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MODELING HOME EQUITY CONVERSION MORTGAGES

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ABSTRACT

Many older Americans who own houses have most of their wealth in their houses. Some may not have sufficient wealth to pay for (1) medical bills resulting from sudden medical problems, (2) major repairs to their houses, and/or (3) everyday expenses for food, clothing, and so on. Home Equity Conversion Mortgages (HECMs) are designed to allow older people to borrow money (for example, a level-payment monthly annuity) by using the equity in their houses as collateral, without being forced to move out of their homes. Private companies (for example, Providential Home Income Plan and Capital Holding Corporation) as well as the Federal Housing Administration (FHA) currently offer HECMs. We describe here a stochastic simulation approach used to estimate the amount of a level-payment annuity payable as long as the older person is alive and living in his/her house.

1. INTRODUCTION

Many older Americans who own their own homes have most of their wealth in their houses. Some may not otherwise have sufficient wealth to pay for (1) medical bills resulting from sudden medical problems, (2) major repairs to their houses, and/or (3) everyday expenses for food, clothing, and so on. Home Equity Conversion Mortgages (HECMs) are designed to allow older people to borrow money by using the equity in their homes as collateral, without being forced to move out of their homes. The amounts borrowed accumulate with interest until the mortgage's due date, at which point the lender is repaid the entire debt.

There are three principal types of HECMs: term, split-term, and tenure. In a term HECM, equal monthly payments are made to the older homeowner for a certain number of months, for example, 180 months or 15 years. At the end of the term, the loan is due and payable. Term HECMs are not popular with older people who fear they will not be able to repay the loan at the end of the term and will then be forced out of their homes.

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In a split-term HECM, equal monthly payments are made for a certain number of months, but the loan need not be repaid until the older person dies, moves out, or sells his/her house. Finally, in a tenure HECM, equal monthly payments are made and the loan need not be repaid as long as the older person is alive and living in his/her house.

The purpose of this work is to investigate the actuarial aspects of HECMs. In particular, we attempt to estimate the amount of the level-payment (annuity) of a tenure HECM. We assume an insurance premium structure comprising two components. The first, payable at origination, is equal to 2 percent of the appraised value of the property. The second is an annual insurance fee equal to 0.5 percent of the actual outstanding balance of the loan and is payable monthly. We also assume that the insurer and/or mortgagee has a share of the future appreciation, if any, of the house.

The statistical model employed here is based on Herzog and Rubin [7]. Our HECM model attempts to approximate likely future experience and is flexible in the sense that it can incorporate a wide range of assumptions. Another important feature of our model is that it incorporates the variation associated with the key parameters of the model. Because these parameter values are themselves statistical estimates, such a model more accurately reflects the total variation of the process of interest.

Our results show that viable HECM programs can be constructed by using either a 50/50 shared appreciation scheme (that is, where the mortgagor and insurer and/or mortgagee share future nominal appreciation equally) or one in which the insurer and/or mortgagee gets 100 percent of nominal appreciation. Of course, the monthly payments are slightly higher in the 100 percent case.

Appendix A consists of two examples that show how a HECM works in practice and helps to clarify some of the terms mentioned above.

2. ASSUMPTIONS

In this section, we discuss the assumptions of our model.

2.1 Appreciation

The annual rate of nominal appreciation of individual houses is a key element of the HECM model. Estimates of the annual rate of nominal appreciation are necessarily imprecise because (1) the rate of appreciation may vary widely from year to year and from neighborhood to neighborhood and (2) the expense of annual appraisals on individual houses makes the attainment of a reliable nationally representative database of U.S. house values impractical.

Our approach to estimating the nominal appreciation of HECM houses is to construct a two-stage stochastic simulation model.* In the first stage, we use annual national appreciation data compiled by the National Association of Realtors (NAR)[12] to simulate the posterior distribution of national appreciation rates. We then use the results of the first-stage model together with some metropolitan area NAR data to simulate the posterior distribution of appreciation rates of individual HECM houses.

As shown in the last column of Table 1, the NAR's mean annual rate of increase of the median sales price of an existing home between December 1981 and December 1988 was 4.26 percent. The corresponding sample variance was 0.000256. The sample autocovariance coefficients of these appreciation rates at lags of one, two, and three years are 0.000110, 0.000029, and 0.00000884, respectively.

TABLE 1

ANNUAL APPRECIATION RATES
1981–1988

Year	Existing Homes Median Sales Price	Annual Appreciation Rate
1981	$66,600	—
1982	67,800	1.80%
1983	70,300	3.69
1984	72,400	2.99
1985	75,500	4.28
1986	80,300	6.36
1987	85,600	6.60
1988	89,100	4.09
Mean		4.26%

Source: National Association of Realtors [12].

