Time-varying effects when analysing customer lifetime duration: application to the insurance market

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Abstract: The Cox model (Cox, 1972) is widely used in customer lifetime duration research, but it assumes that the regression coefficients are time invariant. In order to analyse the temporal covariate effects on the duration times, we propose to use an extended version of the Cox model where the parameters are allowed to vary over time. We apply this methodology to real insurance policy cancellation data and we conclude that the kind of contracts held by the customer and the concurrence of an external insurer in the cancellation influence the risk of the customer leaving the company, but the effect differs as time goes by.

1. Introduction

The product-oriented strategy in the insurance industry has prevailed for many decades and it has put much emphasis on the study of financial and actuarial elements. The customer-oriented strategy for insurance products is recent and has motivated a number of research articles concerning the dynamics behind customer loyalty and the demand for insurance products. For example, one can cite studies on habit formation and the demand for insurance (e.g. Ben-Arab *et al*., 1996), consumer perceptions of service quality (Wells & Stafford, 1995 and Stafford *et al.*, 1998), individual portfolio decisions and demand (Mayers & Smith, 1983), household characteristics (Showers & Shotick, 1994), and demand in the presence of other risks (Doherty & Schlesinger, 1983; Schlesinger & Doherty, 1985 and Gollier & Scharmure, 1994).

Customer lifetime duration has received less attention because the relationship between the insurer and the client is complex. Cross-buying behaviour appears in insurance, because a customer may hold several contracts (also called policies) in the same company, covering risks of quite different nature (property and liability, life, health, etc). Customer decisions regarding one type of product may depend on events related to the other products. In this paper, we address the measurement of lifetime duration in the customer-insurer relationship. In previous studies, we concluded that if a customer cancels one policy, he is likely to cancel all his other policies in the short term.

In this paper, we apply new techniques and conclude that once a contract is cancelled, the expected lifetime duration depends on the type of policy that the customer has kept. Moreover, we observe that survival patterns depend on the type of policies that are retained by the customer and other risk factors. In addition, survival patterns change over time. For example, a customer who keeps a policy covering his house contents has a larger expected lifetime with the company than other customers who do not hold that type of contract. These results were obtained using standard statistical methods for survival analysis (the proportional hazards regression model, see Cox, 1972; Li, 1995 and Bolton, 1998). With our methodology we can also determine the time structure and therefore conclude that this survival pattern is only observed during the first three years. Beyond that, the effect is the opposite. So, after three years, a customer who retains a contents policy is more likely to leave the company than other customers.

Our contribution addresses the persistence of these effects on the probability of staying with the company. A classical survival analysis assumes that risk factors have a constant effect over time, but we relax this assumption. One conclusion that is especially interesting for the insurance manager can be drawn from measuring the aggressiveness of competitors. Classical techniques would conclude that if an external insurer is making the cancellation on behalf of the customer, the risk of cancelling the remaining policies is very high, but constant over time. In our analysis, we are able to show that the effect of an external insurer is very considerable at the beginning but dilutes after the first year.

One of the main hypotheses underlying the proportional hazards regression model is that the effects of covariates are constant over time. This is very often assumed without being explicitly tested; therefore, the potentially changing effect of covariates over time is ignored, together with the valuable information that this would provide business managers.

The main objective of this paper is to investigate the time-varying effect of key factors that influence the extent to which customers are loyal to their insurance companies. In our empirical study we specifically consider customers with three different types of non-life insurance policies with the same company and we analyse their lifetime duration upon the first policy cancellation. This is essentially the time the insurance company has to retain a customer who has announced his first policy cancellation. A real dataset provided by a European insurer is analysed by using a methodology that incorporated time-changing effects of covariates in the proportional hazards regression model. This quantitative research is complemented by qualitative considerations in order to support our study design and conclusions, as argued by Gummesson (2005).

Prior to presenting the model, we briefly review in the second section the literature about loyalty and customer lifetime duration analysis. In the third section the insurance dataset used in the empirical application is presented. In the fourth section we describe the research design, including objectives, hypotheses and methodology. Finally, in the fifth section the empirical analysis is presented, including a discussion of our results and the managerial implications that can be derived from this research.

2. Theoretical background

2.1 Customer loyalty

Many authors have stressed that customer loyalty has a clear positive effect on business performance (Reichheld, 1993). Nevertheless, there is considerable discussion in the academic literature over the definition of customer loyalty. There seem to be two basic approaches: the behavioural and the attitudinal approaches. The former is entirely based on repeat purchases while the latter considers positive attitude and commitment toward the brand.

