, truthful advertising, either voluntary or mandatory, appeared to solve quality uncertainty[4].

A very similar experiment was conducted by Lynch et al. (1991) in a more general environment and using many sessions to study the adverse selection phenomenon and its remedies. The authors substantially found the same outcomes despite of the greatest number of experiments organized.

Miller, Plott (1985) conducted several market experiments in order to test five different models concerning how markets work with asymmetric information. Their research strategy was first to design markets in which several competing models can be legitimately applied, and then to evaluate the models in the light of the results. Participants knew much less than is frequently assumed as a part of standard models: each individual knew only his own parameters. The costs of signals and the value of signals to buyers, for example, were not public information, and no participant was aware of the theory of signaling. The authors investigated if under such circumstances individuals become aware of the value of the potentials of signals. The theory does not provide an operational way of determining the informational content of potential signals, so part of the paper reports or attempts to give the concept of a signal a satisfactory context.

The results seem to depend upon variables that are not adequately addressed in the theory. A potentially important variable was the magnitude of difference in signaling costs. In markets in which a substantial difference exists between the signaling costs of the basic grades, the system seems to move to near the most efficient signaling equilibrium. If the cost of signals is too close, pooling equilibrium seems to occur. Miller, Plott (1985) suggested that experience and awareness of the potential information content of signals are important for signaling and the development of signaling equilibria.

Holt, Sherman (1990) examined a posted-offer market with endogenous quality, letting sellers choose both price and quality independently before buyers shopped. The quality selection was made from one of multiple quality gradations, which provided sellers the opportunity to engage in rather subtle shading on quality deliveries. The authors located

[4] The sellers were given the option to make claims regarding quality when offering contracts for sale. The experiment monitor required that the claims be truthful.

sellers in the same room as buyers, but they observed that a few sellers felt embarrassed after charging high prices for low-quality products. The grade which yielded the maximum trading surplus in the Holt, Sherman (1990) design was not the highest available grade, which opens the possibility of having an inefficiently high level of quality as well as an inefficiently low level of quality. Each of the eight posted-offer sessions began and ended with a number of full information periods in which both price and quality selections were revealed to buyers prior to shopping. In these periods the average quality grade was near to surplus maximizing grade level, and 84% of the maximum possible gains from trade were realized. In contrast, average quality was lower, and only 46% of gains from trade were realized in periods for which prices, but not quality grades, were posted.

3. Laboratory markets

In the experiments reported in this paper, it is explored whether a distribution of income among buyers may alleviate adverse selection outcomes when markets are characterized by asymmetric information on quality product, thus leading to a separating equilibrium consisting in a dispersion of quality-price pairs.

Subjects were recruited among undergraduate students in Economics (first experiment), Cognitive Sciences PhD students (second experiment), and Master students in Economics and Banking (third experiment), all from the University of Siena. There were 3 sellers and 4 buyers in each experiment, and they could not communicate, but all participants were placed in the same room. Buyers could be "rich" (140 euro income per period) or "poor" (90 euro income per period). If buyers or sellers did not participate in the market, at the end of the session they did not earn anything but, under any circumstances, they could not loose money. If they participated, they had the possibility to earn more than their hourly earnings[5]. Sellers chose prices and units to offer for sale (up to 2 units per period), offers were written on a blackboard, and buyers decided sequentially if they want to purchase or not. Trading occurred in a sequence of 10 periods, each of which lasted for about five

[5] Each experiment lasted about 2 hours. The average earning was 20,65 euro.

minutes. There were two qualities: "supers" and "regulars". Table 1 summarizes the three different sessions which have been organized during each experiment.

Tab.1

Session	Information	Product quality
1	**Asymmetric**	**Exogenous**
2	**Asymmetric**	**Endogenous**
3	**Symmetric**	**Endogenous**

In the first session there were two sellers of regulars and one seller of super, whereas in the other two sessions the three sellers could choose the quality of products offered for sale; it was also allowed to offer a combination of qualities (i.e., one super and one regular).

The first session is the situation considered by Akerlof (1970) and Wilson (1980): buyers can not ascertain the quality of the product prior to purchase; in addition, we have assumed different buyers' incomes. In the second session we reproduce the environment related with the experiments conducted by Holt, Sherman (1990) and Lynch et al. (1986). In the last session we simulate the situation described in the models of vertical differentiation: firms (or sellers) can decide the quality (high or low) to produce, and customers know the quality of the product they are buying.