**Pseudo-Random Number Generator.* The uniform pseudo-random numbers used in this analysis are all generated by using the APL primitive function roll (denoted by "?") on an IBM 3090 mainframe computer. This function is a multiplicative congruential pseudo-random number generator with a multiplier of $16807 = 7^5$, a modulus of $2^{31} - 1$, and an initial seed (or starting value) of 16807. This generator is selected because it is the least expensive to use on the available mainframe's APL system even though multiplicative congruential generators have some deficiencies, as Marsaglia [9] has pointed out. The pseudo-random normal deviates were generated by using the polar method as described, for example, in Freiden and Herzog [4], who demonstrate that this is the preferred procedure for generating such numbers in APL.

We assume that the first-stage model has a multivariate normal distribution with mean 4.26 percent and variance-covariance matrix equal to 0.0001 times

$$\begin{bmatrix} 2.56 & 1.10 & 0.29 & 0 & \cdots & \cdots & \cdots & 0 \\ 1.10 & 2.56 & 1.10 & 0.29 & \ddots & & & \vdots \\ 0.29 & 1.10 & 2.56 & 1.10 & \ddots & \ddots & & \vdots \\ 0 & \ddots & \ddots & \ddots & \ddots & \ddots & \ddots & 0 \\ \vdots & \ddots & \ddots & \ddots & 1.10 & 2.56 & 1.10 & 0.29 \\ \vdots & & \ddots & \ddots & 0.29 & 1.10 & 2.56 & 1.10 \\ 0 & \cdots & \cdots & \cdots & 0 & 0.29 & 1.10 & 2.56 \end{bmatrix}$$

Thus, we assume that the average rate of appreciation over the entire U.S. in year $n+2$ is influenced by the rates of appreciation in years n and $n+1$.

The second-stage model is used to predict the appreciation rates of individual house values. For each year, we use a separate univariate normal distribution whose mean is the corresponding result of the first-stage model and whose standard deviation is 0.08. The value of 0.08 is chosen as a rough measure of the dispersion of the distribution of annual appreciation rates from the first quarter of 1988 to the first quarter of 1989 in the 84 large metropolitan areas of the U.S. considered by Downs [1]. In particular, we note from Appendix B that, based on a mean annual appreciation rate of 5.21 percent and a standard deviation of 8 percent, we observe one metropolitan area, namely Fort Worth, whose appreciation rate is more than two standard deviations below the mean and five metropolitan areas in California—San Francisco, Orange County, Los Angeles, San Diego, and Riverside—whose appreciation rates are more than two standard deviations above the mean.

The procedure used to generate the random normal deviates required for both stages of the model is described in Section 2.2 of Herzog [6].

In addition to 4.26 percent, we also run the model with annual average appreciation rates of 3 percent, 2 percent, and 0 percent. This is because the appreciation rates of HECM houses may be substantially below average. As Goldstein [5] says:

"Elderly people tend to live in the oldest housing stock. About 6 of every 10 young-old householders lived in housing built before 1950, a slightly higher proportion than younger householders. This proportion increased with the age of the householders—66 to 71 percent of middle-old householders and 73 to 82 percent of very old householders lived in pre-1950 housing stock. While this housing, which is over 30 years old, is not necessarily in poor condition, it is likely to need more maintenance than newer structures. The people most often found in this older housing, the oldest old, may have the most difficulty keeping it in good repair, especially if they are its owners."

Thus, because the elderly tend to live in the oldest housing stock, have difficulty keeping their property in good repair, and are unlikely to make home improvements, their property is not likely to appreciate as fast as other property.

2.2 Mortality Rates

The basic mortality rates are taken from Wade [13]. Following May and Szymanoski [10], we assume that all the mortgagors are single females. This may not be a sufficiently conservative assumption if many married people or other individuals obtain HECMs jointly. Unfortunately, the Social Security Administration cannot provide us with the necessary projected joint mortality rates for married couples. Moreover, our model does not incorporate the likely adverse selection of healthier older people choosing an HECM. Consequently, we recommend that those using this model to price an HECM product make appropriate adjustments for these two factors.

As with the appreciation component, we develop a two-stage stochastic simulation model to predict future mortality experience of HECM mortgagors. In the first stage, we simulate the death rates $q_{65}, q_{70}, \ldots, q_{105}$ using a separate univariate normal model for each death rate. The means of these models are taken from Wade [13] (see Table 2). In particular, we use the value of q_{65+x} projected for calendar year $1990+x$, for $x=0, 5, \ldots, 40$. We set q_{110} equal to one; that is, we assume that no one survives to age 111.

