Northwestern University

2001 Sheridan Road 580 Leverone Hall Evanston, IL 60208-2014 USA

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Alessandro Lizzeri
Northwestern University

www.kellogg.nwu.edu/research/math

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INFORMATION REVELATION AND CERTIFICATION INTERMEDIARIES

by

Alessandro Lizzeri
Northwestern University

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Information Revelation and Certification Intermediaries

Introduction

Since Akerlof's (1970) work on the market for lemons, a vast literature in economics has discussed the problems that arise in markets with asymmetrically informed agents. These problems are perceived to be important and to affect market institutions and outcomes in a significant manner. They have also been reasons for advocating some type of government intervention in the marketplace.

On the other hand, there is a school of thought that suggests that in cases in which certain types of market interactions create inefficiencies or otherwise distort the distribution of resources, there will be an incentive for the creation of institutions to correct these distortions. These incentives would take the form of unexploited profit opportunities. In the case of asymmetric information, one example of such an institution is the creation of warranties to offset the fact that a seller may know more about the quality of a product than the agent who is buying the product. Grossman (1981) has shown that in certain circumstances the offer of such warranties makes the problem go away. He shows that warranties are sometimes equivalent to the ability to make certifiable statements about quality and that this ability leads to complete information revelation. In some markets it seems that warranties indeed reach the desired effect. However they certainly do not seem to solve all the problems related to informational asymmetries and they are by no means pervasive: even in markets in which these are offered they often have a limited scope. There are good reasons for this. Among others, the existence of moral hazard problems on the part of buyers and the difficulty of ever verifying the true quality of the good have been suggested.

One other type of market institution that can arise in response to the problems we are discussing is that of an intermediary that certifies quality. These intermediaries may be thought of as agents that are endowed with a technology to test the quality of the products and certify this quality to the buyers. Examples abound: mechanics that test the quality of second hand cars, debt rating agencies in financial markets, schools in their rating of abilities through grades, department stores that have a reputation for carrying only the highest quality goods. If one wishes to evaluate the effect that these intermediaries have in addressing the allocative problems raised by information asymmetries, they have to be treated as maximizing agents. Therefore the fees these intermediaries charge for their services should be determined optimally and will thus generally depend on the competition they face and therefore on the market structure in the industry for such services. If this were all there was to the question it would not be too difficult to integrate these intermediaries in the problem: they would just make available to agents a costly way in which to reveal their quality. However, this neglects the fact that an intermediary which has tested the product has superior information relative to the buyer and that therefore it may very well try to exploit this superiority. In other words, one has to deal again with the question of information revelation, only one step back. The information that is revealed by the intermediaries should be the outcome of an optimizing choice in which the intermediary considers the possibility of not revealing such information or of lying about it. If this raises the adverse selection problem once again then it may not be very interesting. But this need not be the case. The incentives faced by some types of intermediary are different from those faced by the seller of the good in that he does not have a good but a testing service to sell. The way information is revealed will determine the fees it will be able to charge and what type of sellers will be willing to submit themselves to the test. In other cases the intermediaries do put themselves in the same position as the original seller of the good, an example is the case of used car dealers. It may be interesting to discuss in what way the latter cases differ from the previous ones.

This paper is an attempt to deal with these questions. Section 1 is somewhat tangential to the main issue but it is referred to in the later proofs. This section deals with the case in which the sellers may make certifiable statements about their quality. The role of this section is to adapt known results in the disclosure literature to the framework of this paper so that a comparison can be made between these results and the ones discussed in this paper in which disclosure is delegated to an intermediary.

Section 2 deals with the case in which a monopoly intermediary exists in a context in which the seller has a reservation value which is independent of his type. It is assumed that tests are costless and perfectly precise and that the seller pays the fee to the intermediary. Under some conditions on the distribution of types there is a unique equilibrium outcome of the game.

Perhaps surprisingly, this equilibrium involves no information revelation and the intermediary extracting all the surplus in the market. This equilibrium exists for all distributions of types but under other assumptions there are other equilibria in which the intermediary makes lower profits. The set of possible equilibrium profit levels is characterized. The central idea here is that a monopolist makes higher profits by pooling low types with high types than by revealing the latter types. The reason is that low types are then willing to go to the intermediary and pay a fee. While it may seem that the results are somewhat extreme, they may help in understanding the following phenomenon: there are intermediaries in markets for electrical goods and engineering goods such as windmill generators whose only role seems to be informational and that do precisely what the analysis of section 2 suggests, namely they certify. Clearly this is the minimum information revelation that may occur. Also, the results of this section may shed some light on the apucity of quality information that is available in some markets such as health care.[1]

Section 3 considers the same setting but with oligopolistic interactions among intermediaries. It is shown that there is generally a large multiplicity of equilibria. One of these involves the intermediaries making no profits and fully revealing information thereby completely doing away with information asymmetries. For some distributions of types there are equilibria in which no information is revealed and equilibria in which the average quality of sellers going to different intermediaries is different. Remarkably, for any number of oligopolists in the market there are distributions for which it is an equilibrium for no revelation to occur and for the aggregate profit level to be equal to the highest possible monopoly profit. On the other hand, for any fixed distribution, in the limit, as the number of intermediaries grows to infinity, prices go to zero and revelation becomes complete. Some of the results in this section provides a rationale for the existence of brand effects. This refers to the perception by buyers that the quality of the product certified by one intermediary is better than that certified by another even in cases where

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[1]Recently the American Medical Association paid for a full page advertisement on the Wall Street Journal sponsoring the so called patient protection act which, among other things, would require insurers to disclose information about health plans.

there is very little hard information to rely on. This seems to be a feature of schools and department stores.[2]

In the context of reservation values independent of type there is no allocative distortion caused by the information asymmetry. The distortion is redistributive, high quality sellers make less than they would make in perfect information environments. A monopoly intermediary may create a distortion if it is costly to set up the intermediary or to administer the test because its role would then be purely wasteful. Moreover the intermediary may deter some socially useful investment on the part of sellers since it extracts so much rent

In order to consider the effect of allocative distortions, section 4 addresses the question of a seller whose reservation value depends on his type. This is an environment similar to the market for lemons in which the good is sometimes not exchanged even if buyers value it more than the seller. In this context, the optimal policy for a monopoly intermediary depends on how large is the surplus generated by the exchange. It is however not generally optimal for the intermediary to reveal nothing because this policy involves losing the highest quality types and therefore reducing the amount lower types are willing to pay to be certified. The intermediary then "solves" the allocative distortion while possibly creating the other distortion mentioned above. The equilibrium that yields the highest profit to the intermediary is described. The disclosure rule in this case is much more complicated than in the previous case and it does not allow the monopolist to extract all the surplus in the market. On the other hand the introduction of the intermediary in the market makes none of the participants better off. They would all prefer that the intermediary not exist and that trade be inefficient.