In each period, seller earnings were calculated as the revenues minus the cost of units sold. Producing (and selling) a super implied a cost of 80 euro, producing a regular implied a cost of 40 euro. In the case of buyers, period earnings were computed as the product value to buyers (super=140 euro, regular=90 euro) minus the purchase price, plus the unspent income. The unspent income could not be used in the following trading periods, but buyers were told that it would be taken into account at the end of each session, in order to calculate their global earnings.

What it was expected as result of the three sessions is the following. In the third session, under perfect information, a clear separating equilibrium was the main candidate: high quality items were expected to be purchased by high income buyers, and low quality items by low income buyers. This because different incomes determine different willingness to

pay for quality, as shown by Tirole (1988). In the first two sessions we wanted to analyze if different incomes among buyers may be enough to avoid a total adverse selection phenomenon found in previous experiments on the same topic.

4. Results and discussion

A time series statistics of all periods of all experiments is contained in Appendix 1. Here we show a summary statistics which can help to understand the main features of subjects' behavior. Supers and regulars traded through the sessions are shown in tables 2 and 3. Normally, regulars are traded more than supers, but supers are traded in all sessions, even in the last periods (see Appendix 1). In previous experiments, last periods of each session were characterized by the lack of high quality items, due to the adverse selection phenomenon. This is not the case for the present experiment: we observe few periods in which supers are not traded. In all experiments, the number of traded supers decreases from the first to the second session, while in the third session the number of supers and regulars traded is very similar; in the third session of the first experiment traded supers are even more than regulars. Then supers do not disappear from the market, as one could think observing previous experiments on asymmetric information: even at the end of each session, someone is selling (and buying) high quality items.

Table 2: Supers

traded supers	exp 1	exp 2	exp 3	total	%
first session	6	11	14	31	10%
second session	3	8	8	19	6%
third session	20	16	19	55	18%
total	29	35	41	105	35%

Table 3: Regulars

traded regulars	exp 1	exp 2	exp 3	total	%
first session	20	11	18	49	16%
second session	31	28	27	86	29%
third session	14	23	21	58	19%
total	65	62	66	193	65%

In table 4 we show the average price and standard deviation for each session. We conducted a statistical test of separation between mean price of supers and mean price of regulars, and we found that they are significantly different for each session considered.

Table 4: Mean prices, Standard deviation, Sd/A

Supers		Exp 1			Exp 2			Exp 3	
	1° sess.	*2° sess.*	*3° sess.*	*1° sess.*	*2° sess.*	*3° sess.*	*1° sess.*	*2° sess.*	*3° sess.*
Av. price	103.6	108.3	94.37	98.27	105.25	95.56	108.43	105.01	93.37
Sd	9.43	9.43	7.36	9.14	6.26	2.53	9.2	0.03	6.06
Sd/A	0.09	0.08	0.07	0.09	0.06	0.02	0.08	0	0.06

Regulars		Exp 1			Exp 2			Exp 3	
	1° sess.	*2° sess.*	*3° sess.*	*1° sess.*	*2° sess.*	*3° sess.*	*1° sess.*	*2° sess.*	*3° sess.*
Av. price	95.6	89.67	60	96.81	87.03	68.41	84.5	85.3	62.95
Sd	12.02	11.98	4.82	23.95	12.26	11.05	7.38	11.59	10.5
Sd/A	0.12	0.13	0.08	0.24	0.14	0.16	0.08	0.13	0.16

The average price of a super tends to be higher in the second session, with respect to the first session: only in the third experiment prices of supers in the two sessions appear to be similar. The variance (and relative variance) is higher for regulars' price: this could reflect the attempt to sell "lemons". As expected, prices and variances decrease in the third sessions, when buyers have full information on products' quality prior to purchase. The decrease of variance in the third session is not clear for regulars.

