

Provided for non-commercial research and educational use.
Not for reproduction, distribution or commercial use.

PLISKA
STUDIA MATHEMATICA
BULGARICA

ПЛИСКА
БЪЛГАРСКИ
МАТЕМАТИЧЕСКИ
СТУДИИ

The attached copy is furnished for non-commercial research and education use only.
Authors are permitted to post this version of the article to their personal websites or institutional repositories and to share with other researchers in the form of electronic reprints.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to third party websites are prohibited.

For further information on
Pliska Studia Mathematica Bulgarica
visit the website of the journal <http://www.math.bas.bg/~pliska/>
or contact: Editorial Office
Pliska Studia Mathematica Bulgarica
Institute of Mathematics and Informatics
Bulgarian Academy of Sciences
Telephone: (+359-2)9792818, FAX:(+359-2)971-36-49
e-mail: pliska@math.bas.bg

ASSESSMENT OF INFORMATION ASYMMETRY

D. Christozov, P. Mateev ¹

In the process of trading, the seller and buyer participate with different initial knowledge about the technical capabilities and about the expected use of the good. This two-side asymmetry affects the success of the negotiation in e-trading. This paper discusses one practical approach to assess information asymmetry and the role of warranty in seller-buyer communication relationship. The presented approach is illustrated with a survey experiment.

1. Introduction

Success of a business deal, involves the two parties – seller and buyer, depends on variety of factors. They may be divided in two major groups:

- **Environmental factors:** properties of environment in which the seller-buyer relationship operates, such as IT infrastructure, Logistic Infrastructure, Financial Infrastructure, and Government regulations.
- **Communicational factors:** properties of interpersonal relationship between two parties. Such as efficiency and effectiveness of communication process, trust and confidence; content and acceptance of the exchanged messages; etc.

¹Partially supported by Pro-ENBIS GTC1 -2001-43031
2000 *Mathematics Subject Classification:* 62P20, 91B42
Key words: information asymmetry, warranty

In general, there no exist error-less communication channel. So the Information Asymmetry is a natural property of any communication process. Information asymmetry often results in misunderstanding and eroded the trust between sellers and buyers. From customers' point of view, missing of adequate knowledge about the product may result in wrong purchase decision. From point of view of the seller wrong customer's understanding about the properties of the products results in customers' dissatisfaction and loss of market positions. Often, the customer doesn't know what he is buying; and the seller doesn't know why the customer buys the product. The two parties will benefit from overcoming the information asymmetry or to introduce techniques to overcome (or sharing) the risk caused by information asymmetry.

The paper addresses the issue of quantifying information asymmetry, as first step in making rational decisions about sharing this risk.

The natural technique used to share the risk is warranty. In the last twenty years there are a great number of researches investigating the properties of different warranty models, based on reliability of the products (see [1], [5], [8]). Also, there are a significant advancement in theory and practice of reliability evaluation (see for example [2], [4], [7]). Some considerations about the information approach in risk analysis as a part or equivalent of product's value are shared in [3] and [7].

The two hot notions "Customers' Satisfaction" and "Customer Related Management" are too general concepts. Warranty statements, oriented to cover the risk of information asymmetry is just one of the techniques used to achieve them. Quantifying of that risk is what we are going to do.

The practice used warranty statements like "If you are not fully satisfied – money back", which addresses the risk caused by the failures in communication between two parties. But there are no research publications, or at least the authors had not seen any, addressing this issue – offering and investigating the properties of models to quantify the risk caused by information asymmetry, which may contribute to define warranty statements of that kind on a rational basis.

2. Description of the problem: a typical case

To illustrate the problem and the adopted approach to quantify information asymmetry, let us consider the case of selling personal computers.

Information usually provided by the **Seller** is as follows:

Pentium IV/1.6C GHz

Intel 440 - LX Power Pro ATX

256MB DDR RAM

1.44 MB FDD
30GB HDD QUANTUM
16MB SGRAM VGA card AGP
15" Color HANSOL 0.28, LR
N.I. (1024x768), CPU CONTROL

Information the **Buyer** normally looks for is something to allow him/her to:

- develop and edit text
- make even sophisticated computations
- use of e-mail
- easy access to Internet
- organize a personal data
- play games
- watch movies.

Additionally the Seller provides warranty information to share the risk among all customers. The two types of warranty statements address different sources of the risk.