The standard errors are estimated as follows. We first use the method of least squares to fit a separate linear equation to each of the four sets of 26 values of q_{65+x}, for $x=0, 5, 10, 15$. The 26 values of the q's are taken from the 1961–1986 U.S. Life Tables for Female Lives, constructed by the National Center for Health Statistics (see Table 3). The standard error of the estimate is used as the estimated standard error of each of these four sets of q's. The remaining estimated standard errors are obtained by fitting a linear

TABLE 2

MORTALITY RATE BY YEAR FOR ANNUITANTS AGED 65 IN 1990

q_{65}^{1990}	1.3653%
q_{70}^{1995}	2.0428
q_{75}^{2000}	2.8602
q_{80}^{2005}	4.4065
q_{85}^{2010}	6.9947
q_{90}^{2015}	11.5756
q_{95}^{2020}	17.8137
q_{100}^{2025}	23.2054
q_{105}^{2030}	28.7804

Source: U.S. Dept. of Health and Human Services, Social Security Administration [13].

equation to the standard errors of the estimates of q_{70}, q_{75}, and q_{80}. The resulting equation is:

$$\text{standard error of } q_{60+5x} = 0.000686\,x - 0.00074$$

for $x = 5, 6, 7, 8, 9$.

After the first-stage simulation model is run, we obtain the intermediate mortality rates by using a geometric interpolation procedure described on page 272 of Waldman and Gordon [14]. To illustrate this method, we calculate

$$q_{70+x} = (q_{70})(q_{75}/q_{70})^{x/5}$$

for $x = 1, 2, 3, 4$.

The second-stage model is a binomial model that simulates the experience of each of the individual insureds. The mortality rates used here are those resulting from the first stage of the model and the interpolation scheme described above. The procedure used to select pseudo-random numbers from a binomial distribution is described in Section 2.3.1 of Herzog [6].

Finally, we wonder how the value of the property will be affected if probate problems increase the time it takes the insurer/mortgagee to acquire legal title to the property.

TABLE 3

U.S. FEMALE MORTALITY RATES BY AGE AND CALENDAR YEAR

Calendar Year	Age 65	70	75	80
1961	1.83%	2.84%	4.64%	7.65%
1962	1.84	2.84	4.69	7.73
1963	1.85	2.84	4.71	7.78
1964	1.80	2.73	4.52	7.46
1965	1.79	2.69	4.50	7.44
1966	1.78	2.73	4.52	7.41
1967	1.73	2.66	4.37	7.12
1968	1.78	2.71	4.46	7.29
1969	1.72	2.66	4.32	7.04
1970	1.69	2.64	4.33	6.99
1971	1.62	2.57	4.20	6.75
1972	1.62	2.62	4.24	6.71
1973	1.57	2.53	4.16	6.62
1974	1.51	2.47	3.95	6.30
1975	1.44	2.36	3.77	5.95
1976	1.43	2.30	3.68	5.86
1977	1.42	2.24	3.55	5.65
1978	1.42	2.22	3.48	5.62
1979	1.39	2.15	3.37	5.45
1980	1.44	2.21	3.46	5.61
1981	1.43	2.17	3.39	5.62
1982	1.42	2.13	3.30	5.28
1983	1.40	2.15	3.34	5.39
1984	1.40	2.15	3.33	5.38
1985	1.40	2.15	3.35	5.41
1986	1.40	2.16	3.33	5.34

Source: Vital Statistics of the United States, Life Tables. U.S. Dept. of Health and Human Services, Public Health Service, National Center for Health Statistics.

2.3 Move-out Rates

Some mortgagors may move out of their homes and repay their HECM loans because they are in poor health and need to move to a hospital, nursing home, or the home of a friend or relative. Others may move simply because they desire to live in another place. Because their monthly HECM payments terminate in all these instances, we must accurately predict the rate and time at which such moves take place for the population of insureds. Unfortunately, little or no useful data are currently available to construct such estimates. One possible source is Jacobs [8], who has examined some data collected by the U.S. Bureau of the Census. The principal problem with this analysis is that it deals with the entire population. For example, Jacobs [8] estimates the "move-out" rate of 85-year-olds is about 30 percent of their mortality rate. Can this rate be applied to individuals who have HECMs? Can it be applied to the first six months of the term of an HECM? Because answers to these questions are speculative, it is not at all clear what estimates should be used. May and Szymanoski [10] use a rate of 30 percent at all ages. We have employed this assumption as well as an alternative assumption of zero. Although we know zero is too low, it nevertheless does give a measure of the sensitivity of our results to changes in the value of this parameter.

