Probabilistic model of optimal price search on the retail core banking services market

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Abstract— The paper is focused on the Stigler's model adjustment for the purpose of modeling the price information asymmetry on the small market. As a case study using this model there is used own research of retail core banking services market for physical entities in the Czech Republic. The demand on this market carries the impacts of the price information asymmetry. Our model shows that more than 50 % of account suitable for the mainstream client profile can be replaced by cheaper one even under the influence of information asymmetry.

***Keywords*—** Stigler's model, small market problem, information asymmetry, retail core banking services.

I. Introduction

INFORMATION asymmetry is a situation where one side of the market benefits from the information advantage at the expense of the second one. This results in the market non-equilibriality. Since the first ground-breaking (or there can be said "neoclassical paradigm-breaking") thoughts of I. Fisher, R. Knight and F. A. Hayek we can't study the market any more without information assessment – the market of retail core banking services, mostly known as current accounts, (thereinafter only as RCBS) is not an exception.

Information asymmetry in financial sector was and it is studied closely. Still the main fields of study were the loan, insurance and investment markets, but not the RCBS one. European Union (thereinafter only as EU) authorities, such as the Directorate-General for Health and Consumers Protection, have focused on this issue for the first time 6 years ago in [1]. There the sub goal of removing the undue barriers associated with all types of bank accounts and to improve the competition between service providers was declared. In the following years there were repeatedly (e.g. in studies [2], [3]) named and proved two real RCBS market problems – tariffs' opacity and hard product comparison. Both are typical empirical examples of information asymmetry. Both can be answered by the market and also by the authorities (e.g. education of the clients, basic financial literacy as points out [4]). The question is: how to make rational consumer decision under those conditions? And what are the conditions on the targeted RCBS market?

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II. Formulation of the Problem - Price Asymmetric Information

The question of consumer decision under the information asymmetry (represented by uncertainty) gained new meaning in the breakthrough paper [5]. What Stigler claimed about his products can be applied on banking products too, to be more specific current account on RCBS market. Stigler is solving the situation where the consumer tries to find the best price by doing the search – or better the searches. The search is the process of canvassing of one supplier. Applying this idea – Stigler's approach shifts the consumer's optimum (consumer's surplus maximization) along the marginal utility curve by adding a new product price component (within the frame of the cardinalistic theory). There was introduced a new way of rational consumer behavior by the balance of marginal costs and marginal returns on information. Marginal costs arise from the search. Marginal returns are achieved through known price(s) and the best found price.

We decided to use the basic idea but to rework the original model for specific RCBS market needs. The returns and so the costs more complex problem here compared to the original conception and the original model.

The real market problem is what are the costs of the search on RCBS market? They definitely exist and EU research indicates that those costs might be very high because of information asymmetry. It is difficult for the consumer event to determine the price moreover to compare the RCBS products and so to find the cost optimal product providing all the demanded services.

In microeconomical point of view RCBS for mainstream client, preferring the Internet as the main communication channel, would be normal non-luxurious goods with income elasticity and almost perfect substitution goods within the RCBS market, because there are no fundamental differences among the e-banking accounts. We presume the same range of

services for all e-banking activated accounts used by mainstream client (for mainstream usage pattern see chapter no. 4). Quality of services is hard to monitor because the main quality indicator (except the correct enter in the books when the payment is done) is how fast client's order will be executed. This is also the same due to EU legal harmonization process, to be more specific it is an impact of the Dir. 2007/64/ES that sets for most of the payment types an enumeration of how long the payment can take.

So why the EU still emphasizes client mobility when microeconomic conditions are mostly met? Because client mobility is very low abhorrent to easy substitution from the economical point of view. What prevents the substitution? Information asymmetry is one of the main reasons. As numerous studies claim the main cause of it is linked to opaque tariffs, lack of RCBS product comparison tool, product-tying, conditional sales and conditional (loyalty) pricing, more about those imperfections can be found in [3], [14], [15].

But how strong those phenomena and overall asymmetry are? Let us try to model it on RCBS market.

III. Small Market Model of Price Search

Stigler described process of searching for minimal price on the market. How to specify the importance of a minimum price and number of searches? From our point of view it is more suitable to search the fixed market price and describe the savings depending on the mean time of finding of the desired market price.

