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I. Introduction

Contracts to service single-family residential mortgage loans for institutional investors represent the primary asset and the primary source of revenues for most mortgage banking companies (MBC's). MBC's acquire servicing contracts either by originating and selling loans to an institutional investor and thereafter servicing them for the investor, or by purchasing the right to service loans from other mortgage originators.[1]

A major problem for mortgage bankers, regardless of whether they originate or purchase servicing, is assessing the value of a servicing contract. It is the purpose of this paper to provide a solution to that problem. The primary objective of the paper is to present and illustrate a model for determining the value of an MBC's servicing portfolio. For mortgage bankers who originate their own servicing, the model should be useful for controlling origination costs; for those who purchase servicing it should be useful for establishing a maximum allowable purchase price.[2]

A secondary purpose of the paper is to use the valuation model to illustrate a dilemma that confronts mortgage bankers. The dilemma arises from the fact that servicing contracts are long-term, fixed revenue commitments that may be terminated only through premature payoff or foreclosure of the loan, both of which are controllable by the mortgagor on the one hand, a high rate of increase in the cost of loan servicing over the long period that the contract is in effect substantially reduces the profitability of servicing the loans and significantly reduces the value of an MBC's servicing portfolio. On the other hand, early termination of the loans may truncate a positive earnings stream and similarly diminish the value of an MBC's servicing portfolio. Through simulation and sensitivity analysis this paper illustrates the severity of these problems.

The paper is organized as follows. Section II briefly discusses the functions of a mortgage banker and the nature of the earnings flows that accrue to a mortgage servicer. This discussion is the basis for the development of a stochastic discounted cash flow valuation model in Section III. After estimating the value of the relevant cash flow parameters in Section IV, Section V illustrates the model and presents the results of sensitivity analysis with respect to different periodic rates of cost increases and different mortgage termination distributions. A final section contains a brief summary and some concluding remarks.

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[1] *MBC's* purchase servicing from commercial banks, savings and loan associations, the Government National Mortgage Association, and other MBC's.

[2] The model also may be useful to those one-bank-holding-companies that have been eagerly acquiring MBC's (11) and (19).

II. Cash Flows of Mortgage Servicing

MBC's or loan correspondents, as they are often called, service loans for savings and loan associations, mutual savings banks, life insurance companies, pension funds, the Federal National Mortgage Association (FNMA), and the Government National Mortgage Association (GNMA).[3] Over 95 percent of these loans are either Federal Housing Administration (FHA) insured or Veteran's Administration (VA) guaranteed.[4] As the representative of an institutional mortgage investor, a loan correspondent's responsibilities include collecting and transmitting monthly mortgage payments, maintaining an accurate record of all transactions between the mortgagor and mortgage, inspecting and safeguarding the mortgaged property, pursuing delinquent mortgage payments, and initiating foreclosure proceedings when necessary.[5] The value of a servicing contract is dependent upon the net cash earnings that an MBC expects to receive for fulfilling these functions. Identification and estimation of those cash flows is the basis for the valuation model developed herein.

Cash Inflows. A correspondent receives a *direct cash* inflow in the form of a monthly servicing fee. This fee is determined as a fixed percentage of the declining principal balance of the loan being serviced. The most common level for the monthly servicing fee is equivalent to an annual rate of three-eighths of one percent of the unpaid principal balance of the loan.[6]

MBC's receive an indirect cash benefit from the management of funds collected for the payment of FHA mortgage insurance premiums, real estate (RE) taxes, and fire and hazard (F&H) insurance premiums. Both FHA and VA require that servicers collect one-twelfth of a mortgagor's annual RE taxes and insurance premiums with each monthly payment and that these funds be placed in a noninterest-bearing escrow account until payments are due.[7] The temporary funds accumulated in escrow are of value because they may be used as compensating balances on commercial bank loans.

Monthly mortgage insurance premiums, which are accumulated by the loan correspondent and transmitted annually to FHA, equal one-twelfth of one-half of one percent of the unpaid principal balance of loan. The amount of funds accumulated for the payment of RE taxes and F&H insurance premiums depends upon local tax rates, the value of the mortgaged property, and the number of times payments are due each year. The implicit rate of return earned on these funds is the opportunity cost of obtaining compensating balances from another source.[8]

As described above, the cash benefits that accrue to a correspondent in each period largely depend upon the unpaid principal amount of the loan being serviced. The unpaid principal amount of the loan in each period is a function of the original face amount and maturity of the loan, and the interest rate paid on the loan. In

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[3] The bundle of goods provided by a mortgage loan may be separated into: (1) financing, provided by a financial institution, and (2) servicing, provided by an MBC. Financial institutions usually employ the services of a loan correspondent because the institution is geographically separated from the location of the mortgaged property, but some institutional investors, such as pension funds, use an MBC because they do not maintain servicing facilities.

[4] Loans Closed and Servicing volume (10), p. 5.

[5] For a more complete discussion of the technicalities of mortgage servicing see DeHuszar [3], or Pease and Kerwood (15, Chapter 21).

