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The Researches on Calculating Method of Insurance Premium of Residential Mortgage Loan

LES RECHERCHES SUR LA METHODE DE CALCUL DE LA PRIME D'ASSURANCE PRET HYPOTHECAIRE RESIDENTIEL

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Abstract
As an effective means to stir up residential consumption, residential mortgage loan insurance is developing very quickly in recent years. However, there are still some inevitable risks, how to calculate insurance rate has been a magnitude task for insurance companies. Based on discrimination between residential mortgage loan insurance and other insurances, the thesis analyze insurance structures of United States, we find that insurance institute in USA can often establish its corresponding insurance structure (include insurance payment mode, number of insurance rate, disposal method when pre-payoff) according to clients' specific circs (such as sum of loan, term of loan, loan to value), so the controlling of risk of regional mortgage loan insurance is become easy, the rights and interests of insurance institute can be well protected. On the contrary, most insurance companies in China adopt single insurance structure, they require all clients must pay insurance by means of once-payoff method, and they will not send back insurance when the client pre-payoff. This method have some problems, on the one hand it is not benefit to controlling risk of insurance business, on the other hand, it is not benefit to exploit market because it cannot make clients to choice appropriate insurance project according to their specific circs. So insurance structure of regional mortgage loan in China will transit from singularity to diversity in the future. It means that insurance payment mode will include 2 types: once-payoff and annual payment; when borrower want to pre-payoff it can be decided into 2 types: insurance sending back and not sending back, so we will have 4 kinds of insurance structures. on the basis of it, we present new insurance structures which suit for china, and then present a new calculating method which can calculate insurance premium in different insurance structures by using expected return equals the expected loss.

Key words: Insurance premium structure; Insurance premium calculation; Residential mortgage loan

Résumé
C'est un moyen efficace pour attiser la consommation résidentielle, l'assurance prêt hypothécaire résidentielle se développe très rapidement depuis ces dernières années. Cependant, il y a encore quelques risques inévitables, comment calculer le taux d'assurance a été une tâche grandeur pour les compagnies d'assurance. Basé sur la discrimination entre l'assurance prêt hypothécaire résidentiel et d'autres assurances, la thèse d'analyser les structures d'assurance des États-Unis, nous constatons que l'Institut d'assurance aux Etats-Unis peuvent souvent établir sa structure d'assurance correspondant (notamment le mode de paiement d'assurance, le nombre de taux d'assurance méthode d'élimination, lors du pré –gain) selon circs clients spécifiques (comme la somme du prêt, la durée du prêt, prêt à la valeur), de sorte que le contrôle des risques de l'assurance prêt hypothécaire régional est devenu facile, les droits et les intérêts de l'Institut d'assurance peuvent être bien protégé . Au contraire, la plupart des compagnies d'assurance en Chine d'adopter la structure unique des assurances, ils exigent que tous les clients doivent payer l'assurance par le biais d'une fois gain méthode, et ils ne renverra pas d'assurance lorsque le client pré-paiement. Cette méthode a quelques problèmes, d'une part, il n'est pas bénéfique pour la maîtrise des

risques des activités d'assurance, d'autre part, il n'est pas bénéficier d'exploiter le marché car il ne peut pas faire aux clients de projet d'assurance choix approprié en fonction de leur circs spécifiques. Par conséquent la structure d'assurance de prêts hypothécaires régionales en Chine transite par la singularité dans la diversité à l'avenir. Cela signifie que le mode de paiement d'assurance comprennent deux types: le paiement une fois gain et annuels, lorsque l'emprunteur souhaitez pré-gain il peut être décidé en 2 types: l'assurance de renvoyer et de ne pas renvoyer, alors nous aurons quatre types de structures d'assurance. Sur la base de celui-ci, nous présentons les structures d'assurance nouvelle qui conviennent pour la Chine, et ensuite présenter une nouvelle méthode de calcul qui permet de calculer la prime d'assurance dans les structures d'assurance différents en utilisant le rendement attendu est égal à la perte attendue.