2.4 Origination Fees and Other Closing Costs

We assume that at the time the HECM is originated, the mortgagor pays closing costs equal to 1.5 percent of the appraised value of the property. This is intended to cover such costs as the origination fee charged by the lender, the cost of the appraisal of the property, and legal fees. We assume the mortgagor will borrow the closing costs from the lender and incorporate them into the loan.

2.5 Transaction Costs

We include estimated transaction costs incurred in selling the house after the older person dies or moves out. Because the real estate sales commission is normally 6 or 7 percent and there are frequently other costs borne by the seller, we assume seller transaction costs of 8 percent of the sale price of the house. If the insurer/mortgagee has to take possession of the property and carry out the preservation normally done for a PD (property disposition) property, the transaction costs may be larger than 8 percent. Foster and van Order [3] used transaction costs of 10 percent of the sale price of the house in their study of defaults on FHA-insured mortgages. We also wonder whether the insurer/mortgagee will be notified promptly after older people die or move out of their homes.

2.6 Salaries and Administrative Expenses

We include a component for staff salaries and administrative expenses incurred in running an HECM operation. We set this cost equal to 1 percent of the initial appraised value of the property insured. This rate is comparable to that employed in the principal FHA single-family program.

2.7 Interest Rates

We consider three pairs of assumptions for the contract interest rate on the annuity and the discount rate:

Contract Interest Rate	Discount Rate
8.5%	7.0%
10.0	8.5
11.5	10.0

2.8 House Price

We assume that the HECM is based on an appraised house value of \$100,000. This value is selected for mathematical convenience. If the appraised house value is less than \$100,000, then the amount of the monthly payment should be reduced proportionally. The NAR data shown in Appendix B for the entire U.S. give a median home sales price of \$91,600 for the first quarter of calendar year 1989. Hence, even in 1990 a substantial portion of older Americans may have less than \$100,000 of equity in their homes. Consequently, their monthy payments would be less than those shown in Table 4.

TABLE 4

MONTHLY ANNUITY PAYMENTS
BASED ON A \$100,000 HOUSE AND
AN ANNUITANT AGE 65 AT PURCHASE

Appreciation Rate	Insurer's Share of Appreciation	Monthly Annuity Payments — Contract Interest Rate 11.5% / Discount Rate 10.0%	Contract Interest Rate 10.0% / Discount Rate 8.5%	Contract Interest Rate 8.5% / Discount Rate 7.0%
		Move-out Factor = 1		
4.258%	100%	\$335	\$379	\$433
	50	269	298	334
3.0	100	282	314	352
	50	240	264	292
2.0	100	247	272	302
	50	221	240	264
0	100	193	208	226
	50	185	199	215
		Move-out Factor = 1.3		
4.258%	100%	\$395	\$439	\$493
	50	321	352	388
3.0	100	337	370	410
	50	290	315	344
2.0	100	299	325	356
	50	269	289	314
0	100	238	254	273
	50	229	243	261

3. RESULTS

We have run each of the first-stage models 10 times and simulated 100 individual HECMs for each such outcome. Thus, we have simulated a total of 1,000 individual HECMs. The mean of the 1,000 simulations is shown in Table 4, and the corresponding standard error, in Table 5. These results are sensitive to changes in mean annual appreciation rates, mortality rates, interest rates, and move-out factors. The choice of an appropriate set of assumptions is of course subjective. The insurer/mortgagee naturally must be conservative. By using a move-out factor of 1.0 (to compensate for the high mortality rates resulting from the use of female lives selected from the general population), an annual average nominal appreciation rate of 2 percent, a contract interest rate of 11.5 percent, and a discount rate of 10.0 percent, we obtain a monthly payment of about $220 with a 50/50 shared appreciation HECM and $245 with all the potential appreciation going to

TABLE 5

STANDARD ERRORS FOR MONTHLY ANNUITY PAYMENTS BASED ON A $100,000 HOUSE AND AN ANNUITANT AGE 65 AT PURCHASE

		Standard Error		
		Contract Interest Rate		
		11.5%	10.0%	8.5%
		Discount Rate		
Appreciation Rate	Insurer's Share of Appreciation	10.0	8.5	7.0%
		Move-out Factor = 1		
4.258%	100%	$27.54	$30.96	$36.42
	50	22.99	22.30	22.82
3.0	100	24.19	26.12	29.18
	50	22.64	21.65	21.28
2.0	100	23.07	23.15	24.99
	50	22.25	21.05	20.69
0	100	20.78	19.90	20.45
	50	20.60	20.07	19.73
		Move-out Factor = 1.3		
4.258%	100%	$48.60	$51.53	$55.16
	50	42.01	42.68	43.41
3.0	100	44.61	46.63	48.88
	50	40.62	40.75	41.73
2.0	100	41.32	42.85	44.64
	50	39.03	39.70	39.83
0	100	36.62	37.09	37.79
	50	36.00	36.09	36.45

the insurer/mortgagee. Hence, HECM instruments may be attractive to some older homeowners. On the other hand, if the insurer decides to decrease the projected mortality rates sharply, increase the standard deviation of the second-stage appreciation model (say, from 8 percent to 18 or 20 percent), and/ or eliminate the shared appreciation feature, then the monthly HECM payment may be so low that no older people will be interested in obtaining one.