In our model we assume, the price distribution of all RCBS products' prices is described by function F(x). On the other hand, from the perspective of the consumer, the number of available products is limited. Range of the products on the market can be assumed as random sample from the sufficiently large population. Then the price distribution function is:

$$F(x)=\int_{-\infty}^{x}\frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{(x-\mu)^2}{2\sigma^2}}. \tag{1}$$

Suppose the fixed price (the market price is presumed as independent to the individual consumer) x is market price the customer requests or it is advised to search for. Then the probability of finding the price less or equal x during searches n is expressed as probability

$$P(x_1>x\wedge x_2>x\wedge\ldots\wedge x_{n-1}>x\wedge x_n\le x) \tag{2}$$

Let l be a number of available products and x be the price maximum that the client is willing to pay for RCBS. Thus expected number k of products cost less than or equal to the asking price (price ceiling) x is given by $k\le lF(x)$. Without loss of generality we can assume that the option at the product price can be determined such that $k=lF(x)$ is fulfilled. Then former mentioned probability is for the small market expressed as:

$$\frac{(l-k)!}{(l-k-n+1)!}\frac{(l-n)!}{l!}k=\frac{\binom{l-n}{k-1}}{\binom{l}{k}}. \tag{3}$$

Then the mean number of searches to be carried out to find the desired price x is in the small market model expressed by the formula

$$T_l(x)=\sum_{n=1}^{l-k-1}n\frac{\binom{l-n}{k-1}}{\binom{l}{k}}=\frac{l+1}{k+1}=\frac{l+1}{lF(x)+1}. \tag{4}$$

Then the expected savings can be expressed as the difference between the yield on the change of a product and costs to find the desired price. But the question is what price should be the desired one – (required as optimal)? There have to be taken into account the costs and the revenues of the search.

Now, let us consider the total expenditure of the search as a combination of the fixed and the variable market price raise (market price search added "costs") consisted of time units multiplied by average costs. Fixed costs rf of search are sunk costs, respectively the costs that have to be made with no regard to the number of searches. This pre-search phase is mainly composed of RCBS provider identification, then consumer is considering his or hers individual pattern of consumption, RCBS share on the consumption basket, future consumption etc.

Variable costs are the search in Stigler's general meaning – general, not the identical one. Stigler presumed specific "shopping tour", where geographical search was not taken into account. If it would be, then the model would have been extremely complex. Now this part can be reflected much more easily and closer to the real situation. The major part of the variable costs is consisted of finding, noting down and computing the individual RCBS price using the PC. All of the banks have the web site with the tariff. Then consumer notes down price for the specific RCBS services and computes the price according his usage pattern. Package products have to be studied more thoroughly when their price has to be computed from the optimal package settings. Let rv are the average variable costs i.e. the time costs of single search. Fixed and so the variable costs are in time units.

To express the total costs, there have to be considered the time unit costs. Let w are the average time unit costs derived from individual value of time unit or from the wage per time

unit. Total costs are then:

$$R_l(x) = w\left[r_F + r_V T_l(x)\right]. \quad (5)$$

The same way as Stigler did we presumed that price structure is stable for specific period of time t – at least during the search. Presume that t is equal to one month. Then the total savings can be expressed by

$$S_t(x) = t(y-x) - w\left[r_F + r_V T_l(x)\right], \quad (6)$$

where y is the actual product price (we presume that consumer already has current account, its month price is y) and x is the desired or an advised one.

Searching is rational for $S_t(x) > 0$ only. It is obvious such values exist only in some cases of combinations x, y, and t. The consumer can achieve the optimal setting of price x, only if

$$\begin{aligned} &\frac{dS_t(x)}{dx} = 0 \\ &-t - wr_V \frac{dT_l(x)}{dx} = 0 \\ &-t + w\frac{l+1}{\left[lF(x)+1\right]^2} r_V l \frac{dF(x)}{dx} = 0, \end{aligned} \quad (7)$$

is fulfilled. As same as above it is obvious such values exist only in some cases of combinations of t, w, rv and l.