Nevertheless, in the third session of each experiment it has been almost reached a perfect competitive equilibrium: production costs for supers and regulars are, respectively, 80 and 40. At the end of the sessions the convergence of prices towards those values was clear. With more periods, a perfect competitive separating equilibrium would be obtained. However, in average, considering only ten trading periods, surplus for sellers of super is lower than surplus for sellers of regulars (in the third session). This is an *ex-post* outcome which might motivate the unclear separating equilibrium emerging from the trading process in the first two sessions, when information was asymmetric. In real markets, usually sellers of high quality items earn higher profits, and then there is the incentive to segment the

market and separate high income buyers from low income buyers. This observation is confirmed by theoretical literature on product differentiation. Modeling a laboratory market in order to better reproduce the same situation, could be a way to obtain a clearer separating equilibrium. Basically, sellers should have the option to choose a high quality product, this involving an increase in fixed costs with little effect on variable costs, as in classical models of vertical differentiation literature.

It should be noted that in the first session of each experiment there was only one seller of super: the difficulty to sell supers, observed also by the other two sellers, probably affected the market outcomes in the following sessions.

It also bears noting that sellers did not use all the possibilities to get information from the trading process. We placed subjects in the same room in order to facilitate the diffusion of market information, but probably this was not enough. In addition, sellers' instructions contained some information on potential buyers. It could be argued that a primary goal of *real* companies is the knowledge of the differences in consumers' willingness to pay, but it is not easy to reproduce such a behavior in laboratory markets. Obviously, if we are studying a market characterized by asymmetric information also with respect to consumers characteristics, we can not reveal all the information to sellers.

5. Conclusions

In this note we have investigated whether an uneven distribution of income among buyers is enough to avoid adverse selection outcomes which can be generated by asymmetric information on product quality. Normally, experimental works in which problems of adverse selection are studied assume equal income for all the participants: only the sellers are assumed to be different according to the quality of the product they offer for sale. In real markets, this is not the "normal" situation. In particular, adverse selection phenomenon is frequently observed with respect to relevant purchases, occurring when people buy (or want to buy) durable goods. This because only with durable goods people can not repeat their purchases and therefore use experience in order to correct their previous

choices. Thus, if relevant purchases have to be considered in the analysis of adverse selection problems, also differences in income turns out to be important.

In general, the experiments which have been conducted at the University of Siena and that have been described lead to the following conclusions:

1) adverse selection phenomenon is alleviated by an uneven distribution of income among buyers;
2) the main result of vertical product differentiation models is confirmed by the experiments: with perfect information, a clear separating equilibrium arises.

These results can shed some light on the regulatory issues in the context of markets characterized by asymmetric information on product quality. In fact, a way to solve problems of adverse selection is to intervene in the market regulating directly or indirectly the quality of products offered for sale. Considering that in real market consumers make their choice taking into account also experience and advertising, the partial results given by the experiments shown (differences in income can alleviate the adverse selection phenomenon) suggest that in some markets the regulating intervention can not be a necessary condition to avoid inefficient market outcomes.

References

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

Bagwell, K., Riordan, M.H. (1991), *High and Declining Prices Signal Product Quality*, American Economic Review, **81**, 224-239.

Bester, H. (1998), *Quality Uncertainty Mitigates Product Differentiation,* Rand Journal of Economics, **29**, 828-844.

Chan, Y.S., Leland, H. (1982), *Prices and Qualities in Markets with Costly Information*, Review of Economic Studies, **49**, 499-516.

Cooper, R., Ross, T.W. (1984), *Prices, Product Qualities and Asymmetric Information: The Competitive Case*, Review of Economic Studies, **51**, 197-207.

Cooper, R., Ross, T.W. (1985), *Monopoly Provision of Product Quality with Uninformed Buyers*, International Journal of Industrial Organization, **3**, 439-449.

D'Aspremont, C., Gabszewicz, J.J., Thisse, J.F. (1979), *On Hotelling "Stability in Competition"*, Econometrica, **47**, 1145-50.

Garella, P.G. (1989), *Adverse Selection and the Middleman*, Economica, **56**, 395-400.

Holt, C.A., Sherman, R. (1990), *Advertising and Product Quality in Posted-Offer Experiments*, Economic Inquiry, **28**, 39-56.

Hotelling, H. (1929), *Stability in Competition*, Economic Journal, **39**, 41-57.

Kim, J.O. (1985), *The Nature of Equilibrium in Markets with Adverse Selection,* American Economic Review, **32**, 45-63.

Leland, H.E (1979), *Quacks, Lemons, and Licensing: A Theory of Minimum Quality Standards*, Journal of Political Economy, **87**, 1328-1346.

