

A SIMULATED EXERCISE FOR TEACHING HOME MORTGAGES

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The cost of financing the purchase of a home has increased steadily in the past seven years. In 1969, the cost of financing a typical single-family detached house was \$1790 or 7% of the cost of the house; by 1974, this cost had increased to \$3580, or 10% of the total cost¹ (U. S. Bureau of the Census, 1974). Much discussion has taken place about the effects of various types of mortgages on housing costs and the stability of the financial market, particularly fixed-rate vs. variable-rate mortgages (Von Furstenberg, 1972; Cohn and Fisher, 1974; Fish, 1975; Hanna, 1975). Consequently, the nature and complexity of home mortgages should be thoroughly understood by students in undergraduate housing courses. This article reports on a computer simulation exercise used at Cornell University by students in an introductory housing course.

Most of the mysteries of home mortgages can be conveniently demonstrated by a computer simulation exercise. Such an exercise can be both simple and a powerful teaching tool, particularly since many students learn general points best by

an empirical demonstration rather than through a purely descriptive approach. Not only will a computer simulation exercise enable students to observe the nature of the amortized mortgage but also it will serve as an analytical tool to study the effects of changing mortgage components on total housing costs. A further advantage is that the computer program will allow students to compare fixed-rate and variable-rate mortgages under different assumptions. Finally, a computer simulation exercise can introduce uninitiated students to the keypunch and the computer. Indeed, many undergraduates were highly motivated by the opportunity to use a computer in carrying out the exercise.

The mortgage simulation program is designed so that students can use it by punching only one data card plus any control cards needed by the particular system (for variable-rate mortgage, more data cards are needed) without any previous knowledge of computer programming. This exercise has been successfully used in a freshman course, "Housing and Society," in the Department of Consumer Economics and Public Policy at Cornell University. It has also been used in the course "Housing for Man" in the Department of Consumer Affairs at Auburn University. Reports from the students suggest that they not only were able to learn and understand the complexity of

¹The major cost items used in the Bureau of the Census report include land, financing, labor and materials, overhead and profit, and others.

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housing mortgage but that they enjoyed the experience as well.

The simulation program can perform two major functions:

- 1) Calculate mortgage payments and related statistics based on either a fixed-rate mortgage or a variable-rate mortgage.

- 2) Estimate the total cost of a house that a family can afford given a constant monthly mortgage payment.

To calculate mortgage payments and related statistics, the program requires the following inputs:

- 1) Maturity term of a mortgage
- 2) Annual mortgage interest rate(s)
- 3) Percent of down payment
- 4) Total sales price of the house
- 5) Percent of initial fees and charges (i.e., closing costs or settlement costs)
- 6) Type of mortgage (fixed-rate or variable-rate)

To estimate the cost of a house from a constant monthly payment, the following information is needed:

- 1) Maturity term of a mortgage
- 2) Annual mortgage interest rate (a fixed rate for the entire term)
- 3) Percent of down payment
- 4) Percent of initial fees and charges
- 5) Amount of monthly payment prespecified by the user

The computer produces for each simulation the following output:

- 1) A summary table (for fixed-rate mortgages only) including monthly payment, total interest costs, mortgage principal, amount of down payment, housing price, initial fees and charges, and total overall cost.

- 2) A mortgage table for all payment periods, including monthly principal, monthly interest, cumulative principal, cumulative interest, and unpaid principal balance.

The source program, program instructions, exercise instructions and examples of input data are shown in the appendix (Tables A1, A2, A3 and A4

respectively).

EXAMPLES OF SIMULATIONS

Several applications of the simulation program are illustrated in this section and analyses of the results are also presented.

No. 1. Nature of the Amortized Housing Mortgage. An amortized mortgage is repaid in specified amounts, usually on a monthly basis, during the term of the mortgage. The payment has two parts: the amount paid on the principal and the amount paid on the interest. In this simulation, each student was told to use the median value of owner occupied homes for a given Standard Metropolitan Statistical Area (SMSA) as the sales price of the house. (This information can be obtained from the Census of Housing.) The median house value for the Durham SMSA is used in this example. It is assumed that the down payment is 15 percent; the maturity term, 25 years; the annual interest rate, 8.5 percent; and the initial fees and charges, 1 percent. From the computer results (Table A5 in the Appendix), students were first instructed to make a table to compare percent and cumulative percent distributions between principal and interest over a 25-year term (Table 1). Secondly, they were instructed to plot cumulative principal payments, cumulative interest payments, and remaining unpaid balance on a graph using dollar values as the vertical axis and years as the horizontal axis.

Table 1 shows the well-known fact that most of the early payments on an amortized mortgage actually are applied to interest, while near the end of the amortization period, most of the payments apply to the principal. Additionally, however, the results of the simulation indicate the exact percent change during the term. For instance, in this particular example, at the end of the first year, 87 percent of the monthly payment is for interest, while at the end of the 25th year, the interest share is only .7 percent. Both interest and principal receive about equal proportions at the end of the 17th year.

