The Study on the Launch of Farmland Reverse Mortgage for the Welfare of the Rural Elderly in South Korea

- Establishment of Monthly Payment Plan & Risk Analysis-

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Abstract: This study aims to launch farmland reverse mortgage for the welfare of the elderly in rural area by liquidating the farmland which produces little products or left uncultivated due to the labor shortage though the farmland value is relatively high for the first time around the world. We build the actuarial model based on Housing Equity Conversion Mortgage(HECM) model suggested by Rodda et al(2000;2003)[1]. Basic factors such as interest rates and farmland value rising rates are elaborated with historical data to be applied to the actuarial model for estimating constant monthly payment that the borrower can gain under the condition PVEL is equal to PVMIP. Then the risk that the lender bears depending on the fluctuation of interest rates is predicted. We provide one more policy option for the elderly in rural area that covers the deficiency which is not fulfilled by existing government welfare policies by suggesting the initiation of FRM.

Key-Words: Farmland Reverse Mortgage, PVEL, PVMIP, pmt, Value at Risk

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1 Introduction

Population structure in current South Korea is characterized as “aging society”. Under this aging society, the prompt and large-scale expansion of welfare for the elderly is required to meet the welfare demand of the elderly and minimum quality of life for the elderly in KOREA. Especially, most of the elderly in rural areas does not protected by the national pension service, and even, are not qualified for the basic old age pension because value of the farmland they have usually exceeds the threshold that the pension is given. To resolve and relieve problems caused by population aging in rural areas, we suggest that the initiation of farmland reverse mortgage (FRM) for the life of the elderly in rural areas by liquidating the farmland which produces little products or left uncultivated due to the labor shortage though the farmland value is high for the first time around the world. In this study, we elaborate critical factors like farmland value rising rates, interest rates, and death rates, apply those to the life-time monthly payment plan model, and estimate affordable and proper monthly payment. Then we estimate the value at risk associated with lower farmland value rising rates than the rates applied to the model, higher interest rates than the rates applied to the model, and longer life expectancy than the life expectancy applied to the model when the pension is contracted. These interest rates, land value rising rates and death rates should be considered carefully when the model is established because those factors may produce risk that the pension provider bears. We provide important information and direction when the model is designed by predicting the amount of risk depending on fluctuation of each critical factor. We provide one more policy option for the elderly in rural area that covers the deficiency which is not fulfilled by existing government welfare policies by suggesting the initiation of FRM.

2 Actuarial Model (Basic Model)

To estimate pm(t constant monthly payment) which is given to the borrowers (the elderly over age 65) by liquidating farmland, we apply Home Equity Conversion Mortgage model which is developed by Rodda et al (2000; 2003) to FRM. As we see the equation (1) below, the amount of monthly payment for the farmland reverse mortgage is calculated under the condition that the presented value of total projected mortgage premium (PVMIP) is equal to the present value of expected losses (PVEL).

\[
PVMIP = UP_0 + \sum_{t=1}^{T(a)} \frac{PVMIP}{(1+i)^t}
\]

\[
= \sum_{t=1}^{T(a)} \left\{ \frac{\max \{ (OLB_{t-1} + pm(t) \} \} (1+i)^t}{(1+i)^t} \right\} = PVEL
\]

\[
PVMIP = \text{Present value of total projected mortgage insurance premium.}
\]

\[
PVEL = \text{Present value of expected losses}
\]

\[
UP_0 = \text{Up-front mortgage insurance premium at } t=0
\]

\[
T(a) = \text{The number of months left for the borrower living until 100years old}
\]

\[
Mip_t = \text{Projected monthly mortgage insurance premium at } t
\]

\[
pm(t) = (OLB_{t-1} + pm(t)) \times m
\]

\[
Mip = \text{the annuity payment(constant monthly payment)}, \ m= \% \text{ of monthly mortgage insurance premium}
\]

\[
OLB_t = \text{Expected outstanding balance at } t
\]

\[
OLB_t = (OLB_{t-1} + pm(t) + Mip_t) (1+i)
\]

\[
P_{a+t} = \text{Loan survival probability for the borrower at age } a \text{ a living until age } a+t
\]

\[
q_{a+t} = \text{the probability of loan termination at age } a+t
\]

\[
i = \text{Interest rates (discount rates)}
\]

\[
L_0 = \text{Expected farmland value at } t;
\]

\[
L_t = L_0 \times (1+g)^t
\]

\[
g = \text{average farmland rising rate}
\]

To apply the basic factors to the model, we elaborate farmland value rising rates and interest rates using land value data from the Ministry of Land, Transport, and Maritime Affairs, and interest rates data from the Bank of Korea. For the loan survival probability and the probability of loan termination, we use mortality rates data extracted from National Statistics Office of Korea. The basic factors applied to the model are as follows.

