

Individual-based annual fee estimation and strategies for new and existing credit card holders

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Abstract

Usually, when the term “pricing” is used with most loan pricing models, it refers to the interest rate dimension of pricing. However, credit institutions have other sources of revenues as well. Studying the credit card case, extra revenue is extracted, not only from the interest revenue, but from the annual fees as well. Credit issuers tend to offer a respectively long period, usually 1-2 years, offering zero fees. This paper researches, on an initially theoretical basis, how a credit issuer should quote fair annual fees taking into consideration the risk and the usage profile of each cardholder.

Actually, credit card issuers have three alternative offers of annual fees and interest rate premium. Cardholder’s potential action is studied for each alternative and, then, an expected profit comes. The card issuer selects to offer the alternative pair of annual fees and interest rate premium that maximizes its expected profit, for a certain period, before deciding to make a new offer again.

Keywords: risk-based pricing; annual fees; credit card; credit scoring; behavioral scoring

1. Introduction

This paper has to do with risk-based pricing in the context of individual pricing of each credit card holder. In some other similar researches (Stamokostas et al, 2004; Stamokostas et al, 2003; Stamokostas et al, 2002) issues in risk-based pricing had been stressed out in the context of credit card industry for new and existing cardholders. The pricing dimension examined was the interest rate dimension. It was an interesting field for research, as past researches had shown a relative inelasticity of credit card interest rates (Ausubel, 1991; Ayadi, 1997; Calem & Mester, 1995; Sullivan & Worden, 1995; Stango, 2000). In our past researches the interest rate is considered as a means of retaining cardholders and not as a means of attracting them (Stamokostas et al, 2003).

However, the cardholder doesn't only pay interest using a credit card. There is an annual fee that has to be paid as well. Many credit institutions offer annual fee-free credit cards for a respective period of time, say one or two years. After that period expires, the cardholder should pay an annual fee, if he or she keeps using the same credit card.

This paper points out and tries to give some logical answers to the following questions: what is the proper level of annual fee? Should the annual fee be adjusted according to the risk of a credit card holder in order to compensate any possible credit losses? Is the credit card holder sensitive to a payment of annual fee and to its level or there is the same relative inelasticity as for the interest rate? What is the proper level of interest rate so that the bank has the opportunity to offer a zero annual fee? Is it worthy enough to offer a zero annual fee in the context of the effort of cardholders' retaining?

There will be an effort to give answers to these questions in the context of this paper. However, this is a theoretical and introductive research for risk-based pricing on the dimension of annual fee. More answers will be available after a survey that will be taken place in credit card holders. This survey will provide empirical evidence to the theory developed in this paper.

In the second section of this paper a model of risk-based pricing on the interest rate dimension is mentioned again in order to link with the model been developed for risk-based pricing on the dimension of annual fee. In the third section, the first approach of risk-based annual fee is mentioned. In this approach, the annual fee is the only means of covering the expected credit losses. In the fourth section, the other case of risk-based

annual fee is presented. In this approach, both the annual fee and the interest rate are adjusted in order to compensate the possible credit losses. That is, there are combinations of interest rate and annual fee quoted so that they are in such a level to cover the expected credit losses. In the fifth section, the effective application of risk-based pricing combining adjusted interest rate and adjusted annual fee is presented. This application takes into consideration the cardholders' behavioral elasticities and how sensitive they may be in changes in annual fee and interest rates. In the sixth section there are the conclusions of this theoretical research.

2. Review of the model for risk-based interest rate

The rationale of this model was for a credit institution to quote an interest rate so that it compensates any possible credit losses. There are some similar pricing models in banking literature that price the credit risk of a loan (Bessis, 1998; Hempel & Simonson, 1999; Rose, 1999; Saunders, 2000). Credit card's interest rate is one of the revenues drivers for of the credit institution. There are some excess revenues from the quoting a premium in this interest rate. The premium should be quoted in such a level that covers any expected credit loss (Stamokostas et al, 2003).

The expected revenues for premium depend on the extent the cardholder uses his or her card. That is, the more unpaid balance he or she keeps; the more purchases he or she makes when is a revolver; the more cash advances he or she withdraws; the more late fee he or she pays; the more revenues are for the credit institution and vice versa. Besides, the more the premium is quoted, the more the excess revenues will be. These excess revenues depended on the level of premium and the usage extent.

