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# A Simulation Approach to the Choice Between Fixed and Adjustable Rate Mortgages

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*This study uses a simulation approach to model the choice between a fixed rate mortgage (FRM) and an adjustable rate mortgage (ARM). Our simulations help assess the risks and benefits of choosing an ARM rather than a FRM. We represent the risk of the ARM with distributions of present value cost differentials for a variety of mortgage life periods. We provide insight on the financial planning aspect by modeling the impact of mortgage rate changes on the size of payments for ARMs. The simulations yield non-intuitive results that may lead to better decision making by borrowers.*

Mortgage borrowers appear to have a difficult time evaluating the costs and risks associated with the choice between a fixed rate mortgage (FRM) and an adjustable rate mortgage (ARM). Anecdotal evidence suggests they often consider only the worst case interest rate scenario, misunderstand the effect of the time value of money and the expected life of the mortgage in making this choice, and often worry more about the uncertain prospect of large monthly payments than the effective costs of the competing mortgages.

This study offers an approach by which borrowers may more effectively evaluate the ARM-FRM choice. It provides a simulation model that yields information on a number of cost and risk factors of demonstrated importance to borrowers. The simulation output allows a borrower to view probability distributions of present value cost differentials between the ARM and the FRM for a variety of mortgage life periods. It also provides a distribution of the breakeven period, the number of years for which the ARM maintains its present value cost advantage from the initiation of the loan. Finally, the simulation permits insight into the financial planning aspect of the choice by modeling the impact of mortgage rate changes on the size of payments for the ARM. A borrower may then compare this uncertain payment to the FRM payment.

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## I. LITERATURE REVIEW

Thus far, the academic literature largely has focused on discovering which variables significantly influence actual borrower choice (e.g., see Brueckner & Follain, 1988; Dhillon, Shilling, & Sirmans, 1987; Goldberg & Heuson, 1992; O'Brien & Wong, 1990; Phillips & Vanderhoff, 1991; Tucker, 1989). These studies generally show that pricing variables are the most important determinants of choice. These factors include the initial mortgage rate differential between ARMs and FRMs and discount point differentials. Normally, an ARM offers a lower initial mortgage rate compared to a FRM. ARMs entail a higher degree of risk with regard to cost, and introduce uncertainty into the financial planning process. Borrowers ought to require a lower initial rate as compensation. Thus, the proportion of borrowers choosing an ARM has been found to be positively related to the size of the initial rate differential.

Five of the six studies cited above have found that the rate level of the FRM is significantly positively associated with the probability of choosing an ARM, *ceteris paribus*. The explanation for this may be that borrowers take advantage of a lower initial rate on the ARM in order to qualify for a larger mortgage. An alternative explanation is that when FRM rates are high, borrowers assume that rates will decline and that the ARM will be the lower cost alternative. At lower FRM rates borrowers may prefer the lower risk of the FRM, or they may assume that rates will increase which would cause the ARM to be a higher cost alternative. Table 1 contains historical data on average contract interest rates for both FRMs and ARMs. It also shows the percent of loans of each variety. Table 1 confirms that higher FRM rates generally are associated with a higher percentage of ARM loans.

Sprecher and Willman (1993) have used historical data to determine if borrowers could have achieved an effectively lower mortgage rate using an ARM during a period (1987 to 1991) in which rates began relatively low and then increased. They collected a sample of ARM and FRM loans initiated at the beginning of this period and compared the

**TABLE 1**

Annual Averages for Mortgage Interest Rates for Existing Homes, 1982-1994. Excludes Refinancing Loans and Federally Underwritten Loans

| *Year* | *Contract Interest Rate (Percent):* | | *Percent of Number of Loans with:* | |
|---|---|---|---|---|
| | *Fixed Rate* | *Adjustable Rate* | *Fixed Rate* | *Adjustable Rate* |
| 1982 | 14.8 | 14.7 | 61 | 39 |
| 1983 | 12.6 | 11.9 | 59 | 41 |
| 1984 | 12.7 | 11.6 | 36 | 64 |
| 1985 | 11.9 | 10.5 | 50 | 50 |
| 1986 | 10.1 | 9.1 | 69 | 31 |
| 1987 | 9.5 | 8.2 | 56 | 44 |
| 1988 | 10.1 | 8.2 | 76 | 24 |
| 1989 | 10.2 | 9.2 | 63 | 37 |
| 1990 | 10.4 | 9.2 | 73 | 27 |
| 1991 | 9.7 | 8.2 | 78 | 22 |
| 1992 | 8.5 | 6.5 | 79 | 21 |
| 1993 | 7.5 | 5.7 | 80 | 20 |
| 1994 | 8.2 | 6.4 | 61 | 39 |

*Source:* Statistical Abstract of the United States, various years.

effective rates of the ARMs for this period to the rates on the FRMs. They found the ARM borrowers paid an effective rate that was 150 basis points lower than the FRM borrowers paid. In the present study, both of these issues surface. In the first reported simulation, rates were relatively low, but the ARM offered a large initial rate advantage. In the second simulation, rates were relatively high and the initial rate advantage of the ARM was much narrower.

A survey conducted by Lino (1992) looked into borrower perception of mortgage costs and risks. He found that borrowers did not properly incorporate expected cost into their decision making. He surveyed recent mortgage borrowers and found that many were unable to correctly determine which type of mortgage had the higher expected present value cost based on the borrowers' own expectations for interest rate changes and the life of the mortgage. For example, borrowers who expected interest rates to fall and who expected to reside in their homes for less than 8 years should have viewed the ARM as the lower cost alternative. Lino found that 30 percent of these actual borrowers thought the relative cost of FRMs and ARMs was the same under these conditions. Those borrowers who expected rates to increase and who planned a residency of more than 12 years should have viewed the FRM as the lower cost alternative. Lino found 10 percent perceived the FRM as the higher cost alternative and another 19 percent thought there was no difference in cost under these expectations. Thus, the ability to predict interest rate movements and length of residency is often beside the point for borrowers. A substantial minority are unable to select the lower cost alternative even given these factors. Lino also has shown that the financial planning aspect of the mortgage payment commitment and the perceived risk of ARMs are quite important to borrowers. Indeed, these factors were significant in a logit analysis predicting mortgage choice, while cost variables were not significant. Borrowers may be well served by a method offering insight into the risk and planning aspects of ARMs.