Nowadays, the concept of loyalty considers these two dimensions, the one related to behaviour and the other related to attitude, simultaneously (Day, 1969 and Jacoby & Kyner, 1973). According to Jacoby and Chestnut (1978) and Dick and Basu (1994), the combination of these two components allows identification of true brand loyalty, which is a form of repeat purchase behaviour that reflects a conscious decision to continue buying the same brand and must be accompanied by an underlying positive attitude and a high degree of commitment toward the brand (Beerli *et al.*, 2004).

Customer loyalty has motivated a great number of articles, some of them concerning its antecedents and the role of satisfaction, service quality or switching costs in the construction of customer loyalty (see, for example, Aydin and Özer, 2005; Ball *et al.*, 2004 and Caruana, 2002).

2.1 Customer lifetime duration

Reinartz and Kumar (2003) reviewed previous works concerned with customer lifetime duration modelling. First and foremost, the authors stressed the limitations of several empirical studies (Allenby *et al.*, 1999; Bolton, 1998; Dwyer, 1997 and Schmittlein & Peterson, 1994) due to the general lack of customer purchase history data. Nevertheless, during recent years there has been an increasing availability of longitudinal customer databases and researchers have started to take a longitudinal perspective in their work. Therefore, studies nowadays are mainly focused on the empirical measurement and modelisation of the customer's relationship with the firm (Reinartz & Kumar, 2000).

Regarding methodology, in most of these studies, survival analysis techniques have been used, namely the proportional regression model (Li, 1995 and Bolton, 1998). Helsen and Schmittlein (1993) supported the superiority of survival analysis methods when handling duration-type data. Other methodologies have also been applied, such as the Tobit regression model (Thomas, 2001) and Bayesian models of customer interpurchase time (Allenby *et al.*, 1999).

The datasets used in these empirical studies are concerned with financial brokerage services and mobile and long-distance telephone service, among many others. This information has provided several key results. The model proposed by Li (1995) identified variables (usage, marketing, demographics, etc) that affect the length of customer subscription and made it possible to build profiles of customers with long or short lifetimes in long-distance telephone service.

Bolton (1998) found out that customer satisfaction is related positively to subscription duration in cellular phone service, but prior cumulative satisfaction is weighted more heavily than recent satisfaction in the decision to continue or not. The Bayesian model proposed by Allenby *et al.* (1999) allows managers to forecast when a customer is likely to change his or her purchase patterns in financial brokerage services.

However, very few applications in the insurance market can be cited. Reinartz and Kumar (2003) highlight the contribution of Crosby and Stephens (1987) to the modelisation of satisfaction with the service providers of life insurance. Their results suggest that non-lapsing customers report higher satisfaction than lapsed customers, but insured customers were followed for 13 months only.

Therefore, we conclude that there is a lack of customer lifetime duration studies in the insurance context. Moreover, a more precise investigation regarding the potential time-changing effects of covariates should be addressed in customer lifetime duration studies. This paper makes a contribution in two aspects: the analysis of time-changing effects of risk factors when analysing customer lifetime duration and the analysis of loyalty for clients who have more than one contract with the same insurer.

3. Insurance customer lifetime information

The dataset used in this research consists of a sample of 1,763 households possessing multiple insurance policies, who sent notification of cancellation of their first policy to a Danish insurer between 1 January 1997 and 1 June 2001. The information was collected according to the time frame shown in Figure 1.

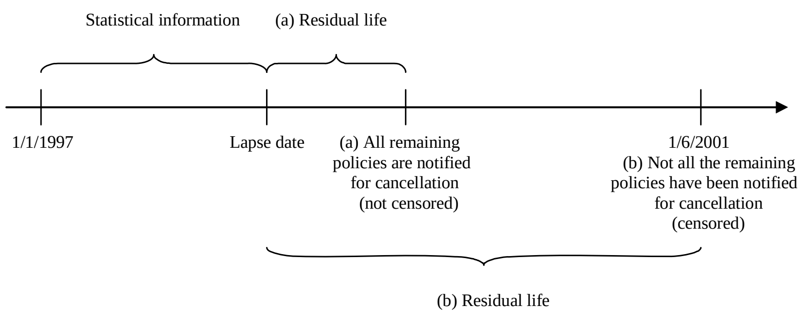

Figure 1. Time frame.

Most of the household covariates refer to the occurrence of an event (a claim, a premium increase, or a change of address) from 1 January 1997 until the date of the first lapse. Once the first policy cancellation occurs, the residual household customer lifetime is measured by the number of days until all remaining policies are notified for cancellation or until the end of the study, 1 June 2001, whichever comes first (some policyholders will cancel one policy but keep others).