[6] FNMA and most other investors pay this rate, although GNMA permits a rate of forty-four-hundredths of one percent of the loan balance on mortgage-backed securities. Because of certain GNMA requirements, the cost of servicing mortgage-backed securities is also higher.

[7] The U.S. Congress is currently considering legislation that would require payment of interest on all funds held in escrow for federally sponsored mortgages. The model developed in this paper could be used to assess the impact of such legislation on the operations of an MBC.

[8] Since the average debt/total assets ratio for MBC's in 1972 was .90, escrow balances are usually of direct benefit to the servicing company, but excess funds may be rented to other firms. Financial Statements and Operating Ratios (5), p. 27.

general, the cash benefits received for servicing mortgage loans vary directly with the maturities, interest rates, and face amounts of the loans being serviced.[9]

Cash Outflows. The cash outflows required to service a mortgage loan may be separated into two categories: (1) cash payments required to perform ordinary servicing functions, including collection and disbursement of mortgage payments, record keeping, and management of escrow funds, and (2) additional cash outlays required to initiate and pursue foreclosure proceedings when all other efforts fail to cure a delinquent loan.[10]

Unlike servicing cash inflows, cash outflows are independent of the sizes, interest rates, and maturities of the loans being serviced. But, over time, the cost of servicing does depend on inflation and technological innovation. As a mortgage loan ages, the cash inflows received per month for servicing the loan decline while the cash outflows required to service the loan are likely to increase. The net cash flow per month resulting from servicing a loan is likely to change from positive to negative sometime before the loan matures.

III. Discounted Cash Flow Model

An investment in mortgage servicing represents a capital expenditure by an MBC. The maximum price that an acquiring company should be willing to pay, or that an originating company should be willing to spend to obtain servicing" equals the discounted value of the net cash flows that are expected to accrue to the MBC as a result of the investment. In general terms, the value of acquiring the right to service a mortgage loan t = 0, ..., J periods after its origination is

$$(1) \qquad E(PVS/O_t) = \sum_{j=t+1}^{J} \frac{E(CF_j/O_t)}{(1+r)^{j-t}}$$

where $E(PVS/0_t)$ represents the expected present value of cash flows received for servicing a J-period-maturity loan that is t periods old (i.e., the loan matures in J-t periods) given that the loan is outstanding at the end of period t; $E(CF_j/0_t)$ represents the expected cash flow received at the end of period j given that the loan is outstanding at the end of period t; and r is a risk adjusted discount rate.

Since the number of periods that a loan will be outstanding is unknown when the servicing contract is acquired, the expected cash flow received at the end of each period depends upon: (1) the probability that a loan outstanding at the end of period t will continue to be outstanding at the end of period j, $P(O_j/O_t)$;(2) the probability that a loan outstanding at the end of period t will be paid off prematurely at the end of period j, $P(P_j/O_t)$; (3) the probability that a loan outstanding at the end of period t will be foreclosed at the end of period j, $P(F_j/O_t)$: and (4) the cash flows associated with each of those events. Let IS j denote the net cash flow received at the end of period j when a loan is paid off or continues to be outstanding (the cash flows received in either event are identical).[11] IS j includes servicing fees, servicing costs, and the implicit earnings on escrow funds. Let PC, denote the net cost of mortgage foreclosure at the end of period j. Expected cash flow at the end of period j is then given by

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[9] Mortgage servicers also receive miscellaneous income from late payment penalties. This source of income also is dependent on the loan amount. These could be included in the model, but will be ignored for convenience of exposition and because they do not alter the primary conclusions.

[10] Foreclose expenses include court costs and legal fees plus any administrative costs. FHA and VA reimburse the mortgage for two-thirds of court costs and legal fees only.

$$(2) \qquad E(CF_j|O_t) = P(O_j|O_t)\cdot IS_j + P(P_j|O_t)\cdot IS_j - P(F_j|O_t)\cdot FC_j$$

which can be written as

$$(3) \qquad E(CF_j|O_t) = \left[\prod_{k=1}^{j-t-1} P(O_{j-k}|O_{j-k-1})\right] \cdot \left[P(O_j|O_{j-1})\cdot IS_j + P(P_j|O_{j-1})\cdot IS_j - P(F_j|O_{j-1})\cdot FC_j\right]^{12}$$

$$t = 0, 1, \ldots, J$$

$$j = 1, \ldots, J$$

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[11] When a loan is paid off at the end of period j, the MBC receives the servicing fee for that period and no income in subsequent periods.