Lynch, M., Ross, M.M., Plott, C.R., Porter, R. (1986), *Product Quality, Consumer Information and 'Lemons' in Experimental Markets*, in Ippolito, P.M., Scheffman, D.T. eds., *Empirical Approaches to Consumer Protection Economics*, Washington D.C.: Federal Trade Commission, Bureau of economics, 251-306.

Lynch, M., Ross, M.M., Plott, C.R., Porter, R. (1991), *Product Quality, Informational Efficiency, and Regulations,* in *Experimental Markets, Research in Experimental Economics,* vol. 4, 269-318.

Miller, R.M., Plott, C. (1985), *Product Quality Signaling in Experimental Markets,* Econometrica, **53**, 4, 837-872.

Mussa, M., Rosen, S. (1978), *Monopoly and Product Quality*, Journal of Economic Theory, **18**, 301-317.

Riordan, M.H. (1986), *Monopolistic Competition with Experience Goods*, The Quarterly Journal of Economics, **101**, 265-279.

Rogerson, W.P. (1988), *Price Advertising and the Deterioration of Product Quality*, Review of Economic Studies, **55**, 215-229.

Rose, C. (1993), *Equilibrium and Adverse Selection*, Rand Journal of Economics, **24**, Winter, 559-569.

Shaked, A., Sutton, J. (1982), *Relaxing Price Competition Through Product Differentiation*, Review of Economic Studies, **49**, 3-13.

Shaked, A., Sutton, J. (1983), *Natural Oligopolies*, Econometrica, **51**, 1469-1483.

Shapiro, C. (1982), *Consumer Information, Product Quality, and Seller Reputation*, Bell Journal of Economics, **13**, 659-680.

Tirole, J. (1988), *The Theory of Industrial Organization*, Cambridge, Mass.: MIT Press.

Von Ungern-Sternberg, T., Von Weizseicker, C.C. (1985), *The Supply of Quality on a Market for Experience Goods*, Journal of Industrial Economics, **33**, 531-551.

Wilson, R. (1980), *The Nature of Equilibrium in Markets with Adverse Selection*, Bell Journal of Economics, **11**, 108-130.

Wolinsky, A. (1983), *Prices as Signals of Product Quality*, Review of Economic Studies, **50**, 647-658.

APPENDIX 1: INSTRUCTIONS

Instructions for sellers

First session

Today, you are a seller of a durable good. As can be seen from the sheet provided, there will be 10 market periods in each session of the trading process. Potential buyers are either high income buyers and low income buyers, but you do not know the ratio between the two groups of buyers neither their absolute number. In each period of the trade process, you have the opportunity to sell units of the commodity. You are a producer and a seller of a "regular" ("super") good, and the production cost of each unit of the good is 40 (80) euro.

At the beginning of each period you have to decide the number of the units you want to offer (1 or 2), and their price; the price of units offered for sale cannot be lower than their production cost. You have to write such choices in the proper space on your sheet, at the beginning of each period. Please do not reveal to anyone the information that you record on your sheet.

The qualities of the goods offered in the market are two: super and regular, but buyers do not know the quality of the goods offered prior to purchase. After two minutes from the beginning of the period, buyers are informed about the offers and they will be given the chance to make purchases if they wish to do so. You can observe the general market outcomes on the blackboard, and you will know how many units you have sold.

The money you earn in each period (total revenue-total costs of production of sold units), which can not be lower than zero, will be calculated in the last row of your sheet. As for the units unsold, they will be automatically bought back by a central store, and their cost of production will not enter in the calculation of your earnings. The earnings in each period will be paid to you, privately, at the end of the session, in addition to the hourly remuneration.

Second session

In this session you can produce (and sell) either super goods and regular goods, up to two units in all. Production cost is 80 for each super, and 40 for each regular. You can

supply any qualitative combinations of qualities. Also, in each period you may modify the composition of your offer. You have to write your choices in the first two rows of your sheet. At the end of each period, you calculate your earnings as in the first session: total revenue-total costs of production of units sold.

In this session too, buyers can not ascertain the quality of the goods offered prior to purchase.

Third session

In this last session, everything remains the same, but now buyers may observe the quality of the goods offered by you before making their choices.