The expected credit losses depends on the probability of default, PD, on the amount of money owed at the time of default or the exposure at default, EAD, and on possible percentage total losses of the exposure at default, or the loss given default, LGD.

Equating the expected excess revenues with the expected credit losses and solving this equation for premium, the estimated premium is derived (Stamokostas et al, 2003).

$$\text{Expected excess revenues} = \text{expected credit losses} \quad (2.1)$$

The premium is on the left side of equation. Solving for this quantity, the formula below is derived:

$$Pr = \frac{m PD \times EAD \times LGD}{n(1 - P_{01}) [\Theta_{bu} + \Theta_p 0.5 \Pi_{bu} + \Theta_{ca} 0.5] + \Sigma \Theta_b d/30} \quad (2.2)$$

$$\text{Where } \Sigma = p \sum_{i=1}^{n_1} P_{0i} + \sum_{i=n_1+1}^{n-1} P_{0i}$$

Θ_{bu} = average balance unpaid for each period

Θ_b = average balance for each period

Θ_p = average purchases for each period

Θ_{ca} = average cash advances for each period

d = average number of delinquency days for each period

p = percentage of minimum payment

P_{01} = probability of not paying the first period

P_{ij} = probability of not paying the j -th period given that not paid the i -th period

Π_{bu} = probability of becoming a revolver, $P(\Theta_{bu} > 0)$

n_1 = the period that the credit institution starts legal actions to recover the amount been owed

n = number of examining periods

m = number of periods that the interest rates accrued in a year

PD = probability of default

EAD = exposure at default

LGD = loss given default

3. Model of risk-based annual fee: Case 1

Further details of this formula there are in the relative paper (Stamokostas et al, 2003). One might notice that in the formula (2.2) the annual fee was absent. Actually, this was an implicit assumption that only the premium of interest rate would compensate the expected credit losses. However, relaxing this assumption, the annual fee could also compensate for the expected losses. There are two cases. One case is only the annual fee to compensate for any possible credit losses. The other case is both the annual fee and the premium of interest rate to compensate for the expected credit losses. Algebraically, the equation (2.1) is transformed as follows, according to case 1:

Case 1

$$\text{Annual fee} = \text{expected credit losses} \quad (3.1)$$

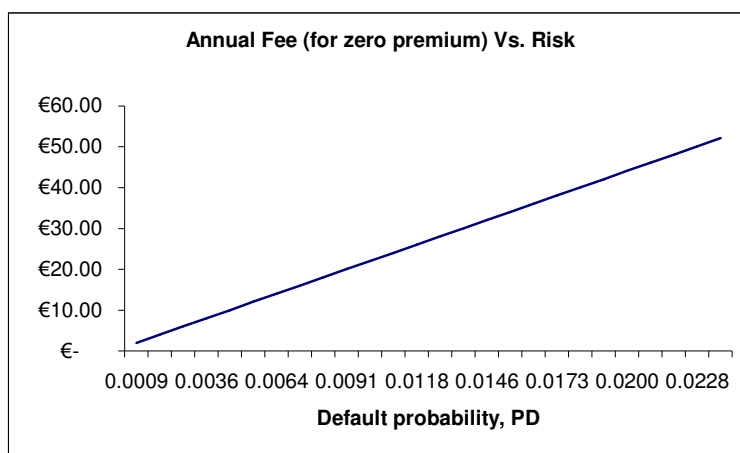
Or

$$F = PD \times EAD \times LGD \quad (3.2)$$

From case 1, an explicit value for annual fee is derived according to the level of possible credit losses. Actually, the annual fee depends on the measures of risk, PD, on the card usage extent, EAD and on the possible recoveries, LGD. It has been implicitly assumed that the premium is zero in that case. That is, all credit card holders are priced with the same interest rate that only covers the funding and operating costs and leave a margin for profit, but doesn't cover any credit losses. These losses are to be covered only by the annual fee.

