Macroeconomic Simulations of Alternative Mortgage Instruments

Dwight M. Jaffee and James R. Kearl*

I. INTRODUCTION

This paper reports on the results of simulating the macroeconomic effects of alternative mortgage instruments using the MPS econometric model. The MPS model (which is a recent version of the model developed by the MIT-Federal Reserve model project) was chosen principally because of the extensive detail in its financial sectors. This depth of detail allows the various effects of alternative mortgage instruments to be distinguished. Additionally, the principal investigators on the MIT Mortgage project were fully familiar with the operation of the MPS model, and this allowed a wide variety of mortgage instruments to be implemented and tested with assurance and speed.

The results presented here must be interpreted as preliminary findings on the macroeconomic effects of the alternative mortgage instruments tested. This "caution on use" is stressed for several reasons. First, the basic model was developed with specification and estimation methods that are subject to errors, while the results are presented as simple point estimates of the expected effects. Second, the technique for implementing the alternative mortgage instruments in the model involves changing certain structural features of the model, which no doubt introduces additional uncertainty into the results, although of an unknown amount. Third, there are several points in the MPS model where the values of specific coefficients necessary for implementing the alternative mortgage instruments are not known. To proceed, therefore, we had to make *ad hoc* guesses of the values of these parameters, and in some cases to simulate the instruments for alternative values to test for sensitivity. These points of uncertainty are stressed in the text below, and are listed in the conclusions under the agenda for future research. Finally, we have carried out only "partial equilibrium" simulations of those sectors of the MPS model in which the mortgage instruments have their direct impacts. The results, consequently, do not allow for the full feedback of the general economy on the sectors of initial impact.

*Dwight M. Jaffee is an Associate Professor of Economics at Princeton University and James R. Kearl is an Assistant Professor of Economics at Brigham Young University.

The mortgage contracts tested in this study have resulted from the continuing discussions among the participants in the MIT mortgage project. Most, if not all, of the instruments have been therefore discussed in some detail in the other studies contained in this volume, and reference is made hereto. However, an attempt has been made to outline the main features of the proposed instruments, and thus the present paper is self-contained in this sense, and indeed may provide a useful summary of some of the principal findings of the MIT mortgage study. Also note that the order in which the alternative instruments are tested represents an attempt to develop in a logical manner the key features of these instruments, and therefore does not represent a view as to the desirability or relative desirability of the contracts.

The paper has been structured to allow for the possibility of reading on three different levels. First, the actual results are presented and discussed in a relatively self-contained manner in Section III. Second, more general background on the MPS econometric model and the structure of the experiments is provided in Section II just below. Third, specific details on how the instruments were included in the actual programming of the MPS model are available in Section V. Summary conclusions and an agenda for future research are given in Section IV.

II. GENERAL FRAMEWORK FOR THE SIMULATIONS

A. *The MPS Model*

Complete and technical descriptions of the housing, mortgage, and savings deposit sectors of the MPS model are available in Gramlich and Jaffee (1972). Fortunately, for present purposes, the equations of basic interest for the simulations can be usefully presented without the details of dynamic lags, proxy variables and empirical approximations, and the like. The relevant equations, making a closed system, are:

(II.1)	KH$	= KH$ [PAYO, LVR, RM, RP, . . .]
(II.2)	MD	= MD [RM, RO, KH$, REP, . . .]
(II.3)	MS	= MS [RM, RO, D, REP, . . .]
(II.4)	MD	= MS
(II.5)	RD	= RD [RM, RO, . . .]
(II.6)	D	= D [RD, RO, . . .]
(II.7)	RES	= RES [INT, RD, D, . . .]
(II.8)	PAYO	= function of mortgage instrument
(II.9)	PAY	= function of mortgage instrument
(II.10)	INT	= function of mortgage instrument
(II.11)	REP	= function of mortgage instrument

Symbols in these equations and others which enter later in the discussion are defined as follows:

c	constant spread between RD and RMS reflecting the costs of intermediation
CB	commercial banks
D	supplied stock of time deposits
GMF	gross mortgage flow during period
GP	graduated-payment mortgage
IN	price-level-indexed mortgage
INT	interest income received by savings and loan associations
KH$	current value of housing stock
LIC	life insurance companies
LVR	maximum available loan-to-value ratio
MD	demand for stock of mortgages
MS	supply of stock of mortgages
MSB	mutual savings banks
PAY	aggregate mortgage payments in period (including both interest and repayment of principal)
PAYO	initial payment on relevant mortgage contract
PH	price of standard house
PLAM	price-level-adjusted mortgage
RCB	long-term bond rate
RCP	commercial paper rate
RD	time deposit interest rate
REP	repayments of principal on mortgage contracts
RES	transfers to reserve accounts of savings and loar associations
RM	long-term conventional mortgage interest rate
rm	real rate of interest on mortgage
RMS	short-term mortgage interest rate
RMS_0	initial short-term mortgage interest rate
RO	"other" rates, typically the long-term corporate bon(rate
RP	current rate of inflation
$\hat{RP}$	expected rate of inflation over the duration of th(contract
RP_0	initial rate of inflation
$(RMS\text{-}RM)_0$	difference between short-term and long-term mortgag rates at initial date of contract
SLA	savings and loan associations
T	maturity of the mortgage
u	degree of graduation, i.e., annual rate of increase i total payment
u_0	initial graduation rate
VRM	variable-rate mortgage

The above equations are briefly described as follows:

(1) *Housing*. In the current MPS model, the housing stock and housing investment are developed from a series of reduced-form equations of the housing market. The housing stock responds positively to various income and demographic variables that increase demand, and responds negatively to the relative price of housing and to the cost and availability of housing finance. The present model does not, however, incorporate the effects of either loan-to-value ratios (LVR) or the initial payment size (PAYO) on housing demand, and the treatment of inflation rates (RP) is not completely satisfactory for present purposes.

James Kearl is currently developing a housing sector that will properly estimate these effects. For present and immediate purposes, however, we have had to make an *ad hoc* adjustment to the model. Following the work of Poole (1972), the main effect to capture is the impact of higher intial payments (PAYO) in reducing housing investment. Because individuals operate within cash flow constraints in terms of the maximum value of PAYO they can afford, mortgage instruments with higher PAYO values will result in individuals buying smaller houses or not buying at all.

This impact has been implemented in the model in the following way. First, we calculated over the simulation period the value of PAYO that would have been (or actually was) associated with the conventional mortgage contracts in force. We denote this time series of values $\overline{\text{PAYO}}$, and note that it will rise and fall with the mortage rate on newly issued mortgages, following the specific formula given in Section V. Second, we calculated within the simulations the value of PAYO associated with the mortgage instrument being studied where again the specific formulas are given in Section V. Thus, thinking of a case in which a new mortgage instrument lowers the initial payment, the saving in cash flow amounts would be given by $\overline{\text{PAYO}}$ - PAYO, and the proportional saving which we denote as β would be given by $\beta = (\overline{\text{PAYO}} - \text{PAYO})\ \text{PAYO}$.

Our assumption is that individuals fully use this saving to purchase additional housing, so that we can increase the housing investment that would have been generated by the model by the factor β to account for the stimulus of the new mortgage instrument. It would be clearly wrong, however, to assume that *all* individuals are actually constrained by these cash flow problems, and therefore it would be wrong to count this full impact on housing. Instead, we assumed that some proportion of households, denoted as α, were actually constrained by cash flow considerations, and thus we counted as a stimulus to housing the multiplicative factor αs.

As for the actual value of α, we were frankly agnostic, other than knowing it was bounded between 0 and 1. In the simulations, unless otherwise noted, we have used what we think to be the conservative value of .25. In one simulation reported below we also tested with a value of .75, and found the effects on housing essentially tripled, implying the model is near linear in this sense.

(2) *Mortgage Demand.* The demand for mortgages is derived from the stock of houses to be financed, and, in fact, MD is proportional to KH$. The factor of proportionality, however, is negatively related to the mortgage rate (RM), reflecting the fact that individuals will opt for lower loan-to-value ratios when RM rises, and, perhaps more importantly, more individuals will choose full equity financing for their housing as RM hits threshold values. Note that the RM elasticity of mortgage demand depends on both the proportionality factor and KH$, since the latter is itself a function of RM.

(3) *Mortgage Supply.* The supply of mortgages is derived basically from the available sources of funds. For savings and loan associations (SLAs), mutual savings banks (MSBs), and commercial banks (CBs), the funds are mainly time deposits, while for life insurance companies (LICs) the driving variable is reserves. In addition, except for SLAs, there are important portfolio allocations whereby mortgage supply rises with RM and declines with other rates (RO). There are also complicated dynamic structures in the model to take into account the commitments process of mortgage lending. These remain in the simulated system in their original form, but are not discussed here since they do not interact in important ways with the changes in the mortgage instruments.

(4) *Mortgage Market Equilibrium.* The MPS mortgage sector allows for disequilibrium in the mortgage market with a mechanism by which the mortgage rate responds only slowly towards its equilibrium value, and this is also retained in the simulated system. Conceptually, however, this affects only the short-run dynamics of the model, and thus it is easier to assume a full equilibrium model for the discussion that follows here.

(5) *Deposit-Rate Setting.* Deposit-rate setting by SLAs, MSBs, and CBs is based on a model of modified profit maximization. For SLAs, for example, deposit rates are set at a level such that the marginal cost of deposit funds equals the yield available on newly issued mortgages. Also, there are certain dynamic factors affecting the rate-setting, but they do not cause the deposit rate to differ significantly from the static profit maximizing level. There are, however, two other constraints that potentially affect the deposit rate. One constraint is the Regulation Q ceiling which, when it is binding, has the effect of suspending normal rate-setting behavior. The role of Regulation Q ceilings in our simulations will be discussed below. The second constraint that can affect deposit rate setting derives from the Federal Home Loan Bank requirements for transfers to reserves from current operating profits by SLAs. Concern for this condition was a basic factor responsible for the enforcement of deposit rate ceilings in 1966, 1969-70, and 1973-74. Our simulations, as indicated below, will have the effect of removing deposit rate ceilings at the same time that a new mortgage contract is introduced. We anticipate that the net effect should be to improve, not hurt, SLA reserve transfers. It is possible, particularly for some of the less preferred mortgage innovations, that SLA reserve transfers may actually fall. Since RES is a variable of the model, such a situation would be indicated in the simulation.