Mots clés: La Structure des primes d'assurance; Le calcul des primes d'assurance; Prêts hypothécaires résidentiels

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INTRODUCTION

Residential mortgage loan insurance is a kind of new business managed by insurance companies in china, which can not only provide credit support to those house buyers who have no enough own capital in short-term but have long-term economy ability to pay loan, but also separate commercial bank's default risk. It is a complement system of residential mortgage loan system; it can eliminate mortgage loan risk, depress bad account to minimum extent and guarantee mortgage right and interest. It's risk transfer and loss compensation mechanism can relieve the risk bring by information asymmetry between bank and clients when they deal on residential mortgage loan business, it can advance boom of real estate financial market. Along with the development of china's housing system reform and the bank's consumption credit business in recent years, residential mortgage loan insurance business has developed very quickly, and it has become high quality business spread energetically by commercial banks. However, along with high speed increase of residential mortgage loan insurance business, the loan doorsill has become fall gradually, the client's income become more and more low and the approach of house buyer's payment peak, the default risk which must be faced by commercial bank will increase gradually, therefore, the risk faced by insurance companies will also increase gradually. So how to establish scientific and logical insurance rate has become an important question to controlling this kind of risk of insurance companies.

At present, most insurance companies in china adopt one-off payoff mode as their insurance payment method, the confirmation of insurance rate is only aim at this kind of circs, and it's calculation method often follow other kind of insurance (such as property insurance, life insurance). Along with severity of market competition and consummation of national policy, insurance companies must develop manifold residential mortgage loan insurance product and they must find corresponding insurance calculation methods. Therefore, the thesis will expatiate difference between residential mortgage loan insurance and other kind of insurance firstly, on the basis of this we will explain the calculation method of residential mortgage loan insurance cannot copy other insurance's calculation method entirely, then use America's residential mortgage loan insurance structure for reference, the thesis present insurance calculation method in four kinds of insurance structures.

1. DISCRIMINATIONS OF RESIDENTIAL MORTGAGE LOAN INSURANCE AND OTHER INSURANCES

Residential mortgage loan insurance is a business which is entirely different from other kinds of insurances. At first, the loss probability of residential mortgage loan insurance is low but loss expense is very high, for example, the default rate of residential mortgage loan in shanghai is only 6‰, however, insurance companies will take more than 80000 RMB yuan for one default event. Secondly, the single risk is not entirely independent when loss of residential mortgage loan insurance have happened, we often suppose that individual single risk is independent of other risks for some other insurance business such as life insurance and auto insurance, but we cannot suppose the loss probability in individual guarantee slip of residential mortgage loan insurance can be comparatively independent entirely. Thirdly, compare to casualty insurance, casualty insurance are usually cover sometime extension, such as one year, so we can use history information to decide the number of its insurance. However, we cannot use the same method to calculate residential mortgage loan insurance because residential mortgage loan insurance cover many periods (such as 20 years) and its insurance must be decided at start. Fourthly, compare to life insurance, residential mortgage loan insurance have exact maturity date, and the claim risk because of borrower's default will decrease along with closing to maturity date. Life insurers have no exact maturity date, and compensation risk of insurance companies will become increase gradually along with insurant's age increase. Moreover, the mechanism of residential mortgage loan insurance is to protect those

banks which provide a loan, in another word, the banks are beneficiary, the borrower not only have no right to change beneficiary but also cannot terminate insurance contract, this is another difference compare to common insurance business. At last, compare to other kinds of insurances, residential mortgage loan insurance have a high systematic risk, because payment rate in advance and default rate of residential mortgage loan is more influenced by total economic environment (such as interest rate, housing price, household income, unemployment rate and so on).

2. RESIDENTIAL MORTGAGE LOAN INSURANCE STRUCTURES OF UNITED STATES AND REVELATION TO INSURANCE COMPANIES IN CHINA

In United States, residential mortgage loan insurances are usually provided by government and personal mortgage loan insurance companies, and most of them are provided by government, it have welfare characters, most of the policy-holders are low income peoples. For example, residential mortgage loan insurances provided by Federal Housing Administration (FHA) and Veteran Affair (VA) have the characters of national intervention and policy guide. On the other hands, those provided by Personal Mortgage loan Insurance companies (PMI) are based on perfect individual credit system and right market mechanism which suit for insurance business, and it's characters are low insurance rate, more kinds and agile. Its insurance structures have the following characters:

2.1 Insurance Structures of FHA

FHA charges different residential mortgage loan insurances aiming at different LTV (Loan to Value), types of loan and term of loan. The higher LTV, the longer term of loan, the insurance rate charged by FHA will become high. In the period from 1983-9-1 to 1991-9-30, FHA only charge one-off insurance payment, they have no annual payment system. From 1992, FHA has provided two payment choices: one-off payment and annual payment. FHA will send back some insurance premium if the borrowers pre-payoff in the seventh year.