Figure 3.1, Annual fee Vs. Risk

Risk (Probability of default)	Annual Fee
0.0009	2.00
0.0018	4.01
0.0027	6.01
0.0036	8.02
0.0046	10.02
0.0055	12.02
0.0064	14.03
0.0073	16.03
0.0082	18.04
0.0091	20.04
0.0100	22.04
0.0109	24.05
0.0118	26.05
0.0128	28.06
0.0137	30.06
0.0146	32.06
0.0155	34.07
0.0164	36.07
0.0173	38.08
0.0182	40.08
0.0191	42.08
0.0200	44.09
0.0210	46.09
0.0219	48.10



If a bank uses this simple approach to quote the annual fees to its credit cardholders, will be both benefited one way and suffered from some costs other way. Quoting low annual fees for good customers and /or heavy users, a credit institution motivate them to retain in its portfolio. However, on the side of costs, the credit institution will suffer from some revenues withdrawals, as many credit cardholders express inelasticity with respect to the interest rate (Ausubel, 1991; Ayadi, 1997; Calem & Mester, 1995). That is, if a credit institution doesn't quote any premium for its cardholders, losses all the excess revenues mentioned in the previous section.

Theoretically speaking, customers may be more sensitive to annual fee quoting than the interest rate quoting. The reason is that if a credit cardholder is not a revolver, he or she doesn't pay any interest irrespectively the level of interest rate. However, annual fee must be paid both from revolvers and from non-revolvers. Therefore, quoting even some low annual fee, this could be a motive for a credit cardholder to swift credit institution to enjoy another annual fee-free time period. Moreover, low risk customers that don't use their card too heavily may be quoted with a relative high annual fee and become dissatisfied.

In order to confirm (or reject) this theory a relevant survey will take place. By this survey, among others, the cardholders' sensitivity with respect to annual fee will be examined.

4. Model of risk-based annual fee: Case 2

In case 2 both the interest rate and the annual fee are used in order to cover the expected credit losses. More particularly, the excess profit generated by the premium rate quoted plus the annual fees are equated to the expected credit losses, as the equation (4.1) expresses.

Case 2

$$\text{Expected excess revenues} + \text{Annual fee} = \text{expected credit losses} \quad (4.1)$$

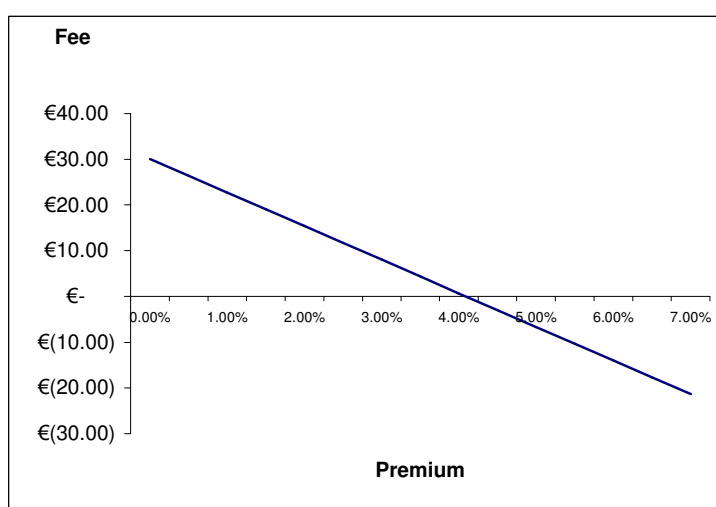
Or

$$F = PD \times EAD \times LGD - \frac{pr}{m} \times [n(1 - P_{01}) (\Theta_{bu} + \Theta_p 0.5 \Pi_{bu} + \Theta_{ca} 0.5) + \Sigma \Theta_b d/30] \quad (4.2)$$

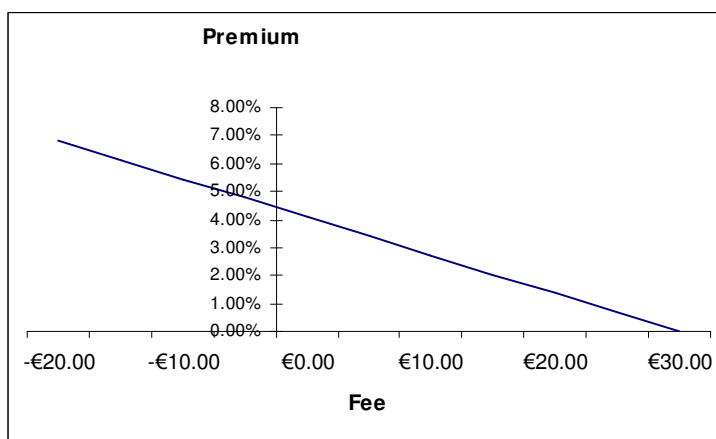
Actually the equation (4.2) represents the relationship between the interest rate premium and the annual fee. That is, for a given level of premium the annual fee is derived and vice versa. Of course, it has been implicitly assumed that the estimates for card usage and risk are constant.

