

SIMULATION OF VARIABLE RATE MORTGAGES

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Variable rate mortgages have been proposed as a solution to tight money situations which dry up mortgage funds. Payments or repayment terms would increase when interest rates increase, and decrease when interest rates decrease. This would provide more money for banks to loan when interest rates increase. Various simulations of variable rate mortgages are discussed to illustrate possible effects of variable rate mortgages on individual families. It is shown that variable rate mortgages offer risks and possible benefits, and may provide some families with a form of budget protection. Variable term mortgages may be impractical in periods of increasing interest rates.

The vast majority of home mortgages granted to homebuyers during the last 40 years have been fixed rate mortgages. With a fixed rate mortgage, the borrower pays the lender the same monthly payment for the entire term of the loan. (The last monthly payment may be different to exactly pay off the loan.) A fixed rate mortgage has attractive features for the borrower. He will know exactly how much he will be paying on the

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mortgage for each year in the future. Since family income often increases as the years go by, the fixed dollar mortgage payments often become a smaller fraction of family income, especially during times of general inflation of prices and wages. If the interest rates that banks charge on new mortgages increase, then the homeowner with a fixed rate mortgage may be in an advantageous situation provided he wants to sell his house. The fixed rate mortgage may become a useful selling point if it is possible for a buyer to take over the old mortgage payments.

Fixed rate mortgages have been beneficial to

borrowers during the period of generally rising interest rates since World War II. The inflation rate and interest rates have been rising more rapidly than expected. But during periods of tight money, it has often been difficult for families to find any banks willing to lend them money for a home. One reason for this problem is that during periods of tight money, banks do not have very much money to lend. Interest rates on investments such as bonds tend to be very high during tight money periods. Savers, attracted by these high interest rates, pull their money out of bank savings accounts and invest in bonds. The banks cannot afford to pay savers higher interest rates, because they have loaned out money for 20 and 30 year mortgages at relatively low interest rates. (See von Furstenberg, 1972.) This process is known as disintermediation. (The banks have also been prohibited by the federal government from raising their interest rates paid on savings accounts.)

One solution which has been proposed to help make more mortgage money available is the variable rate mortgage. (See *Federal Home Loan Bank Board Journal*, 1972; Fish, 1975.) With a variable rate mortgage, if interest rates increase either the monthly mortgage payment, the term of the loan, or both will increase. If interest rates decrease, either the monthly payments, the term of the loan or both will decrease.

There are a number of forms of variable rate mortgages. For illustration, a simple form is shown in Table 1. (For some proposals, see *Federal Home Loan Bank Board Journal*, 1972.) In this example, assume the year is 1950 and a family wants to buy a \$12,000 house. (In 1950, the average selling price of a new single family house was about \$10,000. See U.S. Savings and Loan League, 1957.) The family has \$2,000 for a downpayment and wants to borrow the remaining \$10,000. Assume the bank offers them two mortgage alternatives: a 30-year fixed rate mortgage with an annual interest rate of 4 percent, or a 30-year variable rate mortgage with an initial annual interest rate of 3 percent. (The bank offers a lower initial rate on the variable rate

mortgage because it has protection against possible inflationary trends.)

With either mortgage, the family makes the first monthly mortgage payment on January 1, 1950. For the fixed rate mortgage the repayment is \$47.74 per month for 30 years. For the variable rate mortgage, the monthly payments for the first five years will be \$42.16. Assume that the family income after taxes is \$300 per month, so with either type mortgage, monthly mortgage payments will be less than 16 percent of monthly spendable income.

One of the rules of the hypothetical bank's variable rate mortgage is that monthly payments will stay the same for five years, then the loan balance will be refinanced at an interest rate equal to the average interest rate for the preceding five year period. (Interest rates used in Table 1 are for illustration, and do not reflect exact movements in interest rates in the 1950-1975 period.) With this type of variable rate mortgage, changes in interest rates result only in changes in monthly payments, not in the repayment term of the loan.

Table 1 shows what would have happened if the family had chosen the variable rate mortgage. In 1955, the loan balance is \$8,890. The new interest rate is 5 percent. The monthly mortgage payment for a 25-year loan of \$8,890 at 5 percent interest is \$51.97. This, of course, is higher than the \$47.74 the family would have been paying if they had chosen the fixed rate mortgage. However, assuming the family's spendable income increases at an average rate, it is \$369 per month in 1955. The variable rate mortgage payments of \$51.97 per month are about 14 percent of spendable income, so the family should be able to fit the increased payments into their budget.