In situation (a) in Figure 1, all remaining policies are cancelled before 1 June 2001, so the household customer residual life is the time from the first lapse date until total cancellation of all other policies occurs. At the end of the study, shown in Figure 1 (b), we only know that the residual life is greater than the time from the first lapse until 1 June 2001. In this case, the residual life is listed as the time elapsed from first policy cancellation until 1 June 2001, but note that the observation is right censored.

Table 1 lists the variables in the database and the label given to each one. Since the types of policies held by the household could conceivably affect the retention attributes of the client with respect to the insurer, the following dummy variables were developed: *contents1*, *house1* and *motor1*. They indicate whether the household has contents, house, or automobile insurance policies, respectively, after the first lapse.

Table 1. Variables in the household dataset

Contents1	Contents insurance after cancellation of first policy
House1	House insurance after cancellation of first policy
Motor1	Motor insurance after cancellation of first policy
Address	Change of address prior to cancellation
Claim	Claims
Corecust	Core customer status
Extc	First cancellation notice furnished by any external company

Information on whether a change of address has occurred was included, as it can affect the probability of house and contents cancellations. This information is collected in the dummy variable *address* that is equal to 1 in case of a change of address prior to the first policy cancellation, and 0 otherwise.

Additionally, the data included the occurrence of claims, as they can also affect the probability of lapse. The dummy variable *claim* is equal to 1 in case of a claim prior to the first policy cancellation, and 0 otherwise.

Corecust indicates whether the customer has a core customer status. A core customer is a customer who has a contents policy and at least two other types of policies (they could be automobile, house, or others like life insurance) with the insurer. In the insurance company that has been analysed here, core customers have lower premiums, bonuses, and special advantages. From a marketing perspective, core customers having multiple policies tend to be more profitable and, hence, deserve special consideration.

Finally, considering the competitive nature of the marketplace, and the marketing dynamics of alternative brands in a brand switching model, we have also included information on whether there was any external company involved in the cancellation notification. The customer has a choice of notifying the current insurer him/herself of cancellation or of having the new insurer notify the current insurer. It is clear when the new insurer carries out the notification that a brand switch has already occurred and, at least for that policy, the customer is entrenched with the new insurer for at least the next year. It is also likely that the new insurer will wait until the last moment to signal their competitor of the upcoming brand switch, lest the competitor take measures to try to retain their customer. Further, the new insurer will likely be discussing other insurance policy needs with their newly acquired customer, so subsequent policy cancellations are more likely to occur. Therefore, we included the dummy covariate *extc* that is equal to 1 when there is an external company involved in the first cancellation, and 0 otherwise.

4. Research design

4.1 Objectives

This paper has two basic objectives related to customer lifetime duration in insurance. Firstly, by using a proportional hazards regression model with time-varying coefficients, we look for empirical evidence of covariates having a significant effect on the risk of cancelling all remaining policies. Secondly, we investigate the time-changing effect of factors that make a significant contribution when explaining the risk of cancellation.

The covariates included in the model have been chosen because of their potential influence on the risk of cancelling all remaining policies. *Address* identifies whether or not a customer has changed his address before the first cancellation occurs. When a customer is buying a house, the bank financing the acquisition usually tries to persuade the customer to move his policies to their own insurance branch or company with which they have some business agreement. This is especially notable in the case of contents and house insurance, but it can also affect motor insurance. Therefore, we expect to observe that changes of address are associated with higher risk of cancelling all remaining policies, and therefore shorter customer lifetime duration.

The occurrence of a claim and the way the insurance company handles claims and compensations may affect customer lifetime duration. This claim event implies that the insurance company has to provide the service the insured is paying for, and this service includes many more elements than simply economic compensation, for example, assistance in the moment when the claim occurs, and an efficient claim reporting and handling process. If the customer feels that the insurer is not doing what was promised in the contract, he may reconsider his insurance commitment to that insurer. Schlesinger and

Schulenburg (1993) analysed the German automobile insurance market and found that for customers changing insurers, 52.5% of claims filed with previous insurers took three weeks or longer to get paid, while only 29.6% of those customers who filed a claim with the new insurer had to wait that long. Nevertheless, we should keep in mind that the premium for the following period normally increases when a claim is reported. In the case of a bad claim history, the insured may have to pay a very expensive premium in the new insurance company and could decide not to change insurers. Therefore, it is not easy to formulate a hypothesis regarding the influence of claims on customer lifetime duration, but it is reasonable to think that its effect might vary over time, especially when the final resolution of the compensation of claims takes a long time.