Figure 4.1, Premium Vs. Annual fee and vice versa

Premium	Annual Fee
0.00%	€ 30.06
0.50%	€ 26.39
1.00%	€ 22.71
1.50%	€ 19.04
2.00%	€ 15.37
2.50%	€ 11.70
3.00%	€ 8.02
3.50%	€ 4.35
4.00%	€ 0.68
4.50%	€ (2.99)
5.00%	€ (6.67)
5.50%	€(10.34)
6.00%	€(14.01)
6.50%	€(17.68)
7.00%	€(21.36)



Annual Fee	Premium
-€20.00	6.82%
-€15.00	6.13%
-€10.00	5.45%
-€5.00	4.77%
€0.00	4.09%
€5.00	3.41%
€10.00	2.73%
€15.00	2.05%
€20.00	1.37%
€25.00	0.69%
€30.00	0.01%



In order to construct these table and charts, the parameters of usage and risk had the following values:

$$\Theta_{bu} = 1,300$$

$$\Theta_p = 1,000$$

$$\Theta_{ca} = 100$$

$$\Theta_b = 2,400$$

$$\Pi_{bu} = 0.75$$

$$P_{01} = 0.15$$

$$PD = 0.0137$$

$$EAD = 3.142$$

$$LGD = 0.7$$

From figure 4.1 it is obvious that there is a negative relationship between annual fee and interest rate premium. This is very logical, as the higher the annual fee, the higher the amount to compensate the credit losses and, therefore, there is an opportunity for a lower rate. On the other side, the higher the premium, the higher the excess revenues to compensate the credit losses and, therefore, there is an opportunity for a lower annual fee.

Before closing this section, there is something that should be mentioned. The formulas (3.2) and (4.2) have been derived, assuming that the whole annual fee is charged in order to compensate for credit losses. However, the annual fee, or a part of it, could be alternatively used to cover the funding and /or operating costs. Therefore, formulas (3.2) and (4.2) could alternative derive the premium in annual fee for a given level of annual fee used to cover non-credit losses costs.

5. Models' applications for an effective pricing

In the previous section several pricing schemes were presented. In order to cover the credit losses the bank could offer to the customer a prime rate interest rate (i.e. without premium) with a relative high annual fee or a higher interest rate with a lower annual fee, or even a relative higher interest rate with no annual fee. What was not examined so far was the cardholder actions to those pricing schemes.

The total outcome for the bank in terms of profit depends not only on the quoted interest rate and annual fee, but also on the cardholder transactional behavior. This behavior includes the possibility of the customer stopping using the card or continuing

using it; the possibility of the customer increasing or decreasing the usage of the card in terms of loan amount, purchases amount and cash advances. The customer's behavior depends on his or her personal sensitivity to the changes in interest rates and annual fees. For instance, cardholders that are revolvers may have greater sensitivity to changes in interest rate and lower or even no sensitivity to changes in annual fee. On the contrary, cardholders that are no revolvers probably don't care so much for changes in interest rate, but they may wish to pay low or even no annual fee.

Taking into consideration the previous paragraphs, it is easy to notice that the profit will not be the same for each pricing scheme offered from the credit institution to a certain cardholder. This profit depends not only on the risk and usage profile of a customer, but also on his or her sensitivity to the changes in interest rate and annual fee.