Yohannes (1991) and Tucker (1991) have offered frameworks for helping individuals better make the ARM-FRM choice. Yohannes (1991) has suggested using interest rate changes implied by forward rates to construct an expected breakeven number of years before the present value cost of an ARM exceeds that of an FRM. This expected breakeven period, along with a worst case scenario breakeven period, offers some guidance in making the choice. This approach is limited in that it offers just the two cases and concerns itself only with the present value cost breakeven period.

Tucker (1991) has shown that simulation can reveal important information related to the expected costs of mortgages to borrowers. He has simulated interest rate changes to demonstrate the present value cost differential for ARMs and FRMs assuming a variety of opportunity discount rates. His analysis has shown that, based on loan data from a Connecticut savings and loan institution and market conditions in 1985 to 1989, ARMs were often the lower cost alternative. This result held particularly true for borrowers who anticipated a shorter life for their mortgage and had higher opportunity cost discount rates. Borrowers with a 4 percent discount rate (the lowest rate simulated in Tucker's study) would have found the ARM to be the lower expected cost alternative if the mortgage life had been 18 years or less. Borrowers with an 8 percent discount rate would have found that the ARM dominated the FRM in terms of expected present value cost for any mortgage life up to 30 years. We know, however, that borrowers are concerned with factors in addition to expected present value cost. Both risk and financial planning considerations enter into the decision.

The present study extends the simulation approach to making the ARM-FRM choice by including additional factors important to borrowers. In this study, we compare a thirty year annually adjusted ARM to a thirty year FRM. The simulation results provide information on the present value cost differentials, the breakeven period, and the payment size. They provide both expected values and distributions of these values that would allow borrowers to consider both cost and risk and make a more informed choice. Even with a more complete understanding of cost and risk, borrower choice would likely depend on individual risk preferences.

## II. METHODOLOGY

The present value cost of a mortgage is the sum of the discount points, the present value of the payments, and the present value of the payoff balance. The discount points and the interest portion of the payment are taken on an after-tax basis. Mathematically, the present value cost can be expressed as

$$PVCOST = M \cdot (p) \cdot (1 - tx_i) + \left[ \sum_{t=1}^{T} \frac{[pmt_t - I_t \cdot (tx_i)]}{(1 + r_i)^t} \right] + \frac{B}{(1 + r_i)^T} \quad (1)$$

where $M$ = the mortgage amount
$p$ = the discount points rate
$tx_i$ = the personal tax rate of the borrower $i$
$T$ = the assumed life of the mortgage in years
$pmt_t$ = the mortgage payment at year $t$
$I_t$ = the interest portion of the payment in dollars at year $t$
$r_i$ = the opportunity cost discount rate for borrower $i$
and $B_T$ = the payoff balance at year $T$.

A model was constructed in *Excel* spreadsheet software to compare the present value costs of an ARM and FRM over a thirty year term using Equation 1. The model was simulated using the Monte Carlo technique in *@RISK* simulation software. Table 2 shows a sample input section of the model. A large, midwestern thrift institution provided loan terms data for the period 1989 through 1992. These items include discount points and the initial mortgage rates for both adjustable and fixed rate mortgages, as well as the selection of an index and margins over the index rate for the ARM. Thus, the simulations in this study were performed using real loan terms as parameters.

Simulating interest rate changes over the thirty year term of a mortgage is the engine that drives these simulations. While the loan parameters can be taken from actual contracts, parameters related to the rate changes must be selected by the modeler. For the most part, we use average historical values in setting these parameters. First, we collected data on the one year constant maturity yield of U.S. Treasury securities as reported on a weekly basis by the Federal Reserve. From these Treasury data, we calculated a standard deviation of annual index rate changes of 2.52 percentage points. See Figure 1 for a distribution of annual changes in this index from November 1979 to December 1991. This represents the

**TABLE 2**
Low Interest Rate Environment Simulation Parameters

| *Parameters* | *Adjustable Rate* | *Fixed Rate* |
|---|---|---|
| Term | 30 years | 30 years |
| Loan Amount | $100,000 | $100,000 |
| Discount Points | .500% | 1.000% |
| Index | 1 year treasury | |
| Initial Index Value | 3.16% | |
| Standard Deviation of Index | 2.52% | |
| Maximum Value of Index | 11.00% | |
| Minimum Value of Index | 3.00% | |
| Margin over Index | 2.75% | |
| Initial Composite Rate | 5.910% | |
| Initial Adjustable Rate | 5.375% | |
| Initial Fixed Rate | | 7.875% |
| After-Tax Discount Rate | 4.000% | 4.000% |
| Marginal Tax Rate | 28% | 28% |
| Annual Rate Change Cap | 2.00% | |
| Life Time Rate Change Cap | 6.00% | |

period from just after the major shift in Fed policy regarding managing interest rates through the year just prior to when the first simulation begins. The annual changes appear to be approximately normally distributed. We simply observe the first year index rate. The index rate for the second year is modeled by multiplying a randomly selected $z$-score from a normal distribution times the standard deviation of annual changes and adding this to the index rate value for the previous year. Subsequent index rates are modeled in the same way. An index rate floor of 3% and a ceiling of 11% were selected to keep the simulated index rate within a reasonable range.

This method of simulating interest rates follows Tucker (1991) in setting the expected index value for the subsequent period equal to the present index value. In short, it assumes no reversion toward a mean index value. We have added mean reversion parameters to our model and run again the simulations reported in this study. The effects on the results are not markedly different and the conclusions we draw would not be affected. Because mean reversion is a controversial issue (e.g., Chan, et al., 1992 find insignificant results when testing for it in one month Treasury yields) and it adds complexity to the model, we report results without it. However, mean reversion can easily be added to the model and a user who expected mean reversion could include it. Figure 2 shows a sample thirty year series of simulated index rate values constructed using the technique just described. It also shows an actual series of the index rate for comparison's sake.

For simplicity, the payments are treated as annual rather than monthly. The payment for the FRM is the constant annuity amount that completely amortizes the loan over the thirty year life of the mortgage. The payment for the ARM is recalculated annually. A composite rate is determined for each period by adding the specified margin to the simulated value of the index rate. The composite rate is subjected to annual and lifetime caps specified in the ARM contract to arrive at the simulated mortgage rate for each period. The simulated mortgage rate, the remaining balance, and the remaining number of years in the mortgage determine the adjusted ARM payment.