Instructions for buyers

First and second session

Today, you are a buyer of a durable good. As can be seen from the sheet provided, there will be 10 market periods in each session of the trading process. In each period, you will have the opportunity to buy a single unit of the commodity. If you do not want to buy a unit of the goods offered, you will not earn anything, whereas if you participate to the trading process you have the chance to earn some money that will be paid to you at the end of each session, in addition to the hourly remuneration. In each period, your income is 90 (140).

In each period, you will be informed about the number of the units offered and their price. The quality of the units offered may be "super" (value to you = 140) or "regular" (value to you = 90), but you cannot observe the quality level of the goods offered prior to purchase.

When the offers appear on the blackboard, you have to decide if purchase one of the units offered for sale. You can not spend more than your income. If you do not purchase, a share of your personal (unspent) income per period will be taken into account at the end of the session to calculate your session earning.

If you decide to purchase, you simply have to write the purchase price on your sheet, and when every buyer has made his choice the quality of the good purchased (super or regular) will be disclosed to you. The difference between the value for you (140 or 90) and

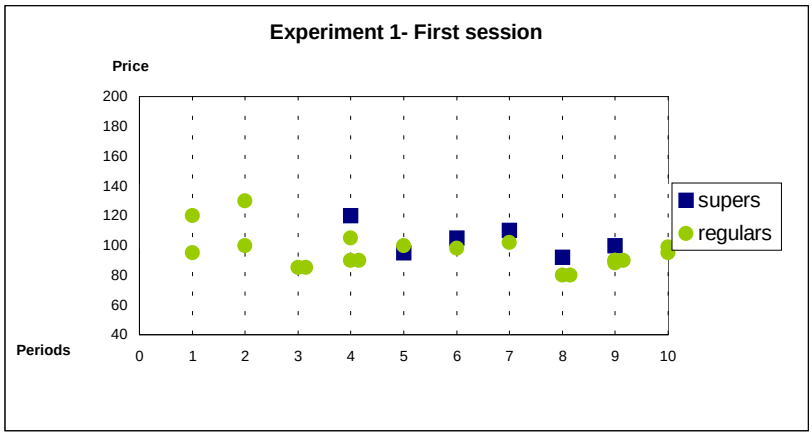
the purchase price will be your earnings, while if the value of the unit turns out to be less than the purchase price, your earnings will be equal to zero. You have to write your earnings in the last row of your sheet. If the purchase price is lower than your income per period, then a share of that will be taken into account at the end of the session to calculate your session earning.

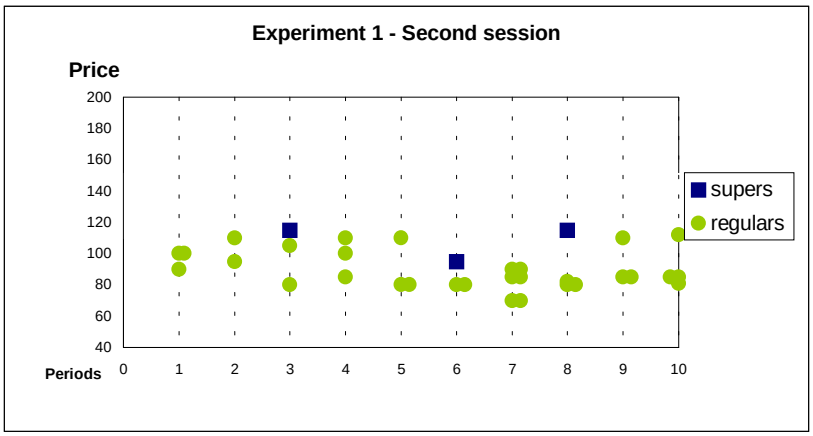
This process will be going on ten periods, and any earnings in each period will be paid to you, privately, at the end of the experiment, in addition to your fixed remuneration.