By 1960, the loan balance is \$7,875. The interest rate has stayed at 5 percent, so monthly mortgage payments remain at \$51.97. Mortgage payments are now only about 12 percent of the spendable income of \$419. In 1965, the loan balance is \$6,572, and the new interest rate is 6 percent. The monthly payment for a 15-year loan for \$6,572 at

Table 1

Fixed Rate and Variable Rate Mortgages, Borrowing \$10,000 in 1950 with 30 Year Repayment

Year	Fixed Rate Mortgage				Variable Rate Mortgage		
	Monthly Spendable Income*	Interest Rate	Loan Balance	Monthly Payment	Interest Rate	Loan Balance	Monthly Payment
1950	\$300	4%	\$10,000	\$47.74	3%	\$10,000	\$42.16
1955	369	4%	9,041	47.74	5%	8,890	51.97
1960	419	4%	7,870	47.74	5%	7,875	51.97
1965	507	4%	6,440	47.74	6%	6,572	55.46
1970	608	4%	4,694	47.74	8%	4,996	60.61
1975	823	4%	2,562	47.74	9%	2,989	62.05
(Total Interest = \$7,186)				(Total Interest = \$9,453)			

*Rate of increase estimated from *Monthly Labor Review*, June, 1975, Table 20, page 94, for average worker in manufacturing, income after taxes if worker has three dependents. Estimates for 1950 and 1955 from *Monthly Labor Review*, September, 1956, Table C-3, page 1120.

6 percent interest is \$55.46. The family may now regret their choice of the variable rate mortgage. However, their spendable income has increased to \$507 per month, with payments at about 11% of income.

In 1970, the loan balance is down to \$4,996, but the interest rate is up to 8 percent, resulting in the monthly payments of \$60.61. Although the family would have been much better off choosing the fixed rate mortgage, their payments on the variable rate mortgage are only about 10 percent of their spendable income of \$608. If the family has money in savings, then they could save interest on the variable rate mortgage by paying it off early.

In 1975, the balance on the variable rate mortgage is down to \$2,989, while the interest rate is up to 9 percent. The monthly payments on a five year, 9 percent loan of \$2,989 are \$62.05. If the family continues the payments until the last scheduled payment on December 1, 1979, then it will have paid the bank a total of \$19,453. Since it borrowed \$10,000, the total interest is \$9,453. If the family had chosen the fixed rate mortgage, then the total interest would have been only \$7,186.

It may be tempting to conclude from the previous example that consumers should never choose variable rate mortgages. However, this conclusion would only be valid for some con-

sumers some of the time. Many families do not stay in the same house for 30 years. In the above example, if the family had moved during the first 10 years, it would have paid less interest with the variable rate mortgage than it would have with the fixed rate mortgage. Even if the family had stayed in the house for 30 years, the extra \$2,267 paid in interest would have reduced its tax burden if it had itemized on federal and state income tax returns. If the family in the example had a combined federal and state marginal tax rate of 25 percent, the extra interest would have represented a net, aftertax cost of only \$1,700. And if the family had had a choice of a variable rate mortgage or no mortgage at all, then the variable rate mortgage might have proven to be a wise choice.

Another reason that variable rate mortgages might not be bad choices for consumers is that the next 30 years may not be similar to the last 30 years. During the last 30 years interest rates have been generally increasing due to increasing inflation rates and government policies of credit restrictions imposed to try to slow down inflation. Expectations of continued inflation are built into present high mortgage interest rates. Although it may seem reasonable to expect the future to be similar to the past, it is certainly possible that interest rates will not steadily increase during the next 30 years as they generally have during the past 30 years. There are many possible future trends in interest rates. Table 2 illustrates three possible trends in interest rates from 1980 to 2005, and the resulting effects on a 30-year variable rate mortgage.

Effects of Future Interest Trends

In the examples in Table 2, it is assumed that a family is borrowing \$35,000 to buy a house, with the first mortgage payment due on January 1, 1980. The family has a choice of a 30-year fixed rate mortgage with an annual interest rate of 9 percent, or a 30-year variable rate mortgage with an initial annual interest rate of 8 percent. The variable rate mortgage is to be automatically

refinanced every five years at the prevailing interest rate. Part D of Table 2 shows what would happen with the fixed rate mortgage. The family would have monthly payments of \$281.62 for 30 years, with the loan balance gradually decreasing. If the family instead chose the variable rate mortgage, it could be certain that its monthly payments would be \$256.82 from January 1, 1980 until December 1, 1984. But in 1980, the family could not be sure what its payments would be starting January 1, 1985, since it could not know what the interest rate would be then.