Table 1. Percent and Cumulative Percent Distributions of Principal and Interest Payments for a 25 Year Term, Durham SMSA, North Carolina, 1970

| Payment Period | Percent Distribution | | Total | Cum. Percentages Over Time | |
|----------------|----------------------|----------|--------|----------------------------|------------|
| | Principal | Interest | | Principal | Interest |
| 1st year | 13.0% | 87.0% | 100.0% | 1.2% | 6.0% |
| 5th year | 18.3 | 81.7 | 100.0 | 7.2 | 29.0 |
| 10th year | 27.9 | 72.1 | 100.0 | 18.2 | 55.4 |
| 15th year | 42.6 | 57.4 | 100.0 | 35.1 | 77.6 |
| 20th year | 65.0 | 35.0 | 100.0 | 61.0 | 93.6 |
| 25th year | 99.3 | .7 | 100.0 | 100.0 | 100.0 |
| Total payment | - | - | - | \$13,770.0 | \$19,493.9 |

Source: Table A4 in Appendix.

Cumulative percentages indicate that 55 percent of the total interest had been paid off at the end of the 10th year, while only 18 percent of the total principal was paid during the same period. A graph should show that the curve of cumulative interest tends to increase at a decreasing rate, while that of cumulative principal tends to increase at an increasing rate. The unpaid balance declines, of course, as more of the principal is paid off.

No. 2. Effects of Changing Mortgage Terms. The purpose of this simulation exercise is to examine the effects of changing interest rate, term to maturity, down payment, and initial fees and charges on mortgage payments. By holding three of four items constant and changing one item at a time, the effects of each specific item can be ascertained.

A table containing information on average terms for conventional home mortgages offered by major types of lenders in the United States was given to students (Table 2). They were then asked to select a set of average terms from one of the major lenders for a newly-built house costing \$50,000. In this simulation, 1974 was used as a base year. Mortgage payments derived from 1974 terms were compared with: (1) payments based

Table 2. Average Terms for Conventional Home Mortgages by Major Types of Lenders (Loans Made for Purchase of Newly-Built Homes)

| Types of Lenders and Month | Contract Interest Rate (%) | Initial Fees & Charges (%) | Term to Maturity (Years) | Down pay. (%) |
|--|----------------------------|----------------------------|--------------------------|---------------|
| 1. National Averages for Savings and Loan Associations | | | | |
| 1974-Dec. | 9.01 | 1.86 | 28.2 | 22.8 |
| 1975-Dec. | 8.79 | 1.58 | 28.0 | 22.0 |
| 2. National Averages for Mortgage Companies | | | | |
| 1974-Dec. | 9.09 | 1.53 | 29.7 | 20.0 |
| 1975-Dec. | 8.29 | 2.53 | 29.8 | 16.8 |
| 3. National Average for Commercial Banks | | | | |
| 1974-Dec. | 9.47 | .66 | 26.3 | 27.6 |
| 1975-Dec. | 8.89 | .99 | 23.8 | 36.0 |
| 4. National Average for Mutual Savings Banks | | | | |
| 1974-Dec. | 9.05 | .36 | 24.9 | 31.1 |
| 1975-Dec. | 8.75 | .48 | 26.9 | 29.8 |

Source: *Federal Home Loan Bank Board News*, Jan. 21, 1976.

on 1975 terms; (2) payments based on the 1975 interest rate and the 1974 term to maturity, down payment, and initial fees and charges; (3) payments based on the 1975 term to maturity, and the 1974 interest rate, down payment, and initial fees and charges; (4) payments based on the 1975 down payment and the 1974 interest rate, term to maturity, and initial fees and charges; (5) payments based on the 1975 initial fees and charges and the 1974 interest rate, down payment, and term to maturity. All of these comparisons are summarized in Table 3. The results based on the average terms for commercial banks are presented in Table 4.

Data in Table 4 indicate that the total cost of financing a \$50,000 newly-built home from a commercial bank had decreased from \$111,600 in 1974 to \$96,000 in 1975—a decrease of 14 percent. This change was primarily attributed to an increase in the down payment of 8.4 percent, a shorter term of maturity of about 2 years and a decrease in the

Table 3. Summary of Various Terms Used in Different Comparisons

| | Interest Rate in Year | Maturity Term in Year | Down Payment in Year | Initial Fees and Char. in Year |
|-----------------|-----------------------|-----------------------|----------------------|--------------------------------|
| Comparison base | 1974 | 1974 | 1974 | 1974 |
| Comparison 1 | 1975 | 1975 | 1975 | 1975 |
| Comparison 2 | 1975 | 1974 | 1974 | 1974 |
| Comparison 3 | 1974 | 1975 | 1974 | 1974 |
| Comparison 4 | 1974 | 1974 | 1975 | 1974 |
| Comparison 5 | 1974 | 1974 | 1974 | 1975 |

interest rate of .58% (see Table 2). These factors had also lowered the interest cost from \$61,300 to \$45,000 (a decrease of 26 percent). Changing the initial fees and charges (.33 percent) had no effect on interest cost because interest was paid only on the remaining balance. The effects of this factor on the total cost was slight compared with the effects of the other three factors. This simulation demonstrates clearly the relationships between components of a mortgage and the financial costs of housing.

No. 3. Estimate of Costs of Financing, Given a Constant Monthly Mortgage Payment. In this simulation, it was assumed that 25 percent of the average monthly family income in Durham,

North Carolina, in 1969 (\$181, based on data from the Census of Population, 1970) was the amount that a family planned to spend on a monthly mortgage payment. The other terms, interest rate, term to maturity, down payment, and initial fees and charges in the simulation were the average terms of Savings and Loan Associations in December, 1975 (see Table 2). The questions to be answered were: What would be the total amount of mortgage that a family with this income could afford? What would be the cost of interest and the total cost of the loan? The results from the computer output indicate that the family could afford a mortgage of \$22,582. Their interest cost would be \$28,234, and the total amount they would have paid by the end of the term would be \$64,301. This simulation would certainly assist housing consumers in preparing their housing budgets.