The opportunity discount rate is the assumed after-tax return the borrower could earn if the difference between the two payment amounts were invested. We use an after-tax

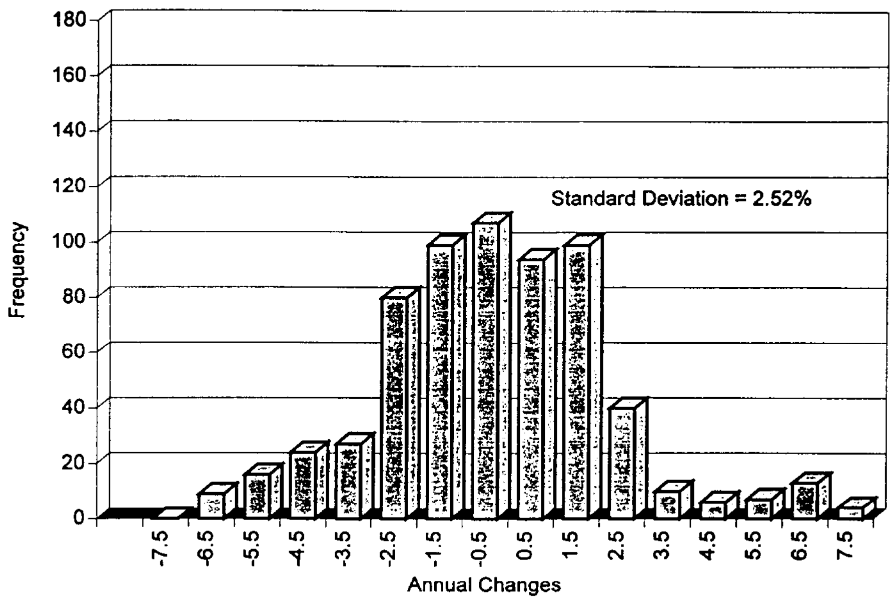


*Figure 1.* Distribution of annual changes in one year constant maturity Treasury rates, January 1979 to December 1991.

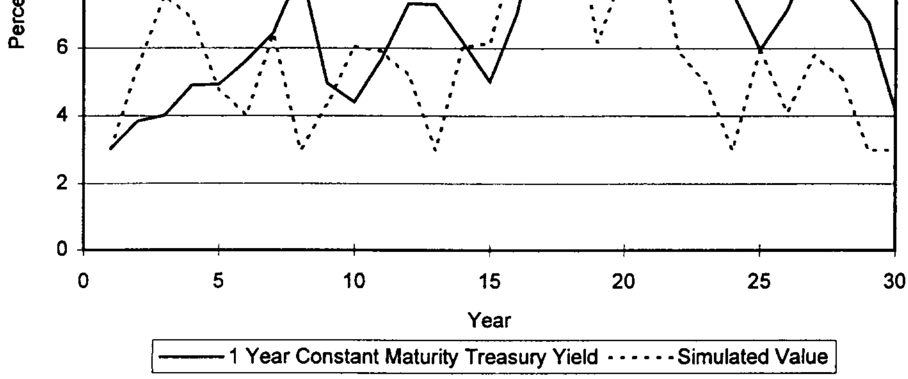


*Figure 2.* An actual thirty year series of the one year constant maturity Treasury Rate (observed in the first week of each year from 1963 through 1992) compared to a sample iteration of the simulated rate.

opportunity discount rate of 4% for all the simulations described in this study. An alternative way to think about the opportunity discount rate is that it is the borrower's next best borrowing rate. Under that view the rate would likely be higher. The marginal tax rate used in these simulations is 28%, a rate typical of higher income borrowers.

For each iteration, the spreadsheet collects the following items:

- The difference in present value cost between the FRM and the ARM using Equation 1 to calculate each. We calculate the difference in present value cost assuming termination of the mortgage in each of years 1 through 30.
- The breakeven period—the number of years for which the ARM maintains its present value cost advantage from the initiation of the loan. Typically, an ARM begins with a lower mortgage rate so that termination of the mortgage in the early years will result in a present value cost advantage for the ARM. This advantage often disappears as the life of the mortgage lengthens and the ARM mortgage rate has the opportunity to move higher than the FRM, although it is possible for the ARM to have a present value cost advantage for the entire term of the mortgage. Because of present value principles, the years of initial cost advantage for the ARM may extend several years after the ARM mortgage rate has risen above the FRM rate.
- The thirty different payment amounts for the ARM and the payment for the FRM.

Each simulation consists of one thousand iterations. Expected values and a distribution of values for the collected items are then compiled.

## III. LOW INTEREST RATE ENVIRONMENT SIMULATION

Month end of September 1992 represented a time of relatively low interest rates. We performed this first simulation using the parameters shown in Table 2. We define the difference between the initial composite rate and the initial mortgage rate offered by the lender as the *teaser* discount. It is customary for lenders to entice borrowers to choose an ARM by offering an initial mortgage rate below the composite rate for the first year. At the first annual adjustment, the mortgage rate would increase even if the index rate did not increase, because the teaser discount disappears.

Figures 3, 4, and 5 show results of the low interest rate environment simulation. In Figure 3, the heavy black line shows the expected present value cost difference (FRM-ARM) for mortgage lives ranging from 1 to 30 years. When the line appears above the horizontal axis the cost advantage is with the ARM. When it goes below the axis the FRM has the cost advantage. This line resembles the results shown in Figure 2 of Tucker's (1991, p. 455) study. Our Figure 3 contains more information, however. It also shows the expected present value cost difference plus or minus one standard deviation and the range that includes ninety percent of the present value cost differentials. From Figure 3 we see that if an individual with a 4% discount rate were to hold a mortgage just 6 years, the ARM would have an expected present value cost advantage of approximately $5,000. The distribution around that expected advantage, though, suggests there could be a cost disadvantage to the

ARM for that mortgage life in roughly one-sixth of the cases. At the extremes, the ARM could have a cost advantage of roughly $11,000 or the FRM could have a cost advantage of roughly $6,000. The iterations produce widely disparate results, and the expected cost is just one component of a thorough analysis. Borrowers must compare these expected benefits to the risks inherent in the ARM.