(6) *Household Supply of Time Deposits.* The MPS model deposit equations follow a mechanism through which household net worth and current savings are balanced first between time deposits and other financial and real assets, and second, between the various depository institutions. The spreads between deposit interest rates and other interest rates determine the allocations and balance at both levels.

(7) *Reserve Transfers of SLAs.* There is now available for the MPS model a series of equations that determines the reserve transfers of SLAs. The two main variables are the mortgage interest income and deposit interest costs for SLAs, but, in addition, taxes and other income and costs are accounted for. A description of these equations is provided in Section V, and their use in simulating the effects of removing Regulation Q ceilings is available in Jaffee (1973).

(8) *Size of Initial Payment.* PAYO is a new variable to be added to the MPS system in order to simulate the effects of changes in the size of initial payment on housing demand. It enters the model in the housing equation (1) as discussed above. The formal specification of PAYO is given below in Section V.

(9) *Aggregate Payments.* Whereas PAYO is the size of the initial payment of a standard mortgage, PAY is an aggregate variable for the total amount of payments made on mortgages during each period. It is used in the model as the basis for calculating INT and REP, its two constituent parts. The effect of alternative mortgage contracts on PAY is discussed in Section III and formulas are given in Section V.

(10) *Mortgage Interest Income.* INT is necessary in the model in order to calculate the reserve transfers of SLAs. It is currently used to simulate actual experience under conventional mortgages, and thus it has to be changed, in the manner described in Section III and V below, for alternative mortgage instruments.

(11) *Mortgage Repayments.* The MPS econometric model incorporates mortgage repayments in a structural way. On the supply side, the "recyling" of repayments take some time, so that an increase in repayments at least temporarily depresses net mortgage supply. Similarly, an increase in repayments depresses net mortgage demand, and this effect continues into the steady state on the grounds that mortgage borrowers rarely adjust their repayment pattern once it is initially set. The variable will be of some importance in the simulations since the timing of repayments depends directly on the conditions of the mortgage contract. The formal specification of REP is discussed below in Section V.

B. *General Points on Simulation Strategy*

(1) *Initial Conditions and Phasing-in of New Instruments.* The simulations were run from a point early in the 1960s, specifically 1962:I, through the latest possible quarter, specifically 1973:IV. The initial conditions for such simulations were necessarily those of a conventional mortgage environment. Consequently, the simulations show the dynamic

effects of introducing the new instruments to portfolios initially based on conventional mortgages. By the end of the simulation period, however, lenders hold almost entirely new instruments since the stock of initial conventional mortgages is almost fully repaid. This would appear an advantageous situation since one observes both the dynamics of transition in the early years and then the new instrument equilibrium in the later years.

(2) *One Instrument at a Time.* We have simulated the effect of each new instrument by allowing it alone in the market during the simulation period. An alternative procedure would be to allow two or more instruments to exist together in the market, with borrowers able to choose among them. We feel, moreover, as a matter of policy that conventional mortgages should co-exist with the new mortgage instrument(s). But, at this point, both in terms of gaining experience with simulating new instruments and in terms of interpreting the results, a regime of one contract at a time was followed.

(3) *No Innovation in Time Deposit Markets.* For similar reasons, the simulations assume no fundamental changes in the nature of the time deposit contract. For example, although as a matter of policy we would be inclined to consider seriously the possibility of indexing time deposits, it was felt we should first simulate and isolate the effects of the new mortgage instruments. Also, it should be stressed that we do allow for any changes in intermediary deposit-rate setting that should result from the introduction of new mortgage instruments.

(4) *Partial Equilibrium Simulations.* One advantage of using a large-scale econometric model, like the MPS model, to simulate the alternative mortgage instruments is that it allows one to calculate the full general equilibrium effects of the innovations. However, in doing so one introduces a variety of complications, including the determination of the proper role for monetary policy in such a setting. Due to time limitations, we have not yet been able to carry out such general equilibrium simulations, and thus this is on the agenda for future research. Instead, the simulations reported here allow for the full interaction of only three sectors of the MPS model — the mortgage, savings deposit, and housing sectors — as summarized above in equations (II.1) to (II.11). The rest of the model was treated as exogenous and fixed for the purposes of the simulations.

(5) *Regulation Q Ceilings.* The mortgage instrument innovations considered here are appropriately viewed as alternatives to a regime of Regulation Q ceilings. In other words, a major objective of the simulations is to evaluate how much better things would have been if new instruments had replaced deposit-rate ceilings over recent historical periods. Consequently, this would imply that the mortgage instrument simulations should be carried out without deposit-rate ceiling constraints on deposit-rate setting. A dilemma will arise, however, if the combination of removing the deposit-rate ceilings and adding the new mortgage contract does not simulate an improvement in the status of SLAs. The dilemma is that the model will continue to function normally in such a situation,

whereas, in reality, the mortgage and housing industries would be seriously disrupted were the SLAs to go out of business. Fortunately, the model generates values for reserve transfers, and therefore for each simulation we compare the reserve transfer being generated by the system with the reserve transfer observed with deposit-rate ceilings. Assuming the transfers to reserves with deposit-rate ceilings were near the minimum amount acceptable (without disrupting the industry), a condition for a feasible instrument innovation is that the simulated amounts exceed the observed minimum. In essentially all cases we do find an improvement in reserve transfers, and thus this magnitude is important only in comparing simulations.

(6) *Treatment of Individual Lenders.* The current MPS mortgage sector structurally distinguishes four private mortgage lenders — SLAs, MSBs, CBs, and LICs — and also includes government-supplied mortgages (FNMA et al.) in the total mortgage supply. This separation will be continued in the simulations. The following points should be noted:

- Government-supplied mortgages are treated as exogenously determined at their historical levels. Within the model, it is straightforward to consider changes in these policy variables, but time limitations indicated these should be evaluated in later work.
- It is assumed that all intermediaries (including the government agencies) issue the new mortgage instrument, given that only one mortgage contract will be allowed in the market in each simulation. In reality, of course, we anticipate a multi-contract regime will evolve and that certain lenders may prefer certain contracts (in particular, insurance companies may continue to prefer fixed interest-rate, long-term contracts). Again, however, simulations of multi-contract regimes must be on the agenda for further work.
- The variables REP and INT cannot be calculated for all the intermediaries. REP is not included in the model for CBs since data on commercial bank repayments are available for only the most recent periods. This should not have an important bearing on the results. INT is explicitly calculated in the model for only SLAs. Since there is no causal feedback from INT to the rest of the model, the simulation results are not affected by this. INT, however, is a variable of interest by itself, and the case of SLAs should serve as a good indicator of the status of the other intermediaries.

III. RESULTS OF THE SIMULATIONS

A. *Simulations of Standard Mortgage Contracts With and Without Deposit-Rate Ceilings*

A useful starting point is to show how the MPS model traces the historical conditions under which all mortgage contracts were standard instruments and under which deposit-rate ceilings acted as constraints at times on the deposit-rate setting of the intermediaries. Table 1A shows the actual historical values for ten variables of interest, and Table 1B shows the corresponding values simulated by the model. Since the same format is used in almost all the tables below, it is important to be clear on the arrangement. The definitions of variable symbols are:

RSL	deposit rate of savings and loan associations (not more than the deposit-rate ceiling when the ceiling is enforced as a binding constraint)
RM	mortgage interest rate on standard mortgage instruments
DESL	total savings deposits at savings and loan associations
MOST	total mortgage portfolios of savings and loan associations
MTotal	total mortgage portfolio of SLAs, CBs, MSBs and LICs.
MINT	mortgage interest income on savings and loan association mortgage portfolios
DINT	deposit interest paid by savings and loan associations to depositors
TRANSFERS	funds available and transferred to reserve and surplus accounts of savings and loan associations
RESERVES	the accumulated sum of transfers by savings and loan associations
EH$	investment in residential housing (National Income Accounts concept)
KH1	accumulated stock of single-family dwellings in constant dollars
HS1$	nominal value of single-family housing starts — quarterly rate

All interest rates are measured in percentage points. All values are in billions of current dollars unless otherwise noted. All flow variables except HS1$ are at annual rates.

The columns in the tables give the relevant data for specific points in actual time: 1965:IV, 1966:IV, and so on through 1973:IV. The computer simulation results, in fact, are available for each quarter from the beginning of our simulation period in 1962:I through the end of the period in 1973:IV. We have presented the results for only the last quarter of each year beginning in 1965 to simplify the presentation. In particular, there is relatively little of interest before 1965 in the simulations, and after that the fourth quarter of each year generally hits the quarters of major interest such as 1966:IV and 1969:IV.

A comparison of the historical values of Table 1A and the simulated values of Table 1B gives an indication of how well the model is fitting. For most of the variables, and for almost all the time, it can be seen the fit to history is remarkably close. Not to overstate the result, however, it

Table 1

STANDARD MORTGAGES WITH DEPOSIT-RATE CEILINGS

A. Historical Values (Levels)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	4.34	4.78	4.96	5.16	5.25	6.00	6.00	6.00	6.50
RM	5.95	6.72	6.66	7.35	8.38	8.44	7.82	7.73	8.78
DESL	110.40	114.00	124.60	132.00	135.90	146.80	174.90	207.70	228.10
MOSL	110.30	114.10	121.60	130.90	140.40	150.60	174.60	206.70	235.50
MINT	6.15	6.63	6.95	7.60	8.45	9.31	10.86	12.99	15.46
DINT	4.49	4.99	5.59	6.01	6.45	7.19	8.60	10.21	12.04
TRANSFERS	0.82	0.65	0.61	0.87	1.05	0.90	1.29	1.73	1.85
RESERVES	8.70	9.35	9.96	10.83	11.88	12.78	14.07	15.80	17.65
EH$	27.40	22.10	28.80	31.40	30.90	33.80	47.50	56.90	54.00
KHI	453.90	461.90	468.20	476.50	484.00	489.20	499.00	512.10	524.60

B. Simulation with Deposit-Rate Ceilings (Levels)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	4.43	4.70	4.90	5.25	5.25	6.00	6.00	5.98	6.33
RM	5.97	6.57	6.88	7.27	8.22	8.87	8.03	7.68	8.20
DESL	109.60	114.30	125.00	133.80	133.40	138.10	163.90	190.20	199.90
MOSL	109.50	114.10	122.70	132.30	135.40	134.70	158.80	189.10	205.00
MTOTAL	263.20	279.80	300.40	322.20	330.70	332.60	387.00	458.30	500.50
MINT	6.25	6.60	7.25	8.04	8.42	8.52	10.70	13.21	14.64
DINT	4.70	5.18	5.78	6.40	6.39	7.71	8.63	9.93	10.99
TRANSFERS	0.66	0.45	0.81	0.91	0.65	0.28	1.44	2.12	1.73
RESERVES	8.72	9.23	10.00	10.92	11.70	11.74	12.91	14.90	16.73
EH$	29.10	25.90	30.00	31.90	31.20	31.90	51.80	55.20	61.00
KHI	453.30	461.60	468.40	476.50	483.80	489.10	497.70	510.30	525.70
HS1$	3.95	3.16	4.08	4.24	3.74	4.02	5.89	7.78	8.78

should be stressed that Regulation Q ceilings constrain deposit rates over much of this period, and that the simulations treat most of the MPS model — all except the mortgage, saving deposits, and housing sectors — as exogenous. Also, there are some deviations of note. For example, starting in 1969, deposit levels (and therefore mortgage levels) for SLAs grow at a much slower pace than the actual history. Similarly, the flow variables such as TRANSFERS and EH$ sometimes have rather large percentage deviations from history; the worst of these, for example, appears in 1973:IV when the simulation value for EH$ exceeds the historical value by $7.0 billion (at annual rates).