Section 5 is a discussion of alternative specifications of the extensive form and of the role of the intermediary. The first case that is analyzed is one in which the buyers pay in order to receive the information obtained by the intermediary rather than the sellers paying in order to be certified or revealed. The results here are strikingly different from the analysis of section 2. The intermediary chooses to reveal all of the information to one of the buyers and nothing to the others. The reason is that this maximizes the informational rent obtained by the informed buyer, and the intermediary can

[2]Of course, there are other explanations, such as reputation. However the explanation of this section might be of interest because it is static and therefore does not require a past history.

fully capture this rent in a previous stage of the game. The profits of the intermediary however are much lower than in the case in which sellers pay to be certified. This may explain why the latter seems to be the prevalent custom in these types of markets: students are the ones who tipically pay schools, bond issuers are the ones that pay bond rating agencies, producers pay certifiers in the engineering and electrical goods markets mentioned above. The discussion in section 5 then turns to an analysis of the case in which the intermediary acts as a middleman, buying the product from the seller reselling it to the buyers. In this case there is indeterminacy in that any profit levels between zero and all the surplus are equilibrium outcomes. The intermediary and the sellers are at the mercy of buyers' beliefs or, maybe, market custom.

The last section concludes suggesting a number of extensions and limitations of the preceding analysis.

Section 1: Market Interactions Without the Intermediary.

In this section I shall discuss market outcomes when no intermediary is present. This discussion is mainly for purposes of comparison with later results.

There are three agents in the market. One informed seller and two uninformed buyers. The seller owns an object that he values zero. This object may be valued a positive amount by the buyers. Indeed, we characterize the value that a buyer has for the object by **t**. This t is known by the seller but buyers only have a prior on the value of t which is denoted by the distribution function F(t). I shall assume that this distribution function is strictly increasing, has continuous density on the closed interval [0,1] and that this fact is common knowledge to all the participants in the market. Sellers may make verifiable statements about their type. Let **B** be the Borel σ-algebra on [0,1]. A statement by the seller is a set $A \in \mathbf{B}$ to be interpreted as "I am one of the types in A". A statement A by type t is true if $t \in A$. Let $\mathbf{A}(t) \subset \mathbf{B}$ be the collection of true statements by type t. Let $\mathbf{A}^*(t) \subset \mathbf{A}(t)$ be the collection of verifiable statements by t. In some cases it might be natural to think that $\mathbf{A}^*(t) = \{t\}$ i.e. the only verifiable statement a seller can make reveals his type precisely. In other cases it is more natural to suppose that [0,t] is in $\mathbf{A}^*(t)$ i.e. the seller can choose to understate his quality. I assume that there are two stages: in the first stage sellers make statements, in the second stage buyers bid simultaneously and independently for the seller's product conditional on the statements in the first period. Therefore a strategy for a buyer is a map from **B** into **R**. Therefore buyers bid the expected value conditional on their beliefs and their actions are completely determined by their beliefs. Let $G(t|A)$ be the beliefs of the buyers conditional on statement A. Since $E(t|A) \geq 0$ for all A the seller will surely accept the offer whatever statement he made in the first period. Therefore the outcome of the subgame is completely determined by the beliefs $G(t|A)$. Let us now discuss the equilibria of the game under different assumptions about $\mathbf{A}^*(t)$.

One case is extremely simple. If the informed seller can not make any verifiable statements about his type, i.e. $\mathbf{A}^*(t) = \{[0,1]\}$ for all t, buyers' beliefs must coincide with the prior F and therefore, the unique sequential equilibrium outcome involves the buyers bidding E(t) and the seller accepting.

Clearly, if the informed seller could make credible statements about his type, this would no longer be an equilibrium since the highest types would reveal their type and therefore, a buyer would no longer be willing to pay E(t) to types that do not reveal their private information. Indeed, it has been shown that, in this case, the unique sequential equilibrium outcome involves all information being revealed and all types of the buyer receiving the full value t.[3] Because the result is important for subsequent analysis and the setup is slightly different from the usual one, I shall give a formal statement of it. In this case buyers' strategies and beliefs can be conditioned on the statements made by the seller.

Proposition 1:[4] Suppose that for all t there exists an $A \in \mathbf{A}^*(t)$ such that $t = \min\{s | s \in A\}$. Then the unique sequential equilibrium outcome involves complete revelation of information and therefore each type t of the seller receiving t.

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[3]This result goes back to Grossman (1981) and Milgrom (1981). The most general discussion of the problem is by Okuno-Fujiwara, Postlewaite and Suzumura (1990).

[4]This is basically a special case of theorem 1 in Okuno Fujiwara et al.(1990), the only difference is that I consider the case of a continuum of types whereas they assume a finite number of types. The proof is also different.

Proof: It is easy to see that there is an equilibrium in which complete revelation occurs. Suppose all types t make the report A(t) such that t is the minimum of A(t), beliefs and offers conditional on any report A are degenerate on the infimum of A. It is then rational for all types to send A(t) and for buyers to make these offers.

I now want to show that complete revelation occurs in every equilibrium. Notice first that every type t must in equilibrium receive offers of at least t because he can certainly induce offers of at least t by reporting A(t). Suppose now that some set of types T receives offers above t. Because the buyers would not make such offers if they knew what types they are facing, it must be the case that there is a set of types S which is making the same report A with positive probability. But then offers conditional on A must be equal to the supremum of S because otherwise some type in S makes less than his type. But this implies that buyers lose money conditional on A and this is impossible. Therefore in equilibrium all types t receive offers of t and complete revelation occurs.

An example of a case in which the proposition would hold is the case in which $A^*(t) = \{t\}$ for all t.

Section 2: Monopoly Intermediary, Reservation Value Independent of Type.

Notation, definitions and structure of the game.

There are now four agents in the market. One informed seller, two uninformed buyers and one intermediary. As in the previous section, the seller owns an object that he values zero. This object may be valued a positive amount by the buyers. Indeed, we characterize the value that a buyer has for the object by t. This t is known by the seller but buyers only have a prior on the value of t which is denoted by the distribution function F(t). I shall assume that this distribution function is increasing, has continuous density on the support [0, 1] and that this is common knowledge. The intermediary does not know the value of t but has the technology to test the buyer at no cost to itself and find out his type with perfect precision.

The sequence of moves is the following:

Stage 1: The intermediary sets a fee P and credibly commits to a disclosure rule D to maximize expected profits. P can be any nonnegative real number. The set of disclosure rules from which the intermediary is allowed to choose is assumed to be very large: it can choose to perfectly disclose test results, to only disclose intervals of test results (grades), to disclose Borel measurable sets of scores, to perfectly disclose test results for some values and to only disclose intervals for other values, to disclose nothing or, finally to disclose a noisy transformation of test results. At the end of stage 1 nature chooses the type of seller according to the distribution F.[5]

Stage 2: Having observed P, D, and t, the seller decides whether to avail himself of the intermediary's service i.e., whether to pay the fee and have the product tested.

Stage 3: If the seller has paid the fee, the product is tested and a test score s is realized. The score is only observed by the intermediary.

Stage 4: Buyers observe the disclosure rule, the fee, whether the product was tested or not and what the intermediary disclosed.

Stage 5: Buyers bid independently and simultaneously for the product.

A strategy for the intermediary is a pair (P,D), i.e., a fee and a disclosure rule. Formally, D is a function from [0,1] into the set of probability distributions on the real numbers. Denote by Ψ the set of such functions. A policy of full disclosure can be represented by a function mapping each type t to a probability distribution degenerate at t. An example of a policy of noisy disclosure is the function that maps type t to the normal distribution with mean t and variance 7. The policy of no disclosure of test results will be important later. This should be thought of as a policy of releasing a certificate that says: "the seller is certified by this intermediary" and nothing else. This policy can be represented by a function that maps all types to some brobability distribution degenerate at some number x independent of t. This specification of a disclosure rule also allows the intermediary to disclose partitions: Let

[5] I assume that nature moves after the choice by the intermediary so that these choices always induce proper subgames.