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APPENDIX A

Example 1

Ms. Jones is 65 years old and owns her home at 123 Elm St., which is worth $100,000. She has no mortgage on her home. Ms. Jones decides she needs additional monthly income to pay her property taxes and her utility bills. So she obtains an HECM from the XYZ Bank, which, in turn, obtains insurance on this mortgage through the ABC Insurance Company.

Ms. Jones agrees to give the ABC Insurance Company all future appreciation, if any, on her house. The bank agrees to pay Ms. Jones $370 per month for as long as she is alive and residing at 123 Elm St. The bank charges Ms. Jones interest at the rate of 10 percent per annum compounded monthly. The ABC Insurance Company assumes house values will appreciate at an annual rate of 3 percent and that 30 percent of the people will move out before they die (more specificially, the move-out factor is assumed to be 1.3). Finally, the insurance company assumes its cost of funds (discount rate) is 8.5 percent compounded semiannually. By using Table 4, the XYZ Bank verifies Ms. Jones' monthly payment to be $370.

Ms. Jones closes on her mortgage on February 1, 1990. She borrows $3,500 at closing to pay (1) a $1,000 origination fee to the XYZ Bank, (2) a $2,000 insurance premium to the ABC Insurance Company, and (3) $500 for other closing costs, including appraisal and legal fees. (The $1,000 reimburses the bank for the cost of initiating this mortgage.) Ms. Jones begins receiving her monthly payments on February 1, 1990. She is also charged monthly insurance premiums at the annual rate of 0.5 percent of her outstanding loan balance.

Ten years later, at age 75, Ms. Jones suffers a stroke and moves permanently to a nursing home. Her house is sold for $134,935, net of closing costs. This is, fortunately, more than the $88,640 outstanding balance on her loan. Ms. Jones receives $11,360 (that is, $100,000 − $88,640), the XYZ Bank is repaid the outstanding balance of the loan, and the ABC Insurance Company receives the $34,935 (nominal net) appreciation on the house. (If the appreciation had been shared 50/50 and the monthly payment had remained at $370, Ms. Jones and the ABC Insurance Company would have each received half of the $34,935.)

Example 2

Modify Example 1 by assuming that Ms. Jones has her stroke at age 85 instead of 75. The outstanding loan balance at the end of 20 years is $330,832 and the house is sold for $182,076, net of closing costs. In this case, the sale price less closing costs will not be enough to pay off the loan, and the ABC Insurance Company will have to pay the XYZ Bank the difference of $158,756 (that is, $330,832 − $182,076). There is no money paid to Ms. Jones.