Lets examine a theoretical case of a customer that should be quoted an annual fee as the fee-free period has been expired. The credit institution has three alternatives. The first is to charge an annual fee so that it covers, along with the current interest rate, the credit losses. As the interest rate remains the same, the transactional behavior is considered to remain the same in terms of loan, purchases and cash advances amounts. However, as from now on the customer is obliged to pay an annual fee, he or she has a motive to change card issuer to exploit another fee-free period. In other words, the attrition probability is to increase. Therefore, the expected profit of case one is the following:

$$EP_1 = (1 - PA_1) (CP_1 + F_1) \quad (5.1)$$

Where, PA_1 = attrition rate given the annual fee quoting

CP_1 = conditional profit (without annual fee) given the customer's remaining the same card issuer

F_1 = the annual fee quoted that corresponds to the current interest rate

The attrition probability, PA can be estimated form several methodologies already developed (Mays, 1998; Mays, 2001; McNab & Wynn, 2000; Thomas et al, 2002). The new attrition probability is something higher due to annual fee quoting. The increase of

this probability depends on the cardholder's sensitivity to annual fee. Therefore, the new attrition probability is equal to:

$$PA_1 = PA + \Delta PA_1 \quad (5.2)$$

Where, PA = the attrition probability before the annual fee quoting

ΔPA_1 = the change in attrition probability due to annual fee quoting

This change in attrition probability can be estimated from a survey in cardholders in order to explore their sensitivity in annual fee. This sensitivity can be estimated across several demographic, risk and usage profiles.

The second case includes the quoting of a prime rate (i.e. without risk premium) and a relative high premium fee according to customer's risk and usage profile. It is expected that on the one side the customer is dissatisfied due to high fee quoting, on the other side the customer is satisfied due to low interest rate quoting. He or she may increase his usages rate due to interest rate lowering. Therefore, the expected profit of case two is the following:

$$EP_2 = (1 - PA_2) (CP_2 + F_2) \quad (5.3)$$

Where, PA_2 = attrition rate given the high annual fee and the low interest rate quoting

CP_2 = conditional profit (without annual fee) given the customer's remaining the same card issuer

F_2 = the annual fee quoted that corresponds to the prime interest rate

The new attrition probability is equal to the attrition probability before the annual fee and new interest rate quoting plus a change due to pricing scheme differentiation. Algebraically the formula is:

$$PA_2 = PA (1 + \varepsilon_{PA, i} di/i) + \Delta PA_2 \quad (5.4)$$

Where, PA = the attrition probability before the annual fee quoting

$\varepsilon_{PA, i}$ = the elasticity of attrition probability with respect to interest rate change

ΔPA_2 = the change in attrition probability due to annual fee quoting

The conditional profit is equal to the conditional profit before the new pricing scheme plus a change due to interest rate increase. Algebraically the formula is:

$$CP_2 = CP_1 + \Delta CP_1 \quad (5.5)$$

$$CP_1 = L \times i/12 + \Theta_p \times cr - (C_F + C_O + PD \times EAD \times LGD) \quad (5.6)$$

Where, $L = n(1 - P_{01}) [(\Theta_{bu} + \Theta_p 0.5 \Pi_{bu} + \Theta_{ca} 0.5) + \Sigma \Theta_b d/30]$

$cr =$ net commission rate

When the interest rate changes, then the loanable amount changes. This change depends on the cardholders' elasticities to interest rate change. Algebraically, the conditional profit is equal to:

$$CP_2 = L_2 \times i/12 + \Theta_{p2} \times cr - (C_F + C_O + PD \times EAD \times LGD) \quad (5.7)$$

Where, $L_2 = n(1 - P_{01}) [(\Theta_{bu}(1 + \varepsilon_{bu,i} di/i) + \Theta_p(1 + \varepsilon_{p,i} di/i) 0.5 \Pi_{bu} (1 + \varepsilon_{\Pi,i} di/i) +$

$\Theta_{ca}(1 + \varepsilon_{ca,i} di/i) 0.5) + \Sigma \Theta_b(1 + \varepsilon_{b,i} di/i) d/30]$

$\Theta_{p2} = \Theta_p(1 + \varepsilon_{p,i} di/i)$

There are some methodologies to be developed for estimating these elasticities. However, these methodologies are beyond the scope of this paper. These are part of a future research. The scope of this paper is to present how a card issuer can exploit these behavioral elasticities in order to optimally decide the proper combination of interest rate and annual fee maximizing the expected profit.