No. 4. Comparisons between Fixed-Rate and Variable-Rate Mortgages. Assuming a housing sales price of \$45,000, a down payment of \$10,000, a term to maturity of 30 years, and initial fees and charges of 1 percent, this simulation compares the costs of financing under two sets of annual interest rates: (1) a fixed-interest rate of 9 percent over the entire 30 years and (b) a variable-rate schedule as follows: 1st to 4th year, 8 percent; 5th to 9th year, 9 percent; 10th to 14th year, 10 percent; 15th to 19th

Table 4. Payment Differences for a \$50,000 Newly-built House Between 1974 and 1975 (based on national average terms for commercial banks, in \$100)

| Variation | Interest Cost | | | | Total Cost | | | |
|--------------------------------------|---------------|-------|------------|----------------|------------|--------|-------------|----------------|
| | 1974 | 1975 | Difference | Percent Change | 1974 | 1975 | Differences | Percent Change |
| 1. Actual terms | \$613 | \$455 | -\$158 | -25.8% | \$1116 | \$ 960 | -\$156 | -14.0% |
| 2. Changing interest rate | 613 | 568 | -45 | -7.4 | 1116 | 1070 | -46 | -4.1 |
| 3. Changing term to maturity | 613 | 556 | -57 | -9.3 | 1116 | 1059 | -57 | -5.1 |
| 4. Changing down payment | 613 | 542 | -71 | -11.6 | 1116 | 1045 | -71 | -6.4 |
| 5. Changing initial fees and charges | 613 | 613 | 0 | 0 | 1116 | 1118 | 2 | .2 |

Table 5. Comparisons Between Fixed-rate and Variable-rate Mortgages

| Fixed-rate Mortgage | | | Variable-rate Mortgage | | | |
|---------------------|---------------|----------|------------------------|---------------|----------|-----------------|
| Year | Interest rate | Balance* | Monthly Payment | Interest rate | Balance* | Monthly Payment |
| 1st | 9% | \$34,762 | \$281.6 | 8% | \$34,709 | \$256.8 |
| 5th | 9 | 33,559 | 281.6 | 9 | 33,338 | 279.8 |
| 10th | 9 | 31,301 | 281.6 | 10 | 31,160 | 300.7 |
| 15th | 9 | 27,766 | 281.6 | 11 | 28,053 | 318.8 |
| 20th | 9 | 22,232 | 281.6 | 12 | 23,218 | 333.1 |
| 25th | 9 | 13,567 | 281.6 | 12 | 14,975 | 333.1 |
| 30th | 9 | 0 | 281.6 | 12 | 0 | 333.1 |

(Total interest = \$66,384)

(Total interest = \$75,256)

*Remaining unpaid balance at the end of a year

year, 11 percent, from 29th year on, 12 percent.

In this simulation, it was assumed that interest rates for the variable-rate mortgage would increase over the term of mortgage. The results, shown in Table 5, indicate (as would be expected from the changing interest rates) that payments on the variable-rate mortgage increase every five years and stabilize after the 20th year. Total interest paid would be \$75,256, compared to \$66,384 with the fixed-rate mortgage. This simulation demonstrates, however, that monthly payments before the 10th year are lower in a variable-rate mortgage than in a fixed-rate mortgage if lower interest rates for the first few years are assumed for the variable-rate mortgage. This rate structure may be of great interest to young home buyers who expect their incomes to rise during the term of the mortgage. Equally, it may also be attractive to those buyers who want to own the house for less than ten years.

SUMMARY

Other types of simulation than the four examples presented in the previous section may be devised. For instance, simulations No. 1 and No. 3 can be applied not only to different metropolitan areas but also to such census units as counties,

cities, urbanized areas, and states. Each student can be assigned a district unit with no overlap between units. The mortgage costs calculated for each unit may be compared with the national average so that geographical variations in the cost of housing mortgages can be ascertained.

Simulation No. 2 could be modified to compare the cost of mortgages from different types of lending institutions. The results of such an exercise would help potential home buyers obtain a mortgage on the most favorable terms.

In simulation No. 4 various future trends in interest rates could be applied to the variable-rate mortgage. The future interest rates may be assumed to follow an increasing, a decreasing or a mixed trend. The results derived from different assumptions could be used to make some interesting comparisons of the effects of different rate structures (see Hanna, 1975).

In sum, various aspects of housing mortgage could be effectively taught in a manner more appealing than the formal lecture. This simulation program provides instructors of introductory housing courses with a powerful teaching tool. It also provides students with the opportunity to manipulate data effectively and to understand fully the complex nature of the housing mortgage.

References

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- U.S. Bureau of the Census, *New One Family Homes Sold and For Sale*, Series C25, May 1974.
- Von Furstenberg, George M., "The Economics of Variable-rate Mortgages," *Federal Home Loan Bank Board Journal*, 5(6), (Jan. 1972) pp. 8-11.