In case of classical warranty statement, which says something like “Three years replacement warranty if the PC or any of its part fails!” and addresses the risk caused by low reliability of the hardware, the Buyer making his/her purchase decision has to find answers to the following questions:

What means ATX, AGP, etc.?

Whether the offered system can fit to my needs (software)?

Whether I need all and every of the listed components?

In case warranty statement is presented in the form “Three months probation period. Money-back if you are not fully satisfied”, it addresses the risk of miscommunication, misunderstanding, misinforming between two parties. In that case the Buyer has simpler task to make his/her decision: “Why not to try! There is no risk that I will hold an unusable monument for three or more years”. This kind of warranty statements also promotes purchasing.

The two warranty statements address two different sources of the risk:

1. **Risk of malfunctioning:** the product does not meet the specified (promised by the producer/seller) properties, during the specified period of its life.

2. **Risk of misinforming** (information asymmetry): the product does not meet the expectations of the buyer (as s/he understands the promises).

Warranty statement reduces the risk to both parties, but it is offer by the Seller.

Buyers, who have to make purchase decision, benefits in different way by the two types of warranties:

- **Malfunctioning.** The seller will cover some negative effects of low quality, and the buyer risk is limited to some inconvenience. Additionally it has also informative role – high level of warranty means low probability for malfunctioning and consequently low probability for such inconvenience.
- **Misinforming.** Second type of warranty reduces the risk of dissatisfaction, based on misunderstanding and uncertainty, and encourages buyer to buy.

Sellers, has to distribute fairly the risk among all customers, preserving profitability. His/her major need is to quantify as precise as possible these risks:

- **Malfunctioning.** Unperfected production is entirely internal problem for the producer (seller). Precise evaluation of that risk is entirely under control of the producer. The seller's risk is in the difference between the real and the expected quality. Both overestimation and underestimation are negative – if the real quality is higher – the warranty statement is weaker (the message to the market is weaker), otherwise – the seller's profit will be lower, caused by more than expected expenses for satisfying claims.
- **Misinforming.** The risk of unperfected communication between seller and buyer is a property of the seller-buyer communication system and the relationship between its elements. Precise evaluation of this risk is not entirely under control of seller. It requires comprehensive study of customers' understanding, his/her assumptions, and biases. In general, the way customers interpret the sellers' messages.

The producer (seller) may assess with high precision the risk of malfunctioning applying well-known techniques. **But how to assess the risk caused by misinforming?**

3. Assessment the risk caused by Information Asymmetry

A simple experiment to illustrate the proposed approach to quantify the risk of misunderstanding was carried out.

3.1. Description of the experiment

Target group: a group of sixty students (35 responded) were offered to purchase a PC. We assumed that these students have an established understanding about what they need. The data were collected in the fall semester of the year 2002. The sample could not be considered representative for some more or less significant population. Despite that, we will be able to illustrate our suggestions and conclusions.

The message: We approached the target group with an offer for a PC, with powerful computational capabilities, designed to serve professional scientists, but without any communication devices, with very simple sound, and no color graphics:

ASUS A7V333/RA sA, VIA KT333,266,ATA 133,RAID, 3DDR,AGP 4x, USB 2.0, IEEE 1394, ATX

AMD XP PALOMINO 2100PR/1.75 GHz

DDRAM 512 MB DDR, PC 333MHz, SAMSUNG

80 GB MAXSTOR / 7200 / ATA 133/2MB

PCI ATI 1MB

17" SAMSUNG 753S 1280x1024/65Hz 1024x768/85 Hz BW

keyboard, mouse, midi tower case

The offered PC is designed to allow word processing and complex computation, but not use of Internet and e-mails, do not allow multimedia as playing 3D games, watch movies, etc. The price was realistic, but highly attractive.

The survey:

1. Students were asked to evaluate whether the given PC satisfies their needs, according to the following list of applications:
 - word processing,
 - complex computations,
 - management of personal data,
 - Internet,
 - e-mail,
 - games,
 - music, and
 - movies.

Students have to specify two parameters for every item of that list: whether they need the given application and whether the given PC allows to such application to be used.

2. They were offered warranty statement “**Three years warranty**” and were asked to make purchase decision (yes/no).
3. They were offered **three months probation warranty**, and again they were asked to make purchase decision (yes/no).

