The Demand for Tests

Thomas Liebi*

University of Bern

May 2003

Abstract

Many consumption goods have inherent attributes that are unknown to both consumers and producers of the good. This is reflected for example by the current discussion about potential harms of food products containing genetically modified organisms. The underlying paper analyzes consumers' demand for product tests in a surrounding of symmetric but imperfect information. It is shown that the demand for information of existing customers is higher than that of potential new ones. In addition, the introduction of an information market unambiguously lowers the product price. This is true, even though expected positive or negative quality news is symmetric in terms of monetary valuation.

Keywords: tests, imperfect quality information, product quality.

JEL-Classifications: L15, D82, D11

*Universität Bern, Volkswirtschaftliches Institut, Abteilung für Wirtschaftstheorie, Gesellschaftsstrasse 49, CH-3012 Bern, Switzerland, thomas.liebi@vwi.unibe.ch, http://www.vwi.unibe.ch/staff/liebi/. I thank Winand Emons for helpful discussions.

1 Introduction

Consumers did not have a quiet time recently. Shortly after antibiotic-laden meat has been detected, they learned that their well-beloved potato chips and Corn-Flakes contain up to a hundred times the allowed amount of Acrylamid, a carcinogenic substance. Even consumers of organically produced goods are not protected from bad news as these. In a recent case in Switzerland, a whole load of organic corn, which does not allow more than three percent of genetically modified organisms (GMO), had to be removed from the shelves after a higher share of these GMO has been discovered by Greenpeace. And the whole branch of producers of organic meat in Germany fears for its reputation - and the premium prices based on it - after above-critical-value amounts of nitrofen, another carcinogenic substance, have been detected in organic poultry. Fortunately, sometimes the news is good. Think about how good wine consumers might feel after it has been detected that red wine probably decreases the risk of getting Alzheimer's disease. Or consider aspirin which does not only ease a headache but has also the property of decreasing the risk of a heart attack as was found out much later. Fact is that consumers happen to receive news about the quality of some products they consume - be it good or bad. And often, not even the producers of these goods were aware of those quality attributes in advance. This is the basic idea of the underlying paper.

We want to analyze a situation where consumers are only imperfectly informed about the quality of the product they consume. Much has been written about imperfectly informed consumers and quality signals. In many cases, unobservable quality is signalled by means of prices whereas this is not necessarily true, as is shown for example by Jones and Hudson [1994]. Wolinsky [1983] finds an equilibrium where prices exactly signal quality in a competitive surrounding. Cooper and Ross [1985] analyze a producer monopoly where prices partly convey information about quality. In both models some consumers receive costless information which is transmitted to the initially uniformed via the firm's optimizing behavior, the price mechanism respectively. Riordan [1986] states that with repeated purchases - and the fact that firms can commit to future prices - prices again perfectly signal quality. This is due to a firm's incentive to provide higher quality in order to retain repeat purchases. In a similar context lies the analysis of high quality sustainment with monitoring in a dynamic context by Liebi [2002].

Bester and Ritzberger [1998] present a model where consumers can buy information about a product's unobservable quality like in the underlying paper. They find a mixed-strategy equilibrium with information-revealing prices. Since information is costly, no pure-strategy equilibrium exists due to the Grossman-Stiglitz [1980] paradox. It states that if prices are perfectly informative no one would spend money to become informed. But if no one gets informed, prices cannot be informative. In this case, it is worthwhile buying information, prices will convey information and we are back where we started.

To concentrate on consumers' information gathering decision when information is costly, we impose exogenous quality and quality shocks. We therefore analyze quality attributes that cannot be predicted even by the producer, like in the examples given above. One of the most popular recent examples is the GMO content in food products. Even if producers know about GMO in their products, nobody is really able to predict wether GMO in food is a harm or a benefit for consumers. This may only be found out after several years of research. In the future, producers and consumers may be surprised about both positive or negative news. By imposing symmetric information between producers and consumers, we not only abstract from producers' moral hazard concerning quality, but also prices are completely uninformative with respect to quality and the only way for consumers to become informed about a product's true quality is by purchasing information from a third party. This could be a consumer organization selling test results, a newspaper or other media selling news to the public etc. In our framework quality information is private, i.e., only those consumers who buy the test know about the true quality.[1] One may think of magazines and consumer reports that have to be bought to obtain the desired information. Another frequent example are Internet sites where only paying customers get access to the test results.