Turning next to Table 2, we show results of simulations still with standard mortgage contracts, but now without the existence of binding deposit-rate ceilings. Table 2A shows the simulated levels of the variables, and thus can be directly compared with Table 1B. Alternatively, in Table 2B, the same results are tabulated in deviations form by subtracting the results of Table 1B (with deposit-rate ceilings) from the results of Table 2A (without deposit-rate ceilings). (Here and below comparisons are always made between two simulation results, and not against the actual history, since we have seen the model does deviate from history at times and this washes out only when two simulations are compared).

We will not go into the results on the removal of deposit-rate ceilings in depth since a more thorough study of essentially the same data is available in Jaffee (1973). The main points, however, are easily noted. It is clear that removing the ceilings has practically no effect in the model before 1969:IV. The reason is that, at least within the model, the ceilings were not found to be significantly binding on the rate-setting of the relevant institutions until 1969. In particular, ceilings were imposed on SLAs after the 1966 credit crunch, so it is not surprising that their removal has no effect during this period. Starting in 1969:IV, however, there is more action, and in particular the deposit rate of SLAs is simulated to increase by 68 basis points, reflecting the effect of removing the ceilings.

Turning to the deposits of SLAs (DESL), one finds positive increments between 1969 and 1971, and then negative increments in 1972 and 1973. This result is basically the sum of two effects. In the first set of years, the SLAs are simulated to raise their deposit rates rather strongly upon the removal of the ceilings, while the commercial banks (not shown in the table) respond much more slowly. Thus the SLAs are able both to attract deposits from the capital markets and to hold more than their own in competition with the commercial banks. In the last two years, in contrast, the commercial banks raise their deposit rate considerably more than the SLAs with the result that the SLAs lose deposits compared to the baseline with deposit-rate ceilings. In fact, the loss of deposits for the SLAs would have been worse were it not that the average level of deposit rates is considerably higher without the ceilings, with the effect that the depository intermediaries in aggregate attract deposits from the capital markets. Also note that the extent to which commercial banks would

Table 2

STANDARD MORTGAGES WITHOUT DEPOSIT-RATE CEILINGS

A. Simulation Without Deposit-Rate Ceilings (Levels)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	4.37	4.70	4.90	5.28	5.93	6.53	6.55	6.26	6.48
RM	5.97	6.57	6.88	7.27	8.15	8.74	8.50	7.70	8.20
DESL	109.60	114.30	124.90	133.80	137.70	149.10	169.20	189.40	195.70
MOSL	109.40	114.10	122.70	132.30	138.30	146.20	165.80	188.00	201.30
MTOTAL	263.00	279.80	300.40	322.20	334.80	348.90	399.80	466.60	508.50
MINT	6.25	6.60	7.25	8.04	8.65	9.50	11.29	13.17	14.39
DINT	4.70	5.18	5.78	6.44	7.45	9.05	9.73	10.35	11.01
TRANSFERS	0.66	0.45	0.81	0.89	0.20	0.01	0.82	1.78	1.32
RESERVES	8.72	9.22	10.01	10.91	11.40	11.35	12.03	13.53	15.02
EH$	29.00	25.90	30.00	31.90	31.80	33.10	47.20	55.30	61.20
KH1	453.30	461.60	468.40	476.50	483.80	489.40	498.00	510.50	525.80
HS1$	3.95	3.16	4.08	4.29	3.80	4.04	5.88	7.73	8.72

B. Simulation Without Deposit-Rate Ceilings (Deviations: 2A-1B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	-0.06	0.00	0.00	0.03	0.68	0.53	0.55	0.28	0.15
RM	0.00	0.00	0.00	0.00	-0.07	-0.13	-0.03	0.02	0.00
DESL	0.00	0.00	-0.10	0.00	4.30	11.00	5.30	-0.80	-4.20
MOSL	-0.10	0.00	0.00	0.00	2.90	11.50	7.00	-1.10	-3.70
MTOTAL	-0.20	0.00	0.00	0.00	4.10	16.30	12.80	8.30	8.00
MINT	0.00	0.00	0.00	0.00	0.23	0.98	0.59	-0.04	-0.25
DINT	0.00	0.00	0.00	0.04	1.06	1.34	1.10	0.42	0.02
TRANSFERS	0.00	0.00	0.00	-0.02	-0.45	-0.27	-0.62	-0.38	-0.41
RESERVES	0.00	-0.01	0.01	-0.01	-0.30	-0.39	-0.88	-1.37	-1.71
EH$	-0.10	0.00	0.00	0.00	0.60	1.20	-4.60	0.10	0.20
KH1	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.20	0.10
HS1$	0.00	0.00	0.00	0.00	0.06	0.02	-0.01	-0.05	-0.08

compete with SLAs for deposits were Regulation Q ceilings to be removed has been a question of considerable debate. The simulations presented here and below assume commercial bank competition of the type last observed in 1967 before the onset of binding deposit-rate ceilings. It is possible, however, that were the ceilings removed today, then commercial banks might compete much more strongly, implying the possibility of more negative results for SLA deposit flows.

A second point of primary note in Table 2 concerns how the SLAs are simulated to do in terms of reserves and transfers of reserves without the protection of deposit-rate ceilings. Looking at the variable RESERVES for 1973:IV, we find that the SLAs accumulate approximately $1.71 billion less in reserves when Regulation Q protection is removed. So the simulations do show some protection for the SLAs from deposit-rate ceilings. We will not consider here, however, whether this magnitude is sufficiently large to make a case for the ceilings (see Jaffee (1973) for an extended discussion including the appraisal for alternative degrees of commercial bank competition).

It is useful to consider the results for housing from removing the deposit-rate ceilings. Looking at the stock of housing KH1 in 1973:IV the final effect over the full simulation is a negligible $0.1 billion (compared to the final level of about $525 billion). In other words the results indicate that the deposit-rate ceilings were essentially neutral over the period with respect to housing. Moreover, it is noteworthy that the removal of the ceilings actually stimulated housing in the low investment quarter of 1969:IV, while it depressed housing in the rather strong quarter of 1971:IV. Thus, it would appear that cyclically, the ceilings were actually slightly destablizing in their effects on housing investment (for a more complete analysis of the effects of ceilings on housing see Fair and Jaffee (1972)).

Finally, examination of the stocks of mortgage holdings of all intermediaries and those of savings and loan associations alone indicates that proportionate holdings change. This changing pattern of mortgage stock portfolios of the various intermediaries results from changing patterns of deposit rates, now free of ceiling constraints, which lead to different patterns of deposit flows and consequently mortgage holdings. It is possible for SLA holdings to move quite differently from the total stock. Indeed, this phenomenon is found to be important in interpreting some of the simulations reported below.

B. *Graduated-Payment (GP) Mortgages*

GP mortgages are the first class of alternative mortgage instruments that we consider. GP mortgages differ from standard mortgages in that the payment made each period grows at a rate set in the contract. Thus, if the first payment were say $100 and the graduation rate were 5 percent, then the second payment would be $105. Otherwise, GP mortgages are the same as standard mortgages in terms of fixed interest rate, fixed maturity, and the accounting whereby interest is subtracted from the payment to determine the repayment. The main advantage of GP mortgages is that they allow the initial payment (PAYO) to be lower than the payment on an equivalent standard mortgage (this lower initial payment is balanced, of course, by higher payments over the later life of the mortgage due to the graduation).

Since GP mortages reduce PAYO, they should stimulate housing investment by relieving the cash flow constraint of meeting the first payment (see discussion above). On the other hand, one would expect no more than secondary effects from GP mortgages on SLAs. There are no direct effects on SLAs in that the mortgage contract continues with a fixed-rate feature. The secondary effects occur through a mechanism whereby increased housing demand generates increased mortgage demand, and therefore there should be upward pressure on the mortgage rate with a positive impact on SLA reserve transfers. Also, it can be anticipated that repayments of mortgages will decline, at least in the early years of the simulation, since the reduction in the payment rate will be reflected in a reduction in the repayment rate (interest is always subtracted from the payment first). Finally, it could be expected that the cyclical variation of housing investment (as distinct from the level) is unlikely to be significantly affected. In particular, GP mortgages would offer no real solution to the SLA problem of disintermediation which appears as an important factor determining the housing downturns in, for example, 1966, 1969-1970, and 1973-74. However, if the demand effects emphasized throughout this volume are important contributors to cyclical variation, appropriate graduation may ameliorate the variation.