2.2 Insurance Structures of PMI

Compare to FHA, PMI provide more kinds of insurance projects. The number of insurance charged is very different according to loan balance, loan to value, loan interest rate, term of loan and payment times. At the same time, payment by stages can be divided into 2 types: the sum of insurance premium per stage is fixed and the rate of insurance premium per stage is fixed. Insurance companies often adopt the structure in which the sum of insurance premium per stage is fixed because it is very simple and easy for borrowers to manage budget. However, generally speaking, the default probability of loan in prophase is usually more than its in anaphase, and the default probability is not fixed, so the structure in which the sum of insurance premium per stage is fixed cannot make insurance premium income per stage correspond to risk at the same stage. Whereas the structure in which the rate of insurance premium per stage is fixed can make insurance premium that actually pay in one stage decrease along with descending of the loan balance, so it can correspond to default risk in the same stage well. But from the point of view of borrowers, it is not welcome because the sum of insurances pay in every stage is not the same so it is not convenient for calculation.

2.3 Revelation to Insurance Companies in China

From above information we can find that insurance institute in USA can often establish its corresponding insurance structure (include insurance payment mode, number of insurance rate, disposal method when pre-payoff) according to clients' specific circs (such as sum of loan, term of loan, loan to value), so the controlling of risk of regional mortgage loan insurance is become easy, the rights and interests of insurance institute can be well protected. On the contrary, most insurance companies in China adopt single insurance structure, they require all clients must pay insurance by means of once-payoff method, and they will not send back insurance when the client pre-payoff. This method have some problems, on the one hand it is not benefit to controlling risk of insurance business, on the other hand, it is not benefit to exploit market because it cannot make clients to choice appropriate insurance project according to their specific circs. So insurance structure of regional mortgage loan in China will transit from singularity to diversity in the future. It means that insurance payment mode will include 2 types: once-payoff and annual payment; when borrower want to pre-payoff it can be decided into 2 types: insurance sending back and not sending back, so we will have 4 kinds of insurance structures. The 4 circs is basis of the following text.

3. CALCULATING METHOD OF INSURANCE PREMIUM OF DIFFERENT INSURANCE STRUCTURE

A reasonable insurance premium should be defined as the present value of anticipative loss (plus some payoff) of a insurance companies equal to anticipative insurance premium income. Suppose terms of loan are T, original loan begin from term 0, in every terms borrower can decide to default, pre-payoff or continue payment. We suppose borrower's default probability is d_t and pre-payoff probability is p_t, then the probability of borrower continuing payment is $c_t=1-d_t-p_t$. we suppose the loss of insurance companies when borrower default can be presented by B_t (equal to loan balances which have not been paid), and loss rate is L_R, which we suppose is fixed in loan terms, the present value of anticipate loss in every

term are EL_t, and accumulative anticipate loss to term t are EAL_t, R= (1+discount rate), we can express it in mathematic formula:

$$EAL = E_1 + E_2 + \ldots + E_t = d_1 L_R B_0 R^{-1} + c_1 d_2 L_R B_1 R^{-2} + c_1 c_2 \ldots c_{t-1} d_t L_R B_{t-1} R^{-1} = d_1 L_R B_0 R^{-1} + \sum_{s=2}^{t} \left(\prod_{l=1}^{s-1} c_l \right) d_s L_R B_{s-1} R^{-s} \quad (1)$$

$$E_t = c_1 c_2 \ldots c_{t-1} d_t L_R B_{t-1} R^{-t} \quad (2)$$

t=1, 2, …, T.

Definition: a_t means insurance premium rate based on loan balance of term t, f_t means insurance premium return rate based on B_0 when borrower choice pre-payoff loan balance in term t. ERt means present value of anticipative insurance premium in every term, EAR_t means present value of anticipative insurance premium cumulated to term t, then express it in mathematic formula:

$$R_t = c_1 c_2 \ldots c_{t-1} (c_t a_t B_t - p_t f_t B_0) R^{-t} \quad (3)$$

$$EAR_t = R_0 + R_1 + \ldots + R_t = a_0 B_0 + (c_1 a_1 B_1 - p_1 f_1 B_0) R^{-1} + c_1 (c_2 a_2 B_2 - p_2 f_2 B_0) R^{-1}$$

$$+ c_1 c_2 \ldots c_{t-1} (c_t a_t B_t - p_t f_t B_0) R^{-t} = a_0 B_0 + (c_1 a_1 B_1 - p_1 f_1 B_0) R^{-1} + \sum_{s=2}^{t} \left(\prod_{l=1}^{s-1} c_l \right) (c_s a_s B_s - p_s f_s B_0) R^{-s} \quad (4)$$

t=1, 2, …, T-1.