$\{T_1,....,T_n\}$ be a partition of $[0,1]$, let D be a one to one function that maps each t in T_i to a probability distribution degenerate on some x_i.

A strategy for the seller is a function from $R_+ x \Psi x[0,1]$ into $\{0,1\}$ that maps the triple (P, D,t) into decisions of using the intermediary (1) or not (0) as a function of type, fee and disclosure rule. A strategy for a buyer is a function from $R_+ x \Psi x\{0,1\} xR$ into R_+ that maps the observed data of price P, disclosure rule D, whether the seller went to the intermediary (1) or not (0), and the realization of the disclosure rule (a real number that can be thought of as a test score after the resolution of any uncertainty caused by a noisy disclosure rule) into bids for the seller's product.

The equilibrium notion I shall use is sequential equilibrium.

Discussion:

Since I assume that buyers are risk neutral and that they bid Bertrand style, given their information, buyers' equilibrium strategies are fully characterized by their beliefs as to the value of t. Such beliefs are characterized by the distribution function G(x) that gives the conditional probability that t lies in $[0,x]$ given all available information. Given G, both firms will bid the expected value of t calculated using G. The requirement that such a G be part of a sequential equilibrium means that G must be consistent with the seller's and intermediary's strategies.

By assuming that the intermediary sets a single fee P, I have ruled out any pricing scheme whereby the intermediary charges different fees for different test scores. This assumption is important for most of my results. It can be justified by the fact that a flat fee makes it possible for the intermediary's statements about test results to be credible. Indeed, with a flat fee, the intermediary has no incentive not to follow its announcements of a disclosure rule. If instead the fee were conditional on test results, these incentives may lead the intermediary to lie about test results. Its announcements would then have to be discounted by the buyer and therefore the intermediary would not favor fees that are not constant in test results. In other words, a fixed fee and credible disclosure would be an equilibrium of a game in which the intermediary cannot commit to credible disclosure.

Let us begin our analysis by considering what would happen if the intermediary were to perfectly disclose the information it acquires. It will be shown later that it is not an equilibrium for the intermediary to choose this disclosure rule. However the discussion is of interest for a number of reasons: First of all, as a by-product, this will provide a generalization of the analysis of section 1 to the case in which agents have access to a costly signal. Moreover this is a useful starting point for the analysis and provides some sort of benchmark for evaluating the role of the intermediary. Finally, there may be legal requirements that force the intermediary to disclose fully the information it has acquired.

For every P, let x(P) be a solution to the following equation:

(*) $x(P) - P = E[t|t \leq x(P)]$.

Let X(P) be the set of such x's and notice that this set may have more than one element.

Proposition 2: Suppose the intermediary chooses a policy of full disclosure and a price P. Suppose also that $0 < P < 1 - E(t)$. Then in the induced subgame, for every sequential equilibrium there is a type $x \in X(P)$ such that all types above x choose to go to the intermediary and all types below x choose not to go.

Proof: Since $1 - P > E(t|t \leq 1) = E(t)$, $0 - P < E(t|t \leq 0) = 0$ and $E(t|t \leq x)$ is a continuous function, (*) has a solution in (0,1). Suppose then that x(P) solves (*), suppose types above x(P) go to the intermediary and types below x(P) do not go. Let offers by the buyers be that any type t who goes to the intermediary gets paid t and types who do not go get paid $E[t|t \leq x(P)]$. Given these offers, types above x(P) strictly prefer to go and types below x(P) strictly prefer not to go to the intermediary. Therefore, the seller's strategy is sequentially rational. It is obvious how to construct consistent beliefs that make this a sequential equilibrium of the subgame.

I shall now show that every equilibrium is of this form for some x in X(P). Let T be the set of types who do not go to the intermediary. Since $P > 0$ this set is not empty. In equilibrium therefore, if the seller does not go to the intermediary, he gets $E(t|t \in T)$. The set T cannot be the entire interval [0,1] because in such a case, $E(t|t \in T) = E(t)$ which is less than $1 - P$ by assumption and therefore all types close enough to 1 would choose to go to the intermediary. Because of the assumption that the distribution F is increasing, there must be a type x such that $x - P = E(t|t \in T)$. Such an x would be indifferent between going to the intermediary and not going. Thus all $t > x$ strictly prefer to go and all $t < x$ strictly prefer not to go. This implies that T must be of the form $[0,x]$ for some x in $X(P)$ and concludes the proof.

Remark: The condition $P < 1 - E(t)$ is necessary because if $P \geq 1 - E(t)$, there is an equilibrium of the subgame such that no type goes to the intermediary. On the other hand, this assumption is hardly restrictive in our context since, if beliefs are such that following such a price, nobody is expected to go to the intermediary, the latter would never charge such a price because it would yield zero profits.

The proposition above implies that the profits to the intermediary from a policy of full disclosure and price $P < 1 - E(t)$ are $\Pi(P) = [1-F(x(P))]\ P$. Where x is in $X(P)$. If $X(P)$ has more than one element $\Pi(P)$ is not well defined. This implies that in such cases we cannot treat the problem of choosing the optimal price for a policy of full disclosure as a simple maximization. Such an optimal price might not even exist because infinitesimal variations in P to P' can cause discrete jumps in Π if, for example we choose the smallest element of $X(P)$ and the largest element of $X(P')$. However an equilibrium for the game in which the intermediary is forced to choose a policy of full disclosure clearly exists since we can always choose, for example, the minimal element of $X(P)$. Under our assumptions on F this induces a function $\Pi(P)$ which is continuous.

Let us briefly consider an example where F is a uniform distribution. In this case $x(P) = 2P$ and $X(P)$ is a singleton for $P \leq 1/2$ whereas $X(P)$ is empty for $P > 1/2$. $\Pi(P) = P - 2\ P^2$ for P in $[0,1/2]$ and is equal to zero for larger P's. Profits are maximized by $P = 1/4$. This induces a subgame where the unique equilibrium involves types in $[1/2,1]$ going to the intermediary and types in $[0,1/2)$ not going. The latter set of types gets offers of 1/4 whereas types higher than 1/2 get offers equal to their type. The intermediary makes an expected profit of 1/8. Let us compare this example with the case in which there is no intermediary and the seller cannot make any verifiable statement about his type. In the latter case, all types of the seller make $1/2 = E(t)$. Therefore types above 3/4 are better off with the intermediary whereas types below 3/4 are worse off.

So far I have discussed a situation in which the intermediary sets a policy of full disclosure. However, this is not an equilibrium for the full game: the intermediary can choose a disclosure rule that yields it strictly higher profits. Before showing this however I shall describe one equilibrium for the full game which exists for all distributions F and is the unique one for some distributions.

Theorem 1: There is an equilibrium in which the intermediary sets $P = E(t)$, D = no disclosure and all types go to the intermediary.