To see how the MPS model must be modified for GP mortgages, it is useful to refer to the model of Section II.A. It can be seen that PAYO (equation II.8) and therefore PAY, REP, and INT (equations II.9, II.10, and II.11) must all be suitably modified to account for the payments schedule of a GP mortgage. The precise formulas used for this purpose are given in Section V. The remainder of the model, however, is adequate in its present form, in the sense that no functions will be *shifted* by the introduction of GP mortgages. For example, the KH$ values (II.1) will vary with PAYO and any induced changes in RM and RP, but the equation will not shift due to GP mortgages. Similarly, there will be induced movements along the MD and MS schedules, but the schedules themselves do not shift. This ease of implementation is due to the fact that GP mortgages are the same as conventional mortgages in all respects except for the graduation.

We have distinguished two alternative simulation schemes for determining the rate of graduation on GP mortgages: *fixed graduation* and *new issue graduation*. Fixed graduation means that the amount of graduation is fixed once and for all at some initial value. The graduation is thus constant over the life of each mortgage contract as well as over time as new mortgages are issued. New issue graduation retains the feature that the graduation is constant over the life of each mortgage contract, but allows the degree of graduation associated with each "vintage" of newly issued mortgages to vary. There is also a third possibility for graduation, namely that the graduation is allowed to vary even over the life of each mortgage contract. This *outstanding stock graduation* is closely related to price-level indexed mortgages and is simulated as the constant-payment sector variable-rate mortgage in IN.1 below.

(1) *Fixed Graduation (GP.1).* For fixed graduation GP mortgages, the rate of graduation must be set once and for all as a constant. For our simulations, the value was the average rate of inflation over the simulation sample, 1962 to 1973. Alternative graduation rates could also have been tested, of course, but the average rate of inflation serves as a useful benchmark for comparison with the new issue graduation to be discussed below. Also, the inflation rate is a natural measure for the graduation rate since this ensures that real payments over the life of the mortgage will be constant (i.e., the nominal payments will rise with the inflation rate). Of course, this situation is somewhat idealized in that in practice one could use only an *expected* inflation rate, whereas in the experiment here we have the benefit of hindsight and use the realized inflation rate.

The results of simulating the fixed graduation GP mortgages are shown in Table 3. The levels are shown in Table 3A, and it is to be stressed that deposit-rate ceilings were not allowed to be binding here (or in any of the results that follow). In Table 3B we show the deviations between the simulation values of Table 3A and the simulated history with deposit-rate ceilings presented above as Table 1B. Consequently, the results of Table 3B show the net outcome of both removing deposit-rate ceilings and introducing the GP mortgages. The one exception is that we also show the variable RSL (a) which is the deviation calculated against the no deposit-rate ceilings simulation of Table 2A. This is introduced so that the change in RSL induced by the GP mortgage alone can be seen clearly.

Checking first for the effect of GP mortgages on housing investment, it can be seen that by the end of the simulation (1973:IV), the stock of real housing has risen by \$9.3 billion. This, it should be recalled based on the conservative value for α of .25. Had we chosen a larger value, say $\alpha =$ .75, then the result on housing would also have approximately tripled. In any case, it appears that we do confirm that GP mortgages can provide an important stimulus to housing demand.

We can next check for the effect on SLAs, using as the measure their accumulated reserves. By the end of the simulation their reserves have actually declined relative to the history simulation by \$3.88 billion. Referring back to Table 2B, we find that \$1.71 billion of this decline can be attributed to the removal of the deposit-rate ceilings, which leaves over \$2 billion of the decline to be attributed to introduction of the GP mortgages. This might seem peculiar in that we had noted above that the secondary effects on SLAs should be positive, albeit perhaps weak. In fact, moreover, the secondary effects do work in the indicated direction. The

Table 3

GRADUATED-PAYMENT MORTGAGES

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
A. Simulation GP.1: Fixed Graduation Rate (Levels)									
RSL	4.50	4.76	4.96	5.33	5.99	6.57	6.61	6.36	6.60
RM	6.08	6.67	6.98	7.37	8.23	8.80	8.16	7.91	8.39
DESL	110.90	115.60	126.10	135.40	140.50	152.40	172.60	193.40	201.80
MOSL	110.90	115.50	124.20	134.00	141.00	149.90	170.30	192.80	207.20
MTOTAL	268.10	285.20	306.50	329.20	343.30	358.50	412.00	482.70	528.20
MINT	6.28	6.68	7.17	7.94	8.70	9.41	11.09	12.95	14.48
DINT	4.83	5.31	5.90	6.59	7.68	9.31	10.02	10.75	11.57
TRANSFERS	0.57	0.39	0.62	0.70	0.09	-0.28	0.44	1.30	1.04
RESERVES	8.41	8.85	9.49	10.21	10.55	10.31	10.63	11.69	12.85
EH$	29.80	26.60	30.80	33.00	33.00	34.20	42.50	56.10	61.00
KH1	457.10	466.30	473.80	482.60	490.80	496.90	506.10	519.10	535.00
HS1$	4.20	3.35	4.31	4.53	4.04	4.27	6.12	7.98	9.08
B. Simulation GP.1: Deviations (3A-1B)									
RSL	0.07	0.06	0.06	0.08	0.74	0.57	0.61	0.38	0.27
RSL[1]	0.13	0.06	0.06	0.05	0.06	0.04	0.06	0.10	0.12
RM	0.11	0.10	0.10	0.10	0.01	-0.07	0.13	0.23	0.19
DESL	1.30	1.30	1.10	-1.60	7.10	14.30	8.70	3.20	1.90
MOSL	1.40	1.40	1.50	1.70	5.60	15.20	11.50	3.70	2.20
MTOTAL	4.90	5.40	6.10	7.00	12.60	25.90	25.00	24.40	27.70
MINT	0.03	0.08	-0.08	-0.10	0.28	0.89	0.39	-0.26	-0.16
DINT	0.13	0.13	0.12	0.19	1.29	1.60	1.39	0.82	0.58
TRANSFERS	-0.09	-0.06	-0.19	-0.21	-0.56	-0.56	-1.00	-0.82	-0.69
RESERVES	-0.31	-0.38	-0.51	-0.71	-1.15	-1.43	-2.28	-3.21	-3.88
EH$	0.70	0.70	0.80	1.10	1.80	2.30	-3.30	0.90	0.00
KH1	3.80	4.70	5.40	6.10	7.00	7.80	8.40	8.80	9.30
HS1$	0.25	0.19	0.23	0.29	0.30	0.25	0.23	0.20	0.30
Addendum: GP.2: New Issues Graduation (Levels)									
EH$	29.10	26.70	30.70	33.70	34.20	35.00	48.80	55.30	65.90
KH1	454.10	463.10	470.60	479.80	488.60	495.60	505.20	518.00	534.90

[1] Deviation calculated against "no Regulation Q" value of Table 2A.

increase in housing demand does stimulate mortgage demand, with the result that the mortgage rate is generally higher in the simulation (19 basis points at the end) and outstanding mortgages are also higher ($2.2 billion at the end).

What has happened to hurt the SLAs, is that the graduated payments have lengthened the average age of a mortgage in the SLA portfolio. In a stationary economy this effect would disappear, but here in a growing economy more and more mortgages are issued at the low PAYO values and the SLAs never catch up although each vintage of mortgages is graduated. This impacts on SLA transfers since, over the simulation period, interest rates are generally rising, and thus a shift to older mortgages also means a shift toward lower-yielding mortgages.

Effects of this sort indicate both why simulations can be instructive and why they must be interpreted with caution. In particular, had we simulated a history in which mortgage rates were generally declining, then the implications for GP mortgages would have been just reversed. That is, the aging effect on the mortgage portfolio would have been a net benefit to the SLAs since a larger part of the portfolio would have had high interest rates.

(2) *New-Issue Graduation (GP.2).* For comparison, we now turn to the new-issue GP mortgage in which the graduation rate is changed period by period on newly issued mortgages. Specifically, for each vintage of mortgages we set the graduation rate equal to the average inflation rate observed over the previous four quarters. As indicated above, once the graduation rate is set for a vintage, the rate is then retained for the rest of the life of the mortgage. Otherwise, the mechanics of implementing GP.2 are essentially the same as GP.1.

One would expect the basic response of the system to be roughly the same for GP.1 and GP.2. Our simulation results bear this out, and in fact the levels are so close that we have not presented a separate table for GP.2. The one possible difference, however, is that new-issue graduation might be expected to stabilize housing in terms of cyclical variations more than fixed graduation. This would occur because the graduation rate on newly issued mortgages is increased under GP.2, and hence PAYO is decreased, in periods of high inflation, which have tended to coincide with low levels of housing activity.

One empirical measure of this effect can be seen in the bottom of Table 3 where we have shown the simulation levels for housing investment and the housing stock generated by the new-issue graduation. Comparing this with the levels of the same variables generated by the fixed graduation in Table 3A, one does find some sign of stabilization due to the new-issue graduation. For example, one finds some sign of stimulus in the low investment quarters of 1966:IV and 1969:IV. An alternative measure of this effect is shown in Table 9 below. To generate the values of Table 9, we regressed the simulated values of real housing investment against a constant and a linear time trend, and then tabulated the resulting standard errors of estimate. These values then represent a measure of the deviations in housing investment around the time trend. From Table 9, it can be seen that GP mortgages tend to stabilize housing relative to the actual historical values and relative to the simulated paths with conventional mortgages and either with or without deposit-rate ceilings. Moreover, the path with new-issue graduation (GP.2) fluctuates less than the path with fixed graduation (GP.1).

(3) *Default and Risk on GP mortgages.* It has been argued that while GP mortgages may serve some purpose in stimulating housing demand, they are unlikely to be accepted by lenders because GP mortgages would have a higher rate of default. The higher rate of default is based on the contention that the critical period for default occurs during the first years of a mortgage, and GP mortgages have a lower amortization rate just at this time, due to the low value of PAYO. Factually, this is all correct, but it overlooks the fact that GP mortgages have been recommended for use primarily in periods of inflation. In periods of inflation, the collateral value of houses will generally be rising, and thus, although the loan may be slowly amortized, the collateral itself will be rising in value. Indeed, if the graduation rate is set equal to the inflation rate, and if housing appreciates with the general price level, then the effective loan-to-value ratio on a GP mortgage will have the same time path as would a standard mortgage contract in a period of no inflation. This path, of course, will have a higher loan-to-value ratio than would a standard mortgage in an inflationary period, but this is a positive feature, not a drawback of GP mortgages.