[12] Equation (3) is derived from (2) by noting that

$$P(O_j|O_t) = \frac{P(O_j)}{P(O_t)}\ ;\ P(F_j|O_t) = \frac{P(F_j)}{P(O_t)}\ ;\ P(P_j|O_t) = \frac{P(P_j)}{P(O_t)}$$

and that

$$P(O_t) = \prod_{k=0}^{t-1} P(O_{t-k}|O_{t-k-1}),$$

$$P(F_j) = P(F_j|O_{j-1}) \prod_{k=1}^{j-1} P(O_{j-k}|O_{j-k-1}),$$

$$P(P_j) = P(P_j|O_{j-1}) \prod_{k=1}^{j-1} P(O_{j-k}|O_{j-k-1}), \text{ and}$$

$$P(O_j) = P(O_j|O_{j-1}) \prod_{k=1}^{j-1} P(O_{j-k}|O_{j-k-1}).$$

Equation (3) can be used to compute the expected present value of acquiring the right to service a mortgage loan. However, an expression that is more convenient to work with can be derived. By noting that

$$P(O_j|O_{j-1}) + P(P_j|O_{j-1}) + P(F_j|O_{j-1}) = 1$$

equation (3) can be rewritten as

$$E(CF_j|O_t) = \left[\prod_{k=1}^{j-t-1} (1 - P(P_{j-k}|O_{j-k-1}) - P(F_{j-k}|O_{j-k-1}))\right]$$

(4)

$$\cdot\left[(1 - P(F_j|O_{j-1}))\cdot IS_j - P(F_j|O_{j-1})\cdot FC_j\right]\cdot$$

Equation (4) expresses expected cash flows at the end of period j solely in terms of the cash flows received at the end of j and the conditional probability that a loan will be terminated, either through premature payoff or foreclosure, in each period after the MBC acquires the servicing contract.

To this point, taxes have been omitted from the discussion. Inclusion of taxes has two implications for determining the value of a mortgage servicing contract: (1) the tax shelter provided by amortization of the acquisition cost of externally purchased or internally originated servicing increases net cash flows, and (2) the payment of taxes reduces the net cash flows received for servicing a loan. By including taxes, by letting $SV_t = E(PVS|O_t)$, and by replacing IS_j with terms that represent its component parts, the value of acquiring the right to service a mortgage loan at any time t subsequent to its origination may be expressed as

$$SV_t\left(1 - \frac{\tau}{A}\cdot\sum_{a=1}^{A}\frac{1}{(1+r)^a}\right) = (1-\tau)\sum_{j=t+1}^{J}\left[\prod_{k=1}^{j-t-1}(1-P(P_{j-k}|O_{j-k-1})-P(F_{j-k}|O_{j-k-1}))\right]$$

$$(5)\cdot\frac{[1-P(F_j|O_{j-1})]\cdot[(SF)\cdot(B_j)-(SC_t)\cdot(1+IF)^{j-t}+(EB_j)\cdot(i_j)}{(1+r)^{j-t}}$$

$$-\cdot\frac{P(F_j|O_{j-1})\cdot(FC_t)\cdot(1+IF)^{j-t}]}{(1+r)^{j-t}}$$

where

τ = tax rate applicable to corporate income.

SV_t = discounted value of the expected after-tax net cash flows received by a loan correspondent for a servicing contract purchased t periods after the loan is originated, t = 0, 1, ..., J. $\frac{SV_t*t}{A}$ Represents the tax shield provided by amortization of the investment outlay over a periods).

SF = monthly servicing fee expressed as a fraction of the unpaid principal balance of the mortgage loan.

B_j = unpaid principal balance of the mortgage loan at the beginning of i month j = 1, ..., J.

SC_t = monthly cost of servicing per loan at end of month t when the servicing contract is acquired, t = 0, 1, ..., J.

IF = monthly rate of increase in the cost of servicing (i.e., inflation rate net of technological change).

EB_j = amount of funds held in escrow at the beginning of month j = 1,….,J (including FHA mortgage insurance premiums, RE taxes, and F&H insurance premiums).

i_j = implicit rate of return earned on escrow funds in month j = 1, ..., J.

FC_t =net cost per foreclosure at the end of month t when the servicing contract is acquired, t = 0, 1, ..., J.

R = after-tax cost of capital per month.

Some interpretation of equation (5) may be useful on the right-hand side of (5) the term (SF*Bj) represents the servicing income earned in each period that the loan is outstanding. The amount of the servicing revenues will depend upon the size of the servicing fee (SF) and the unpaid balance of the loan at the beginning of each period. The term $SCt*(l+IF)^{j-t}$ represents the cost of servicing a loan in each future period. It is clear that the expected cost of servicing a loan over its life will largely depend upon the rate (IF) at which costs are expected to increase over time. The term ($Eb_j * i_j$) represents the implicit cash benefits that accrue to the MBC from the management of escrow funds.[13] These benefits will depend upon the size of the escrow balances (Eb_j) and the opportunity cost (i_j) of obtaining funds elsewhere. Finally, the term $FC_t*(l+IF)^{t-j}$ represents the net cost per mortgage foreclosure in each future period. The first term on the r.h.s. of (5), $(1-\tau)$, adjusts all of these cash flows to their after-tax amounts.

Equation (5) can be solved for SV_t to compute the value of acquiring the right to service an individual mortgage loan. since servicing contracts may be evaluated as independent investments, summation of SV_t over all loans yields the value of an MBC's total servicing portfolio. The valuation equation can be used to assess the value of acquiring the right to service a newly originated loan or an already existing portfolio.