IV. Real Market Data and the Computation

Before the start of an analysis we have to declare that all of the amounts in euro are converted from Czech crown by central foreign exchange spot rate EUR/CZK = 24,96, where EUR is the base currency.

4.1 The Demand Side - Mainstream Consumer Cluster Identification

Stigler's paper [5] specifies the demand side and the consumer only in general. For our purposes the demand side has to be described much more thoroughly (the suitable tool from the opposite point of view can be found at [6], [7]). As the data source there has been chosen the RCBS calculator project (thereinafter only as Calculator). This project is fulfilling main information asymmetry related goal EU has pointed out in 2007 and 2009 – free tool for easy product RCBS offer comparison. Knowledge base of the Calculator contains the tariff data of 13 banks (more that 98 % of the RCBS market in the Czech Republic) and their 46 accounts. Consumer just inputs his or hers individual usage of RCBS and the system advise the best 15 products, that offers all demanded services for best price. Since the pilot run during the winter 2009/2010 the Calculator used more than 35 000 of consumers (or there can be said respondents). For more information about this project please see [9].

Since the data source contains more than 35 000 Calculator's input form fills, there have to be used effective algorithm for large databases. There was used a modified hierarchical method – two-step cluster analysis. Method is implemented e.g. in statistical software IBM PAWS 18. Analysis identified the mainstream cluster representing the RCBS usage pattern for the main group of consumers (RCBS bank clients) in the Czech Republic. The share of the mainstream client was 62 %. For more details about the methodic and clustering outcome, please see [10], [16].

Still due to very specific data acquisition there are very important limitations of subsequent analysis interpretation. All of the analysis, presented in this paper, is limited to mainstream client that has:

- the current account offered on the RCBS market in the Czech republic,
- the Internet connection or uses the Internet for communication (65 % of the Czech population of age 17–74 years according the statistical survey in 2009, see [11]),
- the e-banking service activated, respectively has an account with PC access,
- at least the basic level of ICT literacy (is able to find and use the Calculator's form),
- usage pattern close to the centroid of the computed mainstream cluster.

Still the population we are studying is very important, maybe a major one in the whole population of the RCBS clients in the Czech Republic.

4.2 The Offer Side - Mainstream RCBS Offer

There is being solved the small market problem. When there is taken into consideration the fact that mainstream client will automatically refuse the premium or exclusive accounts, the number of RCBS offered products (or we can say providers – the banks) drops down to 28 products. Premium or exclusive products are cheap and very attractive but only after the consumer meets often very hard conditions (mostly as high balance as 20 000–40 000 € and high turnover). Net median wage in the Czech republic of 710 € [8] is far from that and so all 5 exclusive accounts was discounted.

The mainstream acceptable products prices vary from 0 € to 8,72 € with mean value of 4,99 € and standard deviation of 2,18 €, for better apprehension please see the histogram chart lower.

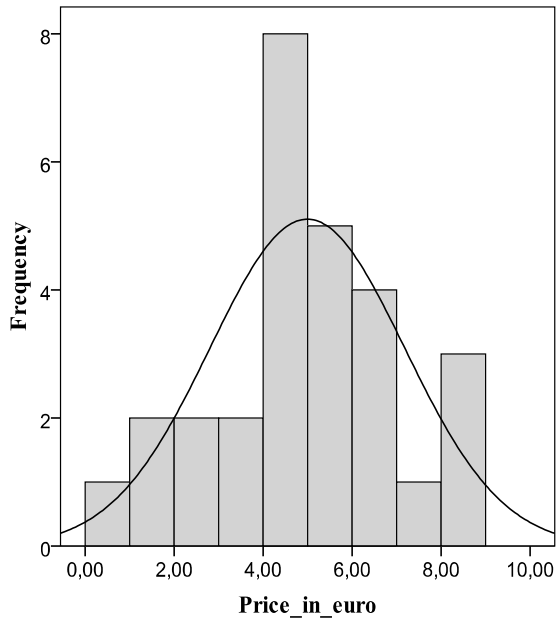

Fig.1: histogram of current account prices for mainstream cluster usage pattern in the Czech Republic, source: own research.