Regarding external companies, once the first policy is moved to the new insurer, the new insurer normally tries to attract the customer's other policies as well. Therefore, it is expected that, when an external company is involved in the first cancellation, the remaining policies are more likely to be moved to the new insurer than in the case when no external company is involved.

Concerning the types of policies the customer may keep after the first cancellation (*contents1*, *house1* and *motor1*), it is not easy to formulate a hypothesis regarding their influence on customer lifetime duration. It is well known that the motor line of business has traditionally registered a great number of policy cancellations, and switching insurers is nowadays especially frequent in that line of business (Schlesinger & Schulenburg, 1993). Accordingly, we may expect that keeping the motor policy after the first cancellation would reduce customer lifetime duration compared to the other two lines of business. Nevertheless, this effect may vary over time, especially if we take into account that customer lifetime duration is measured by considering all three lines of business simultaneously.

Finally, regarding the covariate that identifies core customers, our hypothesis is that those with a core customer status with the insurance company would have a longer lifetime duration, as they have special advantages such as bonuses and lower premiums. Nevertheless, this effect is not necessarily constant over time and therefore its potential time-dependency should be investigated.

More specifically, the above-mentioned general objectives require these seven hypotheses to be tested:

H1. The effect of a change of address on the risk of cancelling all remaining policies changes over time: its contribution to increasing that risk is greater during the initial months after the first cancellation.

H2. The effect of a claim occurrence on the risk of cancelling all remaining *policies changes over time.*

H3. The effect of an external company on the risk of cancelling all remaining policies changes over time: its contribution to increasing that risk is greater during the initial months after the first cancellation.

H4. The effect of keeping the contents policy on the risk of cancelling all remaining policies changes over time.

H5. The effect of keeping the house policy on the risk of cancelling all remaining policies changes over time.

H6. The effect of keeping the motor policy on the risk of cancelling all remaining policies changes over time.

H7. The effect of having a core customer status on the risk of cancelling all remaining policies changes over time: its contribution to reducing that risk is greater during the initial months after the first cancellation.

In order to test these hypotheses, we will consider four models. The first three of them include *addres*, *claim* and *extc* as covariates and additionally *contents1*, *house1* and *motor1,* respectively. They have been proposed basically to compare the effect of keeping different types of policies after the first cancellation. In the fourth model we consider covariates *addres*, *claim*, *corecust*, *extc* and *motor1* As the motor insurance line of business has traditionally suffered a higher frequency of cancellations, in the last model we analyse the effect of keeping that type of policy where *corecust* appears as an additional risk factor.

4.2 Methodology

The changing effect of covariates over time in a causal model is a main issue in survival analysis. Even when the model seems to provide an adequate description of the covariate effect, it is useful to carry out some procedure to investigate whether or not the effect of a covariate changes over time.

In Andersen *et al.* (1993) and Martinussen and Scheike (2006), we can find a summary of the approaches traditionally used for this purpose arising from the Cox proportional hazards model (Cox, 1972). According to this model, the intensity is specified as follows:

$$\lambda_i(t) = Y_i(t)\alpha_0(t)\exp(\beta^T Z_i) \qquad (1)$$

where $Y_i(t)$ is an indicator equal to 1 if the subject is at risk and zero otherwise, $\alpha_0(t)$ is the baseline hazard, $Z_i = (Z_{i1},...,Z_{ip})$ is the *p*-dimensional vector of covariates (which may also be time-dependent) and β is the *p*-dimensional vector of unknown regression parameters.

The following extension of the Cox model has been studied by a number of authors, Murphy and Sen (1991) and Grambsch and Thearneau (1994) among many others:

$$\lambda_i(t) = Y_i(t)\, exp\left[\beta(t)^T Z_i(t)\right] \tag{2}$$

where $Z_i(t)$ are *p*-dimensional covariates and $\beta(t)$ denote the associated regression coefficients. When the first covariate is constant and equal to one $Z_{i1}(t)=1$ the model contains a baseline $\alpha_0(t)$ that is parametrised as $exp[\beta_1(t)]$. Martinussen *et al.* (2002) generalised the previous model to allow that some covariates have constant effects; therefore, they formulate the following model:

$$\lambda_i(t) = Y_i(t)\, exp\left[\beta(t)^T Z_i(t) + \gamma X_i(t)\right] \tag{3}$$

where $Z_i(t)$ and $X_i(t)$ are covariates of dimension p_1 and p_2, respectively, and $\beta(t)$ and γ denote the associated regression coefficients. Martinussen *et al.* (2002) remark that some effects may not depend on time and should therefore not be fitted as general non-parametric regression functions. The same authors recommend starting with the model where all the covariates are allowed to have time-varying effects, and provide tests to decide if these effects are in fact time-varying (see Martinussen *et al.*, 2002, and Scheike & Martinussen, 2004). The corresponding test statistics are based on the asymptotic analysis of the cumulative regression functions in model (3).

