Chapter 5
Empirical Results
- on the aspect of lenders

Based on the parameters set above, we simulated the path of the risk-free interest rate and the return rates on housing in different places of Taiwan are shown in Appendix 2. We illustrated the results of Taipei city in Figure 5.1 and 5.2 as a demonstration. It shows the simulated paths follow the rules that the simulation model developed. The initial risk-free interest rate is 2.5% with 2.51% average long-term interest rate and 1.04% standard deviation. And the average housing return rate is 2.41%, with 0.1% of the regular expenditure rate in housing and 4.91% of the standard deviation in housing return.
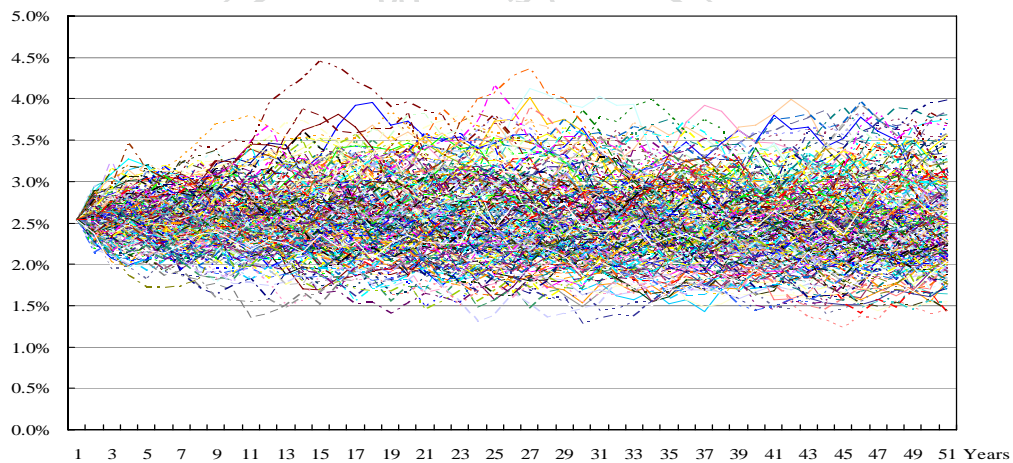

Figure 5.1 Simulated fluctuation of risk-free rate in Taipei city
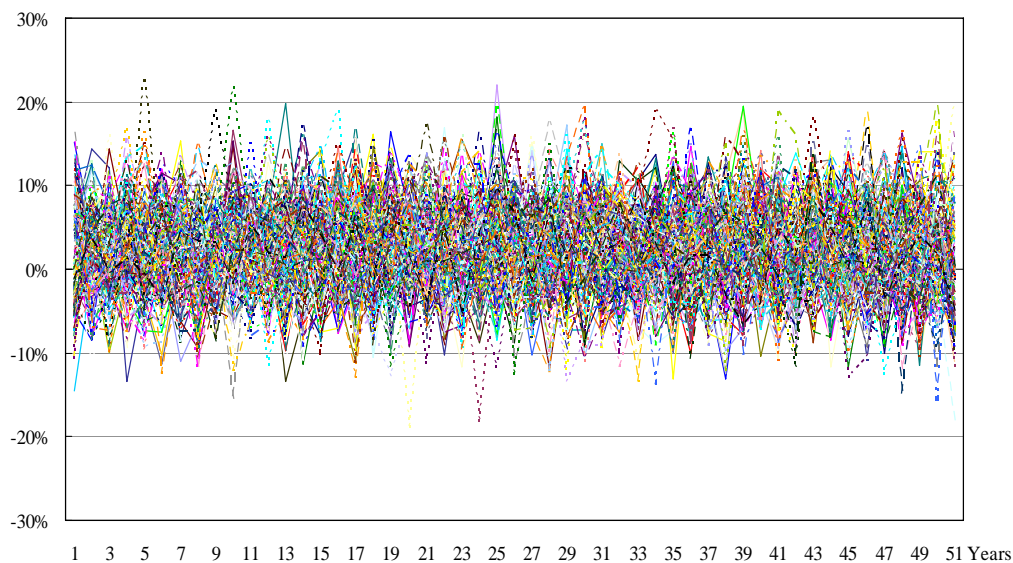