IV. Estimating the Parameters

In order to illustrate the model, values for the cash flow parameters were estimated from financial data provided by a group of eight MBC's.[14] The parameter values used in the illustrations are summarized in Table 1.

The servicing fee, variable (1), was assigned the rate common to most servicing contracts. The dollar amount of the variable servicing cost per loan, variable (2), the variable cost per mortgage foreclosure, variable (3), and the corporate tax rate, variable (5), were assigned the mean values estimated from the financial data provided by the eight mortgage companies. The parameters that determine the amount of funds accumulated in escrow for payment of RE taxes and F&H insurance premiums, variables (6) and (7), were estimated in aggregate from the financial records of the eight companies.[15] The periodic rate of cost increases, variable (4), was estimated from the Functional Cost Analysis for Average Banks.[16] The rate of FHA mortgage insurance premiums, variable (8), is determined by FHA regulation. The implicit rate of return earned on escrow funds, variable (9), was specified as the yield-to-maturity on an intermediate-term treasury bond.[17] The period over which the acquisition cost is to be amortized, variable (10), is standard for the group of MBC's that participated in this study. Both the capital asset pricing model and the constant growth dividends model were used to estimate the return required on the equity capital of mortgage companies. The after-tax weighted average cost of capital, variable (11), was derived from these estimates.[18]

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[13] Although the escrow balances represent an implicit source of revenues they should not be treated as tax-free income. The effect of the escrow balances is to reduce the explicit cost of banking services. Since these costs are tax deductible, the value of the implicit benefits derived from the escrow balances is only that portion that would not have reduced corporate taxes.

[14] In terms of their total servicing portfolios, all eight companies were among the 200 largest mortgage servicers in the United States. Ranking the 200 largest MBC's by size of their servicing portfolios and dividing them into quartiles shows that four of the eight companies are in the first quartile, one is in the second quartile, two ire in the third quartile, and one is in the fourth quartile. The Mortgage Bankers Association reported 750 MBC's in 1972.

[15] In the illustrations escrow balances were computed by using the FHA mortgage insurance formula plus an average balance from other sources. The average balance from other sources equals one-half of the total annual payment (expressed as a percentage of the original face amount of the loan) divided by the number of times payments are due each year.

[16] This estimate was derived for the period 1965 to 1972. Functional Cost Analysis for Average Banks [6].

[17] Alternatively this variable could be assigned the periodic forward rates implied by the current term structure.

[18] The unlevered required return for MBC's as a risk class was estimated by the procedure outlined in Lewellen [12]. This estimate was combined with the capital structures of the firms included in the study to determine their after tax weighted average cost of capital. A more complete discussion of the methodology used to estimate this and other parameters is available from the author or in (14, Chapters 5 and 6).

TABLE 1

PARAMETER ESTIMATES

	Parameter	Value
1.	Annual Servicing Fee - Percentage of Principal	.375%
2.	Average Variable Servicing Cost - Per Annum	$24.59
3.	Net Variable Cost Per Foreclosure	$179.60
4.	Periodic Rate of cost Increase - Per Annum	3.0%
5.	Corporate Tax Rate	49.0%
6.	Annual RE Taxes and F&H Insurance Premiums Percentage of Mortgage Principal	2.0%
7.	Number of Times Taxes and Premiums are Paid Per Annum	2.0 times
8.	FHA Mortgage Insurance Premium - Percentage of Mortgage Principal	.5%
9.	Rate of Return on Escrow Funds - Per Annum	8.0%
10.	Amortization of Acquisition Cost - in Years	8.0 years
11.	After-Tax Weighted overage Cost of Capital – Percent Per Annum	7.0%

FHA historical data were used to estimate the conditional probabilities of premature mortgage payoff and foreclosure in each period. While it would be desirable to estimate termination rates for each "cohort" of mortgage loans as a function of mortgagor characteristics, mortgage maturity, policy year, and economic conditions, these date were not available.[19] However, available data are classified according to policy year and mortgage maturity. These statistics were used to estimate directly the termination distributions (i.e., the conditional probabilities of mortgage payoff and foreclosure in each policy year) for 25- and 30-year maturity loans.[20] The conditional probabilities of payoff and foreclosure for 35-year maturity loans were estimated from the 25- and 30-year termination distributions. The estimation method is described in the Appendix.

For computational purposes the annual conditional probability distributions and the annual cash flow parameter values listed in Table 1 were converted to their monthly equivalents.

V. Illustrating the Model: Simulation and Sensitivity Analysis

The parameter values presented in Table 1 and the conditional probabilities of premature payoffs and foreclosures estimated from the FHA data were used to compute the value of servicing 25-, 30-, and 35-year maturity loans ranging in size from $12,000 to $36,000. This range of loan sizes should contain most of the loans originated and serviced by MBC's.[21] For illustrative purposes, only the results for 30-year maturity loans are presented.