An inference that may be drawn from the expected cost information is that the ARM is advantageous as long as the expected mortgage life is 14 years or less. In Figure 4, we show the distribution of this initial cost advantage to the ARM. Of the 1,000 iterations, the ARM present value cost dominated the FRM cost for the entire thirty year term over 35 percent of the time. On the other hand, the initial cost advantage to the ARM would have lasted only 3 years about 8 percent of the time. Clearly, the expected value of 14 years means little given the distribution of these results. One must be careful in interpreting Fig-

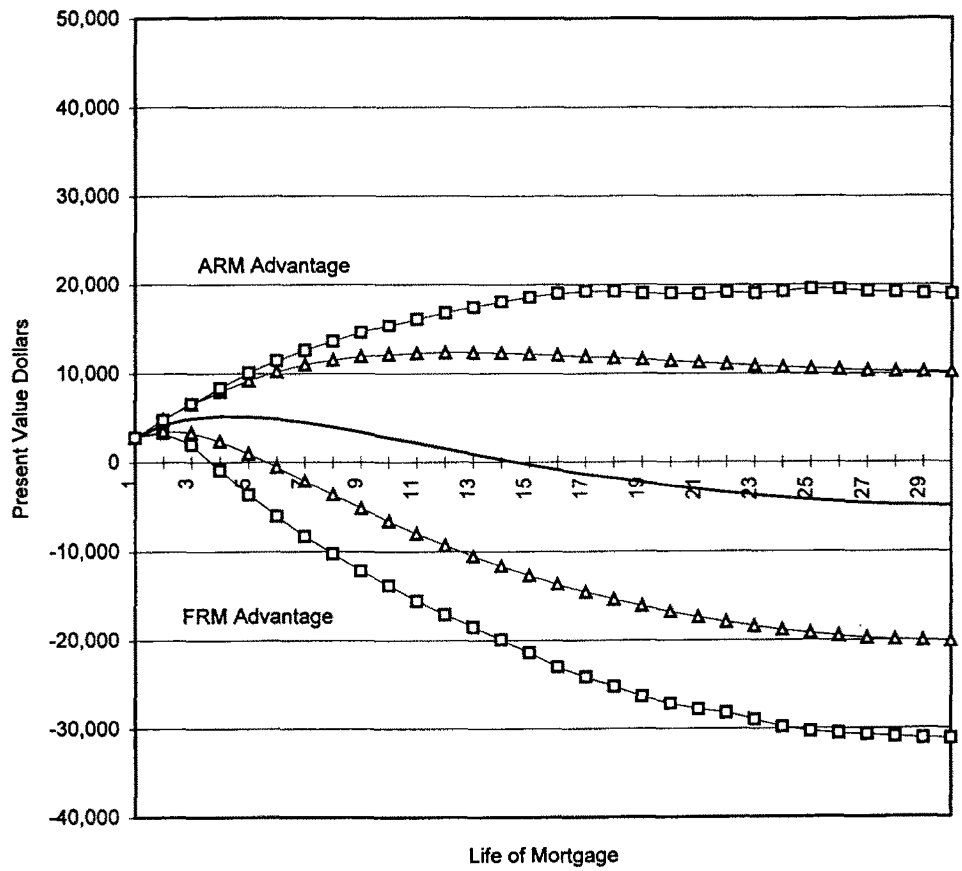


*Figure 3.* Low interest rate environment cost comparison. The heavy black line indicates the expected present value cost differential (FRM–ARM) of $100,000 mortgages at a 4 percent discount rate. The lines marked with triangles represent the expected present value cost differential plus and minus one standard deviation. Ninety percent of the simulation runs resulted in present value cost differentials between the lines marked with squares.

ure 4. We capture only the years of initial cost advantage. Depending upon how interest rates behave in a particular iteration, the cost advantage to the ARM may disappear quickly but return later in the life of the mortgage. Thus, even in some of the cases in which the FRM gains a cost advantage early on, the ARM could regain the advantage in later years. Here we capture only the number of years the initial advantage of the ARM is maintained.

Figure 5 shows the distribution of required annual payments over the thirty year term of the mortgage. The heavy black line shows an expected ARM payment that increases at a decreasing rate and levels off at about $9,570. The FRM payment is shown as a horizontal dashed line at $8,778. This figure allows one to view the expected time path of the ARM payment amount as well as the possible extremes and their likelihood. It also allows one to compare these aspects to the FRM payment. These results show that the payment advantage of the ARM is likely to last about 5 years. This payment advantage period is much shorter than the cost advantage period because of present value principles. From the standpoint of maximizing wealth, borrowers should choose the mortgage that will have the lower expected cost. However, some borrowers may be risking insolvency with higher mortgage payments. These borrowers would probably focus on the payment aspect rather than the present value cost difference.

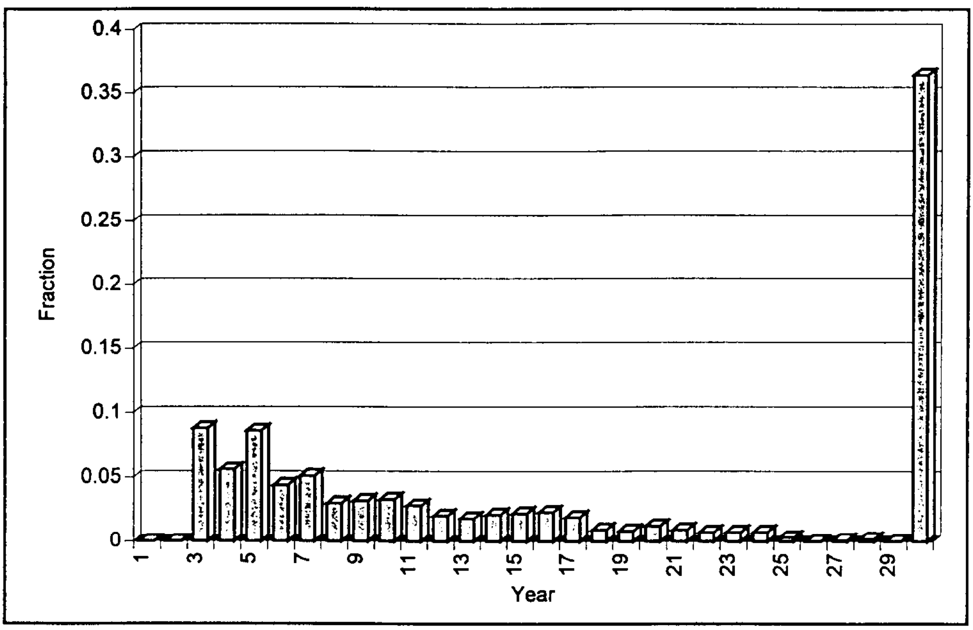


*Figure 4.* Low interest rate environment—Number of years for which the ARM maintains its present value cost advantage from the initiation of the loan. For each year, the bar height shows the fraction of cases for which the ARM's initial present value cost advantage continues for exactly that many years. Thus, the bar height at year 30 indicates the fraction of cases in which the cost of the ARM dominates the cost of the FRM for the entire life of the mortgage. The assumed discount rate is 4 percent.