APPENDIX B

NATIONAL ASSOCIATION OF REALTORS'
METRO AREA HOME SALES PRICE DATA, QI 1989

Metro Area (MSA)	Median Home Price 1989 QI ($1000)	Annual Percentage Price Change 1988–89 QI	Quarterly Percentage Changes in Median Home Prices: 88 QI–88 QII	88 QII–88 QIII	88 QIII–88 QIV	88 QIV–89 QI	Total MSA Population as of 7/1/87
Top Four Areas							
1. San Francisco, CA	$243.9	31.77%	12.80%	4.84%	6.17%	4.95%	1,590,000
2. Orange County, CA	237.9	30.21	9.47	8.70	4.14	5.08	2,219,100
3. Honolulu, HI	236.0	18.95	0.15	13.74	−0.44	4.89	830,600
4. Los Angeles, CA	201.0	26.34	9.93	8.18	1.00	5.18	8,504,500
Averages or totals	$229.7	26.82%	8.09%	8.86%	2.72%	5.02%	13,144,200
Very-High-Priced Next Eight Areas							
5. Nassau, NY	$181.7	−2.83%	3.74%	−0.72%	−6.65%	1.06%	2,631,000
6. New York, NY	181.7	−2.83	3.74	−0.72	−6.65	1.06	8,528,800
7. Boston, MA	178.5	0.90	3.39	0.49	−2.45	−0.45	2,841,700
8. New Haven, CT	166.7	−1.30	0.00	—	−7.67	4.06	519,000
9. Hartford, CT	165.5	−0.54	1.56	−0.12	−2.25	0.30	747,600
10. San Diego, CA	163.9	21.95	6.03	6.74	3.35	4.26	2,285,900
11. Washington, DC	143.7	8.53	−0.91	3.51	−4.20	10.45	3,646,000
12. Worcester, MA	139.1	−5.89	−1.22	—	−6.47	−2.80	410,200
Averages or totals	$165.1	2.25%	2.04%	1.15%	−4.12%	2.24%	21,610,200
High-Housing-Price Areas							
13. Providence, RI	$128.8	4.46%	5.76%	1.15%	0.83%	−3.16%	642,700
14. Springfield, MA	124.5	9.98	−6.54	—	−4.47	2.30	229,000
15. Riverside, CA	116.1	21.57	9.53	4.78	3.28	2.56	2,119,000
16. Albany, NY	102.1	17.36	4.71	1.32	8.45	2.00	846,400
17. Raleigh-Durham, NC	102.0	16.31	13.80	—	−2.40	4.51	665,400
18. Philadelphia, PA	100.4	2.76	4.30	4.51	−2.25	−3.55	4,866,500
19. Sacramento, CA	100.3	13.72	4.65	—	−2.79	2.98	1,336,500
20. Seattle, WA	99.7	13.04	6.12	−5.02	3.37	8.49	1,795,900
21. Chicago, IL	99.3	7.00	7.00	1.51	−2.38	0.91	6,199,000
22. West Palm Bch., FL	94.4	3.17	3.61	13.29	−5.03	−7.45	790,100
23. Baltimore, MD	92.2	10.29	4.43	5.73	−2.93	2.90	2,302,900
Averages or totals	$105.43	10.88%	5.22%	2.48%	−0.57%	1.14%	21,793,400

APPENDIX B—*Continued*

Metro Area (MSA)	Median Home Price 1989 QI ($1000)	Annual Percentage Price Change 1988–89 QI	Quarterly Percentage Changes in Median Home Prices: 88 QI–88 QII	88 QII–88 QIII	88 QIII–88 QIV	88 QIV–89 QI	Total MSA Population as of 7/1/87
Moderate-Housing-Price Areas							
24. Dallas, TX	$88.4	2.67%	−0.35%	0.12%	−1.63%	−4.62%	2,456,000
25. Minneapolis, MN	85.9	1.78	−0.12	2.02	1.40	−1.49	2,335,600
26. Charlotte, NC	85.2	—	—	—	—	−0.81	1,091,000
27. Rochester, NY	84.2	15.03	0.68	6.24	−2.55	10.35	979,100
28. Miami, FL	82.6	5.90	7.05	−1.08	1.69	−1.67	1,791,500
29. Albuquerque, NM	82.0	2.89	2.38	2.21	−9.11	8.18	486,200
30. Fort Lauderdale, FL	81.9	4.20	0.76	6.94	−3.90	0.61	1,162,600
31. Saint Louis, MO	81.4	9.85	7.29	2.01	−6.66	7.53	2,458,100
32. Denver, CO	80.8	−3.46	−0.36	−2.76	−1.73	1.38	1,644,500
33. Las Vegas, NV	80.5	6.34	2.91	3.59	−13.01	14.67	599,900
34. Atlanta, GA	80.3	—	—	—	−0.74	−0.25	2,656,800
35. Nashville, TN	79.6	2.58	0.90	−0.26	−2.05	4.05	956,200
36. Orlando, FL	79.1	0.51	−1.27	4.63	−3.94	1.28	934,700
37. Phoenix, AZ	78.5	−0.63	0.13	4.05	−3.28	−1.38	1,959,600
38. Birmingham, AL	77.3	5.75	4.65	1.05	−3.10	3.20	916,900
39. Memphis, TN	77.0	−0.65	−0.90	−0.26	−2.74	3.36	971,900
40. Syracuse, NY	76.9	12.92	9.99	0.67	0.66	1.32	647,000
41. Fort Worth, TX	75.3	−10.89	−2.25	−4.84	−0.89	−3.34	1,268,900
42. Lexington, KY	74.9	7.46	4.30	—	−0.26	−0.66	341,500
43. Madison, WI	74.7	10.34	6.06	—	−4.72	5.66	347,400
44. Milwaukee, WI	74.5	2.62	3.72	0.40	−3.31	1.92	1,389,100
45. Columbus, OH	73.9	11.63	10.88	1.50	0.13	−0.94	1,320,100
46. Kansas City, MO	73.8	4.09	1.41	−2.78	−0.86	6.49	1,546,400
47. Cincinnati, OH	73.2	9.75	4.35	3.16	−2.23	4.27	1,438,300
48. Charleston, SC	72.4	−0.28	1.24	1.22	−4.17	1.54	502,100
49. Columbia, SC	71.9	5.27	3.37	—	−2.83	4.66	451,400
50. Detroit, MI	71.9	0.56	1.12	5.67	−3.93	−2.04	4,361,600
51. Tampa, FL	71.7	19.10	8.80	3.66	−2.50	8.31	1,965,100
52. New Orleans, LA	71.2	−2.47	0.27	2.19	−5.21	0.42	1,321,000
53. Knoxville, TN	69.8	5.28	−1.06	5.34	−3.18	4.33	594,000
54. Cleveland, OH	69.4	4.36	5.11	5.11	−0.72	0.14	1,851,400
55. Buffalo, NY	68.7	7.18	1.09	2.78	0.00	3.15	958,300
56. Indianapolis, IN	68.0	10.03	7.93	1.20	−1.33	2.10	1,228,600
57. Portland, OR	67.1	6.68	3.18	−0.15	0.00	3.55	1,167,800
58. Salt Lake, UT	66.5	1.84	1.68	5.42	−3.29	−1.77	1,054,500
59. Montgomery, AL	65.9	5.61	5.13	—	−2.60	3.62	297,400
60. Jacksonville, FL	65.9	−4.35	−2.18	1.04	1.04	−2.95	878,200
61. Chattanooga, TN	65.6	7.19	3.27	—	1.09	1.08	431,500
Averages or totals	$75.5	4.39%	2.66%	1.58%	−2.38%	2.49%	48,762,200