Table A1. Source Program for Mortgage Simulation

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/JOB
C      MORTGAGE COMPUTATIONS PROGRAM
C****  VERSION OF OCTOBER 1976
C      COMPUTES MORTGAGE RELATED INFORMATION SUCH AS PAYMENTS,
C      REMAINING BALANCE, TOTAL COST (AND OPTIONALLY TOTAL
C      PURCHASE PRICE, IF MONTHLY PAYMENT GIVEN), ETC.
C      WILL DO VARIABLE INTEREST RATE MORTGAGES.
1      IMPLICIT REAL*8 (A-H,O-Z)
C      MAXIMUM NUMBER OF PAYMENT PERIODS (MONTHS) = 960 = 80 YEARS.
2      DIMENSION OUT(480,5),VRATE(80)
3      DATA NRD,NPK/5,6/
4      PAYMNT(A,B,IC) = A*(B/(1.00-(1.00+B)**IC))
C****  FORMAT STATEMENTS
5      1 FORMAT(I5,3F5.0,2F10.0,3I5)
6      2 FORMAT(17H MONTHLY PAYMENTS ,17X ,F11.2/
1      1 19H MORTGAGE PRINCIPAL ,15X ,F11.2/
2      2 9H INTEREST ,25X ,F11.2/
3      3 24H INTEREST PLUS PRINCIPAL ,10X ,F11.2/
4      4 23H AMOUNT OF DOWN PAYMENT ,11X ,F11.2/
5      5 34H PRICE INCLUDING DOWN PAYMENT ,F11.2/
6      6 25H INITIAL FEES AND CHARGES ,9X ,F11.2/
7      7 12H GRAND TOTAL ,22X ,F11.2/ )
7      3 FORMAT(17H-MORTGAGE PROGRAM,80X,20HVERSION OF OCT. 1976
1      1 19H CORNELL UNIVERSITY/ 18HOYEARS OF MORTGAGE ,20X, 14 /
2      2 34H MORTGAGE INTEREST RATE (PERCENT) ,F11.2/
3      3 21H PERCENT DOWN PAYMENT ,13X ,F11.2/
4      4 35H INITIAL FEES AND CHARGES (PERCENT),F10.2)
8      4 FORMAT(1H1,2(8X,40H MONTHLY MONTHLY CUM. CUM.,
1      1 13H PRINCIPAL,4X)/ 2(29H PERIOD PRINCIPAL INTEREST ,
2      2 33H PRINCIPAL INTEREST REMAINING,3X))
9      5 FORMAT(2(I5,F12.2,3F11.2,F12.2,3X))
10     6 FORMAT(45HO*** TOTAL PRICE INCLUDING DOWNPAYMENT GIVEN, /
1      1 5X,33HPROGRAM COMPUTES MONTHLY PAYMENTS/ )
11     7 FORMAT(35HO*** MAXIMUM MONTHLY PAYMENT GIVEN, /
1      1 5X,50HPROGRAM COMPUTES TOTAL PRICE INCLUDING DOWNPAYMENT /)
12     8 FORMAT(16F5.0)
13     9 FORMAT( 15H INTEREST RATES /( 1X,5F10.2,2X,5F10.2))
C****  READ NUMBER OF JOBS CARD
14     READ(NRD,1) NJOB
15     DO 400 IJUB=1,NJOB
C****  READ CONTROL CARD FOR EACH JOB

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16      READ(NRD,1) NYRS,RATE,PCTDN,FC,TOTP,PMT,IPRT,NPRP,MIT
C****  DESCRIPTION OF PARAMETERS
C      CUL          CONTENTS
C      1-5         NYRS = NUMBER OF YEARS OF MORTGAGE
C      6-10        RATE=ANNUAL MORTGAGE INTEREST RATE AS PERCENT, E.G. 9.75
C      11-15       PCTDN=PERCENT OF TOTAL PRICE IN DOWNPAYMENT
C      16-20       FC = PERCENT OF PURCHASE PRICE FOR INITIAL FEES AND CHARGES,
C                  DEFAULT = 1.0
C      21-30       TOTP=TOTAL PRICE INCLUDING DOWNPAYMENT, OMIT IF MAXIMUM
C                  MONTHLY PAYMENT, PMT, PUNCHED.
C      31-40       PMT = AMOUNT OF MONTHLY PAYMENT WILLING TO PAY, IF PUNCHED
C                  PROGRAM COMPUTES A TOTAL PRICE
C      41-45       IPRT, IF NE 0 SUPPRESS MORTGAGE TABLE, OTHERWISE PRINT IT
C      46-50       NPRP=NO OF PERIODS PER INTEREST RATE PERIOD (IF 0, PROGRAM
C                  USES 12)