In this case the most difficult estimation is the attrition probability. This probability tends to increase due to high fee quoting, but tends to decrease due to prime rate offering. The change of this probability is fully depends on the customer sensitivity to changes in interest rates and annual fee quoting. Customers that are revolvers are expected to express greater sensitivity to lower interest rate offering, rather than to high fee quoting. Therefore, their attrition probability will tend to decrease, along with the increase in usages rates possibly. On the contrary, customers that are no revolvers are expected to be more sensitive to high fee quoting, rather than the low interest rate

offering. Therefore, their attrition probability will tend to increase and their usages rate will not tend to increase so much.

The third case includes a zero fee offering and a relative high interest rate quoting in order to compensate the expected credit loss. A customer will certainly be satisfied due to zero fee obligations, but he or she will be dissatisfied due to relative high interest rate. Therefore, the expected profit of case two is the following:

$$EP_3 = (1 - PA_3) CP_3 \quad (5.8)$$

Where, PA_3 = attrition rate given the zero annual fee and the high interest rate quoting

CP_3 = conditional profit given the customer's remaining the same card issuer

The new attrition probability is equal to the attrition probability before the new interest rate quoting plus a change due to pricing scheme differentiation. Algebraically the formula is:

$$PA_3 = PA (1 + \varepsilon_{PA,i} di/i) \quad (5.9)$$

Where, PA = the attrition probability before the annual fee quoting

$\varepsilon_{PA,i}$ = the elasticity of attrition probability with respect to interest rate change

When the interest rate changes, then the loanable amount changes. This change, as mentioned before, depends on the cardholders' elasticities to interest rate change. Algebraically, the conditional profit for case three is equal to:

$$CP_3 = L_3 \times i/12 + \Theta_{p3} \times cr - (C_F + C_O + PD \times EAD \times LGD) \quad (5.10)$$

Where, $L_3 = n(1 - P_{01}) [(\Theta_{bu}(1 + \varepsilon_{bu,i} di/i) + \Theta_p(1 + \varepsilon_{p,i} di/i) 0.5 \Pi_{bu} (1 + \varepsilon_{\Pi,i} di/i) + \Theta_{ca}(1 + \varepsilon_{ca,i} di/i) 0.5) + \Sigma \Theta_b(1 + \varepsilon_{b,i} di/i) d/30]$

$$\Theta_{p3} = \Theta_p(1 + \varepsilon_{p,i} di/i)$$

Having estimated the behavioral elasticities for each case and the attrition probabilities, the card issuer can estimate from formulas (5.1), (5.3), (5.8) the expected

profit derived for each pricing scheme. The card issuer, then, should select the pricing scheme that gives the maximum expected profit for each customer. This is, actually, a discrete maximization procedure.

6. Conclusions

This paper had to do with the pricing dimension of annual fee on an individual pricing basis. In some previous researches when referring to risk-based pricing or individual-based pricing, it was meant the interest rate dimension and the estimation of the fair premium quotation for each credit card holder new or existing in a credit card issuer's portfolio.

In this paper the research makes one step further by estimating the fair annual fee based on the personal risk and usage profile of each cardholder. After that estimation, the research goes on estimating the fair quotation of both the interest rate premium and the annual fee. Actually, the card issuer has many pairs of premium and annual fee to offer to each customer. In this research three only pairs are proposed to be examined.

The first pair includes the current premium and the corresponding annual fee. The second pair includes zero fee and the corresponding (higher) premium. Finally, the last pair includes zero premium and the corresponding (higher) annual fee.

It is certain that every cardholder will act in different way for each pair offered. Other cardholder are more sensitive in premium changes, other are more sensitive in annual fee changes and so on. For every customer and for each pair the expected profit is estimated, depending on his or her personal behavioral elasticities that affect attrition probabilities and estimated parameters changes. Therefore, for every cardholder three profits are estimated for each pair. The pair that gives the maximum profit is selected to be offered to the cardholder.

This procedure is the same both for new and existing cardholders, as credit card issuers tend to offer for a respective amount of time a fee-free card. Therefore, new cardholders after this respective amount of time have already become "existing" and behavioral data are also available for them.

Another critique of this discrete maximization procedure is that requests the estimation of too many parameters including the behavioral elasticities. It is part of future research to develop and propose some statistical methodologies of fair estimations for all those parameters.

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