Figure 5.2 Simulated rate of return on housing in Taipei city

We Further changed Figure 5.2 from the return rate on housing to the average house value in Figure 5.3, we could observe the "jump" effect in the housing value model. It is reasonable since the housing price is not always stable in reality.
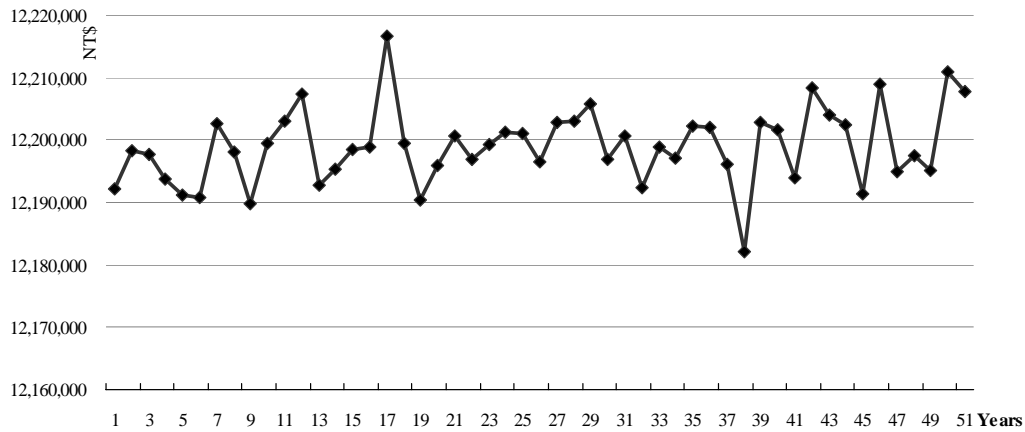

Figure 5.3 Simulated average housing prices in Taipei city

The following sections show the results of the RM pricing models. Two types of RM programs and the difference between lump-sum and annuity payment are discussed below in detail. However, the type of line-of-credit payment is not included in this study due to this type of RM is the mixed type of lump-sum and annuity payments. As an example of the RM pricing model, this study has developed the RM program with a 65-year-old male and female household in Taipei City. In addition, the result of RM in different Taiwan regions are also presented with the sensitivity analysis provided.

5.1 Results with Insurance Program

According to the given assumptions and the parameters, this study conducted the RM pricing model to explore the LTV and IRR$_{RM}$ in Taipei City. The CTE_{90} under the break-even level in different payment programs are Male: 997,329 in Lump-sum payment, 1,009,628 in Annuity payment; Female: 1,000,706 in Lump-sum payment, 1,060,221 in Annuity payment. The frequency data are given in Appendix 3.

Furthermore, the distribution of the expected loss in the two payment types is presented in Appendix 4. It shows that the loss generally occurs near the end

of the tail. The reason is closely related to the mortality and the amount of the mortgage balance in RM. It is because that the termination of the RM is based on the mortality of borrowers. However, the mortality probability is high for people after they are 90 years old. Meanwhile, the mortgage balance also reaches a high level to outpace the housing price at termination. On the contrast, the income of the mortgage insurance premium is mainly collected when the mortgage beginning (see Appendix 5).

Through the break-even point of the RM, the LTV and the IRR_{-RM} can be calculated. Table 5.1 shows the result of the LTV and IRR_{-RM} for 65-year-old Male and Female borrower with the RM insurance program. The average housing price is $TWD 11,912,343 and the average wage for per household per year is $632,242 in Taipei City. As the LTV in RM is determined, the cash-to-borrower value can be computed by multiplying the loan amount by the annuity parameter[12]. And then this study calculates the IRR_{-RM} by comparing the average per household annual wage income[13] and the cash-to-borrower value from RM.