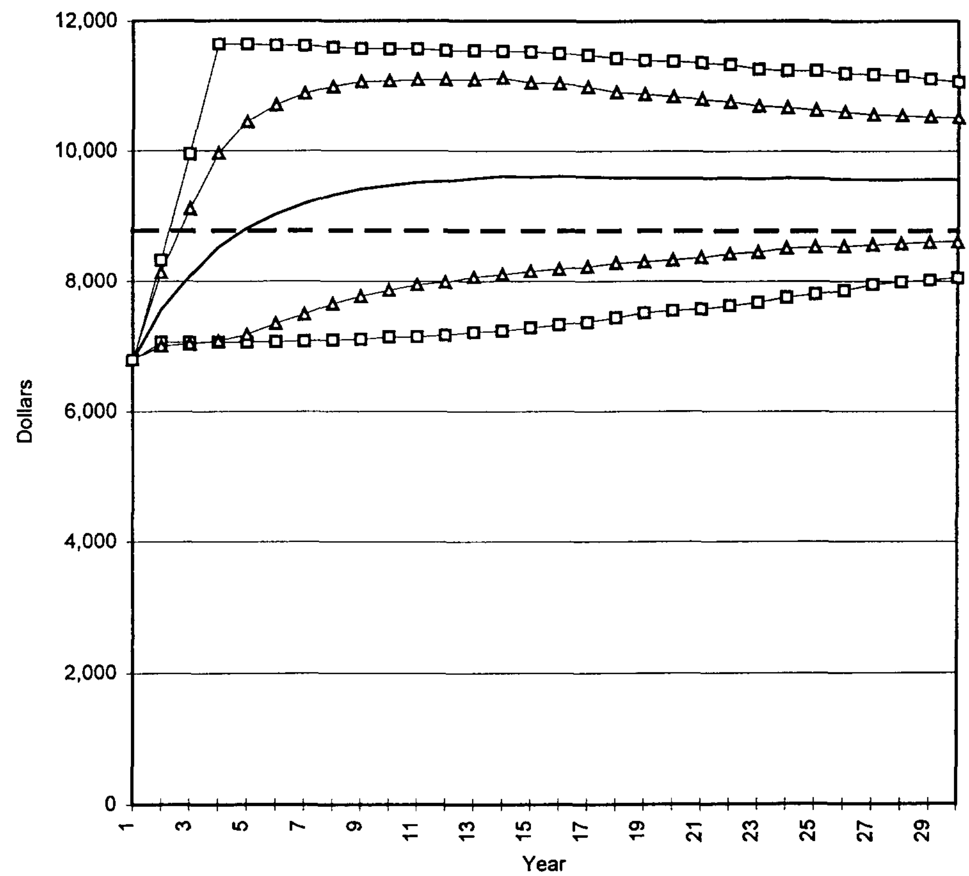


*Figure 5.* Low interest rate environment—Expected annual mortgage payment. The heavy black line represents the expected payment for the ARM. The lines marked with triangles represent the expected payment plus and minus one standard deviation. Ninety percent of the simulation runs resulted in annual payments between the lines marked by squares. The horizontal, heavy, dashed line represents the FRM payment.

## IV. HIGH INTEREST RATE ENVIRONMENT SIMULATION

Month end March 1989 represented a time of relatively high interest rates. The parameters for this simulation appear in Table 3. Figure 6 shows the present value cost differential results of this simulation. It tells a much different story than the low interest rate simulation. The ARM offers an expected present value cost advantage throughout the thirty year term. However, this simulation is artificial in that it assumes no refinancing opportunities for the high rate FRM. A borrower in these circumstances can benefit from falling rates in two ways: select the ARM, or select the FRM and refinance if rates fall significantly. We incorporate this second possibility by simulating a ten year Treasury index rate in the same manner as the one year Treasury index rate and assuming a constant margin between the ten year rate and FRM rates. The simulation of each index is driven by the same random draw from a normal distribution, thus maintaining a connection between the short term and long term rates. Both indexes will move in the same direction, but by amounts proportional to their historical standard deviations of annual changes. In addition, we enforce different floors and ceilings on the simulated index rates. Table 3 also includes parameters necessary to allow the refinancing option. If the simulated FRM rate drops 2.5 percentage points below the initial FRM and there are at least 15 years left in the term of the mortgage, we assume refinancing. For example, if in a particular iteration the simulated FRM rate drops to 8.5% with 20 years left on the mortgage, we add the discount points cost and an additional $1,000 in refinancing costs to the balance of the mortgage and recalculate the payment to amortize the new balance over the remaining 20 years. This refinancing rule approximates rules of thumb used by borrowers.

Including this option in the high interest rate environment simulation causes this FRM to dominate this ARM in terms of expected present value cost. Figures 7, 8, and 9 show the results of this simulation. Now the expected present value cost advantage to the FRM occurs by the end of the third year and increases throughout the life of the mortgage. The teaser discount was just over 2 percentage points in this case. The loss of the teaser discount after the first year explains the short duration of the ARM cost advantage. Falling rates would be advantageous for the ARM borrower, but because of the refinancing option FRM borrowers can also benefit. Since the FRM has both a lower expected present value cost and less risk, risk averse borrowers should prefer the FRM in choosing between these particular loan terms. Figure 8 shows the distribution of breakeven periods. Of the 1,000 iterations, the ARM present value cost dominated the FRM cost for just one year in fifty-nine percent of the cases. Dominance of the ARM over the FRM for the entire thirty year term in this simulation is rare indeed. Figure 9 shows the expected path of the ARM pay-

**TABLE 3**
High Interest Rate Environment Simulation Parameters

| *Parameters* | *Adjustable Rate* | *Fixed Rate* |
|---|---|---|
| Term | 30 years | 30 years |
| Loan Amount | $100,000 | $100,000 |
| Discount Points | 1.250% | 1.000% |
| Index | 1 year treasury | 10 year treasury |
| Initial Index Value | 9.78% | 9.20%* |
| Standard Deviation of Index | 2.77% | 2.21%* |
| Maximum Value of Index | 11.00% | 12.00%* |
| Minimum Value of Index | 3.00% | 5.25%* |
| Margin over Index | 2.75% | 2.050%* |
| Initial Composite Rate | 12.53% | |
| Initial Adjustable Rate | 10.50% | |
| Initial Fixed Rate | | 11.25% |
| After-Tax Discount Rate | 4.00% | 4.00% |
| Marginal Tax Rate | 28% | 28% |
| Annual Rate Change Cap | 2.00% | |
| Life Time Rate Change Cap | 6.00% | |
| Fixed Rate Refinancing Trigger | | 2.50%* |
| Minimum Required Remaining Term for FRM Refinancing | | 15 years* |

*Notes:* These standard deviations of annual changes in index values were based on the period November 1979 to December 1988. The standard deviation of changes in the one year rate is slightly higher than that used for the first simulation. The estimation period for the standard deviation for the first simulation was November 1979 to December 1991. Fixed rate parameters marked with an asterisk are only in the simulation that allows the refinancing option for the FRM.

