

Policyholder Surrender Behaviors under Extreme Financial Conditions

Changki Kim¹

¹Australian School of Business, The University of New South Wales

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Abstract

We model surrender rates with a few explanatory variables such as the difference between reference market rates and product crediting rates, the policy age since the contract was issued, unemployment rates, economy growth rates, and seasonal effects using logit function. We investigate the policy holder surrender behaviors of US single premium deferred annuities (SPDA) and Korean interest indexed annuities under extreme financial conditions.

Keywords: Surrender/Lapse rate model, extreme financial conditions, surrender rate changes.

1. Introduction

Modeling appropriate interest rate sensitive surrender/lapse rates is essential in managing the assets and liabilities of insurance companies. Even though there are a few research papers on the interest sensitivity of the cash flows, the analysis is focused usually on asset sides. For example, in Pesando (1974), the cash flow analysis considers the prepayment rate impacts only. But we have to mention that the interest sensitivity of cash flows through surrender rate fluctuations is a kind of “dual problem” through the prepayment rate fluctuations. So it is important to consider surrender rate impacts on cash flow analysis with proper surrender rate models.

There are many factors affecting surrender/lapse rates such as the difference between reference market rate and policy crediting rate, seasonal effect, age and gender of clients, economy growth rate, foreign exchange rate, inflation rate, policy age since issue date, and unemployment rate. Kim (2005a) presents surrender rate models with explanatory variables such as the difference between reference rates and crediting rates, policy age since issue, financial crises, unemployment rates, economy growth rates and seasonal effects. He uses the logit function and the complementary log-log function in modeling surrender rates and shows that the logit model and the complementary log-log model are generally better than the existing surrender rate models such as the arctangent model. He also shows that the surrender rate models are different according to insurance policy types and finds the proper surrender rate models for the four insurance groups: protection plans, education plans, endowment and annuities.

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¹Actuarial Studies, Australian School of Business, The University of New South Wales, Sydney NSW 2052 Australia. Email: c.kim@unsw.edu.au.

The surrender rate level has significant influences on the cash flows of assets and liabilities. To reflect the exact impacts of surrender rate in asset/liability management(ALM) framework, it is inevitable to consider and devise a proper surrender/lapse rate model. Kim (2005b) investigates the surrender rate impacts on the value, the duration, and the convexity of interest indexed annuities.

This research is focused on modeling the policyholder surrender behavior under extreme financial events and this is the difference from Kim (2005a) which investigates surrender rate models generally. For this, we use Korean surrender rates during the period from 1997 to 2002 including the financial crisis in Asia. The other objective of this paper is to predict the policyholder surrender behavior under the assumption that there occurs an extreme financial shock. For this, we use US surrender rates during the same period from 1997 to 2002. Considering the world wide financial crises triggered by the sub-prime mortgage securities in US, this research would raise an important issue on the policy holder surrender behaviors under the financial crises environment.

We define the extreme financial conditions to be considered and quantify their impact on policyholder surrender behaviors. First we gather data in order to understand and quantify the causes of lapse behavior under extreme conditions. The sources of this data include large US insurance writers and Korean data. We consider surrender rate models reflecting the complicated policyholder surrender behaviors with endogenous and exogenous multi-variables. We use the logit model to describe the surrender rate experiences of Korean interest indexed annuities and US single premium deferred annuities. We try to model surrender rates with a few explanatory variables and predict policyholder surrender/lapse behaviors under extreme financial conditions. This will help the insurance industry to predict the policy holder surrender behaviors and manage risks from sudden rising surrender events under extreme financial crises.

2. The Structure of Single Premium Deferred Annuities

Many insurance companies are selling single premium deferred annuities(SPDA). However, SPDA are sold with the primary focus on accumulation. Only a few of the policy holders purchase SPDA for the purpose of annuitization. In Korea, the annuity market is still young and growing slowly compared to that of the United States(US). The SPDA crediting interest rates are declared each month/year by the issuing companies. Although that is the predominant structure in Korea, other variants such as multiple-year guarantees and interest-indexed annuities(IIA) are also popular.

The distinctive features of SPDA are the surrender options and annuitization options. The purchasers of SPDA can surrender at any time before annuitization if the new money rates (or competitive market rates) move to their advantage with reasonable surrender charges. Kim (2009) discusses the valuation of the surrender options in interest-indexed annuities(IIA). At the date of annuitization, they may also select one type of annuity out of four choices: lump sum of their account value, whole life annuity, fixed term annuity, or inheritance annuity. They might terminate the contract with the lump sum withdrawal of their account value. Selecting whole life annuity, the annuitant receives annuities as long as he/she is alive with ten year fixed annuity guarantees. The annuitant of an inheritance annuity receives only the interest of the account value each year while he/she is alive, and the principal account value at the time of annuitization will be given to the heir/heirress when the annuitant dies.

For Korean IIA, we consider 7 year interest indexed annuities. The death benefits are the account value plus 10% of the premium and another 10% of the premium in the case of accidental death.

For US SPDA, we consider multiple annuity products with different surrender charge schedules. An

example of the products is the 7 year fixed annuity SPDA, and its interest rate may be reset each year at the end of each anniversary. After the first policy year, the policy-owner may surrender up to 10% of the total account value each year without a surrender penalty, with the excess over 10% subject to surrender charges. On full surrenders, the first 10% is penalty-free. Upon confinement in a nursing home/hospital for at least 60 days, some or all of the fund value may be withdrawn, provided it is within 90 days after the end of confinement. The death benefits are the full fund value. Annuitizations are permitted starting in the first policy year, with no surrender charges provided the pay-out is for at least 5 years. For various characteristics and valuation of SPDA, we may refer to Society of Actuaries (1991), Cox *et al.* (1992) and Asay *et al.* (1993).

2.1. Crediting interest rates

Crediting interest rates may be reset each year at the end of each anniversary for the fixed annuity SPDA. Many contracts guarantee a minimum interest rate below which the renewal crediting interest rates will not fall. For Korean IIA, the crediting interest rates are announced every month based on current market interest rates, current investment gain rates, and the expected future portfolio income gain rates. The main factor of the crediting rates is the market interest rates and this is why they call the products interest-indexed annuities.