Parts A, B, and C of Table 2 shows simulations (hypothetical models) of three possible trends in interest rates and the resulting changes in the monthly mortgage payments of the variable rate mortgage. In Part A, a mixed trend is assumed. First, interest rates increase from 8 percent in 1980 to 10 percent in 1990, then they decrease to 7 percent in 2005. With this mixed trend, monthly mortgage payments increase from \$256.82 in the 1980-1984 period to \$299.50 in the 1990-1994 period, then decrease to \$264.41 in the 2005-2009 period. In terms of total interest paid, the variable rate mortgage would be superior to the fixed rate, with interest of \$64,204 compared to \$66,382 with the fixed rate mortgage.

In Part B of Table 2, an increasing trend for interest rates is assumed. The result is that monthly mortgage payments increase every five years, from \$256.82 in the 1980-1984 period, to \$377.48 in the 2005-2009 period. Total interest paid would be \$74,185, compared to \$66,382 with the fixed rate mortgage.

In Part C of Table 2, it is assumed that interest rates decrease to 6 percent in 1990, and stay at that level for the remainder of the mortgage. Monthly payments decrease to \$217.32 in 1990, so that for the last 20 years of the mortgage, monthly payments would be \$64.30 less than they would have been with the fixed rate mortgage. Total interest would be only \$46,676. With the decreasing trend in interest rates, the variable rate mortgage would prove to be clearly superior to the fixed rate mortgage. (A family which had chosen the fixed rate mortgage could try to

Table 2
Simulations of Variable Rate Mortgages, Borrowing \$35,000 in 1980 with 30 Year Repayment

Year	A. Variable Rate Mortgage with Mixed Trend			B. Variable Rate Mortgage with Increasing Rates		
	Interest Rate	Initial Loan Balance	Monthly Payment	Interest Rate	Initial Loan Balance	Monthly Payment
1980	8%	\$35,000	\$256.82	8%	\$35,000	\$256.82
1985	9%	33,274	279.24	9%	33,274	279.24
1990	10%	31,036	299.50	10%	31,036	299.50
1995	9%	27,871	283.69	11%	27,871	316.78
2000	8%	22,316	270.75	12%	22,997	329.94
2005	7%	13,353	264.41	13%	14,832	337.48
(Total interest = \$64,204)			(Total interest = \$74,185)			
Year	C. Variable Rate Mortgage with Decreasing Rates			D. Fixed Rate Mortgage		
	Interest Rate	Initial Loan Balance	Monthly Payment	Interest Rate	Initial Loan Balance	Monthly Payment
1980	8%	\$35,000	\$256.82	9%	\$35,000	\$281.62
1985	7%	33,274	235.18	9%	33,565	281.62
1990	6%	30,334	217.32	9%	31,290	281.62
1995	6%	25,753	217.32	9%	27,755	281.62
2000	6%	19,575	217.32	9%	22,225	281.62
2005	6%	11,241	217.32	9%	13,580	281.62
(Total interest = \$46,676)			(Total interest = \$66,382)			

refinance under these circumstances, but closing costs and prepayment penalties might be substantial.)

Income and Interest Rates

In order to make a perfect choice, a family would need perfect foresight. Since future interest rate trends are unknown, it might seem useless to try to analyze the various alternatives. However, even though the future is uncertain, there probably will be a pattern to future trends. Interest rates will probably be relatively high in times of rapid inflation, and relatively low in times of slow inflation. Family income usually increases rapidly in times of rapid inflation, and more slowly in times of slow inflation. If these relationships hold true in the future, a variable rate mortgage could provide a form of budget protection. When mortgage payments increase, family income would have increased relatively rapidly. When family income has increased very slowly, or even has decreased, mortgage payments would decrease.

To illustrate the relationship of trends in interest rates to trends in family incomes, Table 3 shows three possible income trends (with income *not* adjusted for inflation) for a family with a monthly income of \$2,000 in 1980. In Part A of Table 3, it is assumed that family income increases at a rate of 5 percent each year. In this case, family income would be \$2,552 per month by 1985, and would increase to \$6,772 per month by 2005. This trend in family income might correspond to the mixed trend in interest rates shown in Part A of Table 2. In 1980, monthly payments of \$256.82 would amount to about 13 percent of income. Each year in the future, mortgage payments would be a lower proportion of income. In 1990, mortgage payments would only be about 9 percent of income. In the year 2005, mortgage payments would only be about 4 percent of income.