C      51-55       MIT = MORTGAGE INTEREST TYPE. 0 = FIXED INTEREST RATE MORT-
C                  GAGE, 1 = VARIABLE INTEREST RATE AND PROGRAM EXPECTS CARDS
C                  WITH INTEREST RATES PUNCHED IMMEDIATELY AFTER CONTROL CARD
C                  FORMAT IS 16F5.0 FOR INTEREST RATES.  PGM. USES PREVIOUS
C                  YEAR'S RATE IF GIVEN YEAR BLANK.
C****  CONVERT INPUT DATA FOR PROGRAM USE
17      IF(NPRP .LE. 0) NPRP=12
18      IF(FC .LE. 0.00) FC=1.00
19      WRITE(NPR,3) NYRS,RATE,PCTDN,FC
C****  COMPUTE OUTPUT
20      NMON=NYRS*NPRP
21      XNMON=NMON
22      XNPRP=NPRP
23      PRATE=RATE/XNPRP*.0100
24      T=1.00-(1.00+PRATE)**(-NMON)
C****  BRANCH FOR DIFFERENT INPUTS
25      IF(TOTP .LE. 0.00) GO TO 120
C****  TOTAL PRICE INPUT, COMPUTE PAYMENTS
26      WRITE(NPR,6)
27      ADWN=TOTP*PCTDN*.0100
28      PV = TOTP - ADWN
29      IF(MIT .NE. 0) GO TO 170
30      PMT = PV*(PRATE/T)
31      GO TO 140
C****  PAYMENTS INPUT, COMPUTE TOTAL PRICE
32      120 WRITE(NPR,7)
33      PV=PMT*(T/PRATE)
34      TOTP=PV/(1.00-PCTDN*.0100)
35      ADWN=TOTP-PV
C****  COMPUTE REST OF STUFF
36      140 TCOST=PMT*XNMON
37      TOTI=TCOST-PV
38      FC=TOTP*FC*.0100
39      GTOT=TCOST+ADWN+FC
C****  PRINT REST OF INPUT DATA AND ALSO OTHER STUFF
40      WRITE(NPR,2) PMT,PV,TOTI,TCOST,ADWN,TOTP,FC,GTOT
41      IF(IPRT .NE. 0) GO TO 400
42      DO 160 I=1,NYRS
43      160 VRATE (I)=0.00
44      GO TO 200
C****  PREPARE FOR VARIABLE INTEREST RATES MURTGAGE.
45      170 READ(NPD,8) (VRATE(I),I=1,NYRS)
46      WRITE(NPR,9) (VRATE(I),I=1,NYRS)
47      IF(VRATE(1) .LE. 0.00) VRATE(1) = RATE

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48     IF(VRATE(1) .LE. 0.00) GO TO 400
49     PRATE = VRATE(1)/XNPRP * .0100
50     PMT = PAYMNT(PV,PRATE,-NMON)
51     200 IYR = 1
C****   OUT I,1 = PRINCIPAL; , OUT I,2 = INTEREST; OUT I,3 = CUM PRIN.;
C       OUT I,4 = CUM INTEREST; OUT I,5 = BALANCE REMAINING
52     AINT=PV*PRATE
53     PRIN=PMT-AINT
54     OUT(1,1)=PRIN
55     OUT(1,2)=AINT
56     OUT(1,3)=PRIN
57     OUT(1,4)=AINT
58     UNPP=PV-PRIN
59     AINT=UNPP*PRATE
60     OUT(1,5)=UNPP

C***** NUMBER OF LINES IN OUTPUT TABLE (2 *COLUMNS*)
61     NLINE=NMON/2
62     DO 260 I=2,NLINE
63     PRIN=PMT-AINT
64     OUT(I,1)=PRIN
65     OUT(I,2)=AINT
66     OUT(I,3)=OUT(I-1,3) + PRIN
67     OUT(I,4)=OUT(I-1,4) + AINT
68     UNPP=UNPP-PRIN
69     IF(I/NPRP .NE. IYR) GO TO 240
70     IYR = IYR + 1
71     NMON = NMON - NPRP
72     IF(VRATE(IYR) .LE. 0.00) GO TO 240
73     PRATE = VRATE(IYR)/XNPRP * .0100
74     PMT = PAYMNT(UNPP,PRATE,-NMON)
75     240 AINT=PRATE*UNPP
76     260 OUT(I,5)=UNPP
77     OUT3=OUT(NLINE,3)
78     OUT4=OUT(NLINE,4)
C****   PRINT TABLE
79     WRITE(NPR,4)
80     DO 320 I=1,NLINE
81     I2=I + NLINE
82     PRIN=PMT-AINT
83     OUT2=AINT
84     OUT3=OUT3+PRIN
85     OUT4=OUT4+AINT
86     UNPP=UNPP-PRIN
87     IF(I2/NPRP .NE. IYR) GO TO 280
88     IF(I .EQ. NLINE) GO TO 320
89     IYR = IYR + 1
90     NMON = NMON - NPRP
91     IF(VRATE(IYR) .LE. 0.03) GO TO 280
92     PRATE = VRATE(IYR)/XNPRP * .0100
93     PMT = PAYMNT(UNPP,PRATE,-NMON)
94     280 AINT=PRATE*UNPP
C****   PRINT 2 COLUMN TABLE
95     320 WRITE(NPR,5) I,(OUT(I,J),J=1,5),I2,PRIN,OUT2,OUT3,OUT4,UNPP
96     400 CONTINUE
97     STOP
98     END

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Table A2: Housing Mortgage Program Instructions Given to Students

I. This program computes housing mortgage related information, based on data the user feeds in.

| | |
|-----------------------------|--|
| Data the user feeds in: | Information the program computes: |
| # of years of mortgage term | monthly payments |
| annual interest rate | mortgage principal |
| % down payment | amount of down payment |
| % initial fees and charges | interest paid over term |
| selling price of house. | Amount of Initial fees and charges |
| | grand total (of interest, principal, and fees and charges) |
| | complete amortization table. |

II. Cards.

You will need to punch computer cards in order to get your program into the computer to call up program MORT (control cards) and to give the computer the data you want it to use (data cards). The cards must be submitted in the order in which they are listed here.