The multiplicative model (3) that is an extension of Cox's regression model can supply the needed flexibility to describe the time-dynamics for many applications. One problem, however, is that fitting the model requires smoothing and the results and subsequent test will depend on the choice of this smoothing parameter. Another problem is that the studied rate/intensity may not be multiplicative. Sometimes the model is better described as being additive and one can then fit the additive risk model by McKeague and Sasieni (1994) (see also Martinussen and Scheike, 2006) where

$$\lambda_i(t) = Y_i(t)\left[X_i^T(t)\beta(t) + Z_i(t)\gamma\right]. \tag{4}$$

This model is considerably easier to fit and requires no smoothing when estimating $B(t) = \int_0^t \beta(s)ds$ and γ. One clear advantage of working with the additive model is that it is much easier to estimate the survival probability using this model since it is a direct function of $B(t)$ and γ. For fixed X_0 and Z_0 the survival predictions are $P(T > t \mid X_0, Z_0) = exp\left[- X_0^T \beta(t) - Z_0^T t\gamma\right]$.

5. The empirical analysis

The results for the five models considered here have been obtained with the *timereg* [1] R package and they are presented in Tables 2 to 5.

5.1 Model 1

According to results provided in Table 2, *address*, *extc* and *contents1* have a significant effect when explaining the risk of cancelling all remaining policies after the first cancellation. On the other hand, *claim* does not have a significant effect.

Table 2. Results for Model 1.

	Test for non-significant effects		Test for time-invariant effects	
	Test statistic	p-value	Test statistic	p-value
(intercept)	11.00	0.000	7.30	0.000
address	3.52	0.004	3.38	0.018
claim	2.60	0.252	2.71	0.140
extc	16.80	0.000	3.26	0.026
contents1	6.31	0.000	4.18	0.000

If we now test whether or not these effects are constant over time, we conclude that *contents1* clearly has a time-changing effect on the risk of cancelling all remaining policies, while *extc* and *address* only weakly so; the test statistics also reveal that the non-significant test statistics are due to some weak effects at the edges.

The cumulative parameters and test processes shown in Figures 2 and 3 let us conclude that the overall effect of address is positive (contributing to a higher risk of cancellation) except for short periods during the first year as well as around t = 2.5 and t = 4 years. The effect of *extc* is always positive, but it is greater during the initial months after the first cancellation. This is clearly indicated by the test process for the factor *extc*. On the other hand, *contents1*

[1] Scheike, T. H. (2006), "Timereg semi-parametric timevarying regresión for R", available at http://staff.pubhealth.ku.dk/~ts/timereg.html.

has the opposite effect. During the first three years after the first cancellation it contributes to a lower risk, and beyond this time point it seems to contribute to increasing the risk.

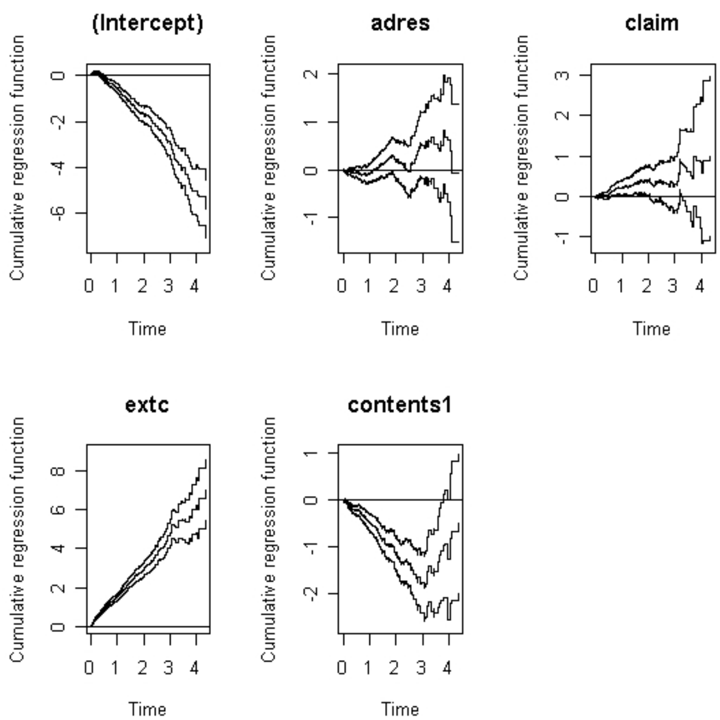

Figure 2.Cumulative parameter estimates for Model 1.