In Part B of Table 3, it is assumed that family income increases at a rate of 9 percent per year. In this case, family income would be \$17,246 per

TABLE 3
Three Possible Trends in Family Income,
For an Income of \$2,000 per month in 1980

Year	A. 5% Annual Increase in Family Inc.	B. 9% Annual Increase in Family Inc.	C. 1% Annual Increase in Family Inc.
1980	\$2,000	\$2,000	\$2,000
1985	\$2,552	\$3,078	\$2,102
1990	\$3,258	\$4,734	\$2,210
1995	\$4,158	\$7,284	\$2,322
2000	\$5,306	\$11,208	\$2,440
2005	\$6,772	\$17,246	\$2,564

month by 2005. This trend might correspond to the increasing trend of interest rates shown in Part B of Table 2. Even though monthly mortgage payments increase to \$337.48 in 2005, they would only be about 2 percent of monthly income.

In Part C of Table 3, it is assumed that family income increases at a rate of 1 percent per year. Family income increases only to \$2,564 per month by 2005. This trend in family income might correspond to the decreasing trend in interest rates shown in Part C in Table 2. In the year 2005, mortgage payments would be about 8 percent of income.

These examples show that if interest rates increase only in times of general inflation of prices and wages, then a variable rate mortgage would not result in mortgage payments becoming an increasing proportion of income for a family which managed to keep up with inflation. Although some families might have trouble keeping up with increased mortgage payments when interest rates increase, families which receive increasing incomes over the term of the mortgage would generally have no trouble with variable rate mortgage payments. It would be prudent for families to look for two features in variable rate mortgages to help prevent possible budget disruptions: payments should change only once every five years, and the new interest rate should be based on an average of the preceding five years in order to avoid the consequences of temporary sharp increases in interest rates at the time of refinancing.

Variable Rate Mortgages with "Fixed" Monthly Payments and Variable Terms

An alternate form of variable rate mortgage is the variable term mortgage. With a variable term mortgage, each time the mortgage is refinanced at the prevailing interest rate the term is adjusted and the monthly payment is kept approximately constant. A simple type of variable term mortgage is shown in Table 4, which contains examples similar to those in Table 1. With the variable term mortgage, in 1955 the mortgage is recomputed by a computer program which searches for the repayment term which will amortize the loan balance without any significant change in the monthly payment. The interest rate is 5 percent in 1955, resulting in a remaining term of 507 months in order to amortize the loan. (The exact monthly payment is \$42.17.) If the interest rate remained at 5 percent, the total term of the loan would be 567 months - about 47 years—instead of the 360 months with the fixed rate mortgage.

In the example in Table 4, the interest rate remains at 5 percent in 1960, which results in a

remaining term of 447 months, 60 months less than it was in 1955. In 1965, the interest rate is 6 percent, which increases the remaining term to 644 months. If the interest rate remained at 6 percent, then the total term of the loan would be about 69 years.

The increase in interest rates to 8% in 1970 makes it impossible to increase the repayment term sufficiently to keep the monthly payment constant while still paying interest on the loan balance. At 8 percent annual interest, \$53.18 per month would be required to cover interest on the \$7,977 loan balance. The monthly payment is set at \$54.18 in order to have one dollar of principal paid during the first month. With this higher monthly payment, the loan would be paid off in an additional 600 months, for a total term of 70 years if the interest rate stayed at 8 percent.

In 1975, the increase in the interest rate to 9 percent forces the monthly payment to be increased to \$60.28 in order to cover interest and about one dollar of principal the first month. The policy of the hypothetical bank which issued the mortgage is that the interest rate becomes fixed at the rate prevailing in 25th year of the loan. The

Table 4
Fixed and Variable Rate Mortgages, Borrowing \$10,000 in 1950 with 30 Year Repayment Scheduled. Variable Rate Mortgage with "Fixed" Payments, Variable Term.