We will observe a separation of consumers into several groups. Some will prefer to remain uninformed, others will buy the test. Given expected quality and no information market, there is always a group of consumers who either should have bought the product and did not or vice versa. Clearly, a market for test results decreases this kind of inefficiency by diminishing the number of uninformed consumers.

Some consumers buy the test since they already buy the product and may fear a quality loss. Others are interested in information since they would buy the product if quality increased. Although the possible quality shock is symmetric in terms of monetary valuation, information demand of these two consumer groups is not. Interestingly, the demand for information is larger for the group of consumers that used to buy the product given the level of quality up to now. This group reacts sensitively to negative news, since this might lead to their valuation of the product being lower than the price

[1] Alternatively, we can define one period in the analysis to last as long as it takes for this private information to become public, e.g., by word-of-mouth recommendation.

they have to pay. This higher demand may be a reason for the observation that the media and consumer organizations seem to put more weight on publishing bad news than good ones. This happens, although potential new buyers of the product are willing to pay a price for information, too, given the possibility that their valuation for the product increases above the product price.

2 The Model

2.1 Setup

Consumers: Consumers value the product given a valuation function $v(q, \theta) = q\theta$. $q > 0$ represents the product quality given all the information up to the considered period, for example due to product tests in the last period that were made public to all potential consumers. Since we want to analyze the impact of good or bad news on consumer behavior, we assume that this quality underlies changes unobservable to consumers. To keep the model simple, we assume that true quality is either $q + \epsilon$, representing good news, or $q - \epsilon$ in the opposite case, with $\epsilon < q$.

A consumer's type is represented by θ, uniformly distributed on $[0, 1]$. We assume that all consumers have a higher valuation for higher quality given their type, but might value the same quality differently.[2] Consumers buy one unit of the product if their valuation exceeds the price of the good, represented by p_g.

Production sector: The good is produced by a monopolist. To concentrate the analysis on the process of information gathering, we assume that

[2]This is why θ is sometimes called a taste parameter.

quality cannot be influenced by the producer. Quality and possible quality shocks are exogenous. This may represent discovering harmful substances that were previously unknown or new positive effects of an already known product. The firm produces the good and decides upon the product price p_g in order to maximize its expected profits. We assume that the producer cannot change the price in the period where the test results are still private information, be it because of time lags in reacting to market events, through self-commitment, for contractual reasons etc.

Suppose that the producer could immediately react to the test results. If it were optimal for him to charge different prices p_g according to whether quality news are good or bad, these prices would (perfectly) signal product quality. Rational consumers could anticipate the producer's optimizing behavior. Given that product prices signal the unknown quality, consumers would have no incentive to pay for information in the first place. But if no one gets informed, prices contain no information at all and consumers will expect quality q, with a single optimal product price for the producer. Given the non-informative price, however, some consumers prefer to buy tests before deciding to buy the product and we are back where we started. Hence, no equilibrium - in pure strategies - exists. This situation is known as the Grossman-Stiglitz-Paradox [1980]. If, as stated above, the producer cannot change prices in the period where quality information is still private, we are able to find an equilibrium where some consumers prefer to be informed while others do not. To save on notation we assume zero marginal cost for production.

Information sector: Finally, there is a producer of information. He is a monopolist performing product tests and selling this information at a price p_i. By testing the product, the testing firm knows for sure the quality of the product. This information is private. Therefore, only consumers who buy the test results will be informed about the true product quality, i.e., if it is $q + \epsilon$ or $q - \epsilon$. We assume marginal costs of the test to be zero. This emphasizes the idea that once information is produced - the testing results are collected - it can be sold to any number of consumers who wish to buy it.

The sequence of events is as follows:

1. The producer sets the product price p_g given (expected) quality q, anticipating that consumers may buy information about its product before they decide to buy the product itself.