5.2 Model 2

In Table III, we have the results for the second model. In this case, we see that *extc* and *house1* have a significant effect when explaining the risk of cancelling all remaining policies after the first cancellation. On the contrary, *address* and *claim* do not have a significant effect.

When testing whether or not these effects are constant over time, our conclusion is that *extc* and *house1* have a time-changing effect on the risk of cancelling all remaining policies. According to the cumulative parameters and test processes shown in Figure 4, the effect of *extc* is again positive (contributing to a higher risk of cancellation), but it is much greater for small *t*'s. On the other hand, we observe that *house1* has a negative overall effect, but its contribution to reducing the risk is much greater during the initial months after the first cancellation. Nevertheless, the effects are almost constant and in this case, the Cox model would give quite accurate predictions.

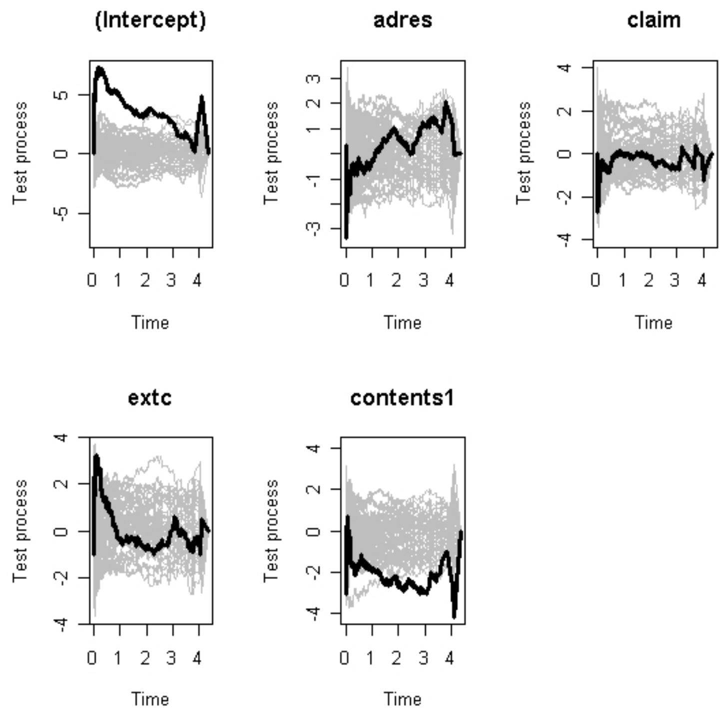

Figure 3.Test processess for Model 1.

Table 3. Results for Model 2.

	Test for non-significant effects		Test for time-invariant effects	
	Test statistic	p-value	Test statistic	p-value
(intercept)	16.20	0.000	7.80	0.0000
address	3.09	0.078	2.66	0.1800
claim	3.18	0.064	2.29	0.3980
extc	17.20	0.000	4.28	0.000
house1	6.68	0.000	6.12	0.000