The majority of contracts guarantee interest for one-year periods; however, longer guarantees are available, with 5-years being the most popular. After the initial 5-year guarantee, the contract might (a) automatically roll into another 5-year guarantee at current rates, (b) automatically switch to annual guarantees, or (c) give a choice between the two. The longer guarantees have gained increasing popularity as some purchasers and salespersons have gotten uncomfortable with “trust me” annual interest declarations.

2.2. Surrender charges

Many contracts credit the full premium to the account value and assess surrender charges when the policy holder surrenders. The amount of surrender charges are usually from 7% to 10% of the account value and decreased to zero over a 6–10 year period. The range of surrender charges of different companies may be higher or lower and the penalty periods may run for shorter or longer. For Korean IIA, we consider surrender charges from 7% of the account value and decreased to zero over a 6 year period. For US SPDA, we consider multiple annuity products with different surrender charge schedules. An example of the surrender charge schedule is 7%, 7%, 7%, 7%, 6%, 4%, 2% of the account value in years 1–7, 0% thereafter.

Usually the maximum initial surrender charge on an SPDA is about 10% and decreased by 1% annually. Surrender charges are generally waived for certain withdrawals, which are called free partial withdrawals. On full surrenders, the first portion of the account value, for example 10%, is penalty-free.

2.3. Free partial withdrawals

A portion of the account value can be withdrawn at any time without surrender charges to provide liquidity to the contract owner. The maximum level is 90% of the account value at the time of partial withdrawal, but a few companies might limit the maximum level significantly lower than 90% of the account value. For example, after the first policy year, the policy-owner may surrender up to

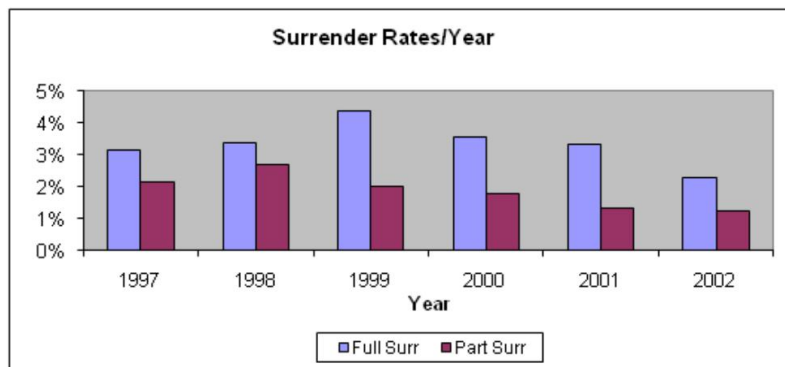


Figure 2.1. Full and partial surrender rates of US-SPDA/Year
(Source: The surrender rate data of US insurance companies provided by the Risk Management Task Force of Society of Actuaries for the Policyholder Behaviors in the Tail Subgroups Project.)

10% of the total account value each year without a surrender penalty, with excess over 10% subject to surrender charges. Often the policy holders can take advantage of this partial withdrawal option several times a year. For example, when the stock markets show signs of an upward jump, the policy holders can withdraw their savings from the account without any surrender charges and invest this amount of money in the stock markets. After enjoying the profits from the stock market, they can return to their insurance contracts paying relatively low interest. So this characteristic of high maximum level of partial withdrawal without surrender charges is a source that one might overuse the partial withdrawal option. For some contracts, upon confinement in nursing home/hospital for at least 60 days, some or all of fund value may be withdrawn, provided it is within 90 days after end of confinement.

Figure 2.1 shows the full surrender rates and partial surrender rates of US insurance companies from 1997 to 2002. The average partial surrender rate is about 1.9% each year and relatively high compared to the average of the full surrender rate, 3.4% each year. Moreover, the death benefit amount is still guaranteed during the partial withdrawal period.

2.4. Death benefits

Usually the death benefit is the account value. A few variations of death benefits are considered according to the company, for example, the account value plus 10% of premium, and another 10% of premium in the case of accidental death. Some contracts allow the spouse to take over ownership of the contract at the time of death of the owner if the spouse was a beneficiary.

2.5. Annuitization

The policy holder can choose the initial annuitization date. The owner may change it before the chosen initial annuitization date. Annuitizations are permitted starting in the first policy year, with no surrender charge provided the payout is for at least 5 years for some US SPDA. For Korean IIA, the range of the initial annuitization date is from age 45 to age 70 and usually 10 years after issue. Guaranteed annuitization rates may be announced by the company, but these rates are really conservative. The crediting rates reflect the current market rates and portfolio income gain rates

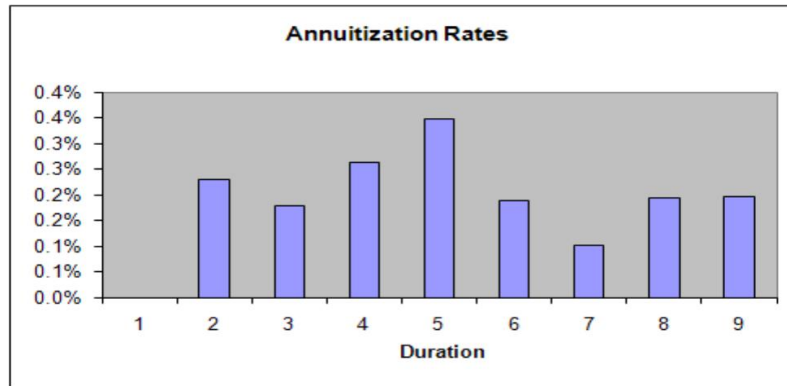


Figure 2.2. Annuitization rates of US-SPDA/Duration

(Source: The surrender rate data of US insurance companies provided by the Risk Management Task Force of Society of Actuaries for the Policyholder Behaviors in the Tail Subgroups Project.)

with minimum guaranteed rate of 3%. But the guaranteed annuitization rates may be based on the minimum guaranteed rate of 3% plus very conservative bonus. Some policy holders prefer minimum rate of return guaranteed products. The mortality may be mildly conservative reflecting annual improvement factors, in recognition of anticipated future mortality reductions.

Approximately less than 2% of deferred annuity values are annuitized each year in both Korea and US. There are several factors for this low annuitization ratio. The main reason is that much of the business is still young and could be considered too early for annuitization. Many purchasers want to pass their annuity accumulation values to their heirs at death. The other reason is that many purchasers do not want to give up control of their investment and, consequently, prefer to take partial withdrawals in lieu of annuitization. Figure 2.2 shows the annuitization rates of US SPDA according to the duration.