Table 5.1 Result of the RM with insurance program (Taipei city) Unit: TWD

Average House Value								11,912,343
Average Wage (per-household, per year)								632,242
Initial insurance premium (% of property value)								*2.0%*
Annual insurance premium (% of outstanding balance)								*0.5%*
Loan rate (plus in Risk-free Rate)								*0.5%*

Age/Sex		LTV		Loan Amount		IRR_{-RM}	
		Lump-Sum	Annuity	Lump-Sum	Annuity	Lump-Sum	Annuity
65	M	43.65%	25.93%	5,199,187	3,088,591	67.80%	40.27%
	F	41.46%	24.08%	4,938,446	2,868,191	64.40%	37.40%

Table 5.1 shows that the lump-sum payment has higher IRR_{-RM} than annuity payment. The reason may be attributed to the risk premium incomes and the accumulating speeds of the mortgage balance between these two payment

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[12] The annual parameter in this paper follows the method of the whole life annuity-due. The whole life annuity-due for a X aged person with Y dollars is:

$$Y \times \ddot{a} = Y \times \frac{N_x}{D_x}$$

[13] The income data in this study are collected form Ministry of Interior (2008).

types. As shown in Figure 5.4 and 5.5, the lump-sum RM has a higher initial mortgage balance and has lower speed in the mortgage balance accumulation than the annuity RM. The higher initial mortgage balance implies the higher risk premium the lender or the insurance institution should assume.
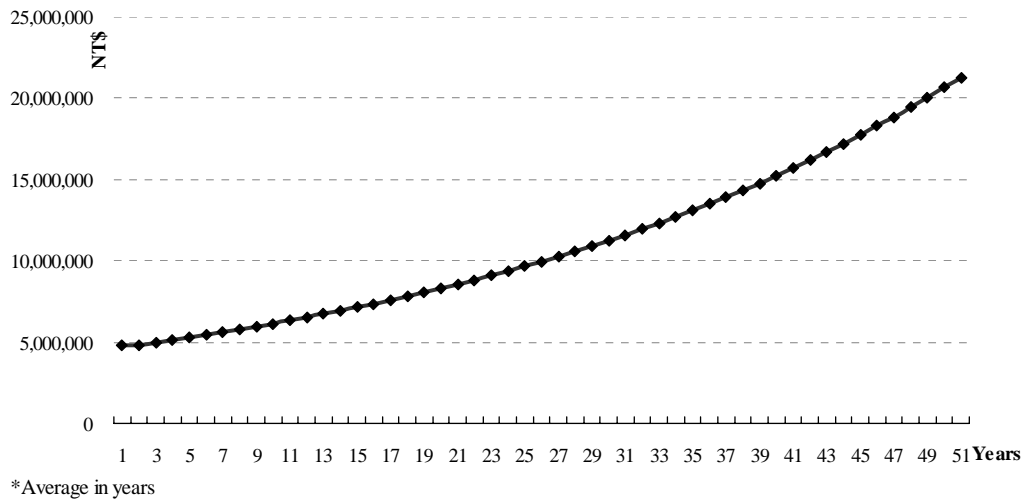

*Average in years

Figure 5.4 Mortgage balance in lump-sum payment of RM

*Aveage in years

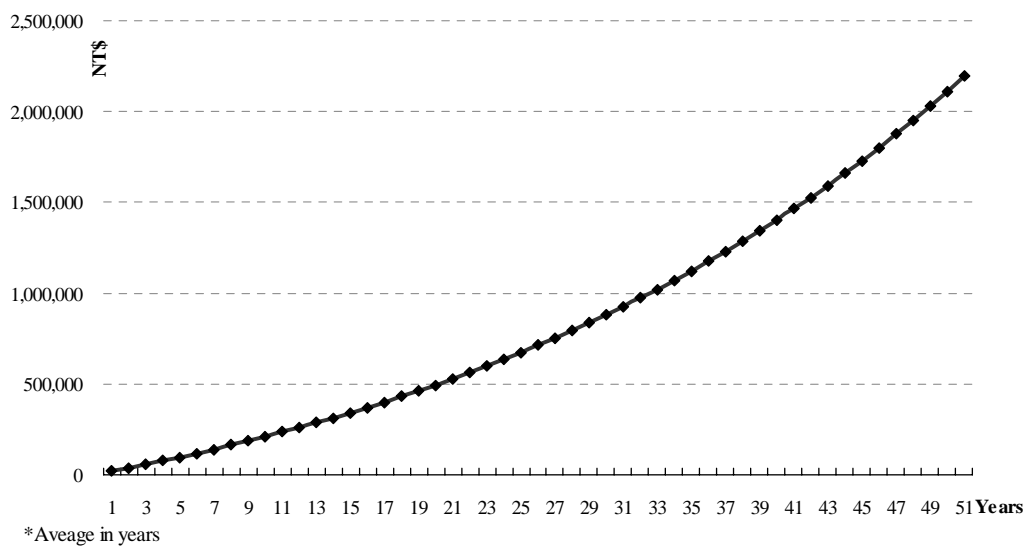**Figure 5.5 Mortgage balance in annuity payment of RM**