3.2. Data: presentation and interpretation

Our proposition is to define the “Information Asymmetry” $f(\mathbf{b}, \mathbf{a})$ as the difference between objective abilities of this PC to allow use of the above eight types of applications; and the buyer’s subjective expectation that the PC possesses these abilities.

The Information Asymmetry depends on:

\mathbf{b} - objective ability of the product, described by the seller in his/her message (seller’s information), and

\mathbf{a} - the subjective (expected) ability of the product as the buyer understand (interpret) the message (buyer’s information).

For any of the eight properties objective (the real) abilities are either true or not true (\mathbf{b} is either true or false – one or zero). Personal expectations of realization of such ability is either true or false – again one or zero.

We are able to estimate the average of individual expectations, in the respondents group, and interpret it as a measure of the (subjective) probability that the product possesses that particular property

For concrete feature i the difference

$$f(a, b) = a\Delta b = b * (1 - a) + (1 - b) * a$$

is equal to one (or TRUE) if and only if the reality and expectations concerning feature i have opposite values, i.e. (0,1) or (1,0). Let denote f_i the average (on the sample) asymmetry of the i -th feature. We able to interpret the quantity f_i as is the probability of misunderstanding caused by given property, or risk of wrong decision.

The overall Information Asymmetry may be evaluated as weighted average, where “need” n_i serve as weight (we may assume that a person who is not going to use particular property is not necessary to know what this property requires):

$$R = \frac{1}{\sum n_i} \sum n_i f_i$$

The ratio $n_i/\sum n_i$ may be interpreted as probability of need i and so the overall the average Information Asymmetry as total probability or risk of misunderstanding.

Application:	Needs		Assessed ability of the system		Actual ability of the system	Risk of wrong decision
	(n)		<i>a</i>		<i>b</i>	(f)
	#	%	#	%	%	%
Word Processing	33	94	27	77	100	23
Complex Computations	10	29	19	54	100	44
e-mail	35	100	25	71	0	71
Internet	35	100	25	71	0	71
Maintain Personal data	33	94	27	77	100	23
Play Games	22	63	21	60	0	60
Movies	28	80	21	60	0	60
Music	35	100	20	57	0	57
Risk of misunderstanding:						51.33

Table 1: Aggregated data

For every of the eight properties, every respondent answer yes or no (checked a box) to the two questions: “I will use” this property (need), and “The above computer system is capable to do” this property. The form to collect data is presented in the Appendix 1. In Table 1 the aggregated data are presented.

The properties “use of e-mail” and “use of Internet” received equal responses and we may combine them in the further analysis.

We had given the following names of the seven variables: *word*, *comp*, *inet*, *pers*, *game*, *move*, *music*.

For every respondent we had defined the needs as the number of expressed needed properties and what share of these needs will be satisfied. Further we counted the positive (*err+*) and negative (*err-*) errors according to whether the respondent had assessed correctly the PC capability.

3.3. Analysis of customers’ behaviour

To analyze further the structure of the group of respondents; from point of view of their behaviour, a cluster analysis was performed. Two clusters were distinguished. We named them “optimists” and “pessimists”. (In the presented figures the optimists are dashed).

The two clusters were outlined according to the four integrated variables: needs, satisfied needs, positive error, negative error. Variables represent the

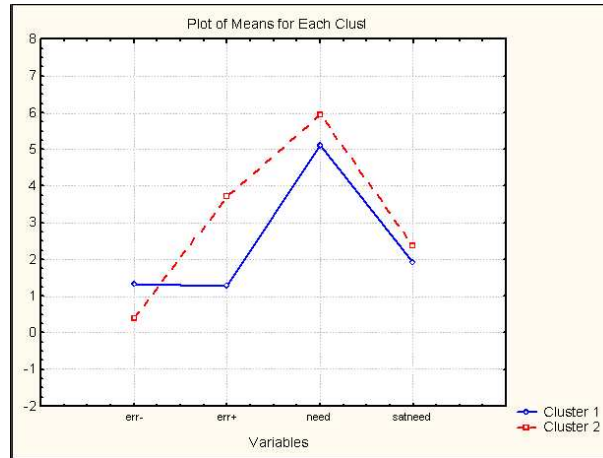


Figure 1: Plot of Means

Type of warranty	Yes	No
Replacement if it fails in three years	29	6
Money back if you are not fully satisfied for a three months trial period	26	9

Table 2: Purchase decisions

number of respective answers. The group of pessimists consists of 19 students, and the optimists are 16. The optimists have higher needs, higher expectations and higher positive errors, the pessimists have higher negative errors.