Suppose gross profit rate of insurance companies is q, which is not a fixed constant because gross profit rate may be different in every term, then present value of anticipative profit should equal to (1+q) multiply present value of cumulated anticipative loss. According to this insurance premium structure, when it reaches to equilibrium, it should have the following formula:

$$EAR_{T-1} = (1+q) EAL_T \quad (5)$$

Cash flow, risk and profit of insurance companies are very different in different insurance premium structures. Therefore, the calculation of insurance premium rate is also different, we will discuss how to calculate insurance premium rate in 4 kinds of insurance premium structures in the following text.

3.1 Fixed Annual Payment Rate and Non-Sending Back when Borrower Pre-Payoff

In this circs, we can calculate insurance premium in every term on the basis of loan balance in that term, and the rate of insurance premium is fixed. However, insurance premium income in term t is not equal to anticipative loss in term (t+1) because the default rate in total loan terms is not fixed. We can make $a=a_0=a_1=\ldots=a_{T-1}$ because insurance premium in every year is fixed, and we can also make $f_1=f_2=\ldots=f_{T-1}=0$ because insurance premium will not be sent back when borrower choice pre-payoff. Then we can use these 2 equation and formula (5) to calculate insurance premium rate a, that means the insurance premium rate which insurance companies should charge are:

$$a = \frac{(1+q) L_R (d_1 B_0 R^{-1} + c_1 d_2 B_1 R^{-2} + \ldots + c_1 c_{T-1} d_T B_{T-1} R^{-T})}{B_0 + c_1 B_1 R^{-1} + c_1 c_2 B_2 R_{-2} + \ldots + c_1 c_2 \ldots c_{T-1} B_{T-1} R^{-(T-1)}} \quad (6)$$

3.2 Once-payoff and Non-sending Back when Borrower Pre-payoff

Because insurance premium have been receipted in the origination of loan, and insurance premium will not be sent back when borrower choice pre-payoff, so the insurance premium in this circs should equal to anticipative default loss plus gross profit rate which insurance companies required, it means insurance premium which insurance companies should charge are: $(1+q)EAL_T$.

3.3 Once-payoff and Sending Back when Borrower Pre-payoff

The difference between this insurance premium structure and others is that insurance companies must send back those insurance premium which have not been used to borrower when they choice pre-payoff. Insurance premium that has not been used means those include from pre-payoff date to maturity date in once-off insurance premium. Giving default rate and pre-payoff rate, we can decide once-payoff insurance premium and insurance premium that insurance companies should send back to borrower when they choice pre-payoff. Obviously, the earlier borrower choice pre-payoff, the more insurance premium they can gain.

Suppose g_t is insurance premium that insurance companies charge when borrower default in term t, then once-payoff insurance premium that insurance companies charge in term 0 are equal to sum of g_t in every terms, it means $a_0=g_1+g_2+\ldots+g_T$. Insurance companies should send back those insurance premium which have not been used to borrower when they choice pre-payoff in term t.

We can find that there are no risks from term (t+1) to maturity date (T), so insurance companies should send back insurance premium and its interest which corresponding to this terms to borrowers. Therefore, if borrower choice pre-payoff in term t, insurance premium that insurance companies should send back to them are

f_tB_0, we can calculate it by $f_tB_0=(g_t+!+g_t+2+\ldots+g_T)$ (1+r) t, r is the interest rate. We can use this equation and above equation ($a_0=g_1+g_2+\ldots+g_T$) to calculate formula (4), we can make at=0 because borrower have not pay insurance premium in every year, then have following formula:

$$EAR_{T-1} = g_1B_0 + (1-p_1)g_2B_0 + (1-p_1-c_1p_2)g_3B_0 + \ldots + (1-p_1-c_1p_2-\ldots-c_1c_2\ldots c_{T-2}p_{T-1})g_TB_0 = ERD_1 + ERD_2 + \ldots + ERD_{T-1} \quad (7)$$