C. *Variable-Rate (VR) Mortgages*

The major issue with respect to VR mortgages is to balance the value of a fluctuating short-term yield to the lender against the cost of a fluctuating yield to the borrower. The advantage to the lender is that his liabilities are mainly short term, and therefore his asset-liability maturity balance is enhanced the shorter the term of the asset. The disadvantage of a fluctuating yield to the borrower can take two forms: the cost of fluctuations *per se* given that the borrower is risk averse; and the possibility of a cash flow crisis should the cost rise early in the life of the contract. The expected cost of the contract over the full maturity, however, is not itself a function of how much the yield fluctuates. That is, given an expectations theory of the term structure, the *ex ante* cost of a mortgage contract corrected for liquidity preference should be the same regardless of whether it is a fixed long-term rate or a series of fluctuating short-term rates. This does not deny that specific individuals, with expectations that differ from the market's, may have a preference for the long or short versions.

A variety of techniques have been suggested as the means for finding a compromise that allows the lender the advantages of a fluctuating yield while protecting the borrower from the more extreme possibilities. One set of techniques limits the frequency and/or absolute amount by which the yield is allowed to fluctuate. In our simulations we have not used such "dampers," but it is possible that future simulations could experiment with such possibilities.

A more important determinant of the fluctuations inherent in a VR mortgage is the maturity of the instrument to which it is pegged. As usually construed, the pegging mechanism works by having the VR mortgage issued at some initial rate, and then over time adding to or subtracting from this rate the fluctuations in the pegging rate. This means that different "vintages" of borrowers may pay different rates during the same period, due to differences in the original "spread" between the mortgage rate and the "pegging" rate. It also means that it is likely that cases will arise in which "old" borrowers will be paying rates higher than the current new-issue rate. Consequently, in order to avoid an arbitrage flow of funds into new contracts at such times, it is generally considered important that prepayment costs be enforced to eliminate such flows.

The basic scheme studied in our simulations can be interpreted as one in which the VR mortgage is pegged to the new-issue rate itself. This is denoted as VR.1 and has a variety of useful features:

(i) All borrowers, regardless of the time they originate the mortgage, will pay the same rate under this scheme. This is true since in each period a borrower of an existing VR mortgage has his yield updated by exactly the change in the new-issue rate.

(ii) An immediate implication of (i) is that neither the borrower nor the lender has any incentive to arbitrage between existing and newly issued VR mortgages. Moreover, there will then be no need to create prepayment costs simply in order to stop such arbitrage. This is important since prepayment costs would also stop arbitrage between VR mortgages and conventional mortgages, assuming both do exist at the same time. Arbitrage between VR and conventional mortgages should not be discouraged. but prepayment costs would have this effect.

(iii) A further implication of (i) is that the rate on VR mortgages is necessarily that of a short-term security with maturity equal to the interval between rate changes. This is true because the yield on an existing VR mortgage is set equal to the newly determined new-issue rate in each decision period. This is advantageous to the lender, but perhaps disadvantageous to the borrower, as discussed above.

(iv) A further feature of our plan is that the VR rate can be interpreted as using the time deposit rate as the pegging rate. This is important since it allows the borrower to interpret the rate he pays each period as equal to that period's time deposit rate plus a suitable markup to cover the costs of intermediation. This is implemented in simulation VR.1A below.

A possible disadvantage of our plan is that the period-by-period cost to the borrower will fluctuate in the manner of a short-term rate. Thus, it would be desirable, at least for purposes of comparison, to simulate VR mortgages that try to correct for this. We, in fact, have considered several alternatives. First, under simulation VR.2A, we have experimented with an instrument developed by the MIT study and termed a "dual-rate" VRM. The basic idea is that while the interest payments are allowed to fluctuate each period with the short-term rate, the total payments are stabilized by being pegged to a long-term rate. This, of course, necessarily implies that the principal repayment acts as the residual from period to period. A potential problem with the plan, consequently, is that a series of low repayments will accumulate such that "balloon" payments will be required toward the end if the short rate is greater than the long mortgage rate over an extended time period. These results which are developed in Chapter 2 of the MIT mortgage study indicate this is not a serious problem, however, and our simulations below tend to confirm this.

A second alternative to moderate the variations in the interest rate on a VR mortgage is to peg the interest rate to a longer maturity. For example, the Federal Home Loan Bank Board (FHLBB) has proposed pegging the VR rate to either a three-to-five year government bond rate or to the new-issue rate on conventional mortgages (assuming conventional mortgages continue to be issued along with VR mortgages). In simulation VR.3 below we report the results of tests on the FHLBB proposal where the rate on the VR mortgages is tied to the new-issue rate on conventional mortgages.

A third alternative to correct for the variations in the interest rate is to mix a VR mortgage contract with some type of graduated-payment mechanism. In this way, every time the VR rate rises, the rate of graduation may also be increased, thus eliminating or at least reducing, the cash flow impact of the change. Again a variety of schemes have been proposed and these are discussed and simulated in Section III.D below.

(1) *The Basic, Short-Term VRM (VR.1).* The key feature of our VR.1 plan is that the interest rate on all outstanding variable-rate mortgages (VRMs) would be a short-term rate appropriate for one-period mortgage loans. We denote this rate as RMS, and since the model is quarterly it can be interpreted as the one-quarter mortgage rate. The problem is to generate this value within the model. In principle, of course, the rate would be determined through a mechanism of demand and supply in the mortgage market, and at least to a first approximation this is what we have done. The details of the method are given in Section V.

Even though we have generated the short-term rate RMS, there remain important questions as to where this rate will apply in the model. Specifically, RMS is taken as the relevant rate in determining the size of the initial payment (PAYO), in determining the amount of interest payments to SLAs (INT), and as the base rate for the deposit-rate setting of SLAs. Similarly, RMS is the relevant rate in determining the demand and supply of mortgages (MD and MS). Thus, in terms of the model presented in Section II.A, the functions just noted will all depend on RMS for the VR.1 simulations. At one point in the model the demand for housing, a long-term mortgage rate concept is more valid. This arises because housing is a durable asset, and thus an investor would be concerned with the long-term cost of capital, not the current one-period rate, RMS. In order to determine such a rate, one must specify how an investor would translate the observed short-term rate RMS into a long-term equivalent. We denote this long-term equivalent as RM, which is the interest rate on conventional mortgages, since our conversion technique amounts to making the long-term equivalent the same as the conventional mortgage rate. Specifically, our conversion has the form: RM = RMS + (RCB-RCP). RCB is the long-term corporate bond rate, and RCP is the four-to-six month prime commercial paper rate, so the formula indicates that investors would translate the short-term RMS into the long-term equivalent RM using the same term-structure relationship that holds for comparable securities in the corporate securities market. The formal details of this adjustment, and the other specification for VR.1 are given in Section V.

The results for our simulations of VR.1 are presented in Table 4. Table 4A shows the levels of the variables, while Table 4B shows the deviations against the simulation of history with Regulation Q ceilings. It should be noted in Table 4A that RMS is the short-term mortgage rate applicable on all VRM contracts, while RM is the long-term equivalent used for the housing investment decision. In Table 4B the deviations for both RMS and RM are calculated against the simulation value for RM in the history simulation of Table 1B. For RMS this means that the deviation gives the total change in the rate in going from a conventional to a VR mortgage, including any differences due to the term structure. For RM, the deviation represents the change in the level of interest rates, holding constant the maturity of the contract at its long-term level.

The primary expectation for VR mortgages is that the reserves of SLAs should improve, and our results bear this out. For example, at the end of the simulation reserves are \$.66 billion higher. Moreover, this simulation eliminates deposit-rate ceilings, which themselves have the effect of reducing SLA reserves by \$1.71 billion (see Table 2B), so that the VRM contract by itself contributes a gross gain to reserves of \$2.38 billion. Also, it can be noted that the gain is actually greater in 1970:IV, before the years of 1971 and 1972 in which VRM contracts had a depressing impact on SLA profits. The depressing impact is due to the low level of RMS in those years, which in turn is due to the low level of short-term interest rates in the same years. For example, in 1971:IV, RMS is only 5.93, which is 210 basis points below the standard mortgage rate simulated in the historical baseline. Thus, in total, it appears that VRMs can help SLAs, although with the *caveat* that in periods of sharply ascending term-structure yield curves the reverse can actually occur.

Turning to the housing variables of Table 4, one finds that the net effect at the end of the simulation is a negligible decrease of \$.7 billion in the real stock. This result is the net effect of two forces. One force comes from the effect of VRMs on the PAYO variable. Since the term-structure

Table 4

SHORT-TERM VARIABLE-RATE MORTGAGES I

A. Simulation VR.1: Basic, Short-Term, VRM (Levels)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	4.34	4.82	4.92	5.18	6.07	6.63	5.99	5.10	6.11
RMS	5.98	7.28	6.21	7.05	9.32	7.15	5.93	6.18	9.77
RM	6.12	6.66	6.95	7.33	8.17	8.77	8.20	7.99	8.44
DESL	98.70	104.70	117.20	128.10	136.00	147.60	157.60	163.20	166.70
MOSL	98.70	103.90	115.30	126.10	135.80	145.70	156.60	164.10	169.60
MTOTAL	251.60	268.30	291.50	315.20	332.20	348.60	393.90	451.50	483.60
MINT	5.59	6.58	6.58	8.20	11.24	11.10	9.64	9.14	16.34
DINT	4.15	4.87	5.44	6.05	7.52	9.10	8.28	7.27	8.84
TRANSFERS	0.59	0.84	0.56	1.48	2.46	1.11	0.42	0.70	4.51
RESERVES	8.73	9.41	10.26	11.44	13.21	14.73	14.74	14.97	17.39
EH$	28.50	25.70	30.40	32.20	30.80	32.40	50.10	54.80	52.20
KH1	452.80	460.90	467.70	475.90	483.30	488.70	497.40	510.20	525.00
HS1$	3.87	3.14	4.11	4.27	3.73	4.01	5.87	7.68	8.24

B. Simulation VR.1: Deviations (4A-1B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	-0.09	0.12	0.02	-0.07	0.82	0.63	-0.01	-0.88	-0.22
RSL[1]	-0.03	0.12	0.02	-0.10	0.14	0.10	-0.56	-1.16	-0.37
RMS[2]	0.01	0.71	-0.67	-0.22	1.10	-1.72	-2.10	-1.50	1.57
RM	0.15	0.09	0.07	0.06	-0.05	-0.10	0.17	0.31	0.24
DESL	-10.90	-9.60	-7.80	-5.70	2.60	9.50	-6.30	-27.00	-33.20
MOSL	-10.80	-10.20	-7.40	-6.20	0.40	11.00	-2.20	-25.00	-35.40
MTOTAL	-11.60	-10.60	-8.90	-7.00	1.50	16.00	6.90	-6.80	-16.90
MINT	-0.66	-0.02	-0.67	0.16	2.82	2.58	-1.06	-4.07	1.70
DINT	-0.55	-0.31	-0.34	-0.35	1.13	1.39	-0.35	-2.66	-2.15
TRANSFERS	-0.07	0.39	-0.25	0.57	1.81	0.83	-1.02	-1.42	2.78
RESERVES	0.01	0.18	0.26	0.52	1.51	2.99	1.83	0.07	0.66
EH$	-0.60	-0.20	0.40	0.30	-0.40	0.50	-1.70	-0.40	-8.80
KH1	-0.50	-0.70	-0.70	-0.60	-0.50	-0.40	-0.30	-0.10	-0.70
HS1$	-0.80	-0.02	0.03	0.03	-0.01	-0.01	-0.02	-0.10	-0.54

[1]Deviation calculated against "no Regulation Q" value of Table 2A.