3. Modeling Surrender Rates for Korean Interest Indexed Annuities and US SPDA

We have seen that the SPDA/IIA product provides the policy holder with a surrender option that he/she may surrender the contract early with specified surrender charges. As market rates rise, we might think that the SPDA/IIA owners would surrender their contracts and reinvest the surrender cash value in high yielding alternatives. But the surrender option may not be exercised by every policy holder even though the market rates rise. That is, it is not exercised optimally. As we show below, the surrender option is not a function of the interest rate only. It depends on the policy age since the contract was issued. It also reflects the unemployment rate and the economy growth rate. Actually the surrender tendency varies between policy holders. So we have to model the policy holder surrender behavior statistically. The variables considered are (a) the difference between the reference new money rates (or market rates) and the product crediting rates with surrender charges, (b) the policy age since the contract was issued (or the duration), (c) unemployment rates, (d) economy growth rates and (e) seasonal effects.

Especially the duration, *i.e.* the policy age since the contract was issued, is one of the most important factors of surrender rates. Figure 3.1 shows the surrender rates of US SPDA according to the duration. The policy is seven year fixed SPDA. For the first five years, the surrender rates are

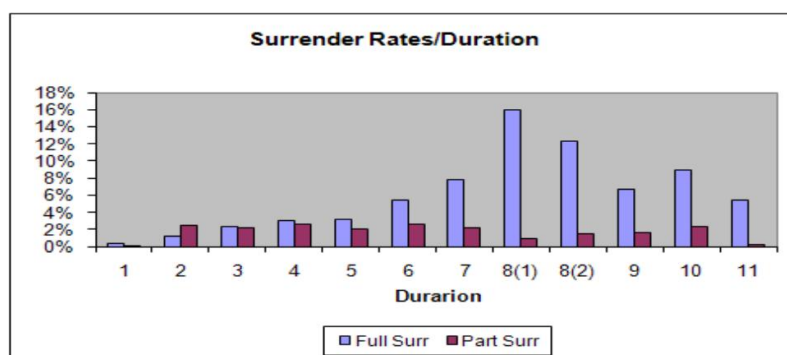


Figure 3.1. Surrender rates of US-SPDA/Duration
(Source: The surrender rate data of US insurance companies provided by the Risk Management Task Force of Society of Actuaries for the Policyholder Behaviors in the Tail Subgroups Project.)

increasing slowly. The surrender rates on the 6th and 7th years are relatively high. Duration 8(1) is first 3 months of the 8th contract year, and the surrender rates are almost 16%. Duration 8(2) is months 4–12 of the 8th contract year, and the surrender rates are almost 14%. We can notice that almost 30% of the contracts are withdrawn on the 8th contract year, right after the accumulation period, 7 years.

Figure 3.2 and 3.3 show the relationships between the unemployment rates, the market interest rates and the surrender rates of Korean IIA. We can easily notice that the unemployment rates, market interest rates, and the surrender rates soared up rapidly during the financial crises, from December 1997 to December 1998.

We can conjecture that the surrender rates are dependent not only on interest rates but also on exogenous factors such as unemployment rates, economy growth rates and seasonal effects.

We use logit link function in modeling the surrender rates of Korean IIA and US SPDA. We can use logit functions for odds and probability functions. There are many examples in which logit functions are used for financial data analysis. Hall (2000) compares logit analysis of data to the results from his prepayment model. Pinder (1996) demonstrates how multinomial logit models can be used in a decision analysis framework to estimate expected monetary value. Kolari *et al.* (2002) use the parametric approach of logit analysis to predict large commercial bank failures. We may refer Johnsen and Melicher (1994) and Lo (1986). For modeling surrender rates we consider the logit function,

$$\ln\left(\frac{q_s}{1-q_s}\right) = \beta_0 + \beta_1 V_1 + \cdots + \beta_n V_n, \quad (3.1)$$

where q_s is the surrender rate (subscript s denotes surrender), β_i is the coefficient to be estimated and V_i is the explanatory variable.

We can model surrender rates considering the duration (policy age since issue date) of a contract. One way is to model surrender rates for each duration. This will help analyze and manage the surrender rate risks according to policy duration. For more details see Kim (2005a). As shown in Figure 3.1, we notice that almost 30% of the contracts are withdrawn on the 8th contract year, right after the accumulation period, 7 years. For Korean IIA the surrender rates are high for 3 year duration contracts. So for illustration purposes, we model surrender rates with the following logit

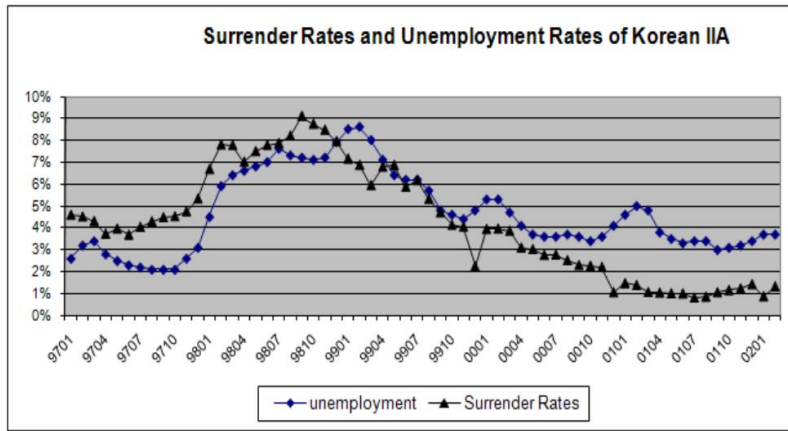


Figure 3.2. Surrender rates and unemployment rates of Korean IIA
 (Source: Unemployment Rate; Korea National Statistical Office (www.nso.go.kr))