Proof: Suppose all types are expected to go to the intermediary. Let beliefs of the buyers be that, if the seller went to the intermediary, beliefs coincide with the prior, F, and if the seller does not go to the intermediary the buyers believe that he is type 0. These beliefs are clearly consistent given the strategies and the strategies of buyers and of the different types of the seller are clearly sequentially rational given the beliefs. With respect to the intermediary, it is making the highest possible profit it can make in the market by appropriating all of the ex ante surplus. Therefore it has no incentive to change either price or disclosure rule. This proves that this indeed forms a sequential equilibrium.

Remarks:

a) As was already mentioned in the proof, in this equilibrium, the intermediary appropriates all the surplus in the market. No type of the seller gets any net payment at all: what the seller gets from the buyer is paid over to the intermediary. No information is revealed. This is an unpleasant feature of this equilibrium. The mere presence of the opportunity of certification by an intermediary reduces the surplus that a seller can hope to make in the market to zero. The construction of the equilibrium also has some of the flavor of market certification: someone who does not get certified is believed to be a bad type even if the certification itself yields no information.

b) Given the pair ($P = E(t)$, D = no disclosure), there is clearly another sequential equilibrium outcome of the subgame starting with the seller's choices. This involves no type of the seller going to the intermediary and receiving offers of $E(t)$. This is sustained by many beliefs of the buyers: e.g., any belief that puts unit mass on a type less than $2E(t)$ conditional on observing the seller going to the intermediary and beliefs equal to the prior upon observing the seller not going to the intermediary. Of course, this is not an equilibrium for the whole game if those are the beliefs of the buyers and the strategy for the seller because the strategy for the intermediary is not sequentially rational in such a case. This type of equilibrium of the subgame following no disclosure exists for any fee P charged by the intermediary. In order to see this, change the beliefs of the buyers following a deviation by the seller to put unit mass on any type less than $E(t) + P$. The multiplicity may however be even worse: for example, with F uniform on $[0,1]$, $P = 1/2$, for any x in $[0,1]$ it is an equilibrium of the subgame for types below x not to go to the intermediary and for types above x to go. This is because in the case of the uniform $E(t|t\geq x) - E(t|t<x) = E(t)$ for every x in $(0,1)$.

I shall now show that under certain conditions the unique equilibrium profit levels are the ones that result from the equilibrium described in the previous theorem. Denote by $L(x)$ the function $E(t|t\geq x) - E(t|t\leq x)$. Clearly $L(0) = E(t)$, $L(1) = 1-E(t)$.

Theorem 2: Suppose $E(t) < 1/2$. Suppose further that the equation $L(x) \geq E(t)$ for all x in $[0,1]$. Then the unique equilibrium profit level for the intermediary is $E(t)$: the intermediary extracts all the surplus in the market.

Proof: We have shown above that in the subgame induced by the proposed choice of price and disclosure rule there are multiple equilibria. Therefore the proof must involve showing that for every pair (P,D) which is different from the proposed one, the intermediary can, by choosing an alternative pair, induce a subgame in which all equilibria yield higher profits.

Let the disclosure rule be described as follows: if the seller is type 1, he is revealed with probability q and nothing is revealed with probability $1 - q$ with $q > 2E(t)$ (this is possible because of the assumption that $E(t) < 1/2$).[6] For all other types, t is revealed with probability δ and nothing is revealed with probability $1 - \delta$, where δ is very small. Let $P = E(t) - \varepsilon$. Let $w(N)$, $w(Y,NR)$ and

[6] By nothing being revealed I mean that for all types the disclosure rule specifies the same report (say, 5) so that no 'hard' information is revealed. In equilibrium of course some information may end up being revealed by the equilibrium actions of different types, but such information is not delivered by the intermediary.

$w(Y,R(t))$ be the offers made to the seller if he does not go to the intermediary, if he goes and nothing is revealed and if he goes and his type is revealed respectively. clearly in equilibrium $w(Y,R(t)) = t$. The objective is to prove that, for a choice of δ and ε sufficiently small, all types will go to the intermediary in any equilibrium of the subgame induced by this choice of (P,D). This is done in a number of steps.

Step 1): Because types are revealed with probability δ, if type x weakly prefers to go to the intermediary, types $t > x$ strictly prefer to do so. Therefore the set of types going to the intermediary is an interval $(x,1]$ or $[x,1]$.

Step 2): I shall now prove that in the subgame following the described (P,D) pair, it is not an equilibrium for no type of the seller to go to the intermediary, i.e. that the interval of types going to the intermediary is nonempty. Because of step 1 the maximum $w(N)$ can be in equilibrium is $E(t)$ (when no type goes to the intermediary). Moreover, the minimum type 1 can get by going to the intermediary is $q - (E(t) - \varepsilon) > E(t) \geq w(N)$ by the assumption on q.

Step 3): Let us now show that it is impossible for type 1 to be the only type to go to the intermediary. If 1 were the only type to go to the intermediary, beliefs would have to be that, following no revelation, the seller who went to the intermediary is type 1. But then all types would want to go to the intermediary since $(1-\delta) - P > E(t)$.

Step 4): Now, suppose x solves the following equation: $(\delta)x + (1-\delta)E(t|t\geq x) - (E(t)-\varepsilon) = E(t|t\leq x)$. (If $\varepsilon=\delta E(t)$, 0 solves the equation). For any x solving this equation, it is an equilibrium of the subgame for all types above x to go to the intermediary and for all types below x not to go. To see this, simply choose $w(N) = E(t|t\leq x)$ and $w(Y,NR) = E(t|t\geq x)$.

Step 5): I now want to show that for appropriate δ and ε all types will go to the intermediary in any equilibrium of the subgame. This is true if $\delta t + (1-\delta)E(t|t\geq x) - E(t) + \varepsilon > E(t|t\leq x)$ for all x in $(0,1]$ because then it cannot be an equilibrium for types below x not to go to the intermediary. We can rewrite this as (*): $E(t|t\geq x) - E(t|t\leq x) + [\varepsilon - \delta(E(t|t\geq x)-x)] > E(t)$. But by assumption, $E(t|t\geq x) - E(t|t\leq x) \equiv L(x) \geq E(t)$ for all x in $[0,1]$. Since we can choose $\varepsilon > \delta[E(t|t\geq x)-x]$ for all x, this implies that (*) is satisfied for δ small enough. We can thus conclude that in all equilibria of the subgame all types (except, possibly 0) go to the intermediary.

This implies that the intermediary can choose δ and ε so that its expected profits are equal to $E(t) - \varepsilon$. But for all these choices, there exists another choice of ε and δ that increases the intermediary's profits. The only outcome that cannot be improved upon is the one in which the intermediary makes a profit of E(t).

Remark: Despite the uniqueness of profit levels for the intermediary, there is a huge multiplicity of equilibria because a profit level of E(t) can be supported by a wide variety of disclosure rules as long as the measure of types that are partially or completely revealed have zero measure. However these disclosure rules differ very little precisely because the set of types over which they differ has to be measure zero. This also implies that this multiplicity would disappear if there were finitely many types.

The condition that $E(t) < 1/2$ is necessary in the theorem. Indeed, if $E(t) > 1/2$ there is a large number of equilibria. This is the subject of the next theorem.

Theorem 3: Suppose $E(t) > 1/2$, then for any Π such that $1-E(t) \leq \Pi \leq E(t)$, there is an equilibrium in which the intermediary makes profits of Π. If in addition $L(x) = E(t|t\geq x) - E(t|t\leq x) \geq 1-E(t)$ for all x in [0,1], then these are the only profit levels that can be part of an equilibrium.