2. The testing firm performs product tests and sets the price p_i for every consumer wishing to receive the information.

3. Given p_g, p_i and expected quality q consumers decide whether to buy the information or not.

4. Based on their respective information, consumers will decide whether to buy the product or not.

2.2 Demand Functions

Product Demand

A consumer of type θ buys the product, given expected quality q,[3] if her valuation of the product is at least as high as the price, i.e., if $q\theta \geq p_g$. The

[3] Without further information consumers put equal weight to positive and negative shocks, resulting in an expected quality of q.

marginal consumer's type therefore satisfies $\hat{\theta} = p_g/q$ and demand for the good is represented by the function $D_g(p_g, q) = 1 - \hat{\theta} = 1 - p_g/q$. After a positive or a negative quality shock, if observable, the marginal consumer's type is $\underline{\theta} = p_g/(q+\epsilon)$ or $\overline{\theta} = p_g/(q-\epsilon)$ respectively. Under complete information and given product price p_g, this leads to the demand function

$$D_g(p_g, q, \epsilon) = \begin{cases} 1 - \underline{\theta} = 1 - p_g/(q+\epsilon) & \text{if news is good} \\ 1 - \overline{\theta} = 1 - p_g/(q-\epsilon) & \text{if news is bad} \end{cases}$$

Demand for Information

Given product price p_g we can derive who has an incentive to buy information about the product's true quality. It is easy to see that the potential demand for information consists of all consumers with type $\theta \in [\underline{\theta}, \overline{\theta}]$. Lower type consumers have a valuation of $(q+\epsilon)\theta < (q+\epsilon)\underline{\theta} = p_g$ and will not buy the product even if news is good. On the other hand, if their type exceeds $\overline{\theta}$, consumers' valuation of the product is higher than its price and they will buy the product even if news is bad. In the following, we concentrate on consumers with type $\theta \in [\underline{\theta}, \overline{\theta}]$.

To derive the demand for tests, we separate the consumers into two groups. Consumers with type $\underline{\theta} \leq \theta < \hat{\theta}$ would like to buy the product only if quality is $q+\epsilon$. Net benefit of such a consumer is $(q+\epsilon)\theta - p_g$. Considering the willingness to pay for information, the marginal consumer of information - not to be mixed up with the marginal consumer of the product - has an expected net benefit from buying a test of zero, i.e., $0.5[(q+\epsilon)\underline{\theta}_i - p_g] - p_i = 0$. $\underline{\theta}_i$ represents the type of the marginal consumer of information in the group of consumers who only buy the product if quality news is good. Here, we imposed that the informed consumer only buys the product if news is good, which happens with an ex-ante probability of 0.5. In this group, the marginal consumer of information's type is therefore

$$\underline{\theta}_i = \frac{p_i + 0.5p_g}{0.5(q + \epsilon)}$$

This leads to a demand for tests by potential new buyers of

$$D_i^1 = \hat{\theta} - \underline{\theta}_i = \frac{p_g}{q} - \frac{p_i + 0.5p_g}{0.5(q + \epsilon)} = \frac{0.5p_g\epsilon - p_i q}{0.5q(q + \epsilon)}. \tag{1}$$

This is the demand for tests of consumers who would not buy the product if quality, or expected quality, of the product were q, but who would do so if they knew that quality is $q + \epsilon$. Some of them are willing to pay for information to be sure about the quality of the product and - in case of good news - to buy the product.

On the other hand, consumers with type $\hat{\theta} \leq \theta \leq \overline{\theta}$ buy the product if expected quality is q or higher, but not if it is to $q - \epsilon$. Their benefit from buying a test is $0.5[p_g - \theta(q - \epsilon)] - p_i$ since they may avoid a loss from buying a low quality product giving them a lower benefit than its cost. In the second group, the marginal consumer of information's type therefore is

$$\overline{\theta}_i = \frac{0.5p_g - p_i}{0.5(q - \epsilon)}.$$

This leads to a demand for tests of these consumers of

$$D_i^2 = \overline{\theta}_i - \hat{\theta} = \frac{0.5p_g - p_i}{0.5(q - \epsilon)} - \frac{p_g}{q} = \frac{0.5p_g\epsilon - p_i q}{0.5q(q - \epsilon)}. \tag{2}$$

[INSERT FIGURE 1 ABOUT HERE]

We notice that although the possible quality shocks are symmetric, this is not true for the information demand of the two consumer groups. In fact it is always the case that $D_i^1 < D_i^2$. Thus, consumers who are sensitive to negative news, i.e., those that would buy the product if quality is as expected but not if it is $q - \epsilon$, have a higher demand for information than the other group. This result is stated in proposition 1.