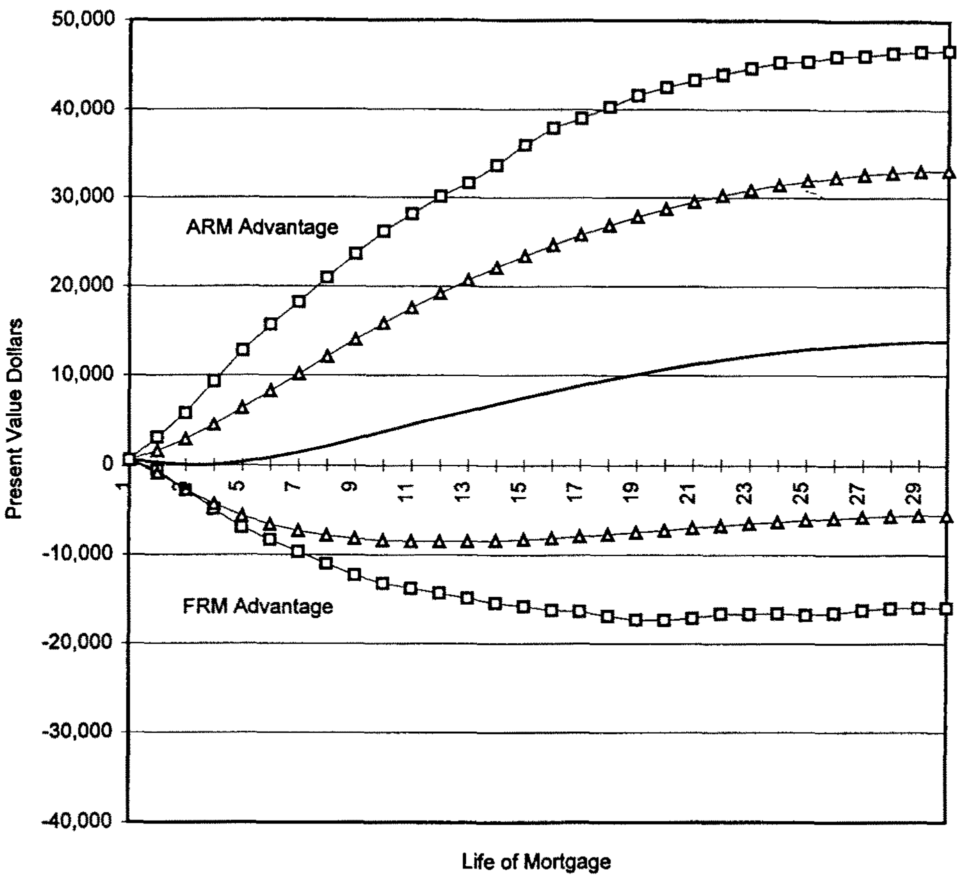


*Figure 6.* High interest rate environment cost comparison. The heavy black line indicates the expected present value cost differential (FRM–ARM) of $100,000 mortgages at a 4 percent discount rate. The lines marked with triangles represent the expected present value cost differential plus and minus one standard deviation. Ninety percent of the simulation runs resulted in present value cost differentials between the lines marked with squares.

ment versus the expected path of the FRM payment. Borrowers who focus on this aspect would also be better served by choosing the FRM given these loan terms.

## V. DISCUSSION

Comparing the loan terms of ARMs and FRMs can be difficult. Borrowers must consider the impacts of multiple variables on total present value cost, payment size, and risk. Future interest rate movements, the initial spread between the ARM and FRM rates, the teaser dis-

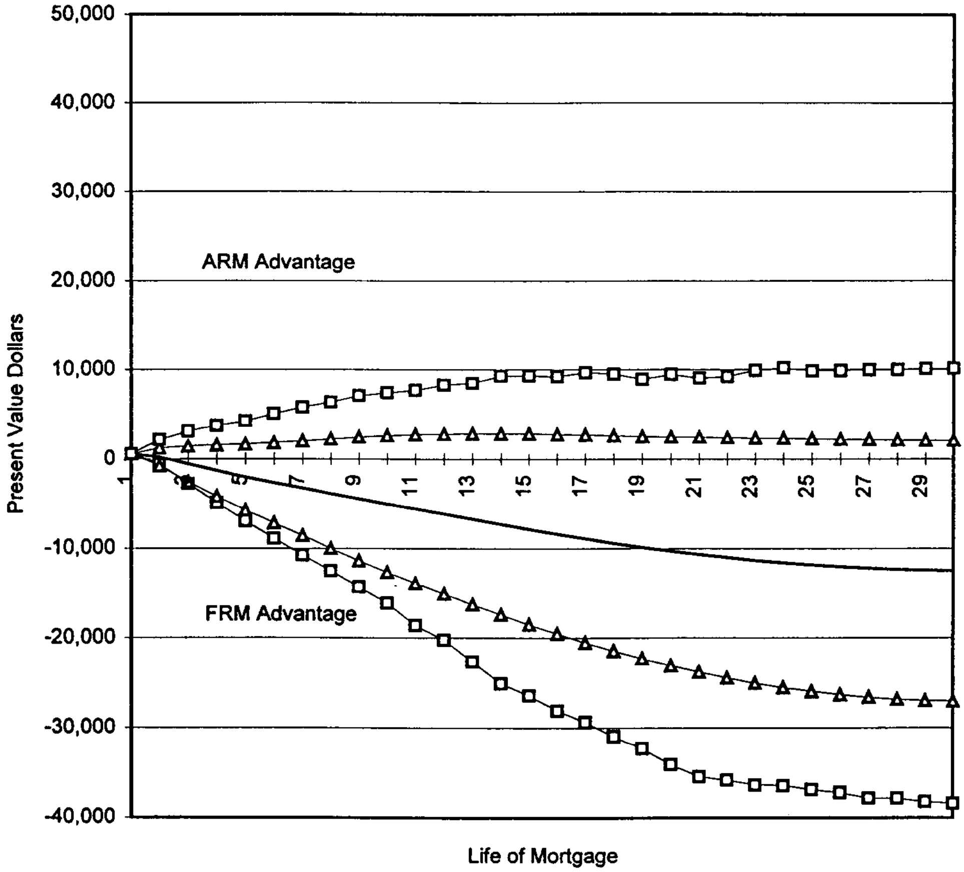


***Figure 7.*** High interest rate environment cost comparison assuming refinancing option. The heavy black line indicates the expected present value cost differential (FRM–ARM) of $100,000 mortgages at a 4 percent discount rate. The lines marked with triangles represent the expected present value cost differential plus and minus one standard deviation. Ninety percent of the simulation runs resulted in present value cost differentials between the lines marked with squares.

count, discount points, refinancing costs, and the planned life of the mortgage all influence this choice.