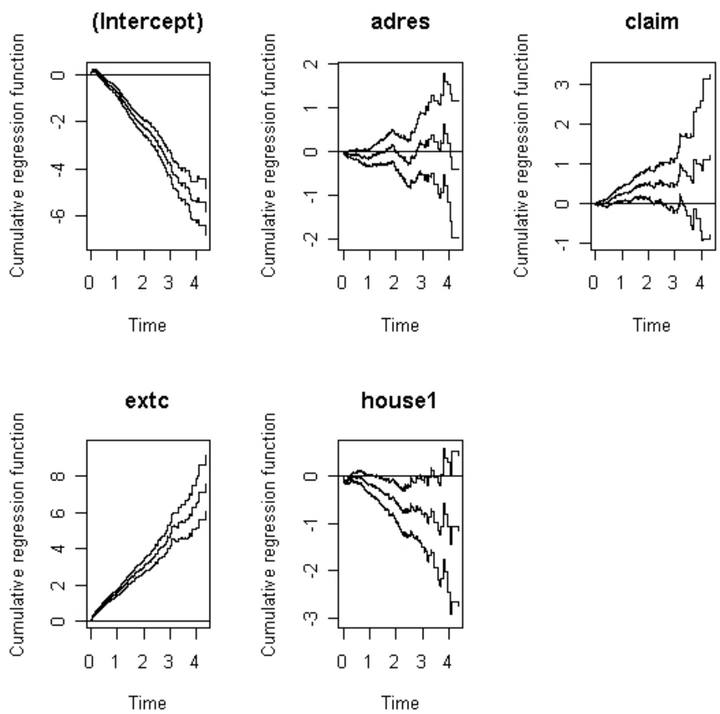

Figure 4. Cumulative parameters Model 2.

5.3 Model 3

According to the results given by model 3 (see Table 4), we see that *extc* and *motor1* have a significant effect when explaining the risk of cancelling all remaining policies after the first cancellation.

We also conclude that *motor1* clearly has a time-changing effect on the risk of cancelling all remaining policies while *extc* only weakly so. If we observe the cumulative parameters shown in Figure 5, we see that *extc* contributes to a higher risk of cancellation, but this effect seems to be greater during the initial months after the first cancellation.

Regarding *motor1*, we see that it has a positive effect during the first three years after the first cancellation; therefore, it contributes to increasing the risk. After three years, its effect is the opposite; it contributes to reduce the risk of cancelling all remaining policies.

Table 4. Results for Model 3

	Test for non-significant effects		Test for time-invariant effects	
	Test statistic	p-value	Test statistic	p-value
(intercept)	20.40	0.0000	6.43	0.000
addres	2.56	0.2960	2.60	0.218
claim	2.55	0.3160	2.63	0.200
extc	17.10	0.0000	3.70	0.012
motor1	4.66	0.0000	5.30	0.000

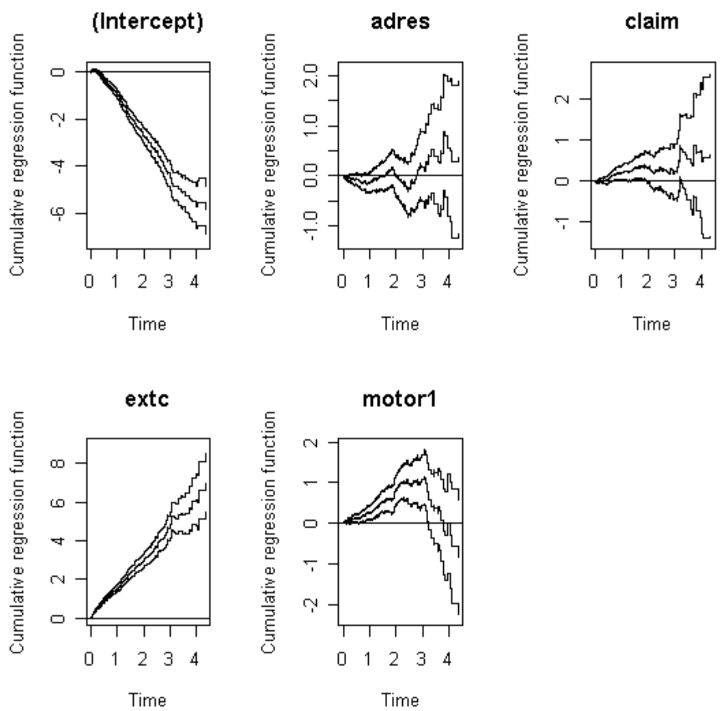

Figure 5. Cumulative parameters Model 3.

5.4 Model 4

In Table 5, the results for the last model are displayed. We observe that factors having a significant effect when explaining the risk are: *corecust*, *extc* and *motor1*.

Again, *motor1* clearly has a time-changing effect on the risk of cancelling all remaining policies and *extc* only weakly so. Additionally, it is important to remark that *corecust* tends to increase the risk of cancellation immediately after the first cancellation (see Figure 6) while after this initial period it seems to have the opposite effect, as it contributes to reducing the risk of cancellation. Nevertheless, the null hypothesis of constant effect cannot be rejected for this factor.