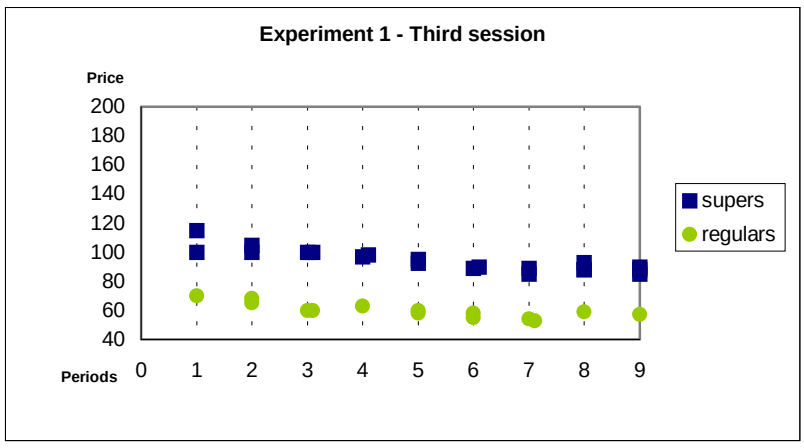
Third session

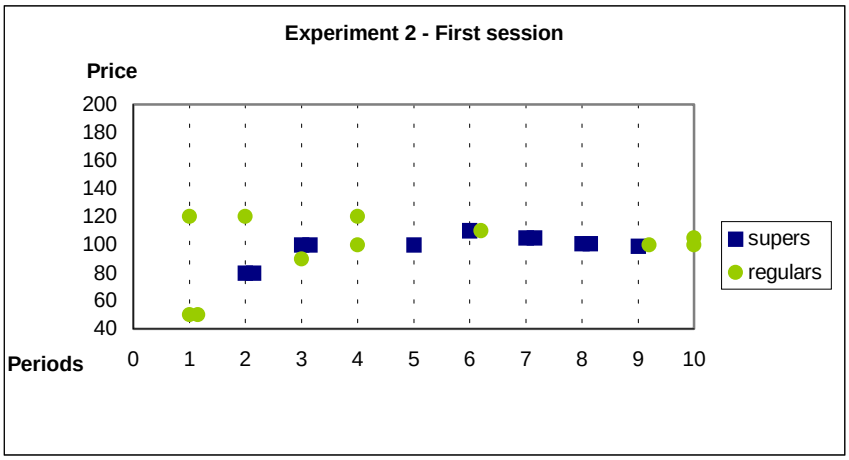
In this session, everything remains the same, but now you can observe the quality of the goods offered prior to purchase: by the price of each unit offered, you will see a "S "(super) or a "R" (regular).

