Pricing and Securitization of Reverse Mortgage for Dependent Lives

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Abstract

Human longevity has been increasing significantly since the start of the 20th century. Whether human longevity will continue to improve in the future is debating. The view that longevity will continue to increase is supported by the mortality experience in many developed and developing countries (Tuljapurkar et al., 2000; Blake et al., 2008; Yang et al., 2009). How to increase the retirement income to maintain the elder's living standard is very important. The pension system was the main financial resource for the elders and retirees. Due to the phenomenon of ageing population and increases in longevity, the pension and annuity providers are suffered substantial financial problem because they are obliged to make payments to their policyholders for as long as they live (Antolin, 2007; Bauer and Weber, 2007). Governments are now facing a great challenge for financing an ageing population. Therefore, the development of innovative financial products in private market to increase retirement income is needed.

Many elders are considered to be "equity rich and cash poor". In Australia[1], total home equity (owner-occupied) was AUD$887 billion with those over the age of 60, accounting for AUD$345 billion (39%) of this amount; the American Housing Survey[2] shows that more than 12.5 million elderly have no mortgage debt, and the

[1] Senior Australians Equity Release Association of Lenders Industry Submission, 2005.

[2] American Housing Survey for the United States (2005), Current Housing Reports, H150/05. US

median value of mortgaged-free homes is US $127,959 (Chen et al, 2009). To increase the retirement income for “cash poor and equity rich” elders, reverse mortgage (RM) is a new financial product that allows retirees to convert a proportion of the equity in their home into cash until they die. In the United States, the department of Housing and Urban Development (HUD) first introduced the Home Equity Conversion Mortgage (HECM) program in 1989. Kutty(1998) indicates that the use of home equity conversion mortgage products could possibly raise about 29% of the poor elderly homeowners in the U.S. above the poverty line. As of May 2007, the HECM accounted for approximately 90% of the market (National Reverse Mortgage Lenders Association Press Release (NRMLA) 2007). In addition to the U.S. market, reverse mortgage products are also found in the U.K., Australia and in Asian countries of Singapore and Japan.

There are many forms of RM products, which differ in terms of the types of loan advance and the time frame. The loan advance can be taken as a lump sum or as a regular income stream. The terms of the RM can either be fixed-term or tenure. The loan value is determined by the borrower's age, the interest rate, and the home's value. Reverse mortgages differ from traditional mortgages in the way that the loans and accrued interests are repaid once when the borrower dies or leave the house. If a borrower lives longer than expected or the decrease in house price, the principal advances and interest accruals may drive the loan balance above the proceeds of sale the property. For the provider’s perspective, house price risk, interest rate risk and longevity risk are the major risks for issuing reverse mortgage products. A traditional method for dealing with the risks associated with reverse mortgages is insurance, for example the HECM program in the United States. The lenders under this program are

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Department of Housing and Urban Development and US Census Bureau, Aug. 2006, P156.

protected against the losses arising when the loan balance exceeds the equity value at time of settlement. Many existing literature of reverse mortgage study the risks for HECM program (Szymanoski, 1994; Tse, 1995; Rodda et al., 2004; Chen et al., 2009). Different to insurance, the issue of no-negative-equity-guarantee (NNEG) can also protect the borrower by capping the redemption amount of the mortgage at the lesser of the face amount of the loan and the sale proceeds of the home. The NNEG can be viewed as a European put option on the mortgaged property. Li et al.(2009) develop a framework for pricing and managing the risks for the NNEG. To deal with longevity risk, Li et al.(2009) and Chen et al.(2009) both use Lee-Carter model to project future mortality but the later paper further considers the jump effects on modeling mortality risks. Most of the above papers analyze the reverse mortgage in the form of a lump sum payment for single live.

In this research, we deal with the pricing and securitization for RM products. Different to existing literature, we consider RM products in the form of last-survivor tenure, which is taken up by a married elderly. The couple will then receive a fixed annuity at the beginning of each year till the end of last survivor. Thus, the first purpose of this research is to build a modeling and pricing framework of RM product for dependent lives. Up to now, no attempt has been made to model the survivorship of dependent lives stochastically to analyze the longevity risk for RM product. This paper attempts to fill up this gap. To model the last-survivor survival probability, we employ a copula approach. In the recent years, the copula models became an increasingly popular tool for modeling dependencies between random variables, especially in such fields as actuarial science, and finance. We focus on the selection of the copula function based on the empirical mortality data. Due to the availability of actual data for couples, we illustrate the methodology in this paper based on Human

mortality database for males and females. We compare the empirical results for the mortality experience in the United States and in Taiwan separately. We model the marginal survival functions and the copula separately. The Archimedean copulas including Gumbel copula, Clayton copula, and Frank copula are examined. The χ^2-test proposed by Fermanian (2005) are used to examine the goodness of fit of each copula model.