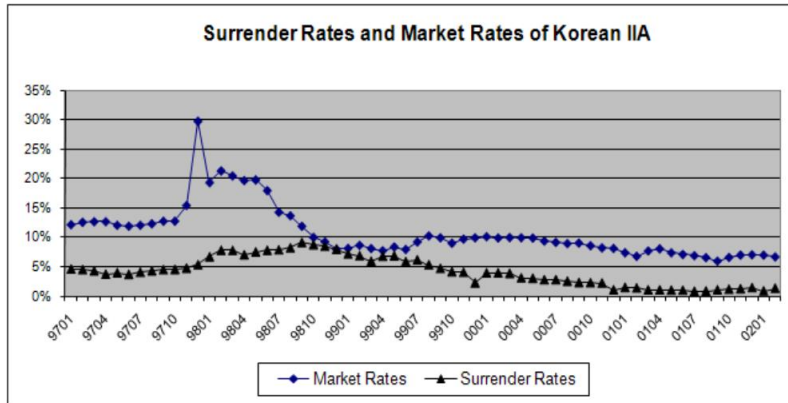


Figure 3.3. Surrender rates and market interest rates of Korean IIA
 (Source: Market Rates; 5 year government bond rates; The Bank of Korea (www.ecos.bok.or.kr))

function using Korean IIA surrender rates with 3 year duration and US SPDA surrender rates with a 5 year duration.

$$\ln \left(\frac{q_s(t)}{1 - q_s(t)} \right) = \beta_0 + \sum_{j=0,2,4,6,8,10,12} \beta_j * (i_m(t - j) - i_c(t - j)) + \beta_{UE} * i_{UE}(t) + \beta_{EG} * i_{EG}(t) + \sum_{j=1}^{11} \beta_{month-j} * DV_j, \quad (3.2)$$

where $q_s(t)$ denotes the monthly surrender rate at month t , i_m, i_c, i_{UE}, i_{EG} denote market reference rate, crediting rate, unemployment rate, economy gross rate respectively, and DV_j denotes the seasonal effect dummy variable. There exists relationship between the explanatory variables. Kim (2005b) considers the relationship to project the variables using a cascade method and model the surrender rate.

Table 3.1. Parameter estimates with Logit model(IIA)

Analysis of Maximum Likelihood Estimates			
Parameter	Estimate	Standard Error	Pr > ChiSq
Intercept	-6.0132	0.00617	<.0001
DIFFLAG0	9.3465	0.0563	<.0001
DIFFLAG2	0.9728	0.0412	<.0001
DIFFLAG4	-6.2020	0.0438	<.0001
DIFFLAG6	-2.7553	0.0399	<.0001
DIFFLAG8	1.4655	0.0390	<.0001
DIFFLAG10	0.5252	0.039	<.0001
DIFFLAG12	-1.8470	0.0468	<.0001
Unemploy	50.6348	0.1640	<.0001
Eco GROWTH	-5.3360	0.1723	<.0001
MONTH1	-0.2111	0.00409	<.0001
MONTH2	-0.4199	0.00446	<.0001
MONTH3	-0.3629	0.00446	<.0001
MONTH4	0.1121	0.00415	<.0001
MONTH5	0.2443	0.00408	<.0001
MONTH6	0.2961	0.00424	<.0001
MONTH7	0.2111	0.00429	<.0001
MONTH8	0.2082	0.00458	<.0001
MONTH9	0.4040	0.00452	<.0001
MONTH10	0.4919	0.00469	<.0001
MONTH11	0.3720	0.00447	<.0001

(Source: Korean IIA surrender rates with 3 year duration)

The parameter estimates are shown in Table 3.1. It is interesting to note that the parameter β_{UE} for the unemployment rates is very large, 50.6348. It means that the surrender rates change very greatly according to the unemployment rate movements. But, considering the unemployment rate change ratio is not so radical as that of the reference market rates (new money rates), it is not strange for us to have a large β_{UE} . It seems also reasonable that the parameter β_{EG} for the economy growth rates is a negative number, 5.3360. We can guess that when the economy condition is good the policyholders may not surrender their IIA policies.

Now our final model for the Korean IIA surrender rates, $\{q_s(t)\}$, is given by the following formula,

$$q_s(t) = \frac{1}{1 + \exp(-\alpha)}, \quad (3.3)$$

where

$$\begin{aligned} \alpha = & \beta_0 + \beta_{UE} * i_{UE}(t) + \beta_{EG} * i_{EG}(t) \\ & + \sum_{j=0,2,4,6,8,10,12} \beta_j * \{i_m(t-j) - i_c(t-j)\} + \sum_{j=1}^{11} \beta_{month-j} * DV_j. \end{aligned} \quad (3.4)$$

We show the graph of the real and predicted (using Logit model) surrender rates of Korean IIA policies in Figure 3.4.

For US SPDA surrender rate models with 5 year duration, we also use the Logit Model,

$$\ln \left(\frac{q_s(t)}{1 - q_s(t)} \right) = \beta_0 + \beta_M * (i_m(t) - i_c(t)) + \beta_{UE} * i_{UE}(t) + \beta_{EG} * i_{EG}(t), \quad (3.5)$$

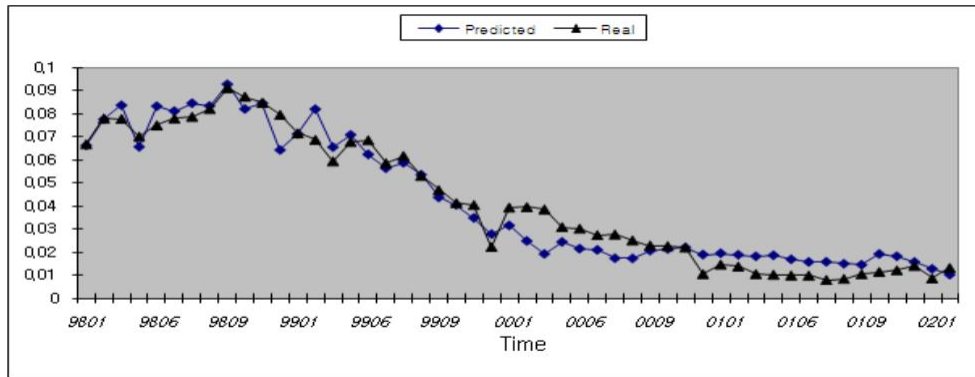


Figure 3.4. Real and predicted surrender rates of Korean IIA

Table 3.2. Parameter estimates with Logit model(US SPDA)

Analysis of Maximum Likelihood Estimates			
Parameter	Estimate	Standard Error	Pr > ChiSq
Intercept	-4.5452	0.00785	<.0001
DIFFLAG	12.7525	0.05831	<.0001
Unemployment	24.3694	0.27836	<.0001
Eco GROWTH	-2.6450	0.86473	<.0001

(Source: US SPDA surrender rates with a 5 year duration)

where β_M is the parameter for the difference between current reference market rates and policy crediting rates. For US SPDA surrender rates, there is little seasonal effects and we do not use the seasonal effect dummy variables in the model.