Proof: Let $P \in [1-E(t),E(t)]$. Then, for any choice of disclosure rule there is an equilibrium of the subgame in which no type of the seller goes to the intermediary. In order to see this, suppose no type of the seller is going to the intermediary and therefore $w(N) = E(t)$ where w(N) denotes the offers made to the seller if he does not go to the intermediary. For any disclosure rule, the highest possible offers to the seller if he goes to the intermediary are offers of 1. But for the P's under consideration, $1 - P \leq E(t)$. It is therefore part of an equilibrium of the subgame to have no type of the seller going to the intermediary following such a P. On the other hand following a policy of no disclosure and any prices in this range, it is also an equilibrium of the subgame for all types to go to the intermediary. (set $w(N) = 0$ based on beliefs that the seller is type 0 if he does not go to the intermediary).

I can now show how to construct an equilibrium of the game that yields the desired profits to the intermediary. Given $\Pi \in [1-E(t),E(t)]$, set $P=\Pi$ and D = no disclosure. Following this (P,D) pair choose the equilibrium of the subgame in which all types go to the intermediary. This results in profits of P for the intermediary. It is clearly impossible to increase profits by lowering P. For any higher prices and any different disclosure rule choose the equilibrium of the subgame in which no type goes to the intermediary. It is clear that with this construction, the intermediary has no incentive to change its proposed strategy.

Let us now show that there are no other profit levels that can be part of an equilibrium. It is clear that there are no equilibrium profits higher than E(t). Suppose then that $L(x) = E(t|t \geq x) - E(t|t \leq x)$ is decreasing in x. I shall show that this additional assumption implies that the lowest equilibrium profits are 1-E(t). It is possible to use the construction of the proof of theorem 2 to show that for any (P,D) pair that yield the intermediary profits below 1-E(t), there exists a disclosure policy and a price level which yield it strictly higher profits. Because L(x) is decreasing in x, and $L(1) = 1-E(t)$, the equation $E(t|t \leq x) - E(t|t \geq x) = 1-E(t) - \zeta$ has no solution for any positive ζ. In the notation of the proof of theorem 2, we can set $P = 1-E(t)-\varepsilon$ and $q > 1-\varepsilon$. The assumption of nonexistence of a solution to the previous equation implies that in the subgame following this price and this disclosure rule the unique equilibrium involves all types going to the intermediary. The rest of the proof follows the lines of the proof of theorem 2.

Discussion:

I shall now briefly discuss the results of this section.

Theorem 1 shows the existence of an equilibrium in which the intermediary extracts all the rents in the market and plays a purely parasitic role not adding anything by its presence. In some sense this result does not shed very much light on the role of a certification intermediary because, as the proof shows, the ability of the intermediary to test privately informed agents plays no role. However the result may be interesting because it points to the possibility that in markets resembling the framework of this model sellers might be compelled to undertake wasteful activities simply because otherwise buyers could be sceptical of the quality of the goods for sale. Indeed there is another way for the intermediary to extract all the rent in the market: this involves setting up a continuum of tests, one for each type t, and charging t for the administration of the t test. With full revelation (or no revelation) of test results and beliefs of the buyers that stipulate that someone who takes none of the tests is the worst type, it is an equilibrium for all types to take the test designed for them. In this equilibrium the intermediary makes profits of E(t) once again. From the point of view of the intermediary however, this instrument is not very satisfactory: the problem is that using a continuum of tests for screening types is too inflexible to assure the intermediary profits close to the maximum. There is no way to alter the menu a little bit to guarantee that the unique equilibrium of the subgame involves all types taking his test.

This instead is the surprising content of theorem 2. This result shows that purely by manipulating the process of information revelation the intermediary can guarantee itself all the surplus in the market.

Section 3 Oligopoly Intermediaries, Reservation Value Independent of Type.

Let us now consider the implications of allowing many intermediaries to compete for the privilege of certifying the seller.

There are a number of extensive forms I could consider. I shall focus on the case in which the intermediaries choose everything simultaneously. However this assumption is not really important, any distribution of profits between intermediaries that can be obtained when intermediaries move simultaneously can be obtained if they move sequentially.

Suppose that there are N intermediaries. The extensive form is the obvious adaptation of the one in the previous section. A strategy for the seller is now a function that maps an N-tuple of fees and disclosure rules into {0, 1, ..., N} i.e. a decision of which intermediary to go to and whether to go to any one at all. A strategy for a buyer now maps observables into bids. The observables are the fees and disclosure rules set by the N intermediaries, which intermediary the seller went to if any and all the information that is revealed by the intermediary i.e. the realization of the disclosure rule.

The first result shows that it may make a big difference if there is one or several intermediaries in the market.

Theorem 4: For all N there is a set of equilibria in which all information is revealed: at least two intermediaries set fees of zero and fully disclose test results, any allocation of types between the two intermediaries is part of an equilibrium.

Proof: Suppose intermediary 1 sets a fee of zero and full disclosure. Whatever the policy of other intermediaries, this sets up a situation in which the seller can, at zero cost make a credible statement about his type. We are therefore in the world of Proposition 1. This implies that the unique sequential equilibrium outcome in all subgames following this policy by intermediary 1 involves full information revelation. Therefore other intermediaries can expect zero demand at any positive fee. This in turn implies that a best response by intermediary 2 is to set a fee of zero and full disclosure. A symmetric analysis for intermediary 1 shows that it is part of an equilibrium for both intermediaries to follow the suggested policy. Given these policies by the intermediaries, it is clear that buyers' beliefs are unaffected by which intermediary the seller went to. Therefore the seller's payoffs are unaffected as well and the allocation of types to intermediaries is arbitrary.

Remark: The previous theorem implies that it is always possible to sustain monopoly as an equilibrium market structure if there are any positive entry costs and the entry process is sequential. In order to see this simply assume that, if any intermediary enters the market after the first has entered, the equilibrium just described in the previous theorem is expected to prevail.

Let Π_{Max} and Π_{Min} be the maximum and minimum equilibrium monopoly profits respectively. Clearly, by theorem 1 $\Pi_{Max} = E(t)$ and under the conditions of theorem 3, $\Pi_{Min} = 1\text{-}E(t)$. The following theorem discusses the circumstances under which the presence of several intermediaries does not change the existence of no disclosure equilibria.

Theorem 5: For any integer N such that $\Pi_{Max} \geq (N)\ \Pi_{Min}$, there exist equilibria in which N oligopolistic intermediaries would choose a policy of no disclosure and all make profits of at least Π_{Min}.

Proof: Let all oligopolists choose a policy of no disclosure. Now choose an n-tuple of prices $(P_1, ..., P_N)$ and a partition of the set of types, [0,1] into measurable sets $(T_1, ..., T_N)$ such that: $E(t|t \in T_i) - P_i = E(t|t \in T_j) - P_j \geq 0$ for all $i \neq j$ and $Pr(T_i)\, P_i \geq \Pi_{Min}$. I claim that these choices of prices and disclosure rules by the intermediaries is part of a sequential equilibrium.