The computed or capitalized value of servicing 30-year maturity loans with interest rates of 8.5 percent and 4.5 percent are presented in Table 2. The table shows the capitalized value of acquiring the right to service mortgage loans that are newly originated, 5, 10, 15, 20, and 25 years old Whose original face amounts ranged from $12,000 to $36,000.

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[19] The author was unable to discover any studies that have attempted to relate mortgagor characteristics to payoff experience. A growing body of literature is devoted to discovering those mortgagor characteristics that determine foreclosures. Among those studies are [1], [4], [7], and [9].

20 The author is indebted to the FHA for making the unpublished data available for this study. The same data were used by Curley and Guttentag [2] and Von Furstenberg [17].

[21] MBC's have tended to concentrate their origination and servicing efforts among lower income mortgagors and those that qualify for government assisted loan programs. The average loan originated in 1972 by this group of MBC's was $19,600. The average balance of the loans in their servicing portfolios was $13,500.

As expected, the table shows that in every age category the capitalized value of servicing increases as the original face amounts of the loans increase and that in every size category the value of servicing newer loans is greater than the value of servicing older loans. The table also shows that the value of servicing higher interest rate loans exceeds the value of servicing lower interest rate loans of the same age and amount.

The results indicate that the value of a portfolio composed of larger loans is substantially greater than the value of a portfolio of smaller loans and that this value increases more than proportionately to size--a tripling of loan amount from $12,000 to $36,000 yields a seven-fold increase in the value of a servicing contract for a newly originated loan.

It is also interesting to note that for 4.5 percent loans of less than $30,000 and for 8.5 percent loans of less than $24,000, the value of servicing is negative prior to year 25.[22] Since all FHA/VA loans that are now 20 years old have an interest rate of 4.5 percent, a loan correspondent should be willing to pay some amount to be relieved of servicing relatively old mortgage loans.[23]

TABLE 2
VALUE OF SERVICING
30-YEAR MATURITY LOANS WITH 8.5% AND 4.5% INTEREST RATES

	Age of Loan (years)					
Face Amount (dollars)	0	5	10	15	20	25
	Capitalized Value for 8.5% Loans (dollars)					
12000	99	83	59	22	(13)	(32)
18000	260	219	179	116	47	(9)
24000	420	356	299	211	107	15
30000	581	92	418	306	166	39
36000	742	629	538	401	226	63
	Capitalized Value for 4.5% Loans (dollars)					
12000	81	57	26	(11)	(37)	(42)
18000	233	181	130	68	11	(23)
24000	385	304	234	146	58	(4)
30000	536	428	338	225	106	15
36000	688	551	441	303	154	34

Termination Distributions. While it is beneficial to an MBC to have older loans paid off before the net cash flow received for servicing the loans changes from positive to negative, a uniform increase in the conditional probabilities of premature payoffs reduces the value of loan servicing. To illustrate the impact of different termination distributions, the term $P(P_j/0_{j-1})$ in equation (5) was replaced with $P(P_j/0_{j-1})$ *R where R represents the expected probability of premature payoff as a fraction of the historical average payoff rate. In the examples below R = .5, 1.5, and 2.5. The probability that a 30year maturity loan will be outstanding at any point in time under each of these termination distributions is illustrated in Figure I. When the periodic probability of premature payoff is 250 percent of the historical average rate (i.e., R = 2.50) there is a 50 percent probability that a 30-year maturity loan will be terminated before the end of the eighth year, but when the probability of premature payoff is fifty percent of the historical average rate (i.e., R = .50) there is a 50 percent probability that a loan will last until the twenty-eighth year.

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[22] In fact, the cash flows for all loan sizes are negative prior to year 30. In general, the results for 25- and 35-year maturity loans are similar to those for 30-year loans. The value of servicing 25-year loans is smaller in every case and becomes negative sooner, while the opposite is true for 35-year loans.