Proposition 1 *Information demand of existing customers who act upon negative news about quality is always larger than information demand of potential new customers who react to positive news.*

In addition we notice that the demand for tests unambiguously increases with the size of the quality shock for both consumer groups.[4] This is intuitively clear, since it represents the fact that the more uncertainty there is, the more valuable it is to get information.

Adding information demand for the two groups we derive the total demand for tests to be

$$D_i = D_i^1 + D_i^2 = \frac{0.5 p_g \epsilon - p_i q}{0.25(q^2 - \epsilon^2)}. \tag{3}$$

As can be seen, the demand for tests increases with the product price. Intuitively, the higher is the product price, the more valuable product information is, since more is at stake for the uniformed consumer. Similarly, D_i increases with the size of the quality shock. The higher is the possible change in quality, the more an uniformed consumer has to lose, either by foregoing the chance to buy a highly valued product or by overpaying the good.[5] Finally, demand for information decreases with the initial quality level, i.e., with expected

[4]Given that the demand for information is positive, i.e., given that $p_g > 2p_i$.

[5]The first statement refers to those consumers who would buy the product if informed about quality, whereas the second refers to consumers who indeed do buy the product but wouldn't do so if informed.

quality q. Given all else equal, especially the size of the quality shock, the relative importance of this shock decreases with an increasing initial quality. This lowers the need for information.

3 Determining the Equilibrium

Let us now derive the equilibrium prices and quantities of information and product.

3.1 Information Sector

The monopolist supplier of tests faces a demand D_i as derived in the last section and has zero marginal costs of producing tests. He therefore maximizes profits given by

$$\pi_i = p_i \left(\frac{0.5 p_g \epsilon - p_i q}{0.25(q^2 - \epsilon^2)} \right).$$

The profit-maximizing price for a test is

$$p_i^* = 0.25 \frac{p_g \epsilon}{q} \tag{4}$$

leading to an equilibrium demand for tests of

$$D_i^* = \frac{p_g \epsilon}{q^2 - \epsilon^2}. \tag{5}$$

3.2 Product Demand

To derive the equilibrium demand for the product we have another look at figure 1.

[INSERT FIGURE 1 ABOUT HERE]

We see that consumers can be separated into four groups. All consumers with type $\theta < \underline{\theta}_i$ have a relatively low valuation of the product. They will neither buy the test nor - given expected quality q - the product. Notice that this may lead to too little trade relative to the full information case, since all types $\underline{\theta} < \theta < \underline{\theta}_i$ value the product higher than its price if quality is high and should therefore buy it.

Consumers with types $\underline{\theta}_i \leq \theta < \hat{\theta}$ do not buy the product given expected quality q. However, their valuation of the product is high enough to have an interest in buying the test. If the test result indicates an increase in quality, they will buy the product. Therefore, this is the group of potential new customers who react sensitively to positive news.

Next, consumers with types $\hat{\theta} \leq \theta \leq \overline{\theta}_i$ buy the product given expected quality q. Nevertheless, their valuation of the product is not high enough to ignore the possibility of negative news. Thus, they buy the test and refrain from buying the product if news about quality is bad. This is the group of existing customers who react sensitively to negative news. As we have shown, this group is always larger than the group of potential new customers.

Finally, there is the group of consumers with types $\theta > \overline{\theta}_i$. They have a relatively high valuation of the product such that they ignore the possibility of bad news in their buying decision. They buy the product without buying the test. Notice, that this can lead to too much trade relative to the full information case, since all types $\overline{\theta}_i < \theta < \overline{\theta}$ value the product less than its price if quality is low and should therefore not buy the product in this case.