[2]Deviation calculated as RMS value (Table 4A) minus RM value (Table 1B).

yield curve over our sample is generally ascending, the mortgage rate (RMS) applicable on VRMs was generally lower than the rate (RM) applicable to standard mortgages. Consequently, PAYO was generally reduced by the introduction of VRMs, and this helped housing. On the other hand, deposit rates are also a function of RMS, and thus lower values for RMS will translate into smaller flows of funds into the lenders which is seen clearly in Table 4. This in turn reduces the supply of mortgage funds and creates upward pressure on the mortgage rate.

The downward pressure of RMS on SLA deposit rates is particuarly strong in the last three years of the simulation, and is worthy of further interpretation. Specifically, one of the functions that SLAs have performed over the historical period is sometimes called "term-structure intermediation." That is, SLAs borrow short and lend long. Now to the extent that they can successfully carry out such intermediation, the SLAs will attract deposits in considerable amounts since they are providing a valuable service. In fact, however, we know that in recent years this has proven to be impossible without at least the protection of deposit-rate ceilings. The simulations here show that the SLAs will carry out less intermediation in a world in which they reduce the amount of "term-structure intermediation" that is attempted.

(2) *Short-Term VRM with Deposit-Rate Spread (VR.1A).* As suggested above, it is possible and intriguing to augment our basic, short-term VR mortgage with a feature that ties the short-term rate, RMS, with the short-term deposit rate paid by the thrift institutions. This has been implemented by replacing the deposit-rate equation of the model (equation (II.5) of the simple model above) with the alternative: RD = RMS - c. Here c is interpreted as the required spread between the mortgage rate and the deposit rate for SLAs to cover costs and make adequate transfers to reserves. An equation of this sort has been implemented for each of the depository intermediaries in the model, but with different c coefficients so that the spreads between deposit rates are maintained at the values that would otherwise have been simulated. For SLAs, for example, the spread constant c cannot exceed 150 basis points.

The results of this simulation, in the form of deviations from the historical simulation with deposit-rate ceilings, are shown in Table 5A. These results can be usefully compared with the deviation values of the basic, short-term VR mortgage presented in Table 4B. The main structural difference between the two contracts comes from the fact that the fixed spread condition of VR.1A generally leads to both a higher deposit rate and a lower mortgage rate (RMS). This in turn leads to two main features of the results. First, the accumulated reserves of the SLAs are less under the fixed-spread condition, reflecting the fact that the constraining spread value is somewhat lower than that achieved with the basic VRM (VR.1). Second, the level of deposits with the fixed-spread condition declines much less (or, in fact, rises) compared with the basic, short-term VRM (in which deposits decline considerably by the end of the simulation). This, of course, is the result of the higher deposit rates simulated under the fixed-spread condition.

Table 5

SHORT-TERM VARIABLE-RATE MORTGAGES II

A. Simulation VR.1A: VR.1 With Deposit-Rate Spreads (Deviations from 1B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	0.01	0.97	-0.03	0.22	2.31	0.53	-0.05	-0.88	1.67
RSL[1]	0.07	0.97	-0.03	0.19	1.63	0.00	-0.60	-1.16	1.52
RMS[2]	-0.03	0.60	-0.75	-0.30	0.84	-1.89	-2.17	-1.51	1.30
RM	0.11	-0.02	-0.01	-0.02	-0.31	-0.27	0.10	0.22	-0.03
DESL	-8.10	-1.20	1.90	5.30	27.40	36.40	13.30	-6.30	5.40
MOSL	-8.20	-3.00	2.80	4.40	22.10	39.80	14.80	-4.80	-0.50
MTOTAL	-7.80	-8.00	6.70	12.00	37.70	64.30	52.10	41.40	54.20
MINT	-0.55	0.29	-0.15	0.80	4.16	4.69	0.24	-3.12	4.30
DINT	-0.34	1.00	0.05	0.55	4.70	2.88	0.63	-1.74	3.26
TRANSFERS	-0.14	-0.29	-0.21	0.37	0.40	1.09	-0.94	-1.42	1.22
RESERVES	-0.20	-0.52	-0.51	-0.46	-0.67	0.57	-0.55	-2.34	-3.24
EH$	-0.20	0.60	0.40	0.40	1.00	0.60	-3.70	0.00	-7.10
KH1	-0.40	-0.40	-0.20	-0.10	0.30	0.70	0.90	1.10	0.80
HS1$	-0.05	-0.06	0.05	0.07	0.13	0.02	0.00	-0.05	-0.24

B. Simulation VR.1B: VR.1 With Reserve Constraint (Deviations from 1B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	-0.09	0.24	0.04	0.33	2.23	1.58	-0.17	-0.86	-0.25
RSL[1]	-0.03	0.21	0.04	0.30	1.55	1.05	-0.72	-1.14	-0.40
RMS[2]	0.00	0.70	-0.70	-0.25	0.95	-2.03	-2.22	-1.60	1.49
RM	0.14	0.08	0.04	0.03	-0.20	-0.41	0.05	0.21	0.16
DESL	-9.50	-8.40	-5.30	-2.50	15.20	40.50	21.20	-1.00	-8.90
MOSL	-9.50	-9.00	-4.90	-3.40	10.40	40.40	27.60	0.00	-9.90
MTOTAL	-8.60	-8.40	-3.40	-0.90	18.90	61.40	55.90	43.00	35.40
MINT	-0.59	0.06	-0.56	0.31	3.32	4.23	0.71	-2.81	4.20
DINT	-0.49	-0.14	-0.20	0.28	3.74	4.89	0.88	-1.47	-0.91
TRANSFERS	-0.07	0.31	-0.29	0.25	0.52	-0.32	-0.92	-1.36	3.53
RESERVES	-0.13	0.02	-0.08	0.09	0.34	0.25	-1.08	-2.81	-1.87
EH$	-0.70	-0.30	0.90	0.30	0.50	2.10	-3.40	-0.10	-9.10
KH1	-0.04	-0.60	-0.50	-0.40	-0.10	0.40	0.90	1.10	0.60
HS1$	-0.07	-0.02	0.05	0.05	0.09	0.16	0.00	0.00	-0.62

Addendum: VR.2A; "Dual-Rate" Version of VR.1A (Deviations from 1B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
EH$	-0.20	0.70	0.20	0.30	1.30	0.50	-4.70	-1.60	-6.30
KH1	-1.20	-1.10	-0.80	-0.90	-0.40	0.20	-0.20	-0.90	-1.60

[1]Deviation calculated against "no Regulation Q" value of Table 2A.

[2]Deviation calculated as RMS value (Table 4A) minus RM value (Table 1B).

(3) *"Dual-Rate" VRM with Deposit-Rate Spread (VR.2A).* Simulation VR.2A is the same as simulation VR.1A just discussed, except that the payments made by the borrower are smoothed through a device involving the long-term mortgage rate RM. Specifically, it is assumed here that the changes in payments made by borrowers are based on the rate RM, not RMS, although, in terms of the interest received by the lender, RMS is used. This means, therefore, that when RMS rises relative to RM, a larger proportion of the payment is credited to interest (on the basis of RMS) and a smaller proportion is left for repayment of principal.

The results for VR.2A are very close to those of VR.1A in terms of levels, and we have not provided a separate table. However, at the bottom of Table 5 we show as an addendum, the deviations for the housing variables of VR.2A that are comparable to the values shown in Table 5A for VR.1A. Two points are worth noting. First, the level of housing achieved at the end of the simulation is slightly reduced by the smoothing scheme of VR.2A. This arises because PAYO is based here on RM, not RMS, and RM is generally above RMS in the simulations. Second, some stabilization in housing investment (EH$) is achieved through the smoothing mechanism of VR.2A. This can also be confirmed in Table 9, in that more stable time paths for housing investment are achieved by VR mortgages than by history, and in that the path of VR.2A is similar to the paths for GP mortgages.[1]

(4) *Short-Term VRM with Reserve Constraint (VR.1B).* Another variant of the basic, short-term VRM is achieved by placing a maximum limit on the reserves that can be accumulated by the SLAs. This constraint is motivated by the fact that in simulations to be presented below, in some cases the SLAs are able to accumulate considerable amounts of reserves above the values simulated with history. It was suggested, therefore, that in practice the SLAs would pay these funds out to depositors via higher deposit rates. To maintain comparability with the results to be presented below with this feature, it has been introduced here for the basic, short-term mortgage (VR.1). Specifically, we have taken the reserves accumulated under the historical simulation with deposit-rate ceilings as the baseline (see Table 1B), and forced thrift institutions to pay out any excess to depositors.[2] (The constraint is directly enforced on the SLAs, but

[1]Our results may understate the stabilization power of VR.1 because of the link between RMS and the deposit rate. When RMS rises, deposit rates should also rise, and this should stabilize the flow of housing finance. However, in the model the link between RMS and deposit rates occurs with a long lag; so long, in fact, that a stimulus to housing may occur not during a current trough, but during the next boom. A better specification would eliminate the lag.