[23] The FHA maximum interest rate was 4.5 percent from May 1953 to December

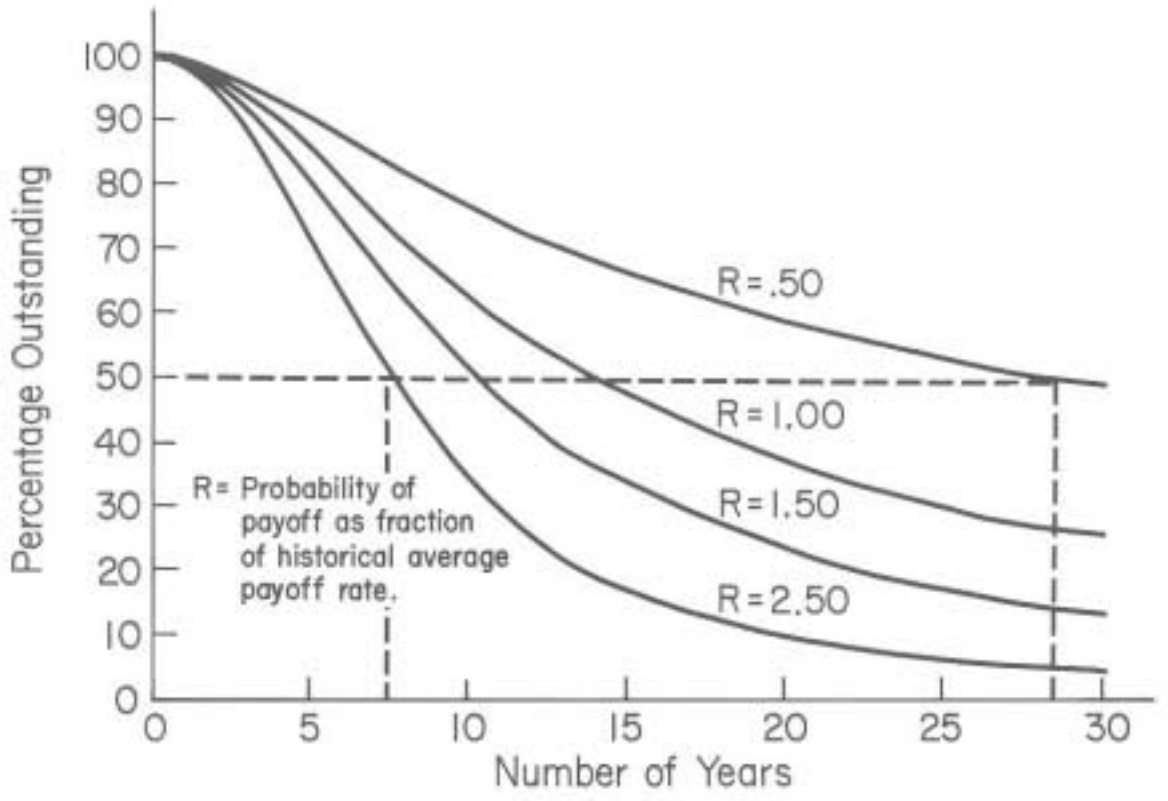

Figure 1

Probability That a Loan Will be Outstanding Under Four Different Prepayment Rates

Table 3 shows the capitalized value of servicing 8.5 percent, 30-year maturity loans under two different termination distributions. The results show that a uniform decrease in the conditional probability of premature payoff enhances the value of a servicing portfolio, while an increase has the opposite effect. An increase in the expected payoff rate from 50 percent to 250 percent of the historical rate produces a 34 percent reduction in the value of servicing a newly originated $24,000 loan. The impact of different payoff distributions on the value of servicing older loans is less dramatic. Thus mortgage bankers that originate or purchase new loans should attempt to assess the likelihood of premature loan termination.

As discussed above, the conditional probability distributions used in this study reflect the influence of policy year and mortgage maturity, but not the effect of exogenous economic conditions. In particular, the distribution of future mortgage payoffs is likely to be influenced greatly by changes in mortgage yields. A decline in mortgage yields will probably be followed by an increase in the incidence of premature payoffs.[24] The loans that are most likely to be terminated following a decline in yields are those that have been originated recently at relatively high rates of interest--precisely those that are of the greatest value to an MBC. In contrast, the payoff rates of ten- and twenty-year-old loans with relatively low interest rates are unlikely to be greatly affected by a decline of 1 or 2 percent in current interest rates. Thus, a decline in interest rates would likely have an adverse

[24] Curley and Guttentag find evidence of this. They note that ". . . in every mortgage age category for which a comparison is possible, termination rates were higher in years of [mortgage yield] ease than in the immediately prior years of [yield] restraint." Curley and Guttentag, [2, p. 124].

effect on the value of an MBC's servicing portfolio. Relatively new, higher interest rate loans may be terminated early, while relatively old, low interest rate loans which have low, or perhaps negative, value may continue to require servicing.[25]

TABLE 3

VALUE OF SERVICING
30-YEAR MATURITY LOANS UNDER TWO PAYOFF DISTRIBUTIONS

Age of Loan (years)						
Face Amount (dollars)	0	5	10	15	20	25
	Capitalized Value When R=.5 (dollars)					
12000	96	78	50	13	(21)	(36)
18000	280	238	186	116	43	(11)
24000	463	398	322	219	106	13
30000	646	558	458	323	170	38
36000	830	717	594	426	233	62
	Capitalized Value When R=2.50 (dollars)					
12000	93	79	67	37	3	(23)
18000	212	171	153	112	54	(1)
24000	330	263	238	187	105	21
30000	449	355	324	262	156	43
36000	568	447	409	337	207	65

Cost Increases. The periodic rate of cost increase used in the computations of Tables 2 and 3 was estimated from the Functional Cost Analysis for the years 1965 to 1972. Over the more recent period 1969 to 1972 the Mortgage Bankers Association's Survey of Single-Family Loan Operations reports an increase of 11.2 percent per annum in the variable cost of servicing a mortgage loan.[26] The impact of different rates of cost increases is illustrated in Table 4. The table shows that an increase in this rate from 3 percent to 6 percent reduces the value of servicing a new $24,000 loan by 17 percent, while an increase from 3 percent to 9 percent decreases its value by 43 percent. The table also shows that the value of servicing a $12,000 loan when the expected rate of cost increase is 9 percent is negative regardless of age. Because MBC's are committed to servicing mortgage loans for the duration of their lives, long-run high rates of inflation could be particularly harmful to the mortgage banking industry. At the very least, MBC's need to assess potential cost increases with great care when acquiring servicing contracts.