A. Input Control cards.

In order to get into the Cornell computer and to call up the mortgage simulation program that is stored there on a disk, you will need the following cards.

```
IT job control card
*WATFIV NOLIST, LINES=660
/*INSERT TLX.MORT
*DATA
```

B. Input Data Cards

1. Job number card: indicates the number of mortgage problems to be computed. For example, Punch a 1 in column 5 if the computer will be figuring out one mortgage problem. Punch a 2 in column 5 if the computer will be figuring out two mortgage problems, etc. For each problem, the following card(s) must be provided:
2. Basic mortgage information card
 - column 4-5 term of mortgage in years
 - columns 7-10 Annual mortgage in-

terest rate as percent. example: for 8.75 percent, punch 8 in column 7, punch decimal point in col. 8 punch 75 in columns 9 and 10.

columns 11-15 Down payment as percent of purchase price. example: 20.00% - start by punching 2 in column 11, etc.

columns 16-20 Initial fees and charges as percentage of purchase price. example: 1.00 percent, start by punching 1 in column 17, etc.

columns 21-30 Total selling price of house. example: selling price of 35000.00 start by punching a 3 in column 22. do not punch the comma. Do punch the decimal point. If user prespecified the monthly payment in the next field, leave this field blank.

columns 31-40 Amount of monthly payment prespecified by the user (optional). If a value is given, the program will compute the total mortgage amount. This option is for the fixed-rate mortgage only.

column 45 Option to print out the mortgage table
0=the program will print the table
1=the program will suppress the table

column 55 Type of mortgage
0=fixed-rate mortgage

| | | | |
|----|---|-------------|----------------------------------|
| | l = variable-rate mortgage | Col. 11-15 | interest rate for the third year |
| 3. | Annual interest rates (for the variable-rate mortgage only): each card will include 16 interest rates. If the interest rate of a given year is the same as the previous one, leave the field blank. | Col. 76-80 | interest for the 16th year |
| | First card | Second card | 17th year to 32nd year |
| | Col. 1-5 interest rate for the first year | Third card | 33rd year to 48th year |
| | Col. 6-10 interest rate for the second year | | so on |

4. / /

Table A3: Instruction for Computer Simulation Exercise As Assigned to Students

This exercise includes four computer simulations by using program MORT.

Simulation 1: (1) purpose: to understand the nature of amortized housing mortgage
 (2) procedure: assume (a) the median housing value for a given SMSA is the average housing price, (b) 20% downpayment, (c) 30 year term and (d) 8.5% annual interest rate and (e) 1.5% initial fees and charges, run program MORT with a fixed-rate mortgage.
 Based on the computer results, (a) compare percent distributions between principal and interest for every five years, (b) calculate cumulative percentages of principal and interest over 30 years (see Table 1), and (c) plot cumulative principal payments, cumulative interest payments and remaining balance on graph paper, using dollar values as vertical axis and years as horizontal axis.

Simulation 2: (1) purpose: to examine the impacts of changing interest rate, initial fees and charges, term to maturity and loan-to-price ratio between 1974 and 1975 on mortgage payments.
 (2) procedure: select a set of average terms on interest rate, term to maturity, initial fees and charges, and loan-to-price ratio for a newly built house of \$45,000 from one of the major lenders in the United States, (see Table 2), use 1974 items as the basis for comparison.
 Compare mortgage payments derived from 1974 terms with: (a) payments based on 1975 terms; (b) payments based on the 1975 interest rate and the 1974 term to maturity, downpayment, and initial fees and charges; (c) payments based on the 1975 term to maturity, and the 1974 interest rate, downpayment, and initial fees and charges; (d) payments based on the 1975 downpayment and the 1974 interest rate, term to maturity, and initial fees and charges; (3) payments based on

the 1975 initial fees and charges and the 1974 interest rate, downpayment, and term to maturity. Present the results in a summary table (see Table 4).

- Simulation 3: (1) purpose: to compare variation of conventional home mortgage between two different lending institutions.
- (2) procedure: assume (a) 25% of the 1969 average monthly family income for a given Central City is the amount that an individual household plans to spend on monthly mortgage in 1975, (b) use 1975 interest rates, maturity terms, initial fees and charges and loan-to-price ratios for previously occupied homes from two lending institutions as reported in table 1. Compare the differences in the following payments: (a)

amount of mortgage that the household is able to afford, (b) total interest payment during the whole term and (c) total amount for the household to pay.

- Simulation 4: (1) purpose: to compare the fixed-rate mortgage with the variable-rate mortgage.
- (2) procedure: assume (a) housing price is \$50,000, (b) \$10,000 downpayment, (c) 30 year term, (d) 1% initial fees and charges, run program MORT with a fixed interest rate of 9%; then run program MORT with the following variable rates of interest:
 1st year - 8.5%; 5th year - 9%; 10th year - 9.5%; 15th year - 10%; 20th year - 11%; 25th year - 12%
- Compare the results in a table (see Table 5).

Analyze the results of all simulations.