This paper has examined the ARM-FRM choice in both relatively high and low interest rate environments and found results that challenge some of the advice commonly given to borrowers. For example, is an ARM the low cost choice when mortgage rates are high? In the case of the lender terms used in this study, the initial spread between ARM and FRM rates in the high interest rate environment was only 75 basis points. In fact, without the first year teaser discount, the initial ARM mortgage rate would have exceeded the FRM rate. Though index rates may decline, any present value cost advantage to the ARM will depend on how long it takes for this decline to occur and how long rates remain at lower levels. On the other hand, the FRM would offer protection against further rises in interest rates, would not be affected by the disappearance of a first year teaser discount, and can be refinanced

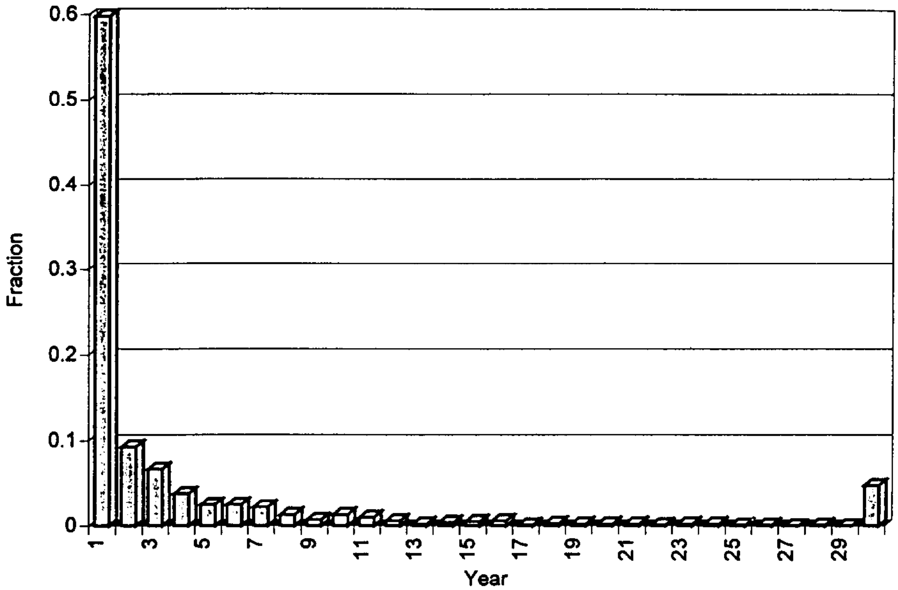


*Figure 8.* High interest rate environment assuming refinancing option—Number of years for which the ARM maintains its present value cost advantage from the initiation of the loan. For each year, the bar height shows the fraction of cases for which the ARM's initial present value cost advantage continues for exactly that many years. Thus, the bar height at year 30 indicates the fraction of cases in which the cost of the ARM dominates the cost of the FRM for the entire life of the mortgage. The assumed discount rate is 4 percent.

if rates fall substantially. Tucker's (1991) simulation results suggest near dominance of the ARM in terms of expected present value cost during the 1985 to 1989 time period, a time of relatively high rates. His results may have been influenced by his neglect of the FRM refinancing option.

When rates are relatively high, it seems that borrowers still would be better served by focusing on rate differentials. Figure 10 shows data from the Federal Housing Board's monthly survey of major lenders. Both the average FRM rate and the average initial rate differential are depicted. The differential is not consistently small when the FRM rate is high or vice versa. Thus, we cannot generalize our results to suggest the FRM is always preferred when rates are high. In addition, the teaser discount is part of the differential and tends to mask the difference between the fixed rate and the initial composite rate.

When FRM rates are relatively low, borrowers may see the FRM as the most attractive alternative. However, our results suggest that a larger initial spread between an ARM and FRM in these circumstances can result in an expected cost advantage that extends for quite a few years. The payment advantage may extend for quite a while as well. For the loans compared here, borrowers whose expected mortgage life was relatively short should have found the ARM terms advantageous. These results are consistent with the findings of Sprecher and Willman (1993) who determined that ARM borrowers had an interest rate advan-