[2]The deviations (Table 5.B) are not zero since the initial reserve pay-out leads to different deposit rates and shifting patterns of deposit flows and mortgage holdings and, hence, changes in reserves. No effort was made to adjust by iteration the pay-out procedure to insure it caused actual reserves to trace the history under deposit-rate ceilings exactly. Since we do not know how depository institutions would react to large changes in reserve positions, this is only one of several arbitrary mechanisms that allow the reserves to affect deposit-rate-setting behavior.

is implied for the other depository intermediaries since we retain the spread between deposit rates that would otherwise have been simulated).

The results for this simulation are shown in Table 5B, in the form of deviations from the historical simulation with deposit-rate ceilings. Compared with the basic, short-term VRM (Table 4B), it can be seen that the reserve constraint (Table 5B) has about the same results as the deposit-rate spread (Table 5A). This is not surprising since both of the latter simulations have the effect of reducing the profit margins for SLAs, with the result that reserve transfers are reduced and higher deposit levels are achieved.

(5) *FHLBB VRM with Reserve Constraint (VR.3).* The last of the VRMs to be considered here is a plan similar to that suggested by the Federal Home Loan Bank Board. The main feature is that after the new-issue rate is established, for any given contract, the rate over time is determined by the movements in some pegging rate. The case developed here is where the pegging rate is the long-term mortgage rate RM (standard mortgage rate). It is useful to recall in this context that although standard mortgages do not actually exist in any of our new instrument simulations, we are able to calculate an RM value following the procedure noted above (see also the discussion in Section V).

The main difficulty with implementing this mortgage instrument in the simulations is to determine the appropriate interest rate when the contract is first issued. It can be shown that the new-issue rate would have to fall between the bounds set by RM and RMS. Otherwise, either the lender or the borrower would prefer a standard mortgage instrument. It was not possible, however, to estimate where within these bounds the actual new-issue rate would fall. Consequently we have defined the new-issue mortgage rate by the formula: $RMA = \partial RM + (1-\partial) RMS$. And we have simulated two values for ∂ : .25 and .75. Since RM generally exceeds RMS in our sample period, lenders will generally be better off the higher the value for ∂ they can enforce. It is our guess that the lower value of .25 is a more plausible one for lenders to sell this contract successfully, but there is room for debate.

The results of these simulations are shown in Table 6 in the form of deviations from the historical simulation with deposit-rate ceilings. Table 6A shows the results with $\partial = .25$, and Table 6B shows the result with $\partial = .75$. In both cases the reserve constraint condition, as discussed above for VR.1B, is enforced. This is done since the results without this constraint indicated large reserve accumulations by the SLAs and implausibly small deposit levels. Results similar to those of Table 6 were also obtained when the fixed deposit-rate spread constraint replaced the reserve constraint.

Looking first at the results of Table 6A, the simulation values are very close to those obtained for the basic, short-term VRM with the reserve constraint (Table 5B). The chief difference is that the mortgage interest income of the SLAs (MINT) is less volatile under the FHLBB scheme than it is under the short-term VRM. This arises because the FHLBB instrument is a mix of a short-term and long-term contract, and

Table 6

FHLBB VARIABLE-RATE MORTGAGES

A. Simulation VRM.3: FHLBB VRM With Reserve Constraint; $\partial = .25$

(Deviations from Table 1.B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	-0.09	0.08	0.01	-0.07	1.33	1.59	0.27	-0.67	-0.20
RSL[1]	-0.03	0.08	0.01	-0.10	0.65	1.06	-0.28	-0.95	-0.35
RMS[2]	-0.04	0.68	-0.73	-0.31	0.99	-1.97	-2.39	-1.77	1.39
RM	0.10	0.06	0.01	-0.03	-0.16	-0.35	-0.12	0.04	0.06
DESL	-8.10	-7.60	-6.60	-5.10	6.20	26.30	17.90	-2.30	-8.30
MOSL	-8.10	-8.00	-6.30	-5.60	2.90	25.60	22.20	-0.80	-10.20
MINT	-0.68	-0.30	-0.18	0.05	1.45	3.45	1.87	-0.76	-0.74
DINT	-0.43	-0.26	-0.30	-0.32	1.99	3.89	1.38	-1.22	-0.80
TRANSFERS	-0.20	0.05	0.13	0.43	0.12	-0.09	-0.14	-0.05	-0.03
RESERVES	-0.41	-0.48	-0.45	-0.10	0.13	0.25	0.05	0.00	-0.02
EH$	-1.00	-0.50	2.10	1.80	-1.90	4.50	3.50	-1.10	10.60
KH1	-0.10	-0.30	-0.30	-0.30	-0.10	0.40	0.90	1.40	0.90

B. Simulation VRM.3: FHLBB VRM With Reserve Constraint; $\partial = .75$

(Deviation from Table 1.B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	-0.01	0.04	0.01	0.54	1.47	1.71	0.69	0.07	0.46
RSL[1]	0.05	0.04	0.01	0.51	0.79	1.18	0.14	-0.21	0.31
RMS[2]	-0.08	0.66	-0.73	-0.35	0.92	-2.03	-2.44	-1.80	1.32
RM	0.06	0.04	0.01	-0.07	-0.23	-0.41	-0.17	0.01	-0.01
DESL	-2.60	-2.60	-2.40	-2.60	16.50	37.40	35.40	22.00	18.00
MOSL	-2.50	-2.80	-2.10	1.30	13.50	36.20	38.60	23.40	16.80
MINT	-0.23	0.18	0.25	0.58	2.30	4.32	3.35	1.68	2.03
DINT	-0.12	-0.07	-0.10	0.81	2.81	4.88	3.07	1.27	1.85
TRANSFERS	-0.09	0.24	0.30	0.05	0.12	-0.12	-0.16	0.00	0.01
RESERVES	-0.35	-0.26	-0.04	0.11	0.19	0.31	0.09	0.05	0.11
EH$	-0.70	-0.10	1.10	2.10	1.60	3.80	-2.50	-2.00	-8.10
KH1	-0.20	-0.40	-0.40	-0.40	-0.10	0.50	0.80	0.80	0.30

[1]Deviation calculated against "no Regulation Q" value of Table 2A.

[2]Devaluation calculated as RMS value (Table 4A) minus RM value (Table 1B).

therefore the yield on the contract varies somewhat less than RMS on the short-term VRM.

The results of Table 6B, on the other hand, indicate a significantly more expansionary effect on deposits and mortgages than any of the simulations reviewed so far. The mortgage interest income (MINT) is much greater because the assumption of this simulation allows the VRM to be issued at a relatively high interest rate (that is, with a large ∂ weight on RM). This then generates profits for the SLAs which, under the reserve constraint, are paid out to depositors, creating a high deposit rate (RSL), and a large amount of interest paid to depositors (DINT) with the outcome that deposits increase dramatically. The impact on housing, however, remains negligible. This occurs because the positive effects through mortgages are offset by the relatively high value for PAYO that comes with the high new-issue mortgage rate. Finally, it should be stressed that the results of this simulation depend critically on whether a contract of this form could actually be sold at a new-issue rate as close to the standard mortgage rate as is assumed.

(6) *Concluding Comments on VRMs.* It is frequently argued that VRMs would have considerable benefits for lenders, particularly the SLAs, but that this would be at least offset by a cost to borrowers. Our results are in this general direction, but show a smaller advantage to SLAs and essentially no negative impact on housing. It is thus important to see why this is the case.

First, with respect to the lenders, the assumed benefits are frequently based on the premise that SLAs would be able to issue VRMs at essentially the same interest rate as standard mortgages. Our analysis, in contrast, has stressed that VRMs are basically short-term instruments, and that generally the term-structure yield curve in the United States has had short-term rates below long-term rates. Consequently, lenders will actually lose on this account. This is made up, however, in that over the simulation period the level of all interest rates has been rising, and that VRMs allow the yield on mortgages to remain current with this movement. In fact, the net gain for the lender is surely positive, but it is less because of the term-structure aspect.

Second, with respect to borrowers, the main costs of VRMs are frequently related to the uncertainty associated with the interest rates to be paid over the contract's life. It is thus concluded that risk-averse individuals would shy away from such mortgage financing and with a detrimental effect on housing investment. Our simulations have not included such an effect for the primary reason that we have no means by which to estimate empirically its magnitude. Moreover, we feel that the importance of this risk-aversion argument has been exaggerated. In particular, to the extent that variations in short-term interest rates reflect variations in inflation rates, a borrower will find that his mortgage financing costs will rise at the same time he is obtaining capital gains on his house and a higher wage income through the inflation effect. Of course, payments are likely to rise more abruptly than wages and it is difficult to realize the capital gain, thus causing some cash flow difficulties. These cash flow effects could be eliminated or greatly reduced through variations on the basic VRM (see III C above and III D below). However, it is not clear that even the basic VRM is more risky than standard mortgage contracts which necessarily introduce risk because they are fixed-rate contracts, and thus will work out either better or worse for the borrower depending on the outcome for inflation. In fact, of course, over recent years inflation has occurred at rates that are much higher than those expected at the time most current mortgages were taken out. Consequently, current holders of mortgages have generally done very well under standard mortgages. However, it is very doubtful that the trend could continue as interest rates have tended to incorporate a growing premium for expected inflation and the reluctance of borrowers to pay the resulting high interest rates currently being required on standard mortgages suggests that they share this view.

D. *Constant-Payment-Factor Variable-Rate and PLAM Instruments*

The macroeconomic effects of GP and VR mortgages stand in contrast. GP mortgages stimulate housing demand directly due to the effects of the graduation on initial payments. GP mortgages help the SLAs, however, only in the indirect way that increased mortgage demand results in higher mortgage interest rates, and thereby improves portfolio earnings. VR mortgages, in contrast, directly improve the SLA earnings position, by allowing them to earn the rate RMS on their mortgage portfolio which, in turn, allows competitive levels for deposit rates. VR mortgages, however, are unlikely to help housing investment both because of the PAYO effects and because of the risk aversion toward fluctuating mortgage rates. Consequently, it is an appealing notion that some combination of GP and VR mortgages will have the joint virtues of stimulating housing investment (the graduated-payment feature) and helping the SLAs (the variable interest rate feature). Two instruments that operate in this way are simulated here: the constant-payment-factor variable-rate mortgage and the price-level adjusted mortgage (PLAM).