4.3 THE EQUILIBRIUM - COST AND SAVINGS DETERMINATION

4.3.1 ECONOMICAL EXPENSES ON SEARCH

As it was mentioned in problem formulation we are deriving the additional consumer expenses from the "price" of his time. Presume that time can be freely substituted by labor and vice versa (with regards to the legal, biological and time limits). Then the consumer considers the time unit spent by performing the search as costly as the wage per time unit is. The median value of time for the one cycle in our model (one month) is net median wage in the Czech republic of 710 € computed from gross wage [8]. The average wage is not suitable because of the skew caused by very high salary percentile. So the one minute of time spend on search is about 0,0733 €. This approach can be used when presumption of consumer labor offer/free time balance is met but according the time consumption of search we are far from legal or any other limitation.

Deriving the time "costs" of one search is much more demanding task. Again we have to use a certain level of approximation or we can say abstraction. Due to extreme individual differences of ICT skills, bank terminology knowledge, IQ etc. there has to be chosen a best case approach. The time consumption of search was studied on rather extreme case of young man, with high ICT skills and above average banking terminology knowledge and above average IQ. This is population's lower cost limit – this consumer has clearly at least below average time costs. In other words, time costs we observed are higher for the rest of the population. This is only a model situation and it needs further research. Still the idea, of using the well prepared consumer and analyze if his undeniable potential is enough to find optimal price under the information asymmetry without external expert comparison tool, might show an interesting results.

At first we have to declare that our user is not a "protouser" in other words he already knows his usage pattern from his previous experience. It can be easily derived from last account statements. The second initial task is to get the list of the RCBS providers – retail banks. This can be done using the Google by search for "bank". There on the first three pages there are the links of all the 13 banks monitored by the Calculator. Banks' web pages mostly well-arranged and consumer can easily find what and where are the retail accounts. Construction of the table with demanded services, usage frequencies and banks that provides RCBS took 32 minutes. This can be called as fixed cost or pre-search obligatory phase.

The second phase is the search itself, to be specific search one by one. One search consists of e-tariff search and noting down the individual services fees. Table will computed the price our model consumer will pay according the mainstream usage pattern. The problem was when the package accounts were found. Then we constructed the price by presumption of rationality, to be specific by the cost optimal settings of the package. One search in average took 21 minutes. An exception was the first search or rather it can be called the zero one. Presuming the consumer is not a proto-user, he knows his price for one (actual) account for minimal search costs.

4.3.2 ECONOMICAL REVENUES ON SEARCH

The basic idea is the same as Stigler's one. When there is found cheaper product (account) additional saving (or we can say price reduction) is the difference of actual minimum (real or better probable minimum) and the new one. Still we are consuming (using) the account much longer than one month. The total price reduction has very strong correlation to time. The problem is even more complex when we have to declare market price stability that strongly determines the total expenses.

The question of how often the banks make fundamental tariff changes can answered by past experience. We asked the expert P. Nacher (well known person in the Czech Republic for public basic finance literacy improvement projects). He estimates that those changes come at least once per 1,5 year., still he prefer the one years. But the ration consumer cannot set one of the main parameters without the foresight margin. We presume the tariff stability of 8 months.

The final price paid for the account is then consisted of moth charges, initial costs on search and costs of the performed search and all is multiplied by the number of months the product will be used. At the end of the sub-section there has to be reminded that the consumer does not know what account will be discovered by the additional search. It can be only estimated.

4.4 THE COMPUTATION – OPTIMAL PRICE UNDER THE INFORMATION ASYMMETRY CONDITIONS IN THE CZECH REPUBLIC

As stated above, the prices of banking products for a specified client of the mainstream cluster can be described by the normal distribution see below output of IBM PASW 18.

Table I.: Normality test results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Nonexclusive RCBS pricing	,117	28	,200*	,973	28	,652

a. Lilliefors Significance Correction

*. A lower bound of the true significance.

The distribution parameters are estimated from the market prices computed by the Calculator system or the prices can be computed from the tariffs on the banks' websites.