In addition to longevity risk, we also consider the dynamics of house prices in the pricing framework. House price volatility has been found to be time-varying; that is, house prices exhibit the volatility clustering or GARCH (generalized autoregressive conditional heteroskedasticity) effects (Crawford and Fratantoni, 2003; Miller and Peng, 2006). For example, based on nationwide house price index in the U.K. market, Li et al. (2009) found that ARMA-EGARCH model is a better model to capture the dynamics of house price returns. In this research, we also examine the house price dynamics based on the S&P Case-Shiller 10-City Composite Home Price Index (CSXR)[3] in the U.S. market. We found that the Normal Inverse Gaussian ARMA-GARCH process (NIG-GARCH) provide a better model to explain the tail risk in house price return.

The second purpose of this research is to transfer the risk for RM product using securitization. Wang et al.(2007) investigate the merits of developing survivor bonds and survivor swaps for reverse mortgage products. In this research, we design the collateralized reverse mortgage obligation(CRMO) that is linked to the risks of the underlying reverse mortgage for last-survivor tenure. The structure of CRMO is described in Figure 1, which is similar to collateralized debt obligation(CDO). The

[3] The S&P/Case-Shiller Home Price Indices measures the residential housing market, tracking changes in the value of the residential real estate market in 10 metropolitan regions across the United States. Source: http://www.standardandpoors.com/home/en/us/

provider of RM pays the premiums (*P*) to special purpose vehicle (SPV). SPV issues three tranches of the CRMO to investors with different degree of risk preferences. The different tranche investors receive different regular tranche premium (*W*). SPV invests the premium (*P*) the proceeds from the sale of bond (*A*), in default-free bonds with coupon rate (*D(t)*). If the loss (*L(t)*) on the underlying RM product occurs, the tranche investor will receive the residual nominal value of contract (*A-L(t)*). The loss is modeled based on the mortality dynamics and house price dynamics described above. The tranche premium of the CRMO is calculated using Monte-Carlo simulations.

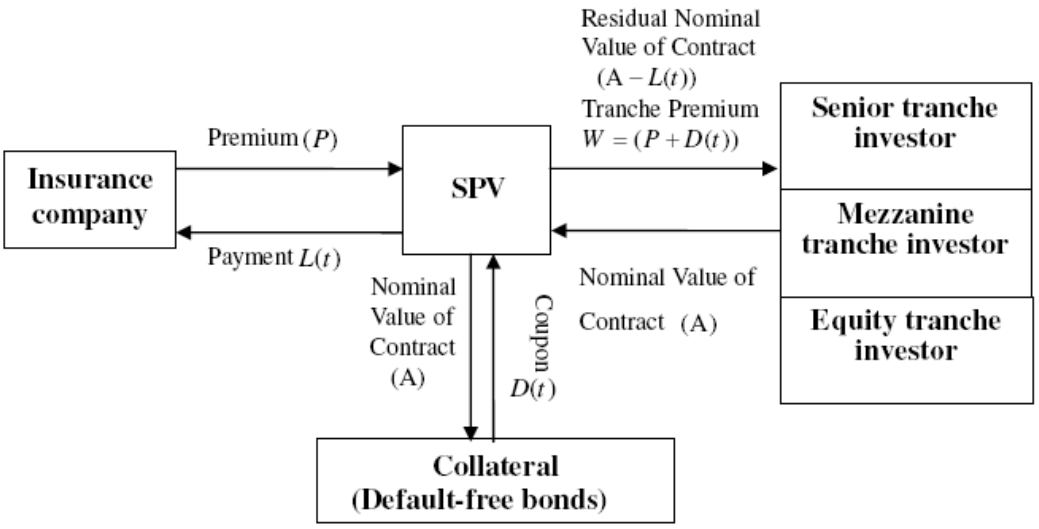

Figure 1 The Structure of CRMO

The contributions of this research are:

(1) We provide a pricing framework for RM products in the form of last-survivor tenure.

(2) We model the mortality dependence for couples using a copula approach. The goodness of fit of the copula function is examined.

(3) We take into account the tail risk for house price uncertainty.

(4) The shortfalls for RM products in the form of last-survivor tenure are calculated and compared with that of single-live tenure and lump sum.

(5) The collateralized reverse mortgage obligation is proposed and the corresponding premiums for each tranche are calculated.