Let the set of types T_i go to intermediary i and offers by the buyers be w(i) $= E(t|t \in T_i)$ if the seller goes to intermediary i and w(N) = 0 if the seller does not go to any intermediary. The choice of consistent beliefs for the buyers associated with these offers is obvious. With these offers all types of the seller are indifferent between the different intermediaries and weakly prefer going to one intermediary to going to none. Thus we see that this forms an equilibrium of the subgame following the above proposed choices by the intermediaries.

I must now show that the choices by the intermediaries are sequentially rational. Following these choices, select the equilibrium of the subgame that was just described. Because $Pr(T_i)\, P_i \geq \Pi_{Min}$, every intermediary is making at least the minimum monopoly profit in the market. We can then deter any deviation in the following manner: Suppose intermediary j deviates to any other price disclosure rule pair (P*,D*). Let beliefs following the deviation be that if the seller goes to any intermediary $i \neq j$ he is the worst type. Set offers w(j),w(N) and beliefs if the seller goes to intermediary j or to no intermediary be the same as those following a deviation by a monopolist to the (P*,D*) pair that sustain Π_{Min} as equilibrium monopoly profits.[7] This is possible because $P_j^* > \Pi_{Min}$ is necessary for higher profits. This implies that intermediary j does not want to deviate proving that the proposed construction is indeed a sequential equilibrium.

Remarks:

a) Under the assumptions of theorem 3, we see that it is possible to sustain no disclosure equilibria as long as $E(t) \geq N(1-E(t))$. This implies that for every N there are distributions such that it is possible to support no disclosure equilibria: we must simply choose E(t) very close to 1.

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[7]For example, if, as in theorem 3, E(t) > 1/2 and the minimum monopoly profits are 1-E(t), we can select the equilibrium of the subgame in which following any price higher than 1-E(t) no type goes to the intermediary.

b) Although intermediaries choose a policy of no disclosure, there are equilibria in the class described in the proof of the theorem in which some information ends up being revealed by the equilibrium actions of the different types of the seller. Indeed, it is clear from the proof that it is possible to partition the set of types so that $E(t|t\in T_i) > E(t|t\in T_j)$ for some i and j. In such a case to preserve indifference of the different types of the seller we need $P_i > P_j$. This seems to represent a real feature in some of the markets we are discussing. For example the differential in expected quality of students graduating from different universities seems to be too large to be explained solely on the basis of the hard information that is revealed.

The next result shows that for a fixed distribution of types, in the limit, as the number of intermediaries in the market grows, the outcome must result in full disclosure and zero profits for all intermediaries.

Let $w^N(t)$ denote the offers received by type t when there are N intermediaries in the market and P^N be the minimum price charged by any of the N intermediaries. Let $\mu(T)$ denote Lebesgue measure of set T.

<u>Theorem 6</u>: For a fixed distribution of types F, in any equilibrium, prices go to zero for at least one intermediary and μ $\{t: |t-w^N(t)| \geq \varepsilon\}$ goes to zero for all ε as the number of intermediaries grows to infinity.

<u>Proof</u>: Denote by Π^N the minimum profit made by any intermediary when there are N of them in the market. Since the maximum Π^N can be is E(t)/N, Π^N converges to zero as N goes to infinity.

Suppose that P^N does not converge to zero. Then there exists a δ such that $P^N \geq \delta$ for all N. But in this case the intermediary who is supposed to make Π^N can, for some N high enough, deviate and obtain a profit which is bounded away from zero. This can be done by a policy of full disclosure and a price $P < \delta$.

Suppose now that there is an ε such that μ $\{t: |t-w^N(t)| \geq \varepsilon\}$ does not converge to zero so that it is bounded below by some $\xi > 0$. This implies that in equilibrium also μ $\{t: (t-w(t)) > \varepsilon\}$ is bounded away from zero for this ε. The reason is that otherwise buyers would be losing money on average which is impossible. Once again this implies that the intermediary who is supposed to make Π^N has a profitable deviation for some N high enough. This set of types is willing to pay a positive amount γ independent of N in order to be revealed.

Therefore the intermediary can, by choosing a policy of full disclosure and a price low enough, receive a profit above Π^N for N sufficiently high.

Section 4: Reservation Value Dependent of Type.

In the previous sections, it was assumed that, regardless of his type, the seller's value from keeping the product was zero. In this section I shall discuss the case in which this value is type dependent. Most of the discussion will be conducted under the assumption that a seller of type t has reservation value t and is valued by the buyer $\alpha + t$, $\alpha > 0$ The seller's strategy now includes the possibility that he will choose not to sell to a buyer. A buyer now has to take into account this possibility when making offers. All other assumptions and notation are the same as in the previous sections.

Market Interactions with no Intermediary.

If the seller can make credible perfectly precise statements about his type, nothing changes from the analysis of section 1. Full information revelation is the unique equilibrium outcome.

When the seller cannot make statements of any kind, the analysis is a little more complicated than in the first section because the fact that he is not willing to trade at a particular price is a signal about his type. This is a version of a model of bargaining with common values. The fact that the seller accepts to trade is a bad signal to the buyer. In equilibrium, if trade takes place with positive probability, there must exist a type x(b) such that all types below x(b) accept bids of b and all types above x(b) reject such bids. This clearly implies that $b = x(b)$ Therefore, for an equilibrium, we must have that the following condition is satisfied:

(*) $\qquad x(b) = E(t|t < x(b)) + \alpha$

And that all types below x(b) be willing to trade. If $E(t) + \alpha > 1$, (*) can be satisfied by $x(b) = 1$. Therefore, if α is large enough, it is possible for all types to trade. Otherwise the maximal amount of trade that can take place is defined by the highest x(b) such that (*) is satisfied.

For example, in the case of a uniform distribution, if $\alpha > 1/2$, all types of the seller will trade at a price of $E(t) + \alpha$. If $0 < \alpha < 1/2$, only types between 0 and 2α will trade at a price of 2α. For $\alpha = 0$, of course, no trade will take place.

Notice that, compared to the analysis of the first sections, there are two extra elements. First, even without the intermediary some information is revealed. Second, whereas in the first sections the only impact of the private information was redistributive (high types got less than their value, low types got more), here there is an allocative impact as well. Indeed, when the probability of trade is less than one, with positive probability the good remains in the hand of the seller who values it less than a buyer.

Market Interactions with One Intermediary.

Let us now consider the role of the intermediary in this market. We shall see that, in general, a policy of no disclosure is no longer part of an equilibrium. The reason for this is that the highest types would then choose not to come to the intermediary thereby lowering the amount lower types would be willing to pay to obtain "certification".

In order to find an equilibrium for the game, we shall use the same approach as in theorem 1: find the maximum surplus that can possibly be extracted by the intermediary and then look for a disclosure rule and a price that yield this profit to the intermediary in an equilibrium of the subgame. Because the surplus α is generated by trade, the minimum possible offer that can be made in equilibrium to the seller is α regardless of beliefs. Therefore types close to zero will certainly trade which implies that the intermediary cannot fully extract their surplus contrary to what happened in section 2. Indeed, types in $[0,\alpha]$ must therefore receive minimum payments of α net of any fee paid to the intermediary. The minimum net payment types t in $(\alpha,1]$ can receive is t for otherwise they would prefer not to trade. Buyers of course are willing to pay $t + \alpha$ for a type t. This implies that the maximum profit the intermediary can possibly make in the market is $\Pi(\alpha) = \int_0^{\alpha} t\,dt + (1-F(\alpha))\alpha = F(\alpha)E(t|t\leq\alpha) + (1-F(\alpha))\alpha$. The following theorem shows that there is an equilibrium in which the intermediary makes this profit.