The parameter estimates are shown in Table 3.2. We can notice that the parameter β_{UE} for the unemployment rates is 24.3694 and very smaller than that of the Korean IIA unemployment parameter, 50.6348. It means that the US SPDA surrender rates change less sensitively according to the unemployment rate movements. It seems also reasonable that the parameter β_{EG} for the economy growth rates is a negative number, -2.6450.

For the US SPDA, the surrender rates, $\{q_s(t)\}$, are estimated by the following formula,

$$q_s(t) = \frac{1}{1 + \exp(-\alpha)}, \tag{3.6}$$

where

$$\alpha = \beta_0 + \beta_M * (i_m(t) - i_c(t)) + \beta_{UE} * i_{UE}(t) + \beta_{EG} * i_{EG}(t). \tag{3.7}$$

We show the graph of the real and predicted (using Logit model) surrender rates of US SPDA policies in Figure 3.5. The average of the real surrender rates is 2.97% and the average of the expected (predicted) surrender rates using Logit model is 2.92%.

4. Surrender Rate Changes under Financial Rate Shocks

There are many factors affecting surrender rates such as the difference between the reference market rate and policy crediting rate, seasonal effects, age and gender of clients, economy growth rate,

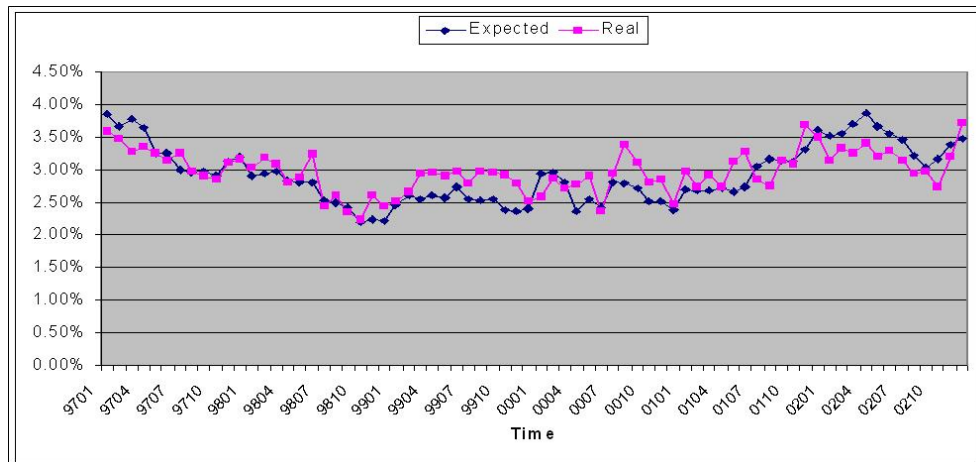


Figure 3.5. Real and predicted surrender rates of US SPDA

foreign exchange rate, inflation rate, policy age since issue date (duration), and unemployment rate. During the stable interest rate period, all of these factors play an important role in determining the surrender rate. But sometimes, if there are any shocks (or sudden changes) to financial rates, such as the unemployment rates, the economy growth rates, or the market interest rates, the surrender rates can be changed much more than expected. For example, during the financial crises in Korea from December 1997 to December 1998, the surrender rates show a sudden peak.

Figure 3.3 shows the sudden increase in the market interest rates during the financial crises and the surrender rates of Korean IIA, and we can see that interest rate fluctuation is an important factor in determining surrender rates. Figure 3.2 shows the unemployment rates and the surrender rates of Korean IIA. We can easily notice that the unemployment rates and surrender rates soared during the financial crises. So we can conjecture that the surrender rates are dependent on interest rates as well as also on exogenous factors such as unemployment rates, economy growth rates and seasonal effects.

Now we want to investigate the surrender rate changes under the assumption that there are financial rate shocks (or sudden changes). As an example, we first look at the pattern of the financial rate shocks during the Korean financial crises.

Let us denote $i(t)$ to be a financial rate at time t . We use the following formula for the financial rate at time t ,

$$i(t) = \mu + k(t)\sigma, \quad (4.1)$$

where μ is the average and σ is the standard deviation of the financial rate during a stable state period.

We define $k(t)$ to be a risk measure of the financial rate $i(t)$,

$$k(t) = \frac{i(t) - \mu}{\sigma}. \quad (4.2)$$

We define that the financial rate $i(t)$ experiences a financial rate shock at time t if

$$|k(t)| \geq 2 \quad (4.3)$$

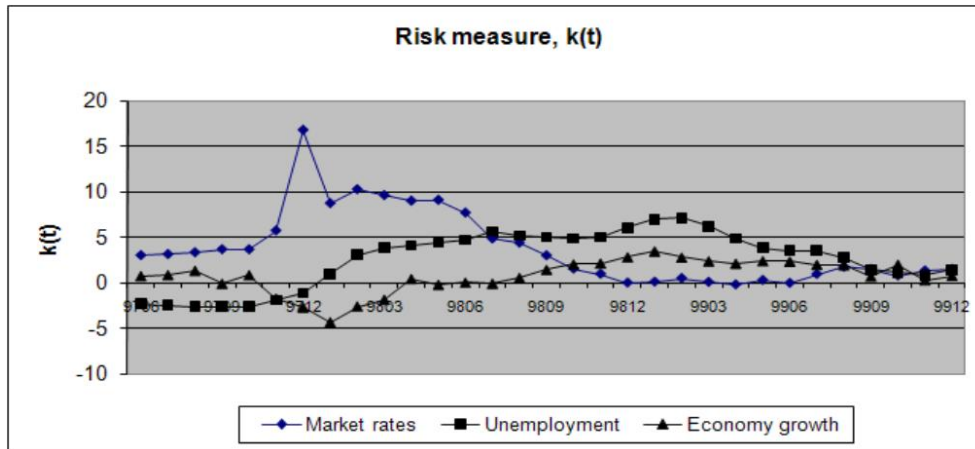


Figure 4.1. Risk measure, $k(t)$, of Korean Financial Rates

Source: Market rates; 5 year government bond rates; The Bank of Korea (www.ecos.bok.or.kr)

Unemployment rate; Korea National Statistical Office (www.nso.go.kr)

Economy growth rates Korean Statistical Information System (www.kosis.nso.go.kr)

and we say that the financial rate is in a stable status at time t if $|k(t)| < 2$. We also say that we are under extreme financial conditions if the financial rates experience financial rate shocks.