If quality news is bad, all consumers who bought the test will not buy the product. Therefore, the marginal consumer of the product has type $\overline{\theta}_i$. The demand for the product in this case is

$$D_g^l = 1 - \overline{\theta}_i = 1 - \frac{0.5p_g - p_i}{0.5(q - \epsilon)} \tag{6}$$

Evidently, product demand increases as expected quality q increases and decreases as the size of the quality shock ϵ increases. Interestingly, product demand increases as the price for information increases. Intuitively, the more expensive the tests are, the fewer consumers will buy them. In the case of bad quality news this increases product demand relative to the case of more informed consumers. Remembering the optimizing behavior of the information monopolist in equation (4), we saw that the price for tests increases with p_g. This leads to the situation that by increasing the product price, the producer can indirectly induce a positive effect on the product demand he faces. The more expensive the good is, the more expensive the tests will be. And if news is bad, the initial price increase had even a positive effect on product demand.

Proposition 2 *By increasing product price, the producer induces the testing firm to increase the price for information. This in turn increases product demand if quality news is bad because fewer consumers are informed .*

On the other hand, if quality news is good, all the consumers that bought the test will also buy the product. The marginal consumer of the product has type $\underline{\theta}_i$ and product demand is

$$D_g^h = 1 - \underline{\theta}_i = 1 - \frac{0.5p_g + p_i}{0.5(q + \epsilon)} \tag{7}$$

Again, product demand increases with expected quality q but this time also with increasing size of the quality shock ϵ, which is evident since we are talking about a quality increase. The information price effect we found above is reversed here. The more expensive a test is, the fewer consumers will buy it. Therefore, fewer consumers will know about the good news which would cause them to buy the product.

Proposition 3 *By decreasing product price, the producer induces the testing firm to decrease the price for information. This in turn increases product demand if quality news is good.*

In his price setting decision, the producer thus has to take into account these two opposing effects of increasing product price: in the case of bad news it will increase product demand while it decreases it in the case of good news. Appendix A presents a more detailed analysis of these price effects. Direct price effects lead to a lower product demand by increasing product price. Indirect price effects, via information prices, influence product demand in opposing directions as is stated by propositions 2 and 3. The results are stated in the following proposition.

Proposition 4 *The indirect effect in case of bad quality news always dominates - in absolute values - the indirect effect if news is good. But indirect effects are always dominated by the direct price effects.*

3.3 Producer's Optimizing Behavior

The producer acts as a leader in the sense that the information supplier will adjust his price to the product price. As mentioned above, the producer has to take into account the two possible - indirect - effects of his price setting on product demand, in addition to the usual direct price effect. At the time of price setting, the producer does not know whether news is good or bad, therefore the two events are equally weighted in his optimization. He will, as uninformed consumers do as well, optimize his behavior given an expected quality of q. Expected demand is

$$D_g^e = 0.5\left(1 - \frac{0.5p_g - p_i}{0.5(q-\epsilon)}\right) + 0.5\left(1 - \frac{0.5p_g + p_i}{0.5(q+\epsilon)}\right). \tag{8}$$

Considering the information supplier's price reaction in equation (4) and simplifying (8) leads to

$$D_g^e = 1 - p_g\left(\frac{2q^2 - \epsilon^2}{2q(q^2 - \epsilon^2)}\right). \tag{9}$$

Maximizing expected profits $p_g D_g^e$ leads to the optimal product price

$$p_g^* = \frac{q(q^2 - \epsilon^2)}{2q^2 - \epsilon^2}. \tag{10}$$

The monopolist adjusts product price given expected quality q and quality shock ϵ such that expected product demand is constant at $D_g^{e^*} = 0.5$. Information demand in equilibrium is

$$D_i^* = \frac{q\epsilon}{2q^2 - \epsilon^2}. \tag{11}$$

which is strictly smaller than 1, meaning that whatever prices and expected quality, resp., quality shocks, there is always a fraction of consumers that chooses to remain uniformed. Thus, although the introduction of an information market eases the inefficiencies in trade as mentioned above, there will always be too little or too much product purchases relative to the full information case.