$$ERD_t = (1-p_1-c_1p_2-\ldots-c_1c_2\ldots c_{T-2}p_{t-1})g_tB_0 \quad (8)$$

ERD_t means anticipative insurance premium profit of default risk in this term on the basis of borrower pre-payoff in term t. from formula (8) we can find anticipative loss under default risk in term t are equal to part of insurance premium which charged by insurance companies corresponding to time t, and multiply probability of continue payment loan until term (t-1). We make insurance premium income are equal to anticipative loss plus reasonable profit margin in every term, it means that:

$$EAR_t = (1+q)E_t \quad (9)$$

we can calculate g_t by using formula (2), (7) and (9), then:

$$g_t = \frac{(1+q)c_1c_2\ldots c_{t-1}d_tL_RB_{t-1}R^{-t}}{(1-p_1-c_1p_2-\ldots-c_1c_2\ldots c_{t-2}p_{t-1})B_0} \quad (10)$$

So, insurance companies should charge insurance premium by means of once-payoff in this circs are a_0, and the insurance premium which they should send back are f_tB_0 (we can calculate a_0 and f_tB_0 by using g_t).

3.4 Annual Payment and Insurance Premium are Fixed in Every Term

In this circs, borrower pay the same insurance premium by means of annuity in loan period, it seems that insurance companies allow borrowers pay premium in maner of divided payments. Borrowers must pay remenant non-payment insurance premium if they choice pre-payoff loan balance. Before pre-payoff, remenant non-payment insurance premium shoulf equal to present value of insurance premium in the future. Therefore, anticipative accumulative insurance premium income are:

$$EAR_{T-1} = m + (1-d_1)mR^{-1} + (1-d_1-c_1d_2)mR^{-2} + \ldots + (1-d_1-c_1d_2-\ldots-c_1c_2\ldots c_{T-2}d_{T-1})mR^{-(T-1)} \quad (11)$$

m represent fixed insurance premium in every term. We can calculate m by using formula (5) and formula (11):

$$m = \frac{(1+q)EAL_T}{1+(1-d_1)R^{-1}+\ldots+(1-d_1-c_1d_2-\ldots-c_1c_2\cdot c_{T-2}d_{T-1})R^{-(T-1)}} \quad (12)$$

CONCLUSION

Insurance premium structure and calculation method of residential mortgage loan insurance are larruping because of its characteristic. The thesis presents 4 kinds of insurance premium structure that can be treated as a basis when insurance companies reform their residential mortgage loan insurance. At the same time, we also present a new calculating method that can calculate insurance premium in different insurance structures by using expected return equals the expected loss, the excellence of this method is that we can calculate insurance premium in different circs if we have related parameters (such as default rate, pre-payoff rate); it's disadvantage is that these parameters are not easy to get, and we must often change insurance premium because these parameters often change along with time. Therefore, insurance companies should reference it according to their practical environment.

REFERENCES

Ambrose, Brent W. & Charles A. Capone. (2000). The Hazard Rate of First and Second Default. *The Journal of Real Estate Finance and Economics, 20*(3), 275-293.

Boyer, L.G, J.R.Follain, J.Ondrich, & R. Piccirillo. (1997). A Hazard Model of Prepayment and Claim Rate for FHA Insured Multi-family Mortgage. *The Journal of Finance, 38*(5), 1569-1581.

CAO Xiaoyan & YANG Yi. (2003). Research on Criterion of Residential Mortgage Loan Insurance. *Insurance Research, 10*, 52-54.

Dennis Barry, Chionglong Kuo, & Tyler T. Yang. Rationales of Mortgage Insurance Premium Structures. (2006). *The Journal of Real Estate Research, 14*, 359-378.

Escolas, Edmond L, & Ronald W. Spahr. Mortgage Guaranty Insurance: A Unique Style of Insurance. *The Journal of Risk and Insurance, 53*, 308-319.

Kau, James B, Donald C. Keenan, & Taewon Kim. (1994). Default Probabilities for Mortgage. *Journal of Urban Economics, 35*(3), 278-296.

WU Chengxiang, & WANG Jianhong. (2003). Regional Mortgage Loan Insurance Innovation Product - Default Insurance. *Real Estate Finance of China, 5*, 33-35.

WU Yixian. (2002). *Research on Residential Mortgage Loan Insurance* (Master's thesis). Chao Yang Science & Technology University, Xi'an.