Theorem 7 : There is an equilibrium in which the intermediary sets a price $P = F(\alpha)E(t|t\leq\alpha) + (1-F(\alpha))\alpha$ and the following disclosure rule: if the intermediary sees type $x \in (\alpha,1]$ it reports $J(x)$.[8] If the intermediary sees any type $y \in [0,\alpha]$ it reports the constant $E(t|t\leq\alpha)$ with probability θ and with probability $(1-\theta)$ it reports $J(x)$ according to the density $h(x)$ where:

$$\theta = 1 - \int_a^1 \frac{[a - E(t|t \leq a)]f(x)}{[x - aF(a) - (1 - F(a)E(t|t \leq a)} dx$$

$$h(x) = \frac{1/(1-\theta)[a - E(t|t \leq a]f(x)}{[x - aF(a) - (1 - F(a))E(t|t \leq a)]}$$

In the subgame following this announcement of price and disclosure rule all types of the seller go to the intermediary.

Proof: Given the price and the specified disclosure rule, if the buyers observe $E(t|t\leq\alpha)$ they will offer $w(E(t|t\leq\alpha)) = E(t|t\leq\alpha) + \alpha$; if they observe $J(x)$ they will offer $w(J(x)) = x + F(\alpha)E(t|t\leq\alpha) + (1-F(\alpha))\alpha = x + P$. The reason for the first offer is obvious. The reason for $J(x)$ follows from the fact that by Bayes' rule, upon observing $J(x)$, buyers are facing type x with probability $q(x) = \Pr(J(x)|x)f(x)/[\Pr(J(x)|x)f(x)+\Pr(J(x)|t\in[0,\alpha])F(\alpha)] = f(x)/[f(x)+(1-\theta)h(x)F(\alpha)] = 1-F(\alpha)[(\alpha-E(t|t\leq\alpha))/(x-E(t|t\leq\alpha)]$ and are facing some type in $[0,\alpha]$ with probability $1-q(x)$. With these beliefs, the expectation of the value to the buyer conditional on $J(x)$ are precisely $x+P$.

Set beliefs if the seller does not go to the intermediary that he is type 0. This implies that a seller of type $x > \alpha$ is willing to go to the intermediary rather than not trading, or trading without going to the intermediary thereby receiving offers of α.

It remains to show that types in $[0,\alpha]$ are willing to go. These types receive offers of $E(t|t\leq\alpha)+\alpha$ with probability θ and with probability $(1-\theta)$ they receive $x+P$ with density $h(x)$. Taking the expectation we see that this comes out exactly to $\alpha+P$. Therefore these types are also willing to go to the intermediary. This concludes the proof.

[8] $J(x)$ should be different for different x's, one possibility is $J(x) = x + P$

Section 5: Alternative Extensive Forms

The buyer pays the intermediary

I shall now discuss what happens if we consider different extensive forms from the one analyzed in section 2. In particular, I shall first consider the effect of assuming that the buyers pay for the intermediary's service instead of the seller. This means that the buyers pay for information about the quality of the product. The extensive form is as follows.

Stage 1: The intermediary chooses a pair of disclosure rules (D_1, D_2). These are the same objects as in section 2. D_1 represents the information that is revealed publicly to both buyers, D_2 the information that is revealed privately to only one of them.

At the end of stage 1 nature chooses the type of the seller.

Stage 2: The seller chooses whether to go to the intermediary having observed the disclosure rule and knowing his type.

Stage 3: If the seller went to the intermediary testing takes place and the type is revealed to the intermediary.

Stage 4: Buyers bid for the information that the intermediary is willing to reveal according to the disclosure rules. One of the two wins and obtains the information.

Stage 5: Buyers bid for the seller's product according to a sealed bid auction.

Discussion:

If the two buyers have the same information, we already know that they will both bid the conditional expectation given that information. This means that neither buyer is willing to pay anything for the information if this information is also available to the other buyer. The only reason to bid any positive amount in stage 4 is to have an informational advantage in stage 5. Indeed, if only one buyer buys the information, if the intermediary's revelations are informative and the seller went to the intermediary, stage 5 is an asymmetric information auction. Because at stage 4 buyers are equally uninformed, the intermediary will capture all the informational rents available to the buyer who wins in stage 4. The intermediary therefore wishes to maximize these rents. The theorem below shows that, in contrast with section 2, the policy that maximizes the intermediary's profit involves full disclosure. First however we state a lemma that says that the better the information available to the informed buyer, the higher his equilibrium profits.

Lemma: Let A and B be two asymmetrically informed bidders in a sealed bid auction for a good that has the same (possibly unknown) value to both. If A's information is known to B than A's profits from the auction are zero. B's profits are increasing with the accuracy of his (private) information and, if we let $H = E(t|D_2)$ where D_2 is a random variable denoting the information privately available to the informed buyer and we let G be the distribution of H, then the profits of the informed buyer are $\int(1-G(h))G(h)dh$.

Proof: This is a summary of a number of results in Milgrom and Weber (1982) and Englebrecht-Wiggans et al. (1983).

Theorem 8: The highest equilibrium profits in this game are obtained by the intermediary by choosing D1 = no disclosure, D2 = full disclosure. In this equilibrium all types of the seller go to the intermediary and the expected profits to the intermediary are $\Pi^* = \int_0^1 (1-F(t))F(t)dt$.

Proof: The intermediary can capture in the bidding at stage 4 all the difference between the informed and uninformed bidder's profits. Roughly speaking therefore the intermediary wants to maximize the informational advantage of the informed buyer so as to maximize his informational rents.

Let beliefs be that the seller is the worst type if he does not go to the intermediary. In equilibrium, all types of the seller receive positive expected bids in the subgame following full disclosure.[9] Therefore they are all willing to go to the intermediary. Clearly this is the situation in which the difference in the information between the informed and uninformed bidders is maximal since the uninformed bidder knows nothing more than at the beginning of the game (his posterior is just equal to the prior F()) whereas the informed

[9]This is true also of the worst type of the seller. The reason is that the uninformed buyer sometimes wins and, having no information, bids positive amounts also for the worst type of the seller. A full description of the equilibrium bids can be found in Milgrom and Weber (1982).

bidder knows everything of relevance, the type t of the seller. The lemma then implies that in the bidding subgame the uninformed bidder's profits are zero and the informed bidder's profits are Π^*. The intermediary extracts these profits at stage 4. Any different disclosure rule, for example a rule that reveals something publicly and that therefore increases the quality of the uninformed bidder's information, can only decrease the informed bidder's profits and therefore the intermediary's as well.

Corollary: The maximum profit level Π^* which can be obtained in this game are less than the minimum equilibrium monopoly profits in the case in which the seller pays for the information namely (1-E(t)) for E(t) > 1/2 and E(t) for E(t) ≤ 1/2.[10]

Proof: Just note that $\Pi^* < \mathrm{Min}\{\int F(t)dt, \int (1-F(t))dt\} = \mathrm{Min}\{1\text{-}E(t), E(t)\}$.