Figure 4.1 shows the risk measure $k(t)$ of the reference market rates (5 year government bond rates), the unemployment rates, and the economy growth rates of Korea around the financial crises period. From Figure 4.1, we can notice that the market rates experience financial shocks, $k(t) > 2$, for the period from July of 1997 to September of 1998, for 14 months around the financial crises. The unemployment rates experience financial shocks, $k(t) \geq 2$, for the period from February of 1998 to August of 1999, for 19 months around the financial crises. The economy growth rates experience financial shocks, $k(t) \leq -2$, for the period from November of 1997 to March of 1998, for 5 months around the financial crises.

Now, we want to consider the surrender rate changes of US SPDA under the assumption that US financial rates experience financial rate shocks. We make two assumptions on the pattern of $k(t)$, the risk measures of financial rates:

Assumption 4.1. (A1): The pattern of $k(t)$ is same as that of Korean data when the rate experiences financial shocks.

Assumption 4.2. (A2): $k(t) = c$, where c is a constant integer such that $|c| \geq 2$ and the financial rate $i(t)$ is changed to $i(t) + c\sigma$.

First, in Assumption 4.1 (A1), we assume that the policy holder surrender behaviors would change suddenly in a relatively short time period after a financial rate shock. We could observe this from the Korean policy holder surrender behaviors during the financial crisis in Asia from December 1997 to December 1998 as shown in Figure 3.2 and Figure 3.3. And we further assume that the policy holder surrender behaviors in US SPDA would be similar to those of Korean IIA if financial rate shocks occur in US.

Second, in Assumption 4.2 (A2), we consider the case that the policy holder surrender behavior

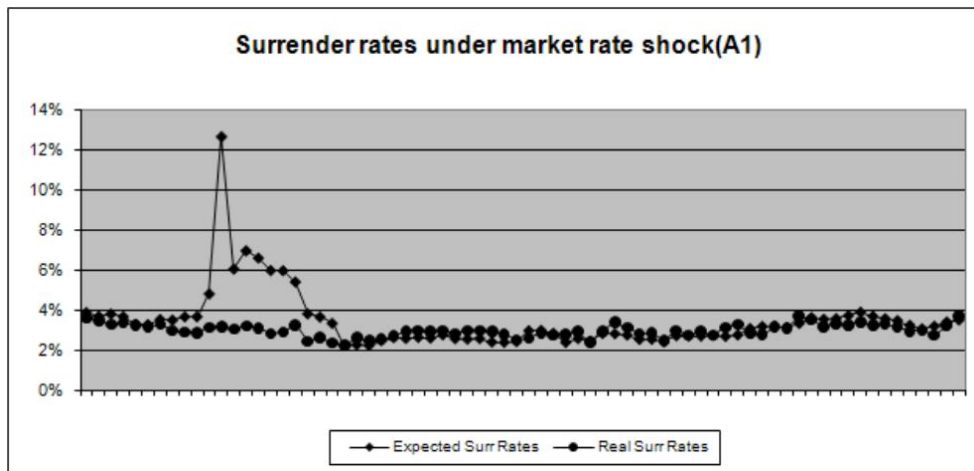


Figure 4.2. US SPDA Surrender Rate Changes under Market Rate Shock (A1)

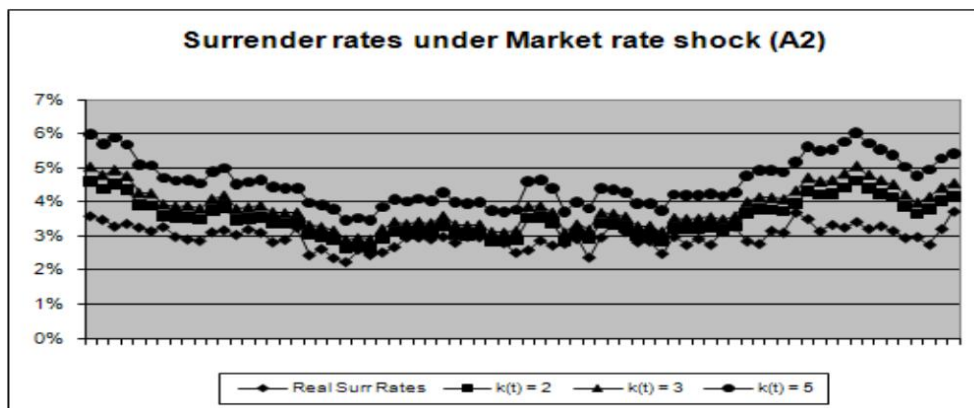


Figure 4.3. US SPDA Surrender Rate Changes under Market Rate Shock (A2)

would change consistently but significantly during a relatively long period of time after a financial shock. For this, we assume that financial shocks would occur with more than two times of volatilities in financial rates and impact the surrender rates for a long period of time.