It is likely that high rates of inflation and high interest rates are not unrelated. A rise in the former is likely to be accompanied by a rise in the latter, while a decline in the former is likely to be accompanied by a decline in the latter. It might be argued that Table 2 gives the mortgage banker the best of both worlds, a low (relative to recent standards) rate of cost increases and the historical payoff distribution. Table 5 contains the results of a joint variation in the payoff distribution and the rate of cost increases for 8.5 percent loans. In this table the monthly conditional probabilities of premature payoff are 50 percent of the historical rate and the annual rate of cost increase is 9 percent. In terms of its impact on the value of an MBC's servicing portfolio, this is the worst

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[25] FHA and VA forbid non-assumption clauses and prepayment penalties.

[26] Part of this increase was due to an increase in the incidence of delinquent and difficult-to-collect loans. Survey of *Single-Family Loan* Operations [16, P. 16], and Wetmore [18, p. 85].

TABLE 4

VALUE OF SERVICING
30-YEAR MATURITY LOANS WITH DIFFERENT RATES OF COST INCREASES

Face Amount (dollars)	Age of Loan (years) 0	5	10	15	20	25
	Capitalized Value When Cost Increase 6.0% (dollars)					
12000	28	27	13	(12)	(32)	(38)
18000	188	164	133	83	28	(14)
24000	349	300	523	178	88	10
30000	510	437	373	273	148	33
36000	671	574	493	368	210	57
	Capitalized Value When Cost Increase 9.0% (dollars)					
12000	(84)	(54)	(52)	(58)	(46)	(44)
18000	77	83	70	40	7	(20)
24000	238	219	190	135	67	3
30000	398	356	310	230	127	27
36000	559	492	430	325	187	51

of a joint variation in the payoff distribution and the rate of cost increases for 8.5 percent loans. In this table the monthly conditional probabilities of premature payoff are 50 percent of the historical rate and the annual rate of cost increase is 9 percent. In terms of its impact on the value of an MBC's servicing portfolio, this is the worst combination of events--mortgages, on average, are expected to be outstanding for a relatively large fraction of their potential lives and servicing costs are expected to rise steeply. With the exception of $36,000 loans the results are worse than any other combinations shown. (For 4.5 percent loans the results are even worse.) It is precisely this combination of events that MBC's have experienced recently. As interest rates have increased, there has been a decline in premature terminations and costs have risen substantially. These results may explain in part some of the problems that currently afflict the mortgage banking industry.[27]

It is interesting to note the analogy between the problem of MBC's and savings and loan associations. When interest rates are high, old low interest rate loans remain outstanding and act as a drag on their earnings. However, when interest rates decline, the newer, high rate loans are prepaid or refinanced.

VI. Summary and Conclusion

This paper presented a stochastic discounted cash flow model with which mortgage companies can assess the value of a mortgage-servicing contract. The model was illustrated with data provided by a group of eight MBC's. Simulation and sensitivity analysis showed the impact of different mortgage amounts, termination distributions, and expected rates of servicing cost increases on the value of a mortgage-servicing portfolio. In general, because servicing contracts are long-term fixed revenue arrangements, high rates of servicing cost increases substantially reduce the value of an MBC's servicing portfolio. To the extent that mortgage

[27] It is also quite possible that the "cost of capital" and anticipated inflation are not unrelated. However, an increase in the discount rate when cost increases are high would reinforce the above conclusions. Hendershott and Van Horne [8] contains empirical estimates of the relationship between required equity returns and inflationary expectations. Long [13] contains a more complete theoretical development of the same relationship.

prepayments are reduced by high inflation rates, the impact of high cost increases on the value of a servicing portfolio is compounded.

TABLE 5
VALUE OF SERVICING 30-YEAR MATURITY LOAN
WHEN R = .5 AND THE RATE OF COST INCREASE = 9.0%

Face Amount (dollars)	0	5	10	15	20	25
12000	(175)	(124)	(98)	(82)	(67)	(48)
18000	9	35	38	22	(3)	(24)
24000	192	195	174	125	60	0
30000	376	355	310	229	123	25
36000	559	515	446	332	187	49