Year	Fixed Rate Mortgage				Variable Rate Mortgage			
	Interest Rate	Loan Balance	Remaining Term (months)	Monthly Payment	Interest Rate	Loan Balance	Remaining Term (months)	Monthly Payment
1950	4%	\$10,000	360	\$47.74	3%	\$10,000	360	\$42.16
1955	4%	9,041	300	47.74	5%	8,891	507	42.17
1960	4%	7,870	240	47.74	5%	8,542	447	42.17
1965	4%	6,440	180	47.74	6%	8,095	644	42.18
1970	4%	4,694	120	47.74	8%	7,977	600	54.18
1975	4%	2,562	60	47.74	9%	7,903	548	60.28

Mortgage paid off in 360 months. Last monthly payment on December 1, 1979. Total interest paid = \$7,186.	Mortgage paid off in 848 months. Last monthly payment on August 1, 2020. Total interest paid = \$36,402.
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borrower makes a total of 848 monthly payments, with the last payment on August 1, 2020—almost 41 years after the last payment for the fixed rate mortgage.

The total interest paid on the variable term mortgage is \$36,402, compared to only \$7,186 with the fixed rate mortgage. The monthly payments are less with the variable term mortgage for the first 25 years, then the payments are higher than the payments for the fixed rate mortgage. The loan balance decreases slowly with the variable term mortgage, but during the period of 1950 to 1975 real estate prices

were generally increasing very rapidly, so the owner's net equity would probably have increased substantially during the first 25 years.

Under rules proposed for variable rate mortgages by the Federal Home Loan Bank Board, the total term of a mortgage could not be stretched out to more than 35 years. (*Federal Home Loan Bank Board Journal*, 1972). With this rule, it would be often impossible to maintain constant monthly payments during periods of rising interest rates.

Table 5 shows a variable term mortgage under the three interest rate trends previously shown in

Table 5
Simulations of Mortgages, Borrowing \$35,000 in 1980 with 30 Year Repayment Scheduled. Variable Rate Mortgages with "Fixed" Payments, Variable Term.

A. Variable Rate Mortgage, Mixed Trend					B. Variable Rate Mortgage, Increasing Trend			
Year	Interest Rate	Loan Balance	Remaining Term (months)	Monthly Payment	Interest Rate	Loan Balance	Remaining Term (months)	Monthly Payment
1980	8%	\$35,000	360	\$256.82	8%	\$35,000	360	\$256.82
1985	9%	33,274	478	256.78	9%	33,274	478	256.78
1990	10%	32,730	676	273.75	10%	32,730	676	27.75
1995	9%	32,652	301	273.78	11%	32,652	625	300.32
2000	8%	30,474	203	274.37	12%	32,573	581	326.74
2005	7%	25,242	132	272.73	13%	32,490	544	352.98

Mortgage paid off in 432 months.
 Last monthly payment on December 1, 2015.
 Total interest paid = \$81,394.

Mortgage paid off in 844 months.
 Last monthly payment on April 1, 2055.
 Total interest paid = \$241,885.

C. Variable Rate Mortgage, Decreasing Trend.					D. Fixed Rate Mortgage			
Year	Interest Rate	Loan Balance	Remaining Term (months)	Monthly Payment	Interest Rate	Loan Balance	Remaining Term (months)	Monthly Payment
1980	8%	\$35,000	360	\$256.82	9%	\$35,000	360	\$281.62
1985	7%	33,274	242	257.00	9%	33,565	300	281.62
1990	6%	28,771	164	257.50	9%	31,290	240	281.62
1995	6%	20,843	104	257.50	9%	27,755	180	281.62
2000	6%	10,148	44	257.50	9%	22,225	120	281.62
2005	6%	0	0	0000	9%	13,580	60	281.62

Mortgage paid off in 284 months.
 Last mortgage payment on August 1, 2002.
 Total interest paid = \$42,179.

Mortgage paid off in 360 months.
 Last mortgage payment on December 1, 2009.
 Total interest paid = \$66,382.

Table 2. With the mixed trend in interest rates, the total term of the mortgage is 432 months, and total interest paid is \$81,394. Even though the total interest is higher with the variable term mortgage than it would be with the fixed rate mortgage, the smaller monthly payments might make it preferable for some families.

With the increasing trend in interest rates, the variable term mortgage would be practically a perpetual mortgage, taking over 70 years to pay off. If the borrower and his grandchildren kept making only the regular payments, then the total interest paid would be \$241,885. However, with the inflationary trend shown in Part B of Table 3, the loan balance of \$32,490 in 2005 could be paid off with about two month's income.

With the decreasing trend in interest rates, the mortgage would be paid off in only 284 months instead of the initial term of 360 months. Total interest would only be \$42,179.

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