Figure 4.2 shows the surrender rate changes of US SPDA under the Assumption (A1) that the US market rates (10 year T -bond rates) experience the financial rate shock, $k(t) \geq 2$, as the same pattern of $k(t)$ as that of Korean data. We reproduce the US market rates under this $k(t)$ and estimate the surrender rates using the changed market rates. It shows a very high peak of 12.63% at the beginning of the market rate shock period, which means that the surrender rate can increase suddenly after a financial rate shock similar to that of Korea experienced during the Asian financial crisis period. The average of the expected (predicted) surrender rates is 3.42% whereas the average of the real surrender rates is 2.97

Figure 4.3 shows the surrender rate changes of US SPDA under the Assumption (A2) that the US market rates (10 year T -bond rates) would experience financial rate shocks with $k(t) = 2, 3$ and 5

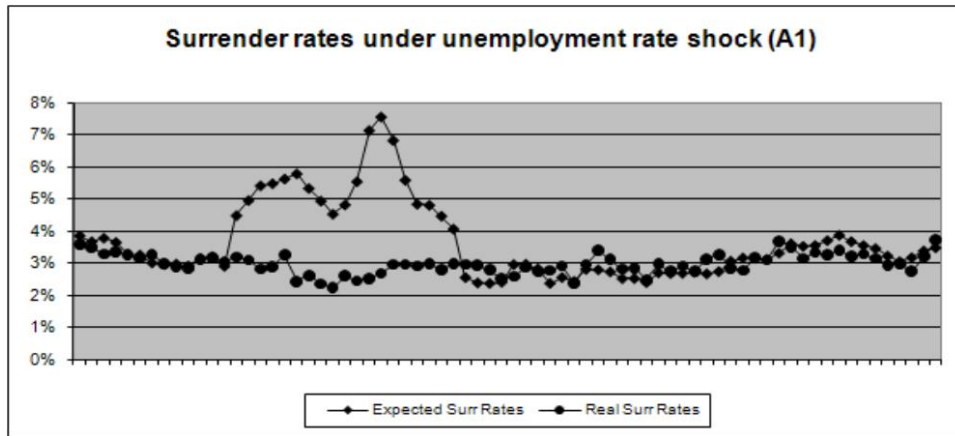


Figure 4.4. US SPDA surrender rate changes under unemployment rate shock (A1)

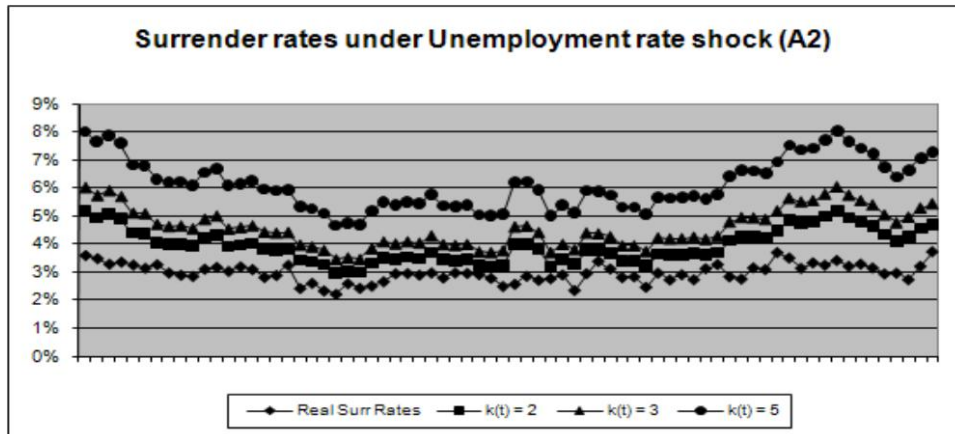


Figure 4.5. US SPDA surrender rate changes under unemployment rate shock (A2)

over the whole period. We produce the US market rates under this $k(t)$ values and then estimate the surrender rates using the changed market rates. It shows that the surrender rates are increasing as $k(t)$ goes up, *i.e.* market rates increase. The average of the expected (predicted) surrender rates is 3.49% when $k(t) = 2$, 3.82% when $k(t) = 3$ and 4.56% when $k(t) = 5$, whereas the average of the real surrender rates is 2.97%.

Figure 4.4 shows the surrender rate changes of US SPDA under the Assumption (A1) that the US unemployment rates experience the financial rate shock, $k(t) \geq 2$, as the same pattern of $k(t)$ as Korean data. It shows a very high peak of 7.56% in the middle of the unemployment rate shock period. We also make an interesting notice that the unemployment rate shock period starts later than the market rate shock, and lasts longer. The average of the expected (predicted) surrender rates is 3.42% whereas the average of the real surrender rates is 2.97%.

Figure 4.5 shows the surrender rate changes of US SPDA under the Assumption (A2) that the US unemployment rates experience the financial rate shock, $k(t) = 2, 3, 5$ over the whole period. It

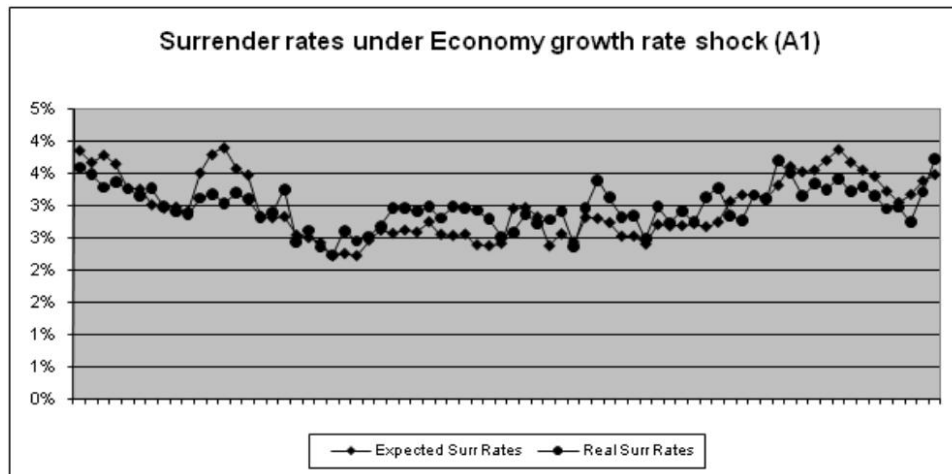


Figure 4.6. US SPDA surrender rate changes under economy growth rate shock (A1)