As mentioned previously, results of our survey show that the basic need for RM ranges from 40% to 60%[14]. Compared with the investigation results, it is noted that the IRR_{-RM} in the simulation model basically meet the results in the

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[14] This study accordingly supposes the feasible level of RM is the IRR could reach nearly 40% in Taiwan.

survey (except the annuity payment the female apply for). However, the National Annuity System in Taiwan offers the elderly benefits around 34%[15] in the income replacement ratio for insured person. Hence, the study suggests that the IRR_{-RM} over 30% should be very helpful for the borrower when they are retired.

5.2 Results without Insurance Program

The average house value, the average wage for per household per year; the LTV and IRR_{-RM} are presented in Table 5.2. The CTE_{90} under the break-even level in this program is: Male: 91,829 in Lump-sum payment, 205,533 in Annuity payment; Female: 86,581 in Lump-sum payment, 205,495 in Annuity payment. The frequency and the distribution of expected loss is shown in Appendix 3 and Appendix 4.

As shown in Table 5.2, the premium structure of the RM without insurance program is different with the RM with insurance program. In the RM program without insurance, the lender should assume the risks by charging the premium on the loan rate. Furthermore, the lender receives the risk premium income only under the termination of RM, which is different from the annual receipt in insurance program. The distribution is illustrated in Appendix 5.

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[15] With the assumption that the seniority of participant is 25 years and the basic wage is TWD 17,280. Data source: Council of Labor Affairs, Executive Yuan.

Table 5.2 Result of the RM without insurance program (Taipei city) Unit: TWD

Average House Value						11,912,343
Average Wage (Per-household)						632,242
Risk premium rate (plus in Risk-free Rate)						*2.0%*

Age/Sex		LTV		Loan Amount		IRR$_{-RM}$	
		Lump-Sum	Annuity	Lump-Sum	Annuity	Lump-Sum	Annuity
65	M	40.21%	23.13%	4,790,423	2,754,736	62.47%	35.92%
	F	38.09%	21.47%	4,537,510	2,557,827	59.17%	33.35%

Table 5.2 indicates the IRR$_{-RM}$ with the 2% of risk premium rate lower than the IRR$_{-RM}$ with the insurance program. It is expected that the loan amount will moderately rise as the risk premium rate rises. Meanwhile, the mortgage balance will rise dramatically as well. The rapid accumulation of mortgage balance will aggrieve the benefits of the borrowers' heritor because the surplus of the house value after repaying the RM belongs to them.

We may conclude that not only the RM lender should assume the risks, but also the RM borrowers should take the risks, especially when the RM lenders go bankrupt or terminate the RM payment unilaterally. The study suggests that the RM without insurance program should be more cautious, since the RM loan has a major risk－the asset liquidity risk－for the RM provider if the RM loans lack the securitization scheme.

5.3 Sensitivity Analysis

We conducted the sensitivity analysis of the RM pricing model to figure out the diversification of LTV and IRR-RM in the RM. We performed the replacement with different parameters to see the change as the expected value operator and borrowers' ages varied. Furthermore, the RM pricing model with different house locations and varied borrowers' income level are also conducted to explore the variance in the IRR-RM

5.3.1 Different Expected Value Operator

In this study, we define the expected loss value in RM as the Conditional Tail

Expectation at 90% level (CTE_{90}). The reason is that we assume the RM lenders should be more conservative when they offer the RM in reality. As compared to the mean value in the simulated process shown in Table 5.3, it has higher value in the CTE_{90}.

Table 5.3 Risk Value of RM (Taipei City)

Risk level	Age	Sex	RM with insurance		RM without insurance	
			Lump-Sum	Annual	Lump-Sum	Annual
CTE$_{90}$	65	M	997,329	1,009,628	91,829	205,533
		F	1,000,706	1,060,221	86,581	205,495
Mean Value	65	M	789,482	539,047	106,167	133,800
		F	822,074	587,641	99,950	138,323

Since the duration of RM is over 30 years, the simulated result show the major expected loss occurs at the end of the duration. The RM lenders could compute the expected loss value by adopting the CTE_{90} value. The mean approach could cause the expected loss underestimated.