So, consider the market prices are described by the normal distribution with the parameters $\mu = 4{,}99\,€$ and $\sigma = 2{,}18\,€$. For the specified type of client, the number of suitable accounts is 28. With respect to text above, we get the market price raise (search costs) $r_F = 32 \cdot 0{,}0733 = 2{,}35\,€$ and $r_V = 21 \cdot 0{,}0733 = 1{,}54\,€$.

Following the idea of limited marked we can create the basic model of savings depending on parameters x, y and t. With respect to frequency of more or less fundamental changes (we abstract from very small tariff changes) of the market prices of RCBS accounts, the return of the invested time and money, represented by the parameter t, have to be adequately short – otherwise the search just does not pay off. So, parameter t is desired up to 8. For $t > 8$, we risk the price of chosen product changes before returning the invested costs of the search (market price raise). The consumer might estimate the tariff changes successfully, but it is highly unlike (even the banks are not able to predict behavior of their competitors) and so we abstract this option has zero influence.

For example using previous settings of consumer pattern, skills and tariff stability if the market price of actually used banking product is y = 4€ and consumer asks the return t = 8 months, then, with respect to [5] idea and our model, we get the positive savings for desired market price $x \in [1{,}17; 2{,}42]$ and the optimal value of desired market price x is 1,73€. For the better understanding and overview of other market price situations, please see figure lower (the difference of actual market prices between two curves is 0,8€, so the highest curve represents actual price of 5,6€ and the lowest one of 1,6€).

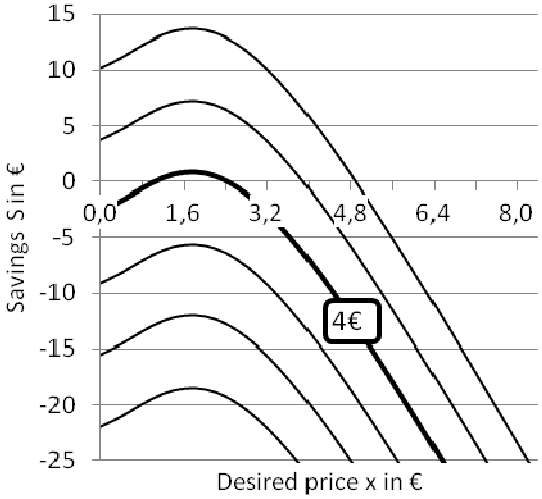

Fig.2: Graph of dependence of savings S on the desired price x for various actual market prices y and return during t = 8 months.

The bold curve shows our model case. Mainstream client with low costs on search in case of actual price of 4€ should perform the searches until the price of 1,73€ will be found. The mean number of searches to be carried out to find the desired price is 9,5. Of course in sufficiently large population there would consumers with fast optimal price identification and so the slow one, still on an average the value is 9,5. Total savings of one consumer will be then 13,84€. The actual paid price can be even lower by 56 eurocents in order to be rational to perform the searches.

Let us remind that average market price is almost by 1€ higher concerning the price distribution. Concerning the real market data from the previously mentioned Calculator system then the average price is higher almost by 2,5€. That means that the savings would be even higher in that case. By other words more that 50 % accounts can be replaced by cheaper one without loss of functionality. We can also observe that the search of a better product is suitable only for clients with sufficiently expensive actual product and certain values of t.

Let us model the same costs and actual price for the different t as demanded return.

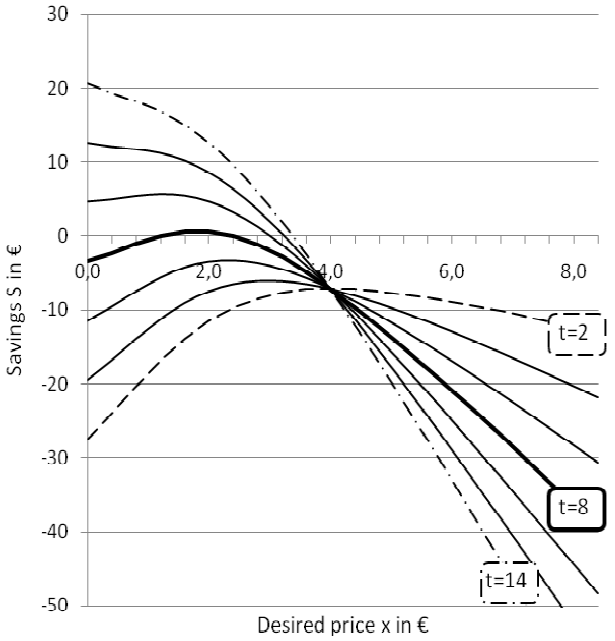

Fig.3: Graph of dependence of savings S on the return t in months for actual market price y = 100 €.