Table 1, Basic factors applied to the actuarial model

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\[1\] We estimate the average farmland value rising rates and interest rates using ARIMA with EViews and CB Predictor with Crystal Ball.
Factors | Definition
--- | ---
Up-front mortgage insurance premium | 2% of farmland value
Monthly mortgage insurance premium | (OLB\_t-1 + pmt)*0.5/12
Monthly Interest Rate | 6.78% (certificate of deposit interest rate 4.78% + spread 200 basis points)/12
Monthly Farmland value rising rate | 2.87%/12
Probability of loan termination | Mortality rate extracted from National Statistics Office
Loan survival probability | (1-mortality rate)

<table>
<thead>
<tr>
<th>Age</th>
<th>Up</th>
<th>m</th>
<th>pmt</th>
<th>PVMIP</th>
<th>PVEL</th>
<th>NL</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>2%</td>
<td>0.5% /year</td>
<td>144,759</td>
<td>5,447,271</td>
<td>5,447,258</td>
<td>-13</td>
</tr>
<tr>
<td>75</td>
<td>2%</td>
<td>0.5% /year</td>
<td>245,062</td>
<td>5,359,925</td>
<td>5,359,717</td>
<td>-208</td>
</tr>
<tr>
<td>85</td>
<td>2%</td>
<td>0.5% /year</td>
<td>467,289</td>
<td>4,758,731</td>
<td>4,758,672</td>
<td>-59</td>
</tr>
</tbody>
</table>

L0=100,000,000 won, g=2.87%, i=6.87%

As we see in the table, 144,759, 245,062 and 467,289 won is given to the borrower at age 65, 75 and 85 respectively every month until she reaches 100 years old. As borrower’s age gets older, the amount of pmt gets bigger. If land value rising rate gets higher, the amount of money the borrower receive gets bigger although it gets smaller as interest rates get higher. We add 2% spread to the CD interest rates in actuarial model as margin the lender can take. If the government manages the FRM, margin could be decrease because the government does not pursue the margin. In this case, pmt increase as interest rate decreases.

4 Risk Analysis

We predict risk that the lender bears depending on the fluctuation of interest rates using Monte-Carlo simulation with Crystal Ball. To predict the risk, we estimate average CD interest rate and probability distribution of CD interest rate with the historical CD interest rate., Average mean of CD interest rate is 4.78%, standard deviation is 1.13, and probability distribution follows lognormal distribution. The below pictures show the risk that the lender bears depending on the borrower’s age 65, 75, and 85 with 100,000,000 won value farmland. Figure 1, 2, and 3 are charts that the probability of risk occurs. In case of age 65 years old borrower who gain pmt 144,759 won a month, predicted mean of value at risk (NL) is 1,330,268 won, 80% value at risk is 7,024,425 won, 90% value at risk is 10,676,122 won and 95% value at risk is 13,685,855 won. We summarize average of PVEL, average PVMIP, average

3 100,000 trials are performed.
NL, 80% VaR, 90% VaR and 95% Value at Risk depending on age 65, 75, and 85 plan in table 3.

Fig.1, 65 years annuity plan

Fig.2, 75 years old annuity plan
As we see in table 3, as the age joins FRM gets older, the risk value due to fluctuation of interest rate gets smaller. VaR implies expected maximum loss under the given probability distribution.

### 5 Conclusion

This study is a pilot study building actuarial model for the farmland reverse mortgage which is initiated for the first time in the world. We estimate pmt(constant monthly payment) under the condition that PVEL is equal to PVMIP, and predict the risk that the lender could bears depending on the fluctuation of interest rate. By developing the basic annuity model, we can extend the model in various ways. We can extend the model depending on who manage the FRM by changing upfront insurance premium and spread. We also can extend the model by changing payment-option such as lump-sum payment, and combination of lump-sum and pmt payment. This study contributes to the launch of FRM by providing basic annuity plan model which could be extended to various optional models.

### References:

Table 3, Result of Risk Analysis

<table>
<thead>
<tr>
<th></th>
<th>Age 65</th>
<th>Age 75</th>
<th>Age 85</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average PVEL</td>
<td>6,752,113</td>
<td>6,241,490</td>
<td>5,106,235</td>
</tr>
<tr>
<td>Average PVMIP</td>
<td>5,455,121</td>
<td>5,364,619</td>
<td>4,760,876</td>
</tr>
<tr>
<td>Average NL</td>
<td>1,297,012</td>
<td>876,871</td>
<td>345,359</td>
</tr>
<tr>
<td>80% VaR</td>
<td>6,954,342</td>
<td>5,666,552</td>
<td>3,626,357</td>
</tr>
<tr>
<td>90% VaR</td>
<td>10,649,709</td>
<td>8,668,419</td>
<td>5,536,964</td>
</tr>
<tr>
<td>95% VaR</td>
<td>13,641,826</td>
<td>11,136,060</td>
<td>7,134,885</td>
</tr>
</tbody>
</table>

(Unit: KRW)