4 Who Benefits from Introducing an Information Market?

As was derived above, product demand in absence of an information market - completely based on expected quality - is equal to $1 - p_g/q$. This leads to a product price in equilibrium of $p_g = q/2$. This is unambiguously higher than the equilibrium product price if there is an information market.

Proposition 5 *The introduction of an information market unambiguously lowers the product price even if possible quality shocks are symmetric in size and probability.*

The producer's fear of losing consumers after bad news is stronger than the hope for good news to increase demand. The producer therefore lowers its price to reduce the number of informed consumers[6]. Consumers who buy information thus exert a positive externality on those consumers who buy the product without buying the test. Note, that the cause of this externality is not that prices now reflect information - they do not. The mere anticipation that consumers may become informed leads the producer to lower the price. Product price is lowest if all potential consumers, i.e., all types in $[\underline{\theta}, \overline{\theta}]$, are informed. From equation (11) we know that this is not the case in equilibrium. The fraction of informed consumers is strictly smaller than 1. The price-cutting effect of an information market does not fully apply.

All consumers with type $\theta \geq \overline{\theta}_i$ unambiguously benefit from the introduction of an information market. Given expected quality they buy the product at a lower price without buying the test.

[6]Remember that the demand for information increases with product price, see equation (5).

For consumers with types $\theta \leq \underline{\theta}_i$ nothing changes since they do not buy the test and - given expected quality q - neither the product.

Consumers with type $\theta \in [\underline{\theta}_i, \hat{\theta}]$[7] have an expected benefit from introducing an information market of

$$\frac{1}{2}[\theta(q + \epsilon)] - p_i,$$

which is strictly positive given the equilibrium price for information in equation (4).[8]

On the other hand, consumers with type $\theta \in [\hat{\theta}, \overline{\theta}_i]$[9] have an expected benefit from introducing an information market of

$$\frac{q}{2} - \frac{1}{2}[p_g + \theta(q - \epsilon)] - p_i,$$

which is strictly positive considering equation (4) and (10).[10]

Therefore, also consumers that do buy the test strictly benefit from the introduction of an information market. This is true even though the marginal consumers of information are indifferent between buying and not buying the test. The results are summarized in proposition (6).

[7]Those who would not buy the product if there is no possibility to buy tests, i.e., those who react to positive quality news.

[8]It is even strictly positive for the marginal consumer of information, who is indifferent between buying the test or not, once the information market has been installed.

[9]Those who buy the product if there no possibility to buy tests, i.e., those who react to negative quality news.

[10]The consumer with the highest type in this group, $\overline{\theta}_i$, is just indifferent between buying the test or not. She strictly benefits from the price decline. All other consumers in this group benefit even more since buying the test delivers them a positive utility.

Proposition 6 *All consumers, those who buy the test and those who buy only the product, strictly benefit from the introduction of an information market. The rest of the consumers is unaffected.*

5 Conclusion

It is not unusual that consumers receive news about products they knew and consumed for a long time. These news may be good or bad. Sometimes even the producers are surprised about their products having these hitherto unknown properties.

In this paper we analyze the decision of consumers to buy information about product quality attributes that are otherwise unobservable to them. We therefore consider a monopolist who offers a product of an exogenously given expected quality on which his price decision is based. Consumers know that quality may be different from their expectation and have the possibility to buy product tests before purchasing the product itself. Given that consumers have heterogenous preferences for quality we observe a separation into several groups.

Interestingly, present consumers of the product, i.e., those who will react to negative news, have a strictly larger demand for tests than potential new consumers although quality shocks are completely symmetric. A second interesting finding is that product price is strictly lower if an information market exists. Although not all consumers decide to buy the test, the mere possibility that consumers become informed leads the producer to lower his price. By doing so, he lowers consumers' incentives to become informed which in turn will lead to a higher demand in the case of bad quality news. By lowering the price the producer also lowers demand in the case of good news. But this is accepted to avoid the - more feared - loss of demand in the opposite case.

We conclude by stating that the introduction of a market for tests is a Pareto improvement for consumers. Those who never buy the product given their low valuations are not affected, while all others strictly benefit.