Remarks:

The result of the theorem is in stark contrast with the results of section 2. In order to understand the reason for this difference it may be useful to discuss an example. Suppose F is uniform. Then the equilibrium of the bidding subgame is the following: The informed bidder bids t/2 for a seller of type t, the uninformed bidder bids according to a mixed strategy which is uniform on [0,1/2]. The profits of the informed bidder and therefore of the intermediary are 1/6. These profits are clearly less than 1/2 which were the unique equilibrium profit levels for the case discussed in section 2. This result is much more general however as shown in the corollary. The intuition for this result comes from the fact that in this game the intermediary has to rely on the informed buyer's informational rents to extract the seller's surplus. But these rents cannot come close to extracting the full surplus because the uninformed buyer does provide some competition which leaves some surplus to the seller. Moreover this competition is more severe the higher E(t), i.e. the more likely it is that the seller is a high type.

Another interesting comparison can be made by noticing that in the case of the uniform, profits were shown to be 1/8 in the discussion following proposition 2 when the monopolist was restricted to a policy of full disclosure.

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10 This is under the assumptions of theorems 2 and 3.

We have just shown that instead profits are 1/6 in the setting of this section. Therefore profits are higher in the game discussed in this section even if the monopolist adopts the same disclosure policy. This may be surprising: one might think that, given that the intermediary chooses the same disclosure policy, the fact that it is forced to obtain its profit through the informational rents of the informed buyer ought to push profits below what he can obtain by charging directly for its services as it did in section 2. The reason for this is that in section 2 we did not allow the intermediary to charge different prices to different types, the fee was fixed at P for all types. In this section instead, although the seller pays nothing directly, he pays something indirectly by receiving bids below t. This indirect payment is higher for higher types.

The intermediary buys the seller's product

I shall now consider the case in which the intermediary buys the product directly from the seller instead of selling the testing service. The intermediary then resells the product to the buyers. Let us first consider an extensive form which is a direct adaptation of the one in section 2. The intermediary first announces a disclosure rule and a price P at which it will buy the product from the seller. Then the seller decides whether to sell to the intermediary or wait to sell directly to the buyers. Buyers then bid simultaneously for the product. If the disclosure rule is credible, in the sense that the buyer can commit to a disclosure rule, this game has equilibria that are similar to the one discussed in section 2. For example, there is an equilibrium in which the intermediary sets $P = 0$, D = no disclosure, all types of the seller sell the product to the intermediary, buyers bid $E(t)$ to the intermediary and 0 to the seller. Therefore it is again possible for the intermediary to extract all the surplus. However in section 2 it was possible to prove that such an outcome was the unique equilibrium for some distributions. In section 2 changing the disclosure rule changed the payoff to the seller both if he went to the intermediary and if he did not go. Therefore the intermediary could alter the disclosure rule to exploit this fact. Such a result is not possible in this case. In order to see this, notice that the disclosure rule does not affect what the seller makes when he sells to the intermediary: all types receive P. This implies that there is also an equilibrium of this game in which the intermediary makes zero profits. The proof of this is simple. First notice that it clearly is not an equilibrium for the intermediary to offer a price $P > E(t)$. next note that, for any disclosure rule and any price $P \leq E(t)$, there is an equilibrium of the subgame in which no type of the seller sells to the intermediary, and they receive offers of $E(t)$ from the buyers. This implies that there is an equilibrium for the whole game in which the intermediary makes zero profits.

It is now easy to show that any profit level between 0 and $E(t)$ can be an equilibrium of the game: For a price P in $(0,E(t))$, suppose that if the seller does not sell to the intermediary he is the worst type. Thus all types sell to the intermediary which makes profits of P. Now suppose the intermediary deviates to any higher P and punish this deviation by selecting the equilibrium of the subgame in which no type goes to the intermediary. Let us summarize the previous discussion in the following theorem.

Theorem 9: In the game in which the disclosure announcement is credible and the intermediary offers a price to the seller to buy the product, any profit level between 0 and $E(t)$ is an equilibrium.

This result suggests that the intermediary is totally at the mercy of buyers beliefs, if they decide to think bad things of the seller who did not sell to the intermediary, the latter makes high profits otherwise it does not. Again this stands in sharp contrast to the analysis of section 2 in which the intermediary was able to guarantee itself a sizable profit.

In the previous analysis there is also an indeterminacy about the disclosure rule: all of the previously discussed profit levels are independent of the disclosure rule the intermediary announces. This indeterminacy disappears if the disclosure is verifiable but the intermediary cannot commit itself to a disclosure policy. In this case an announcement of a disclosure rule different from full disclosure is not credible. The reason is obvious: If the intermediary finds out that the product it has bought is of high quality, it has an ex-post incentive to reveal this fact. Indeed, the usual revelation argument from section 1 implies that full disclosure must take place in equilibrium.

Conclusions

In this paper I have discussed some of the issues that arise when we consider the possibility of certification intermediaries intervening in the market attracted by the profit opportunities created by the existing informational asymmetries between agents. After briefly restating and adapting some results from the disclosure literature in section 1, the next three sections were concerned with an analysis of the case in which the seller pays the intermediary to be certified and the latter chooses how much to reveal to buyers. Under one assumption on the nature of the good being traded, I have shown that under certain circumstances a monopoly intermediary can appropriate the whole surplus in the market and that, more generally, its role is purely parasitic since its presence does not change in any way the asymmetry of information but it still manages to capture a substantial surplus. I have then shown that if there are several intermediaries, there exist equilibria in which the informational problem disappears because full revelation results and the intermediaries get none of the surplus. However, for any finite number of intermediaries there are always distributions for which the monopoly case is replicated. For any fixed distributions in the limit this cannot happen and full revelation occurs. However, for any positive costs of entry there are still "fully collusive" equilibria. In section 4 a different assumption on the nature of the good was made and the maximum profit equilibrium for the monopolist was characterized. Partial revelation occurs in this equilibrium and the allocational problem is "solved". However serious informational asymmetries remain and the monopolist still captures a sizable amount of the surplus: all agents are worse off in the presence of the intermediary then they would be without it. In section 5 I discussed the effects of considering alternative market organizations. In particular the case in which buyers pay for the information that the intermediary decides to provide and the case in which the intermediary buys the good and then resells it are analyzed. Both cases provide striking contrasts to the case of section 2 and to each other. The role of information disclosure turns out to be entirely different under these seemingly minor modifications.

Some extensions of the analysis of this paper readily come to mind. One involves a discussion of an oligopolistic industry in the cases of sections 4 and 5. Another involves making different assumptions about the nature of the good to be traded, and therefore indirectly, about the value to the buyers of information about the good to be traded. In this paper, knowledge of the quality of the good was only useful to the buyers in deciding their bidding strategies. In other contexts, the information might be useful also in allocating resources appropriately, for example in allocating workers to tasks when different types of workers ought to be assigned to different tasks. More revelation is to be expected in these cases.

Another important issue that was not considered is the possibility that the informed agent may manipulate test results. One example is studying activity by students. Another is the preparation of misleading income statements by firms. In this setting the results of section 2 can easily be replicated. However other results, particularly oligopoly results, are much harder to obtain. The reason is that, instead of simply taking a participation decision (whether to go to an intermediary and which one to go to), the informed agent also has to decide how much effort to exert in manipulating information as a function of equilibrium strategies of all other types. This introduces strategic interactions of a higher dimensionality and complicates the analysis considerably.

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