Table 5.4 shows the LTV and IRR$_{-RM}$ under the mean approach are obviously higher than CTE_{90}. Based on the different mortgage pools and risk tolerance the RM lenders assume, this study suggests that the RM lender could offer diverse LTV for borrowers according to different risk levels.

Table 5.4 Result of RM under Different Risk Level (Taipei City)

RM with insurance

Risk level	Age	Sex	LTV		IRR$_{-RM}$	
			Lump-Sum	Annual	Lump-Sum	Annual
CTE$_{90}$	65	M	43.65%	25.93%	67.80%	40.27%
		F	41.46%	24.08%	64.40%	37.40%
Mean Value	65	M	58.77%	35.34%	91.29%	54.89%
		F	56.39%	33.07%	87.60%	51.37%

RM without insurance

Risk level	Age	Sex	LTV		IRR$_{-RM}$	
			Lump-Sum	Annual	Lump-Sum	Annual
CTE$_{90}$	65	M	40.21%	23.13%	62.47%	35.92%
		F	38.09%	21.47%	59.17%	33.35%
Mean Value	65	M	49.96%	29.28%	77.61%	45.49%
		F	47.44%	27.22%	73.70%	42.28%

5.3.2 Different Ages of the Borrowers

The study divided the RM borrower into six groups (male and female with 60, 65, and 70 years old, respectively) to calculate the LTV the lender could offer under different RM programs. We then discuss the IRR$_{-RM}$ the borrowers could obtain at different age levels while they apply for RM.

As shown in Table 5.3, the older when borrowers apply for RM, the more LTV and IRR$_{-RM}$ they can get. Besides, the male borrower could receive more loan amount than the female. The major reason for the different IRR$_{-RM}$ is due to the difference of borrowers' mortality. According to the 2002 TSO, the older people and the male have higher probability of mortality. Since the termination of RM is based on the decease of borrowers, if one has higher expected death rate, the lenders assume the lower risk of mortgage balance exceeding the housing price. Therefore borrowers with higher expected death rate can obtain higher LTV.

Table 5.5 Result on different age of the borrowers (Taipei city) Unit: TWD

Age/Sex		LTV		Loan Amount		IRR-RM	
		Lump-Sum	Annuity	Lump-Sum	Annuity	Lump-Sum	Annuity
RM with insurance program							
60	M	38.06%	21.46%	4,533,935	2,556,385	59.12%	33.34%
	F	35.94%	20.03%	4,281,174	2,385,731	55.83%	31.11%
65	M	43.65%	25.93%	5,199,187	3,088,591	67.80%	40.27%
	F	41.46%	24.08%	4,938,446	2,868,191	64.40%	37.40%
70	M	49.85%	31.89%	5,938,392	3,798,942	77.44%	49.54%
	F	47.28%	29.36%	5,632,480	3,497,904	73.45%	45.61%
RM without insurance program							
60	M	34.76%	18.96%	4,141,208	2,257,996	54.00%	29.44%
	F	32.50%	17.49%	3,871,306	2,084,011	50.48%	27.18%
65	M	40.21%	23.13%	4,790,423	2,754,736	62.47%	35.92%
	F	38.09%	21.47%	4,537,510	2,557,827	59.17%	33.35%
70	M	46.19%	28.60%	5,502,638	3,406,841	71.75%	44.42%
	F	43.57%	26.20%	5,190,549	3,120,801	67.68%	40.69%

5.3.3 Different Regions

Because of different features from different places of Taiwan, the study conducts the RM model with different parameters to explore the difference of LTV and IRR-RM value in Taiwan. The result is shown in Appendix 6. With the relatively stable housing prices and the higher housing price, results show that there is high feasibility of RM in Taipei city and Taipei county. However, the IRR-RM in Yilan city and Taichung city take the third and fourth place, respectivey. It is because the borrower in Yilan city has lower wage (TWD 32,930) and the housing value is higher (TWD 4,403,122) in Taichung city.

5.3.4 Different Wage Levels

We further divide the RM borrower into different income level to examine the change of the IRR-RM that borrowers could get. First of all, borrowers are divided by sex and income levels. Second, to figure out the degree of IRR-RM the elders can get, this study adopted the average wage of two groups of people (aged 55-64 and more than 65) as a pre-retirement income. It is based on the

assumption that some people may tend to remain employed as they are worried about the financial instability after they are 60 years old. Hence, it may be a good choice for them to apply for RM.