Appendix

Direct and Indirect Price Effects

Analyzing product demand we found that an increase in product price influences product demand in two ways. First, there is a direct effect. If the product becomes more expensive, consumers will want to buy less. But there is a second effect. If the product is more expensive, so is the test by the optimizing behavior of the testing firm, see equation (4). This means less consumers will decide to become informed. This tends to increase product demand if quality news is bad and to decrease product demand if quality news is good. Let us analyze this more formally.

According to the kind of quality news, product demand can be represented for two cases, as done in equations (6) and (7),

$$D_g^l = 1 - \overline{\theta}_i = 1 - \frac{0.5p_g - p_i}{0.5(q - \epsilon)} \tag{6}$$

and

$$D_g^h = 1 - \underline{\theta}_i = 1 - \frac{0.5p_g + p_i}{0.5(q + \epsilon)}. \tag{7}$$

The effect of an increase in the product price on product demand in case of bad quality news is

$$\begin{aligned}\frac{\partial D_g^l}{\partial p_g} &= -\frac{1}{0.5(q-\epsilon)}(0.5 - \frac{\partial p_i}{\partial p_g}) \\ &= -\frac{1}{(q-\epsilon)} + \frac{\epsilon}{2q(q-\epsilon)},\end{aligned} \tag{12}$$

where the derivative of p_i with respect to p_g results from the profit maximizing behavior of the information monopolist summarized in equation (4).

The effect of an increase in the product price on product demand in case of good quality news is

$$\begin{aligned}\frac{\partial D_g^h}{\partial p_g} &= -\frac{1}{0.5(q+\epsilon)}(0.5+\frac{\partial p_i}{\partial p_g}) \\ &= -\frac{1}{(q+\epsilon)} - \frac{\epsilon}{2q(q+\epsilon)}.\end{aligned} \tag{13}$$

The first terms after the equation signs in equations (12) and (13) represent the direct price effect, whereas the second terms represent the indirect effects.

First, we notice that the direct effects are larger in absolute values than the respective indirect effects in both cases. Second, the indirect effect in the case of negative quality news is larger in absolute value than if news is good. Finally, although the direct price effect in the case of bad news is larger, the total effect of a price increase on demand is smaller if quality news is bad, i.e.,

$$\frac{\partial D_g^l}{\partial p_g} < \frac{\partial D_g^h}{\partial p_g}.$$

References

BESTER, H. and RITZBERGER, K. "Strategic Pricing, Signalling, and Costly Information Acquisition." *Discussion Paper*, Freie Universitaet Berlin 1998/35.

COOPER, R. and ROSS, T.W. "Monopoly Provision of Product Quality with Uninformed Buyers." *International Journal of Industrial Organization*, Vol. 3, (1985), pp. 439-449.

GROSSMAN, S. and STIGLITZ, J.E. "On the Impossibility of Informationally Efficient Markets." *American Economic Review*, Vol. 70, (1980), pp. 393-408.

JONES, P. and HUDSON, J. "Signalling Product Quality: When is Price Relevant?." *Journal of Economic Behavior and Organization*, Vol. 30, (1996), pp. 257-266.

LIEBI, T. "Monitoring Eco-Labels: You Can Have Too Much of a Good Thing" *Working Paper University of Bern*, No. 0207 (2002).

RIORDAN, M.H. "Monopolistic Competition with Experience Goods." *Quarterly Journal of Economics*, Vol. 101, (1986), pp. 265-280.

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

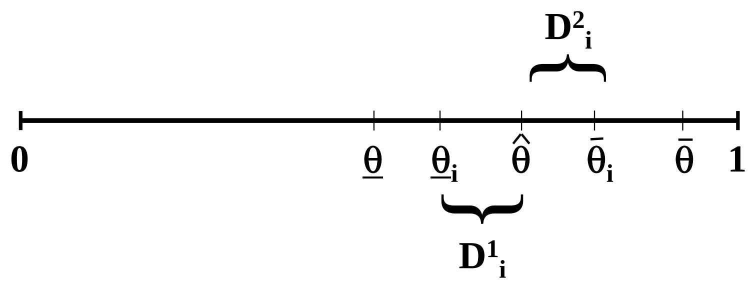

Figure 1: Consumer Types