Metro Area (MSA)	Median Home Price 1989 QI ($1000)	Annual Percentage Price Change 1988–89 QI	Quarterly Percentage Changes in Median Home Prices 88 QI–88 QII	88 QII–88 QIII	88 QIII–88 QIV	88 QIV–89 QI	Total MSA Population as of 7/1/87
			Low-Housing-Price Areas				
62. Dayton, OH	$64.4	4.21%	2.59%	—	−0.31%	1.26%	938,800
63. Little Rock, AR	63.4	0.63	0.16	—	−2.74	−0.63	511,500
64. Corpus Christi, TX	63.2	0.00	2.53	—	5.22	−4.96	360,300
65. Houston, TX	62.9	4.49	5.48	3.15	−13.28	10.74	3,228,100
66. Pittsburgh, PA	62.4	2.46	2.13	6.59	−5.28	−0.64	2,105,400
67. Greenville, SC	61.9	−3.43	1.25	—	−6.11	−4.03	611,900
68. Baton Rouge, LA	61.1	−7.00	−1.83	—	1.09	−5.71	538,300
69. Omaha, NE	60.9	4.46	0.69	2.73	−0.66	1.67	616,400
70. San Antonio, TX	60.8	−4.10	2.84	4.60	−8.94	−2.09	1,306,700
71. Tulsa, OK	60.5	−4.72	2.36	0.77	−0.31	−7.35	733,000
72. Wichita, KN	60.4	4.86	4.69	—	−3.87	1.34	474,700
73. Grand Rapids, MI	59.6	7.58	5.23	1.20	0.34	0.68	657,000
74. Daytona Beach, FL	59.5	0.34	6.75	—	2.23	−7.18	331,900
75. Lansing, MI	57.9	8.43	8.24	—	−1.40	3.02	427,800
76. Toledo, OH	57.7	2.12	5.66	0.3	−5.84	2.30	611,000
77. Des Moines, IA	57.3	5.14	6.79	−5.5	−0.36	4.56	385,100
78. El Paso, TX	57.2	−1.04	4.67	2.5	−5.16	−2.72	572,800
79. Louisville, KY	56.7	8.62	3.64	3.5	−1.61	2.90	966,500
80. Akron, OH	56.0	−1.93	5.25	—	−6.71	−4.11	647,000
81. Oklahoma City, OK	52.3	−7.43	0.71	1.8	−7.60	−2.24	975,000
82. Mobile, AL	50.9	0.59	−1.78	—	−0.53	−8.78	483,000
83. Spokane, WA	50.2	0.60	6.01	—	−1.18	−0.20	355,300
84. Peoria, IL	42.0	1.45	11.11	—	−3.28	−5.19	338,500
Averages or totals	$58.2	1.14%	3.70%	0.94%	−2.88%	−1.19%	18,176,000
Averages or Totals All 84 metro areas	$90.6	5.21%	3.48%	1.83%	−2.20%	1.40%	123,486,000
United States	$91.6	3.40%	—	—	—	—	243,400,000

DISCUSSION OF PRECEDING PAPER

GERTRUDE FISH*:

I find the assumptions and estimates in the article reasonable and would like to see them applied at the policy level by the Department of Housing and Urban Development (HUD).