The risk caused by Information Asymmetry differs significantly for the two groups:

- The whole group – 51%;
- The pessimists – 36%;
- The optimists – 60%.

3.4. Impact of warranty statements

In Table 2 are shown results of the next part of the survey: purchase decision according to the type of warranty.

These data shows that the group of respondents do not clearly understand the possible problems caused by Information Asymmetry.

4. Conclusion

A simple approach to quantify the Information Asymmetry in the case of making purchase decisions was proposed and illustrated.

An experiment was designed and performed to highlight:

1. How and whether customers evaluate risk caused by Information Asymmetry?
2. How the seller may assess the risk caused by Information Asymmetry?
3. What is the role of warranty statement in reducing this risk?

The experiment shows that:

1. the risk caused by Information Asymmetry could be high enough and it is worthy to be studied more systematically;
2. it may be expected that significant percentage of customers do not understand the risk of misinforming;
3. warranty statements are instruments for sharing the risk, but also allow receiving feedback about sensitivity of the customers toward this risk.

Growing customers' requirements in market globalization force producers/sellers to pay special attention and to develop and apply techniques for evaluation and sharing the risk of misunderstanding as this was done for the risk of malfunctioning. There is urgent need for development and investigate the properties of variety of models serving to assess and quantify the risk of information asymmetry. This is especially important for complex devices, which needed special knowledge for their usage.

5. Appendix

Purchasing a PC

Consider the following offer of a PC with highly attractive price:

ASUS A7V333/RA sA, VIA KT333,266,ATA 133,RAID, 3DDR,AGP 4x, USB 2.0, IEEE 1394, ATX
AMD XP PALOMINO 2100PR/3.75 GHz
DDRAM 512 MB DDR, PC 333MHz, SAMSUNG
80 GB MAXTOR / 7200 / ATA 133/2MB
PCI ATI 1MB
17" SAMSUNG 753S 1280x1024/65Hz 1024x768/85 Hz BW

keyboard, mouse, midi tower case

What kind of applications you will use?

Application:	I will use	The above computer system is capable to do
Word Processing		
Complex Computations		
e-mail		
Internet		
Maintain Personal data		
Play Games		
Movies		
Music		

(Mark with \surd)

Warranty statement 1:

Replacement if it fails in three years

I will purchase this PC! Yes No

Warranty statement 2:

**Money back if you are not fully satisfied
for a three months trial period**

I will purchase this PC! Yes No

REFERENCES

- [1] BLISCHKE, W.R., D.N.P. MURTHY (editors) Product Warranty Handbook, Marcel Dekker Inc., New York – Basel – Hong Kong, 1996.
- [2] CHRISTOZOV, D. Computer system for evaluation of machines' reliability *ICTT "Informa"*, Sofia, 1987 (in Bulgarian)

- [3] CHRISTOZOV, D., P. MATEEV Warranty as a factor for e-commerce success, *InSITE'03 - Informing Science + IT Education Conference*, (2003), 491–495.
- [4] CHUKOVA, S., Y. HAYAKAWA Warranty Cost Analysis: Non renewing warranty with Non-zero Repair Time *Applied Stochastic Models in Business and Industry* **20**(1) (2004), 59–71.
- [5] CHUKOVA, S., B. DIMITROV, V. RYKOV Warranty analysis. A survey *Journal of Soviet Mathematics* **67**(6) (1993), 3486–3508.
- [6] DIMITROV, B., S. CHUKOVA, K. ZOHEL Warranty Costs: An Age-Dependent Failure/Repair Model *Naval Research Logistic Quarterly* **51** (2004), 959–976.
- [7] MATEEV, P. On Information Theory and Risk Aversion, *First International Conference for Mathematics and Informatics for Industry - MII 2003 - Thessaloniki, Greece*, 2003, 348–355.
- [8] MURTHY, D.N.P., I. DJAMALUDIN New product warranty: A literature review *International Journal of Production Economics* **79**(2) (2002), 236–260.

D. Christozov
American University in Bulgaria
Blagoevgrad, 2700
e-mail:dgc@aubg.bg

P. Mateev
Institute of Mathematics
and Informatics
Bulgarian Academy of Science
8 G. Bonchev Str.
Sofia 1113, Bulgaria
e-mail:pmat@math.bas.bg