Bold curve is the former case from the computation and fig. 2. In that specific setting the savings are possible for $t \geq 8$ only. The step of t is 2 months. There can be seen that for $t > 8$ there can be demanded the account for free with positive savings.

Still we have to admit that our time cost determination was set to find minimal search costs. Then there can be expected, that costs of average consumer would be higher. That means the curve of savings would be placed significantly lower. The same situation concerns the desired price rationality range which would be much tighter.

V. Comparison of Stigler's model and our small market rework

Stigler in the paper [5] described the idea searching the minimal product price on the market and devoted to the efficiency of such searches. Stigler's presumption was that price distribution is the uniform one. Let us describe the distribution of price by the distribution function F(x), where x stands for price, a for the lowest and b for the highest market price:

$$F(x): y = \begin{cases} 0 & for \quad x < a \\ \int_a^x f(t)dt & for \quad x \in [a,b]; F(x) = \dfrac{x-a}{b-a} \\ 1 & for \quad x > b \end{cases} \tag{8}$$

We presume the normal distribution unlike Stigler, for F(x) see (1). It is highly disputable question if the real market price distribution would pass the test of uniformity. The normality test was passed; to be more specific, we failed to reject the normality hypothesis as seen on Table I.

In [5] the market is big, big enough to use the central limit theorem, which implies i.a. that if the consumer performs one search (finds the market price of the one supplier-bank) and the number of unexplored suppliers will drop down by 1, the influence on the total number of suppliers would be limit to 0. This is far from reality as shown earlier. We assume analyzed market prices as a sample from the sufficiently large population.

Stigler assumed that consumer sets variable c based on the pricing information knowledge. Stigler does not describe this variable more closely. The price reduction appears from the difference between c and newly found lower market price x. Then the probability of finding the price less than c during searches n is expressed as probability:

$$\begin{aligned} &P\left(\min_{i\in\{1,2,\ldots,n\}}\{x_i\} \leq c\right) = \\ &= 1 - P\left(x_1 > c \wedge x_2 > c \wedge \ldots \wedge x_n > c\right) = \\ &= 1 - \prod_{i=1}^{n} P\left(x_i > c\right) = \\ &= 1 - \left[1 - F(c)\right]^n \end{aligned} \tag{9}$$

Then the distribution of minimum prices with n searches is then:

$$F_n = n\left[1 - F(x)\right]^{(n-1)} \tag{10}$$

Stigler's main goal was to set the optimal number of searches considering the costs on search (those cost were not described) compared to the savings. Savings were derived from the expected value of the minimal price after n searches. There can be determined the expected value of the minimal price after n searches (of random sample on observations) by the formula:

$$E_n = n\int_a^b x[1 - F(x)]^{(n-1)} F'(x)\, dx \tag{11}$$

expressed by Robert Sollow. The calculation is relatively easy, if the price is described by uniform distribution as Stigler assumed. Here Stigler ended his model computation and description. So we used his presumptions, implications and former verbal descriptions to describe the model more thoroughly and to express it as establish-ready. Established and derived Stigler's En is expressed as:

$$E_n(x) = n\int_a^b \left[\frac{b-x}{b-a}\right]^{(n-1)} \frac{x}{b-a}\,dx = a + \frac{b-a}{n+1}. \tag{12}$$

For the needs of the comparison let us presume that Stigler would have adopted the approach concerning the costs as we had. Still there has to be noted that rf is additive constant for further derivation as seen on (5). So it won't influence the original model in a fundamental way. Then the savings after n searches are expressed as:

$$S_n = w\left[y - a - \frac{b-a}{n+1}\right] - r_f - r_v n. \tag{13}$$

Assuming the same savings rationality as earlier in the small market model, then there is a condition of:

$$\begin{aligned} &\Delta S_{n-1} = S_n - S_{n-1} \geq 0 \\ &\Delta S_{n-1} = w\left[y - a - \frac{b-a}{n+1}\right] - r_v = \\ &= \frac{w(b-a) - r_v n(n+1)}{n(n+1)} \geq 0 \end{aligned} \tag{14}$$