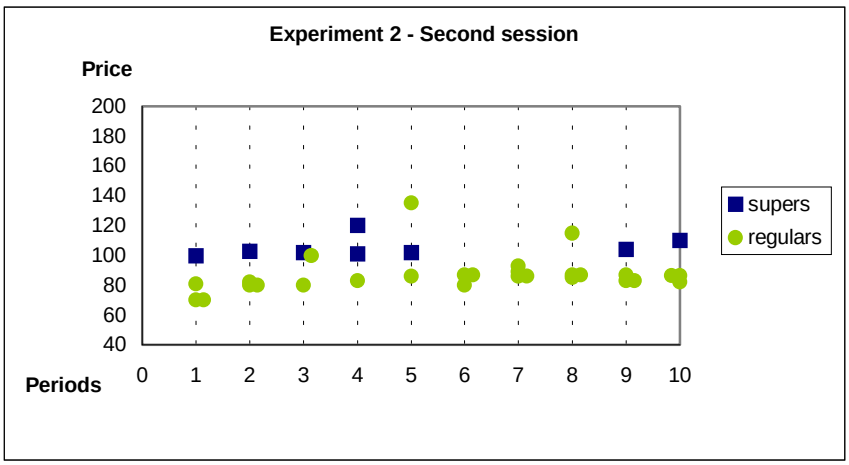
APPENDIX 2: SINGLE EXPERIMENTS RESULTS

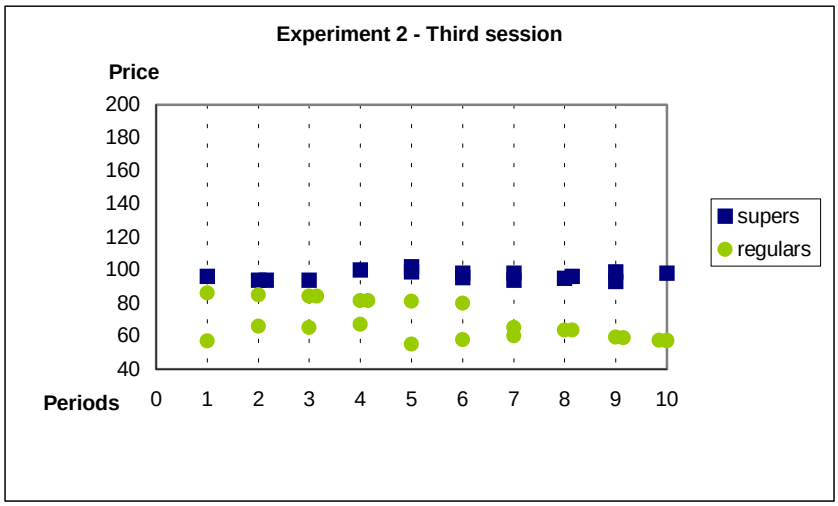


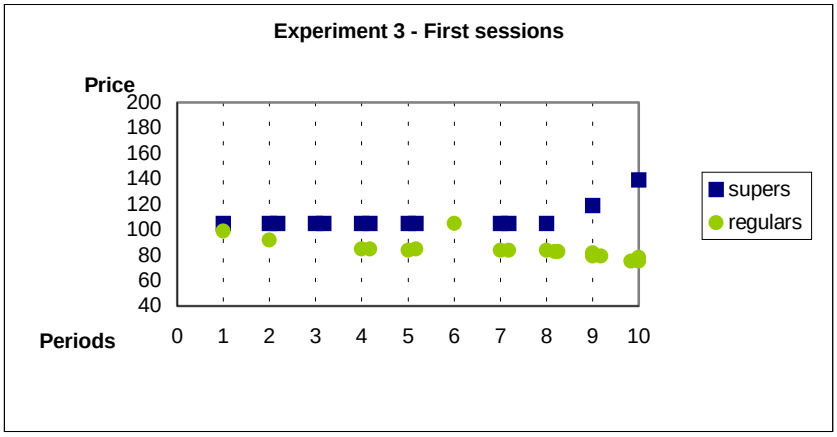


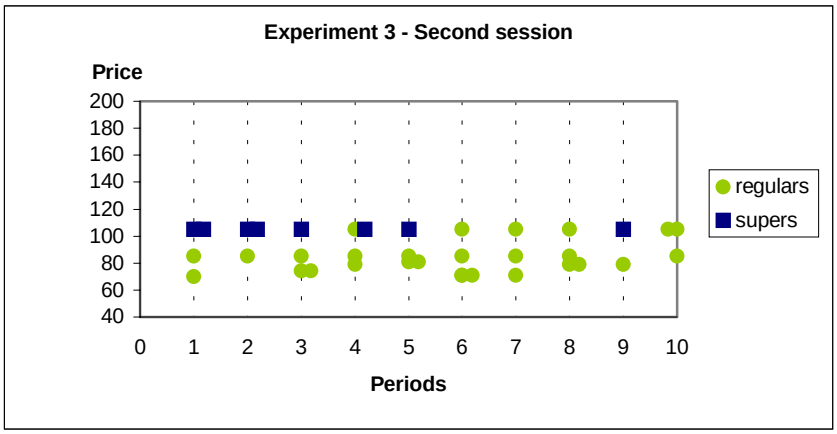


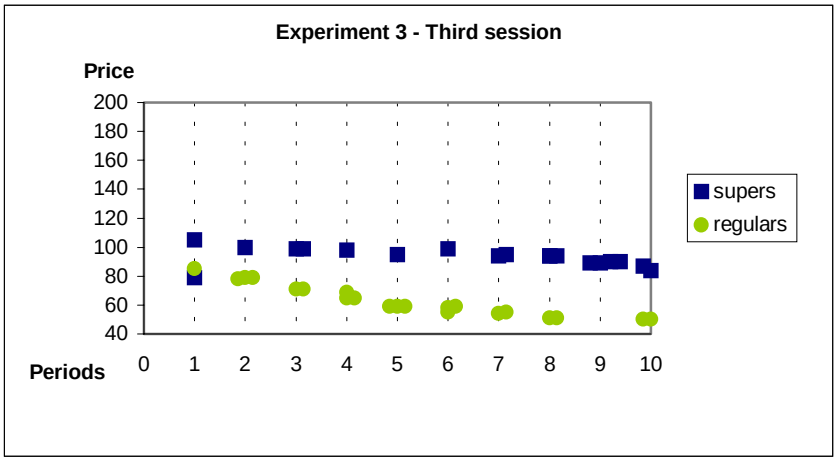

Experiment 2 - First session
Price
200
180
160
140
120
100
80
60
40
Periods
0 1 2 3 4 5 6 7 8 9 10
supers
regulars