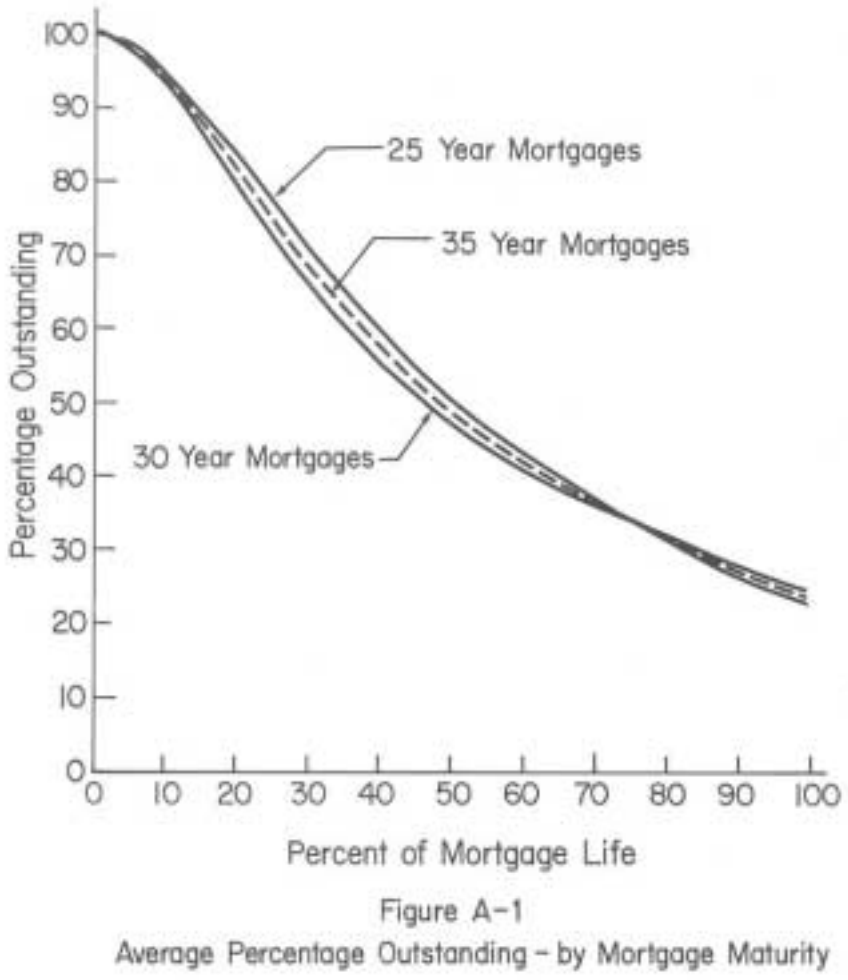

Figure A-1
Average Percentage Outstanding – by Mortgage Maturity

APPENDIX

Terminations classified by mortgage maturity and policy year have been accumulated by the FHA only since 1951. From these data payoff and foreclosure distributions were computed for each cohort of 25- and 30-year mortgages for the period 1951 to 1972.

The payoff percentages were computed by dividing the number of mortgage payoffs in each policy year from a particular cohort by the number of mortgages from that cohort that were active at the beginning of the policy year:

$$PP_{k,m} = \frac{PO_{k,m}}{NO_{k,m}}$$

where

$PO_{k,m}$ = number of mortgage payoffs of cohort m in policy year k = 1,…, 21[28]
$NO_{k,m}$ =number of mortgages of cohort m outstanding at the beginning of policy year k = 1, ..., 21.

The conditional probability of premature payoff in each policy year was estimated as the average of the individual cohort payoff percentages in that policy year:

$$P(P_k/O_{k-1}) = \frac{I}{M} \left(\sum_{M=1}^{M} PP_{k,m}\right)$$

where M = number of observations on policy year k.[28]
The same methodology was used to estimate the conditional probability of mortgage foreclosure in each policy year.

Since the termination distributions are incomplete, it was necessary to extrapolate the payoff and foreclosure rates for policy years 22 through 25 for 25-year maturity loans, and for policy years 22 through 30 for 30-year maturity loans. Because the average payoff rate is relatively constant for policy years 16 through 21, the average payoff rate for that period was used as the conditional probability of mortgage payoff for nonobservable policy years. Because mortgage foreclosure rates approach negligible levels after the fifteenth policy year, a rate of zero foreclosures was used as the estimate of the conditional probability of mortgage foreclosure in the nonobservable policy years.

Since the number of 35-year maturity loans are too few and their inception too recent to provide any reliable information about their expected termination distribution, the payoff and foreclosure experience of 25- and 30-year mortgages was extrapolated to the longer maturity loan. The method chosen to estimate the termination distribution for 35-year mortgages is illustrated in Figure A-I.

To estimate the termination distribution for 35-year loans, the conditional probabilities of premature payoff and foreclosure for 25- and 30-year loans were used to compute the percentage of 25- and 30- year mortgages outstanding after each policy year. Policy years were then converted to percentages of mortgage life. The

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[28] The number of observations declined by one for consecutive policy years. There are twenty-one observations for policy year 1, but only one observation for policy year 21

average percentages outstanding after each policy year were then plotted against percentage of mortgage life for both loan maturities, and the percentage of 35-year loans expected to be outstanding at each point in time subsequent to mortgage origination was estimated as the average of the percentage outstanding for 25- and 30-year loans. Percentage of mortgage life was then reconverted to policy years for 35-year loans, and the percentage of loans outstanding after each policy year was used to estimate the conditional probabilities of mortgage termination.

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