The optimal number of searches for the Stigler's model is then:

$$n \leq -\frac{1}{2} + \sqrt{\frac{5}{4} + \frac{w}{r_v}(b-a)}\ . \tag{15}$$

It is obvious that Stigler used the neoclassical approach of the "golden rule", where maximum gain (profit, here used for savings) occurs at a point where marginal cost equals marginal revenue. From the Stigler's comments we presume that in case of marginal costs (that is rv) and marginal savings (see (14)) inequality cannot be achieved, he prefers the situation when marginal costs are lower than marginal savings. Then in case of the n as a decimal number it would be always rounded down.

Our approach was different; we are to set the price for the specific consumer according to the maximized savings from switching the actual product for the new one with the optimal price. Optimal price brings together two basic problems. If the consumer searches for the high price, it will be found quickly. In that case the revenues or we can say savings would be too low. On the other hand the search for very low price will bring very high search costs that even high revenue would not cover – the savings would too low or negative as it was in the first case. Let us continue from the (7) and derive:

$$-t + w\frac{l+1}{\left[lF(x)+1\right]^2} r_v lf(x) = 0 \tag{16}$$

Unlike Stigler's model there can be used numerical solution only because of normal distribution function and probability density. So for the dependent variable of savings S(x) is computed independent variable of optimal price x under the condition of S(x) extreme.

Due to different price distribution direct comparison is very hard then. The mere fact that uniform distribution has a minimum unlike the normal one prevents direct comparison. Still there can be expected, that price marginal savings during the early searches, will be higher in our small market model. When number of performed searches n will be raising the rate of price reduction will be higher in the Stigler's model. The cause is that in the Stigler's model there can be found minimum price unlike the small market one. On the other hand the question of high number of searches n can be answered shortly that this option possesses too high search costs, respectively opportunity costs, to occur.

The only way to compare both models or at least both approaches is to use uniform distribution form our model but it would change the main feature of this model that made it much closer to the real market than the Stigler's one was.

VI. Conclusion

The information asymmetry in banking is not just the problem of loan market [12] it is present on the RCBS market too. The Stigler's model [5] presents the idea that asymmetric information of prices generates additional costs for the consumer that does not know all the prices on the market and so the optimal choice cannot be made. We agree and we present our model that can be used for estimation of the RCBS optimal price the consumer should pay under certain conditions of his usage pattern, asymmetric information represented by costs on search, tariff stability and actually used product, respectively actual price paid.

The information asymmetry on the RCBS market in the Czech Republic exists and so the real price of RCBS consists of market price and costs of the search for it. Information asymmetry determines the fees also from the offer side allowing higher profits – this factor can be one of the missing factors in the study [13] that was focused on central Europe RCBS pricing.

Nevertheless even under its influence, there can be found lower market price for indispensable part of the consumer population. Our model case showed how the rational consumer can face the information asymmetry. Our model can be used to reflect and to model the market intervention aimed for information asymmetry reduction. For the future the model can be used as a sort of information asymmetry indicator. In other words the tighter the range where the savings can be realized the higher the information asymmetry is (the higher the costs

of search are). Still we have to keep in mind the limitations and presumptions such as normal distribution of the market prices, 8 months of tariff stability, mainstream e-banking activated client cluster, low search costs, actual RCBS offer in the Czech Republic, exchange spot rate, net median wage.

Compared to the original Stigler's model our model is focused on optimal price determination instead of optimal number of searches. The second main difference comes from the replacement of uniform distribution by more suitable normal distribution. Also the costs determination differs when our fixed and variable cost on search are much closer to the real market. The model comparison is difficult because of the different approaches, distributions and components. There can be only presumed that for lower number of search the Stigler's approach is more effective, still less closer to the reality and much harder for the computation in case of other than the uniform distribution of market prices.

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