Experiment 2 - Second session
Price
200
180
160
140
120
100
80
60
40
Periods
0 1 2 3 4 5 6 7 8 9 10
supers
regulars

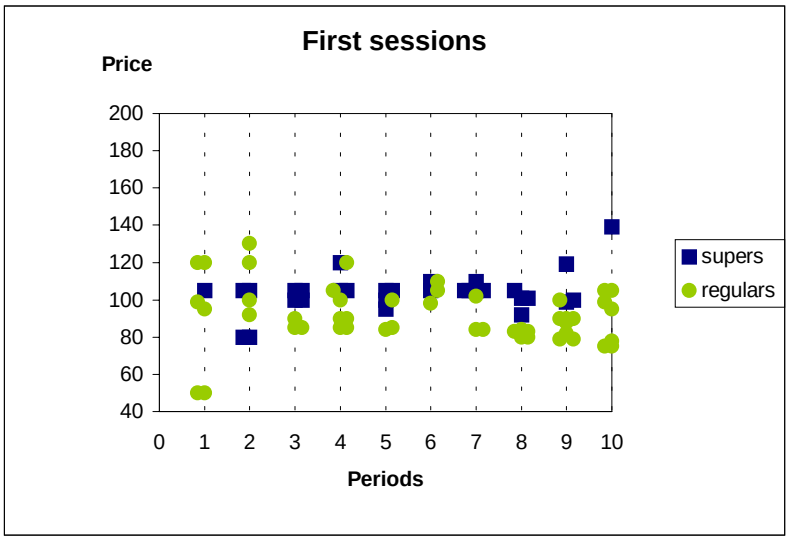

Experiment 2 - Third session
Price
200
180
160
140
120
100
80
60
40
Periods
0 1 2 3 4 5 6 7 8 9 10
supers
regulars

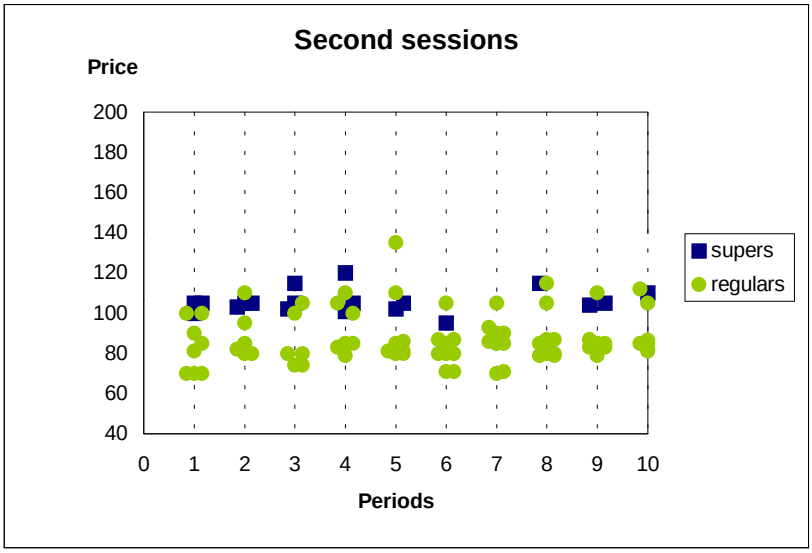

Experiment 3 - First sessions
Price
200
180
160
140
120
100
80
60
40
Periods
0 1 2 3 4 5 6 7 8 9 10
supers
regulars


Experiment 3 - Second session
Price
200
180
160
140
120
100
80
60
40
0 1 2 3 4 5 6 7 8 9 10
Periods
regulars
supers


Experiment 3 - Third session
Price
200
180
160
140
120
100
80
60
40
Periods
0 1 2 3 4 5 6 7 8 9 10
supers
regulars

APPENDIX 3: GLOBAL RESULTS (ASYMMETRIC INFORMATION SESSIONS)





APPENDIX 4: GLOBAL RESULTS, PRICE DISPERSION