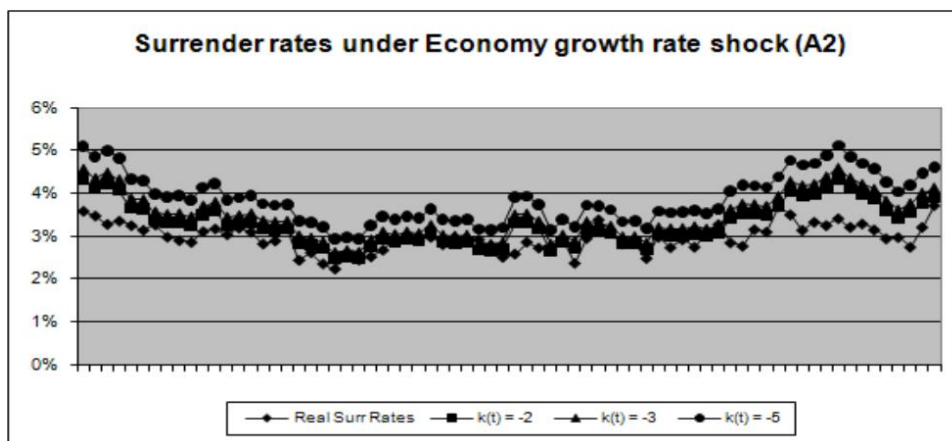


Figure 4.7. US SPDA surrender rate changes under economy growth rate shock (A2)

shows that the surrender rates are increasing as $k(t)$ goes up, *i.e.* unemployment rates increase. The average of the expected (predicted) surrender rates is 3.94% when $k(t) = 2$, 4.57% when $k(t) = 3$ and 6.13% when $k(t) = 5$, whereas the average of the real surrender rates is 2.97%.

Figure 4.6 shows the surrender rate changes of US SPDA under the assumption (A1) that the US economy growth (GDP) rates experience the financial rate shock, $k(t) \leq -2$, as the same pattern of $k(t)$ as Korean data. It shows a small peak of 3.89% in the beginning of the shock period. We can notice that the economy growth rate shock period last for a short period of 5 months and the impacts of the economy growth rate shock to surrender rates are relatively small. The average of the expected (predicted) surrender rates is 2.98% whereas the average of the real surrender rates is 2.97%.

Figure 4.7 shows the surrender rate changes of US SPDA under the Assumption (A2) that the US economy growth (GDP) rates experience the financial rate shock, $k(t) = -2, -3, -5$ over the whole

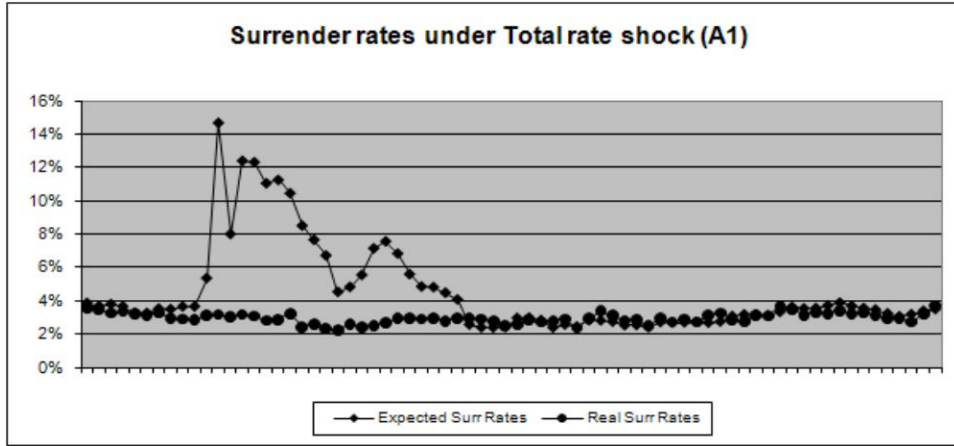


Figure 4.8. US SPDA surrender rate changes under total rate shock (A1)

Table 4.1. Surrender rate changes under extreme conditions

Assumption	Market rates		Unemployment rates		Economy Growth rates		Total rates	
	max	average	max	average	max	average	max	average
A1	12.63%	3.42%	7.56%	3.66%	3.89%	2.96%	14.71%	4.48%
$ k(t) = 2$	4.62%	3.49%	5.20%	3.94%	4.32%	3.27%	9.23%	4.37%
$ k(t) = 3$	5.04%	3.82%	6.02%	4.57%	4.57%	3.46%	11.57%	6.24%
$ k(t) = 5$	6.01%	4.56%	8.04%	6.13%	5.11%	3.87%	15.03%	10.85%

period. It shows that the surrender rates are increasing as $k(t)$ goes down, *i.e.* the economy growth rates decrease. The average of the expected (predicted) surrender rates is 3.27% when $k(t) = -2$, 3.46% when $k(t) = -3$ and 3.87% when $k(t) = -5$, whereas the average of the real surrender rates is 2.97%.

Figure 4.8 shows the surrender rate changes of US SPDA under the Assumption (A1) that the total three US financial rates (market, unemployment, and economy growth rates) experience the financial rate shock, $|k(t)| \geq 2$, at the same time, as the same pattern of $k(t)$ as that of Korean data. It shows a high peak of 14.71% at the beginning of the shock period. And the surrender rates are quite high with the average of 7.67% during the shock period for almost 2 years. The average of the expected (predicted) surrender rates is 4.48% whereas the average of the real surrender rates is 2.97%. We summarize the analysis results in Table 4.1.

From Table 4.1, we can notice that the surrender rates change very much under extreme conditions. We see a high peak of 14.71% when all of the 3 variables experience financial rate shocks under the Assumption 4.1. And the surrender rates are quite high with the average of 7.67% during the shock period for almost 2 years. The average of the expected (predicted) surrender rates is 4.48% whereas the average of the real surrender rates (without extreme condition assumptions) is 2.97%.

5. Conclusion

Many insurance companies are selling single premium deferred annuities(SPDA). But SPDA are sold with the primary focus on accumulation. Only a few of the policy holders purchase SPDA

for the purpose of annuitization. In Korea, the annuity market is still young and growing slowly compared to that of the US. Interest-indexed annuities (IIA) are one of the most popular SPDA products in Korea. The distinctive features of SPDA are the surrender options and annuitization options. In this paper we consider the surrender behaviors of SPDA / IIA policy holders under extreme economic conditions.

We have considered a model on the policy holder surrender behavior statistically. The variables considered are the difference between reference market rates and product crediting rates with surrender charges, the policy age since the contract was issued, unemployment rates, economy growth rates, and seasonal effects. Especially the duration, *i.e.* the policy age since the contract was issued, is one of the most important factors of surrender rates. For extreme events or financial rate shocks, we define a risk measure of a financial rate and consider the surrender rate changes of US SPDA under the assumption that US financial rates experience financial rate shocks. We notice that surrender rates can experience huge changes under extreme financial conditions and this should be a consideration for insurers to predict sudden changes in surrender rates and prepare appropriate hedging strategies.

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