Table A4: Examples of Input Data (for ten different jobs)

| Description | Columns | | | | | | | | | | | | | | | | |
|------------------|---------|------|-------|------|-------|----|-------|-----|----|----|----|----|----|----|----|----|----|
| | 1 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 |
| No. of jobs | 10 | | | | | | | | | | | | | | | | |
| Simulation No. 1 | 25 | 8.50 | 15.0 | 1.0 | | | 16200 | | | 0 | | 0 | | | | | |
| Simulation No. 2 | 26 | 9.47 | 27.6 | .66 | 50000 | | | | 1 | | 0 | | | | | | |
| | 24 | 8.89 | 36.0 | .99 | | | 50000 | | | 1 | | 0 | | | | | |
| | 26 | 8.89 | 27.6 | .66 | | | 50000 | | | 1 | | 0 | | | | | |
| | 24 | 9.47 | 27.6 | .66 | | | 50000 | | | 1 | | 0 | | | | | |
| | 24 | 9.47 | 27.6 | .66 | | | 50000 | | | 1 | | 0 | | | | | |
| | 26 | 9.47 | 36.0 | .66 | | | 50000 | | | 1 | | 0 | | | | | |
| | 26 | 9.47 | 36.0 | .66 | | | 50000 | | | 1 | | 0 | | | | | |
| Simulation No. 3 | 28 | 8.79 | 12.0 | 1.58 | | | | 181 | 1 | | 0 | | | | | | |
| Simulation No. 4 | 30 | 9.0 | 22.22 | 1.0 | | | 45000 | | | 0 | | 0 | | | | | |
| | 30 | 9.0 | 22.22 | 1.0 | | | 45000 | | | 0 | | 1 | | | | | |
| | 8 | | | | | | | 9 | | | | 10 | | | | | 11 |
| | | | | | 12 | | | | | | | | | | | | |

Table A5: Computer Results - Portions of the printout showing information calculated.

**MORTGAGE PROGRAM
CORNELL UNIVERSITY**

YEARS OF MORTGAGE 25
MORTGAGE INTEREST RATE (PERCENT) 8.50
PERCENT DOWN PAYMENT 15.00
INITIAL FEES AND CHARGES (PERCENT) 1.00

*** TOTAL PRICE INCLUDING DOWNPAYMENT GIVEN,
PROGRAM COMPUTES MONTHLY PAYMENTS

MONTHLY PAYMENTS 110.88
MORTGAGE PRINCIPAL 13770.00

INTEREST 19493.93
INTEREST PLUS PRINCIPAL 33263.93
AMOUNT OF DOWN PAYMENT 2430.00
PRICE INCLUDING DOWN PAYMENT 16200.00
INITIAL FEES AND CHARGES 162.00
GRAND TOTAL 35855.93

| PERIOD | MONTHLY PRINCIPAL | MONTHLY INTEREST | CUM. PRINCIPAL | CUM. INTEREST | PRINCIPAL REMAINING |
|--------|----------------------|---------------------|-------------------|------------------|------------------------|
| 1 | 13.34 | 97.54 | 13.34 | 97.54 | 13756.66 |
| 2 | 13.44 | 97.44 | 26.78 | 194.98 | 13743.22 |
| 3 | 13.53 | 97.35 | 40.31 | 292.33 | 13729.69 |
| 4 | 13.63 | 97.25 | 53.94 | 389.58 | 13716.06 |
| 5 | 13.72 | 97.16 | 67.66 | 486.74 | 13702.34 |
| 6 | 13.82 | 97.06 | 81.48 | 583.79 | 13688.52 |
| 7 | 13.92 | 96.96 | 95.40 | 680.75 | 13674.60 |
| 8 | 14.02 | 96.86 | 109.42 | 777.62 | 13660.58 |
| 9 | 14.12 | 96.76 | 123.54 | 874.38 | 13646.46 |
| 10 | 14.22 | 96.66 | 137.76 | 971.04 | 13632.24 |
| 11 | 14.32 | 96.56 | 152.07 | 1067.60 | 13617.93 |
| 12 | 14.42 | 96.46 | 166.49 | 1164.06 | 13603.51 |
| 13 | 14.52 | 96.36 | 181.02 | 1260.42 | 13588.98 |
| 14 | 14.62 | 96.26 | 195.64 | 1356.68 | 13574.36 |
| 15 | 14.73 | 96.15 | 210.37 | 1452.83 | 13559.63 |
| 16 | 14.83 | 96.05 | 225.20 | 1548.88 | 13544.80 |
| 17 | 14.94 | 95.94 | 240.14 | 1644.82 | 13529.86 |
| 18 | 15.04 | 95.84 | 255.18 | 1740.65 | 13514.82 |
| 19 | 15.15 | 95.73 | 270.33 | 1836.38 | 13499.67 |
| 20 | 15.26 | 95.62 | 285.59 | 1932.01 | 13484.41 |
| 21 | 15.37 | 95.51 | 300.95 | 2027.52 | 13469.05 |
| 22 | 15.47 | 95.41 | 316.43 | 2122.93 | 13453.57 |
| 23 | 15.58 | 95.30 | 332.01 | 2218.22 | 13437.99 |
| 24 | 15.69 | 95.19 | 347.71 | 2313.41 | 13422.29 |
| 25 | 15.81 | 95.07 | 363.51 | 2408.48 | 13406.49 |
| 26 | 15.92 | 94.96 | 379.43 | 2503.45 | 13390.57 |
| 27 | 16.03 | 94.85 | 395.46 | 2598.30 | 13374.54 |
| 28 | 16.14 | 94.74 | 411.60 | 2693.03 | 13358.40 |
| 29 | 16.26 | 94.62 | 427.86 | 2787.65 | 13342.14 |
| 30 | 16.37 | 94.51 | 444.23 | 2882.16 | 13325.77 |
| 31 | 16.49 | 94.39 | 460.72 | 2976.55 | 13309.28 |