Table 5. Results for Model 4

	Test for non-significant effects		Test for time-invariant effects	
	Test statistic	p-value	Test statistic	p-value
(intercept)	23.90	0.000	5.49	0.000
addres	2.30	0.498	2.24	0.458
claim	2.69	0.202	2.60	0.208
corecust	3.39	0.032	2.71	0.146
extc	16.60	0.000	3.92	0.004
motor1	4.63	0.000	4.94	0.000

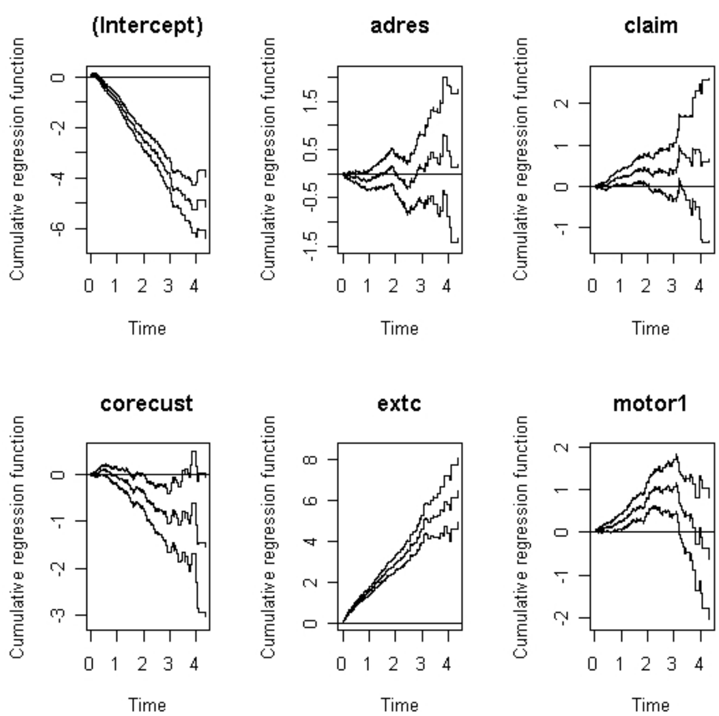

Figure 6. Cumulative parameters Model 4.

6. Discussion and managerial implications

Evidence of time-changing effects of factors explaining customer lifetime duration in insurance have been found. Firstly, the involvement of external companies in the first cancellation is always associated with a reduction in customer lifetime duration. Moreover, the contribution this makes to increasing the risk of cancelling all remaining policies is greater during the initial months after the first cancellation.

Secondly, regarding each type of policy the customer may keep after the first cancellation, we found that, during the first three years after the first cancellation, the effect of keeping the contents policy contributes to increasing customer lifetime duration, while motor has the opposite effect, instead reducing customer lifetime duration. Therefore, content is protective against policy cancellation during the first three years. On the other hand, after the first three years, the effects of contents and motor switch: contents contributes to reducing customer lifetime duration while motor now increases the length of time the customer stays with the insurance company.

The house policy, generally speaking, contributes to increasing customer lifetime duration, especially during the initial months after the first cancellation. Nevertheless, this effect suddenly changes around 6 months and the change lasts for approximately 6 months. During this period it contributes to reducing customer lifetime duration.

These findings have several managerial implications. Firstly, customer loyalty during the first three years after the first policy cancellation seems to be linked to the contents and house policies. Therefore, customers keeping these types of policies are expected to stay with the company for a longer period of time than those keeping the motor policy. This fact lets us identify two general subsets of customers to which the company should address different retention strategies: those who keep their motor policy and those who do not keep that type of policy.

Additionally, our results let us conclude that the months immediately following the announcement of the first cancellation are especially important because the intensity of effects are, generally speaking, greater during this initial period. Special attention should be paid to customers keeping the motor policy, who have a higher risk of cancelling all remaining policies especially shortly after the first cancellation.

At the same time, the company should also take care of those customers keeping the house policy, especially during the first year after the first cancellation, as this seems to be one of the periods when these customers are more likely to cancel all remaining policies. Regarding the customers keeping the contents policy, the company should take into account that this is the group with the highest loyalty, showing a clear tendency to stay with the company for a longer time after the first cancellation.

Finally, for customers keeping two types of policies, the company should basically distinguish between those keeping the motor policy and those not keeping that policy, because, according to our results, it seems these two groups can be expected to have completely different behaviour over time.

The main contribution of the methodology proposed here is to identify which customers present a high risk of cancelling all remaining policies and what the evolution of that risk is over time. Nevertheless, this research has been limited to a particular period of the customer lifetime with the insurance company: from the first policy cancellation until the moment when all remaining policies are cancelled. Therefore, our conclusions cannot be extended beyond that context. At the same time, even though the dataset comes from a major Danish insurance company, our objective was to illustrate how to implement this methodology in a particular company with its own customer retention problems, problems which may nevertheless be quite similar to those found in other European insurers.

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