Appendix 7 provides the result of the IRR$_{-RM}$ at the wage level divided by sex. It shows the reverse condition in both the RM with or without insurance program as compare to Appendix 6. The IRR$_{-RM}$ for the female borrower is higher than the male borrower could obtain even though the LTV the female could get is generally less than the male. It indicates that the female could be the major benefit receiver due to their pre-retirement wage is less than male in average.

In addition, according to Appendix 7, it provides the basic level of RM programs in lump-sum payment for the borrower aged over 65 in Hsinchu and Taichung city. And the basic level of RM in Kaohsiung city and Taoyuan city is female borrowers of over 70 years old in lump-sum payment with insurance program. As for the IRR$_{-RM}$ of the Taipei city and Taipei county, it ranges from 45.6% to 133.5% in Taipei city and 25.8% to 66.8% in Taipei county, which generally reaches the basic level of RM either with or without insurance program.

The result of the IRR$_{-RM}$ of different ages and wages are shown in Appendix 8. It shows a great raise of IRR$_{-RM}$ for the borrowers aged over 65. The IRR$_{-RM}$ for them all reaches 100% level in all nine regions either with or without insurance program. However, the study indicates the result is less accurate due to the elder after 65 could receive the financial support from the government and may have other income source such as life insurance and the interests from their deposits. We did not tend to estimate the exact income the household have in maintaining their basic life quality when they become senior. Nevertheless, the results in Appendix 8 still provide a direction that senior household could have substantial income support from RM.

According to the HUD (2008), the gender of borrower in the HECM program is 46.4% in single female, 17.3% in single male, and 36.3% in borrower irrespective of gender in average (see figure 5.6). The average borrower age is 75.2, which is higher than the marginal standard (aged over 62) of RM borrower in the U.S. It indicates the elder women borrower could be the main

beneficiaries from RM, which is consistent with the simulation result in this study.
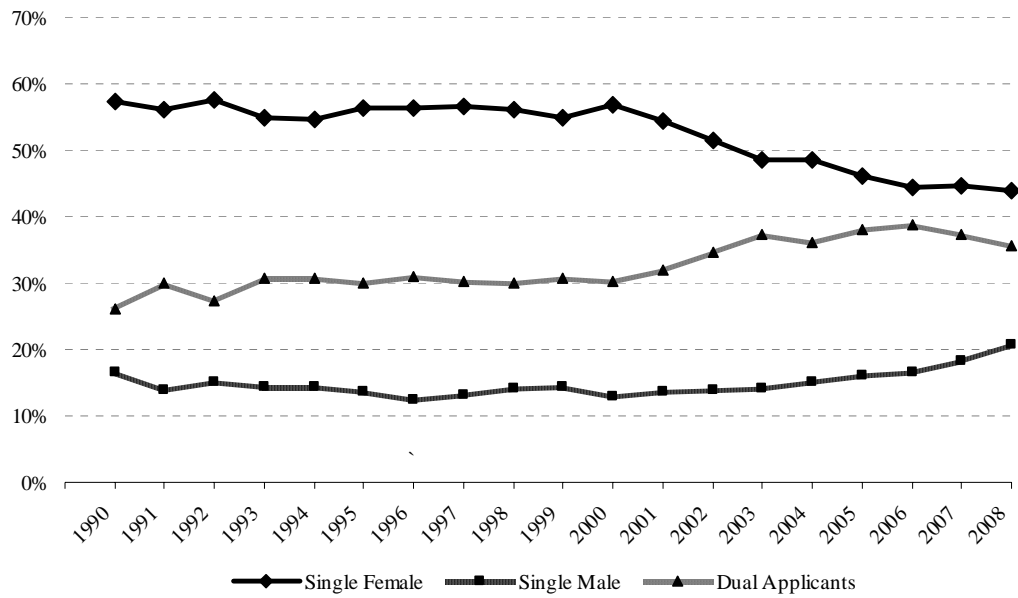
Source: Department of Housing and Urban Development, U.S., 2008.

Figure 5.6 Gender of borrower in HECM in the U.S. from 1990 to 2008