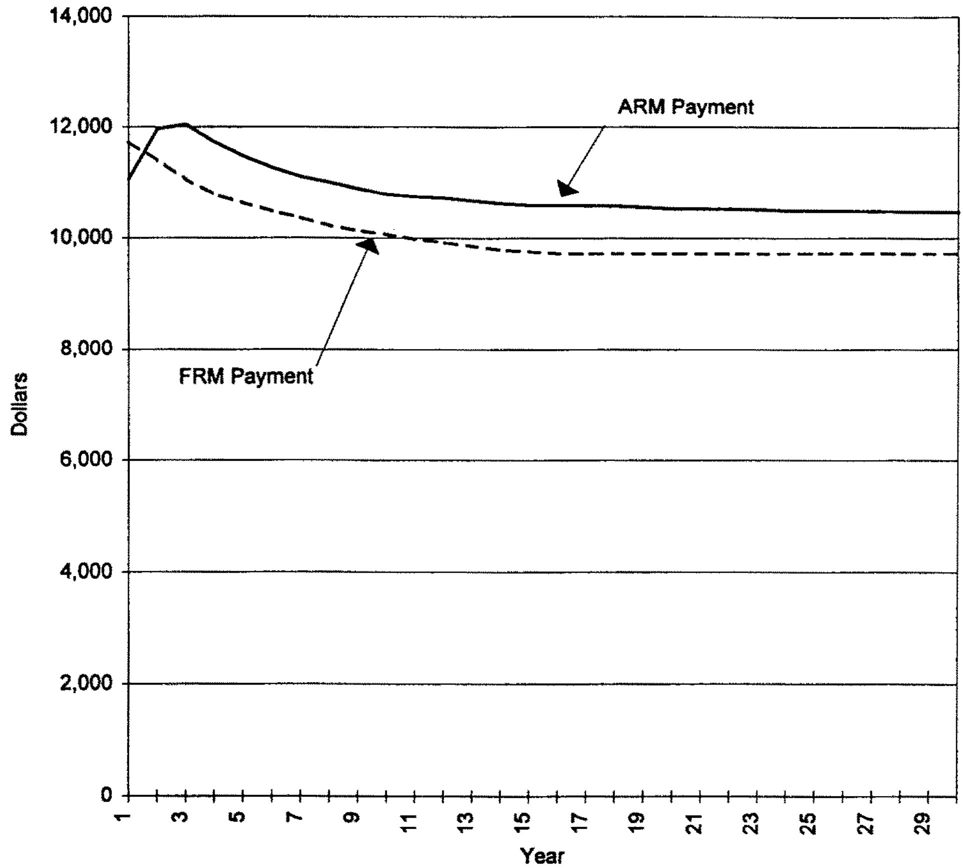


***Figure 9.*** High interest rate environment assuming refinancing option—Expected annual mortgage payment. The solid line represents the expected payment for the ARM. The dashed line represents the expected FRM payment. It declines because refinancing of the FRM to a lower rate is likely.

tage over FRM borrowers during a four year period in which rates rose. Borrowers must weigh these cost advantages against the increased risk associated with the ARM.

To summarize, although analysis yields no hard and fast rules about when to select an ARM rather than a FRM, larger initial rate differentials should cause borrowers to favor the ARM, particularly if the differential does not merely reflect the teaser discount. Borrowers should attempt to identify the size of the teaser to avoid being deceived by an attractive rate differential that will not last past the first year. Borrowers who intend a short mortgage life should also tend to favor ARMs. ARMs tend to exhibit expected cost and payment advantages for short lived mortgages. We suggest borrowers probably should avoid selecting a mortgage based on the level of fixed rates alone. In the simulations reported here, the initial rate differentials and the teaser discount were more important factors in determining the relative cost. The opportunity to refinance a FRM significantly alters its expected cost and relative attractiveness compared to ARMs. Borrowers ought to keep this option in mind.

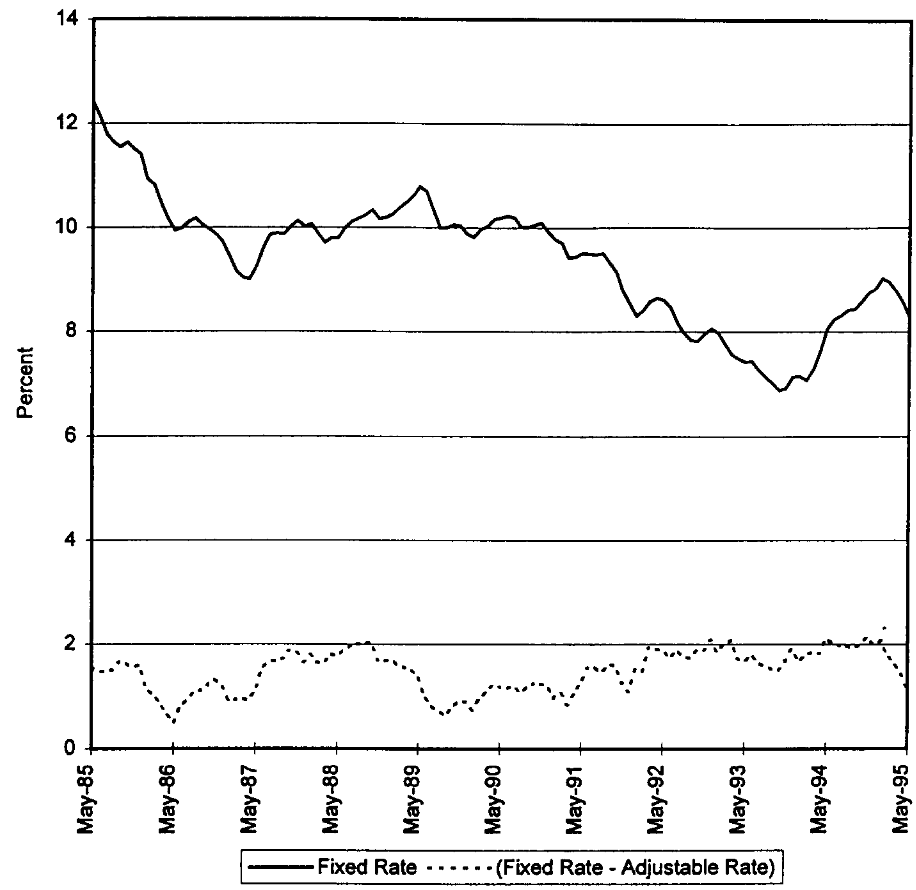


***Figure 10.*** Average FRM rates as reported by the Federal Housing Finance Board from its monthly national survey of major lenders. Also shown is the average initial rate differential between FRMs and ARMs from the same source.

Although we can make some statements regarding each of these factors and their influence on the choice, the value of the simulation approach is that it considers these aspects simultaneously and provides an overview of the choice. Comparisons ought to be done for each pair of competing loan terms. A borrower who can select an appropriate discount rate, estimate the mortgage life, set a tolerance for increases in payments, and determine his own risk aversion level ought to be able to make a better decision using simulation results as described in this study.

Though this study has compared just two types of mortgages, the thirty year FRM and the one year ARM, the technique can easily be extended to the more exotic types of mortgages. ARMs that have a fixed rate for the first five or seven years and adjust annually after that are becoming more popular. Other ARMs adjust their rates every six months or every three years. The model presented here may be used to compare two mortgages of any variety.

## VI. CONCLUSION

This paper has presented and demonstrated a simulation model that shows the impact of future interest rate movements, the initial spread between the ARM and FRM rates, the teaser discount, discount points, refinancing costs, and the planned life of the mortgage on cost and payments. The model also provides borrowers a clearer picture of the risks involved. Taken together, the simulation results would allow borrowers to make a more informed choice. Typical borrowers would not have the necessary expertise to build and interpret the simulations reported here. Financial advisors, such as mortgage brokers or thrift officers ought to be able to construct such models, however. Simulation outputs could greatly aid their clients in comparing loan terms.

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