| PERIOD | MONTHLY PRINCIPAL | MONTHLY INTEREST | CUM. PRINCIPAL | CUM. INTEREST | PRINCIPAL REMAINING |
|--------|-------------------|------------------|----------------|---------------|---------------------|
| 32 | 16.61 | 94.27 | 477.33 | 3070.83 | 13292.67 |
| 33 | 16.72 | 94.16 | 494.05 | 3164.98 | 13275.95 |
| 34 | 16.84 | 94.04 | 510.89 | 3259.02 | 13259.11 |
| 35 | 16.96 | 93.92 | 527.85 | 3352.94 | 13242.15 |
| 36 | 17.08 | 93.80 | 544.93 | 3446.74 | 13225.07 |
| 37 | 17.20 | 93.68 | 562.14 | 3540.42 | 13207.86 |
| 38 | 17.32 | 93.56 | 579.46 | 3633.97 | 13190.54 |
| 39 | 17.45 | 93.43 | 596.91 | 3727.40 | 13173.09 |
| 40 | 17.57 | 93.31 | 614.48 | 3820.71 | 13155.52 |
| 41 | 17.69 | 93.18 | 632.17 | 3913.90 | 13137.83 |
| 42 | 17.82 | 93.06 | 649.99 | 4006.96 | 13120.01 |
| 43 | 17.95 | 92.93 | 667.94 | 4099.89 | 13102.06 |
| 44 | 18.07 | 92.81 | 686.01 | 4192.70 | 13083.99 |
| | | | • | | |
| | | | • | | |
| | | | • | | |
| 162 | 41.57 | 69.31 | 4026.40 | 13936.13 | 9743.60 |
| 163 | 41.86 | 69.02 | 4068.26 | 14005.14 | 9701.74 |
| 164 | 42.16 | 68.72 | 4110.42 | 14073.86 | 9659.58 |
| 165 | 42.46 | 68.42 | 4152.88 | 14142.29 | 9617.12 |
| 166 | 42.76 | 68.12 | 4195.63 | 14210.41 | 9574.37 |
| 167 | 43.06 | 67.82 | 4238.69 | 14278.23 | 9531.31 |
| 168 | 43.37 | 67.51 | 4282.06 | 14345.74 | 9487.94 |
| 169 | 43.67 | 67.21 | 4325.73 | 14412.95 | 9444.27 |
| 170 | 43.98 | 66.90 | 4369.72 | 14479.84 | 9400.28 |
| 171 | 44.29 | 66.59 | 4414.01 | 14546.43 | 9355.99 |
| 172 | 44.61 | 66.27 | 4458.62 | 14612.70 | 9311.38 |
| 173 | 44.92 | 65.96 | 4503.54 | 14678.66 | 9266.46 |
| 174 | 45.24 | 65.64 | 4548.79 | 14744.29 | 9221.21 |
| 175 | 45.56 | 65.32 | 4594.35 | 14809.61 | 9175.65 |
| 176 | 45.89 | 64.99 | 4640.24 | 14874.60 | 9129.76 |
| 177 | 46.21 | 64.67 | 4686.45 | 14939.27 | 9083.55 |
| 178 | 46.54 | 64.34 | 4732.98 | 15003.62 | 9037.02 |
| 179 | 46.87 | 64.01 | 4779.85 | 15067.63 | 8990.15 |
| 180 | 47.20 | 63.68 | 4827.05 | 15131.31 | 8942.95 |
| 181 | 47.53 | 63.35 | 4874.58 | 15194.65 | 8895.42 |
| 182 | 47.87 | 63.01 | 4922.46 | 15257.66 | 8847.54 |
| 183 | 48.21 | 62.67 | 4970.67 | 15320.33 | 8799.33 |
| 184 | 48.55 | 62.33 | 5019.22 | 15382.66 | 8750.78 |
| 185 | 48.90 | 61.98 | 5068.11 | 15444.65 | 8701.89 |
| 186 | 49.24 | 61.64 | 5117.35 | 15506.28 | 8652.65 |
| 187 | 49.59 | 61.29 | 5166.94 | 15567.57 | 8603.06 |
| 188 | 49.94 | 60.94 | 5216.88 | 15628.51 | 8553.12 |
| 189 | 50.30 | 60.58 | 5267.18 | 15689.10 | 8502.82 |
| 190 | 50.65 | 60.23 | 5317.83 | 15749.33 | 8452.17 |
| 191 | 51.01 | 59.87 | 5368.84 | 15809.19 | 8401.16 |
| 192 | 51.37 | 59.51 | 5420.21 | 15868.70 | 8349.79 |
| 193 | 51.74 | 59.14 | 5471.95 | 15927.85 | 8298.05 |
| 194 | 52.10 | 58.78 | 5524.05 | 15986.63 | 8245.95 |
| 195 | 52.47 | 58.41 | 5576.52 | 16045.03 | 8193.48 |
| 196 | 52.84 | 58.04 | 5629.36 | 16103.07 | 8140.64 |
| 197 | 53.22 | 57.66 | 5682.58 | 16160.73 | 8087.42 |
| 198 | 53.59 | 57.29 | 5736.17 | 16218.02 | 8033.83 |
| | | | • | | |
| | | | • | | |
| | | | • | | |

All months of the repayment schedule are calculated. Due to space, only selected parts are reproduced here.