When one reflects on the long-run consequences of the program, there are additional pitfalls to be considered. For instance, not only do older people have houses of lower appraised value than younger people, but also, now that the FHA is insuring HECM loans, one might expect a less careful appraisal by lenders at the origination of a HECM loan.

Further, Ms. Jones (Appendix A) probably will not spend the monthly payment of $370.00 on the maintenance and repair of the house. By the time the lender acquires the property, it may be in substandard condition and decreased in value rather than appreciated in value. After all, the U.S. Census shows that many more people are living to age 85 and beyond. One result of the HECM program could be the deterioration of whole neighborhoods of houses as the residents age in place.

The houses most apt to be in the HECM program are houses that are affordable to young, first-time home buyers. The HECM program will remove those houses from the market.

Example 2 in Appendix A represents a likely outcome, and the FHA should administer its program using these assumptions. The loss reserve fund should be large enough to sustain the losses expected under Example 2's conditions. The program's actual strengths and weaknesses will not become apparent until currently originated loans reach maturity. Are the data for an analysis of the program being carefully recorded? HUD has a responsibility to evaluate the program from its inception and in careful detail.

TAPEN SINHA†:

Ms. DiVenti and Dr. Herzog provide some interesting stochastic simulation results about tenure HECMs. The model needs assumptions about (1) appreciation of home values in nominal terms, (2) mortality rates, (3) move-out rates, (4) various transactions costs, and (5) interest rates.

*Dr. Fish, not a member of the Society, recently retired from the Department of Housing and Urban Development.

†Dr. Sinha, not a member of the Society, is Associate Professor of Finance, School of Business, Bond University, Gold Coast, Queensland, Australia.

The model is quite useful. Therefore it needs further exploration. I suggest the following three items be given a closer look: (1) appreciation of home values, (2) mortality rates, and indirectly, (3) inflation rates. I discuss them in turn.

Appreciation of Home Values

From Table 4, it is clear that the rate of appreciation of home values affects the results of the simulations drastically. For example, for a discount rate of 8.5 percent, the annuity is $379 for 4.258 percent appreciation per annum and $199 for 0 percent appreciation per annum. Would the appreciation in the values of American homes in the next 30 years be anywhere near the experience of the past 30 years? The answer from the economists seems to be negative. For example, Mankiw and Weil [1] argue that the appreciation of American housing costs in the past 30 years has been driven by the baby boom and the relocation of population (mainly from the Northeast to the South and Southwest). It seems unlikely that these events will ever be repeated. Thus, except for a few spots in the South and Southeast, prices are likely to *go down*. Mankiw and Weil predict a general decline in home values to the tune of 50 percent over the next 30 to 40 years. Thus, for older people who do not benefit from the deductibility of interest payment (because their homes are already paid off) it might be more desirable to sell their homes right after retirement. Therefore, at the very least, we should extend the simulations to falling home prices as well.

Mortality Rates

The authors recognize the clear problem of adverse selection at work here. To obtain a more conservative estimate of the death rates, we could use the following method. First, calculate the age-specific mortality rate differential between annuity buyers and the general population. Next, apply the differential in the model of the authors. Standard errors can also be estimated similarly. The process that leads to lower mortality rates among annuity buyers will also be operating here in similar magnitude.

Inflation

The authors get estimates and standard errors of *level* annuities. However, if the purpose of the annuities is for (1) major medical bills, (2) major home repairs, and (3) recurrent expenses, it is unlikely that they will stay the same over the coming decades. A more useful approach would be to build an (or several possible) inflation factor into the annuity payments.

REFERENCE

1. MANKIW, N.G. AND WEIL, D. "The Baby Boom, the Baby Bust, and the Housing Market," *Regional Science and Urban Economics* (1989): 235–258.

(AUTHORS' REVIEW OF DISCUSSION)

THERESA R. DIVENTI AND THOMAS N. HERZOG:

The discussions of both Dr. Sinha and Dr. Fish expand the ideas of our paper. Dr. Sinha's suggestion of building an inflation factor into the annuity payments is a good one, although it could make the model more complex. We also wonder whether potential mortgagors would find this feature attractive because it would reduce the monthly payments during the early years of the mortgage.

Let us hope that the economists whose work Dr. Sinha cites are overly pessimistic about general appreciation in the values of single-family homes in the U.S. in the next 30 years. Some of HUD's staff economists are much more optimistic. Nevertheless, we share Dr. Sinha's and Dr. Fish's pessimism about the future appreciation of single-family homes owned by elderly HECM mortgagors. As Dr. Fish states in her discussion, such mortgagors are unlikely to be able to maintain and repair their homes themselves or to use their limited financial resources to hire others to do so.

We thank both discussants for their thoughtful comments.