(1) *The Constant-Payment-Factor Variable-Rate Mortgage*

Donald Tucker of the Federal Reserve System has suggested a type of mortgage that directly combines GP and VRM. The first two papers in this volume confirm the attractiveness of this type of instrument and discuss two specific designs. One of these, which we in the mortgage study have termed the constant-payment-factor variable-rate mortgage, is simulated here.[3]

[3]This instrument is virtually identical to one of the forms of Tucker's proposal. The term constant-payment-factor VRM is applied to clearly differentiate this design from plans which have graduated nominal payment schedules fixed at the time the contract is negotiated.

The VR features of the mortgage have essentially the same form we used in the VR simulations above. Specifically, we use both the basic, short-term VR mortgage (VR.1) and the extension with a fixed deposit-rate spread (VR.1A); these are now denoted respectively as IN.1 and IN.1A. Thus, each period, interest is debited to borrowers at the new short-term mortgage rate RMS. However, payments are based on the constant payment factor, which is an estimate of the real rate of interest, and thus rise over time by the difference between the payment factor and the debiting rate. (It can be readily seen that this is equivalent to computing in each period a new path for payments which is graduated over time by the difference between the payment factor and the debiting rate, such that the contract is fully amortized over its remaining maturity). A different payment factor is used for each vintage of mortgage. The details of our specification are given in Section V.

For lenders, the effect of the constant-payment-factor VR mortgage is basically to retain the advantages of a VR contract. For borrowers, however, the cash flow problems of a VR contract are basically eliminated, since a higher graduation rate, and therefore a lower payment, is allowed to offset the effects of higher RMS interest rates. Of course, if interest rates systematically rise over the life of a mortgage, then ultimately the borrower will have to face up to larger payments in the end. The expectation, however, is that over time short-term rates will approximately average the same value as long-term rates, and then the payment-factor VRM will successfully eliminate the cash flow problems that would otherwise arise.

The results of our simulations for the constant-payment-factor VRM mortgages are given in Table 7. Table 7A shows the deviations from the historical simulation with deposit-rate ceilings for the case with the basic, short-term VR feature. These results can be compared with the simulations of VR.1 (Table 4B), since they are the same except for the GP feature of the constant-payment-factor VRM. The results for interest rates, deposits and mortgages, and the reserves of SLAs are very similar. In this sense the constant-payment-factor VRM does retain the advantages of VR mortgages for the SLAs. On the other hand, in terms of the housing stock, the constant-payment-factor VRM has a considerable positive effect: a gain of $8.6 billion in the real stock by the end of the simulation. The basic VR mortgage of Table 4B, in contrast, achieved a loss, albeit negligible, of $.7 billion.

Table 7B shows a constant-payment-factor VRM simulation where the VR feature includes a fixed deposit-rate spread. This is comparable to the VR mortgage discussed above in Section III.C.2 with results presented in Table 5A. Comparing these results, we again find very little difference in terms of the variables affecting SLA welfare. And again in terms of housing, the constant-payment-factor VRM allows a significant stimulus, $10.0 billion, to the real stock at the end of the simulation, whereas the pure VR mortgage allowed only the negligible gain of $.6 billion.

Table 7

CONSTANT-PAYMENT-FACTOR VARIABLE-RATE MORTGAGES (TUCKER PLAN)

A. Simulation IN.1: Constant-Payment-Factor VRM (Deviation from 1.B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	-0.08	0.13	0.04	-0.05	0.84	0.67	0.02	-0.85	-0.20
RSL[1]	-0.02	0.13	0.04	-0.08	0.16	0.14	-0.53	-1.13	-0.35
RMS[2]	0.03	0.74	-0.64	-0.18	1.16	-1.65	-2.06	-1.46	1.64
RM	0.17	0.12	0.10	0.10	0.01	-0.03	0.21	0.35	0.31
DESL	-10.80	-9.30	-7.50	-5.20	3.20	10.50	-4.80	-25.60	-32.10
MOSL	-10.70	-9.90	-7.10	-5.60	1.30	12.00	-1.70	-23.40	-33.70
MTOTAL	-11.00	-10.40	-7.60	-4.90	4.70	19.30	11.50	-2.40	-10.50
MINT	-0.64	0.01	-0.62	0.23	2.94	2.74	-0.93	-3.93	1.92
DINT	-0.54	-0.29	-0.30	-0.30	1.20	1.50	-0.22	-2.56	-2.06
TRANSFERS	-0.07	0.40	-0.24	0.59	1.85	0.87	-1.01	-1.40	2.87
RESERVES	0.01	0.19	0.28	0.56	1.58	3.10	1.97	0.22	0.86
EH$	0.10	0.60	1.20	1.60	1.20	1.70	0.10	1.20	-4.60
KH1	1.30	1.90	2.60	3.50	4.70	6.10	7.20	7.90	8.60
HS1$	0.11	0.19	0.24	0.37	0.46	0.44	0.35	0.21	0.65

B. Simulation IN.1A: Constant-Payment-Factor VRM With Deposit-Rate Spread

(Deviation from Table 1.B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	0.03	0.99	-0.01	0.26	2.37	0.57	-0.01	-0.85	1.75
RSL[1]	0.09	0.99	-0.01	0.23	1.69	0.04	-0.56	-1.13	1.60
RMS[2]	-0.01	0.62	-0.72	-0.26	0.90	-1.82	-2.12	-1.55	1.38
RM	0.13	0.00	0.02	0.02	-0.25	-0.20	0.15	0.26	0.05
DESL	-7.80	-0.70	2.50	6.20	28.60	38.10	15.40	-4.40	7.30
MOSL	-5.90	-2.50	3.50	5.40	23.60	41.70	20.00	-2.70	1.90
MTOTAL	-6.90	0.90	8.80	15.30	43.00	70.90	58.80	47.60	63.10
MINT	-0.53	0.34	-0.08	0.90	4.33	4.93	0.43	-2.94	4.61
DINT	-0.31	1.06	0.10	0.65	4.88	3.06	0.80	-1.61	3.54
TRANSFERS	-0.15	-0.29	-0.19	0.37	0.40	1.14	-0.92	-1.40	1.25
RESERVES	-0.20	-0.52	-0.51	-0.46	-0.66	0.61	-0.49	-2.27	-3.16
EH$	0.50	1.40	1.10	1.70	2.50	1.80	-2.10	1.40	-2.80
KH1	1.50	2.20	3.10	4.00	5.50	7.20	8.20	9.00	10.00
HS1$	0.13	0.27	0.25	0.41	0.60	0.45	0.36	0.26	0.96

Addendum: IN.2A; "Dual Rate" Version of IN.1A (Deviation from 1B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
EH$	0.50	1.60	0.90	1.60	3.00	1.60	-3.60	-0.60	-1.30
KH1	0.60	1.30	2.40	3.10	4.60	6.70	6.90	6.60	7.00

[1] Deviation calculated against "no Regulation Q" value of Table 2A.

[2] Deviation calculated as RMS value (Table 4A) minus RM value (Table 1B).

Finally, in the addendum to Table 7, we show the results for the housing variables of introducing a "dual-rate" feature to the VR mortgage. As indicated above, Section III.C.3, this contract should serve to stabilize housing investment even further. Comparing the results of Table 7B with the addendum, this can be seen to be the case. Alternatively, the standard deviation measures of Table 9 can be used as the criterion. It can be seen in Table 9 that the constant-payment-factor VR mortgages (IN.1 and IN.1A) have essentially the same housing path as comparable pure VR mortgages. The "dual-rate" constant-payment-factor VR mortgage, on the other hand, achieves a more stable path and is dominated in Table 9 by only GP.2 and IN.3A.

(2) *Price-Level-Adjusted Mortgages (PLAMs).* The last mortgage considered in our study is the PLAM. The key point in the PLAM is that the interest rate set in the contract is a real rate. We denote this real rate as rm, in contrast to the nominal rate RM. The real rate rm is determined in the model essentially through the forces of demand and supply. The rate rm then serves to determine the level of PAYO, which in turn is a main determinant of housing investment. Since rm will generally be below RM, the PAYO effect will stimulate housing in much the way achieved through a GP mortgage.

In two points in the model, however, it continues to be necessary to use a nominal mortgage rate. First, as a determinant of the deposit rate, since savings deposits are not indexed, a nominal mortgage rate should be used. Second, in the housing sector, the model is currently specified to allow for the direct impact of a nominal mortgage rate. In principle this equation could be re-estimated to separate the influences of the real rate and inflation. For present purposes, however, it is expedient to translate the real rate into nominal terms. This is achieved using the formula: $RM = rm + \hat{RP}$, where $\hat{RP}$ is the expected rate of inflation over the duration of the contract. $\hat{RP}$ is measured through an expectations mechanism already in the MPS model.

PLAMs, requiring the calculation of a real rate of interest, must be integrated into the model in other ways. To account for the indexing, the oustanding stock of mortgages is updated each period by the rate of inflation that occurs. We do not, however, have borrowers paying this amount each period. Instead, given the revised amount of the mortgage, and the real rate associated with the specific vintage of the mortgage, the payment is calculated so as to amortize the amount over the remaining maturity of the contract. It can be seen this is closely analogous to the graduation feature built into the constant-payment-factor VR mortgage.

In terms of the accounting for SLAs, however, we do treat the inflation premium on the mortgage stock as interest income. An alternative procedure would be to treat the inflation premium as a capital gain. These techniques could well have different tax implications, and thus we are assuming here that the inflation premium would be treated as regular mortgage income. In any case, the main point is that the inflation premium does get added into income, and then is either paid out to depositors or is

Table 8

PRICE-LEVEL-ADJUSTED MORTGAGES

A. Simulation IN.3: Straight PLAM (Deviations from Table 1.B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	0.05	0.04	0.03	0.05	0.70	0.52	0.55	0.32	0.17
RSL[1]	0.11	0.04	0.03	0.02	0.02	-0.01	0.00	0.04	0.02
RM[1]	1.38	-2.46	-2.87	-3.54	-4.62	-4.73	-.3.73	-2.97	-5.17
RM	0.07	0.05	0.04	0.03	-0.07	-0.16	0.04	0.13	0.07
DESL	1.00	0.80	0.50	0.80	5.90	12.60	6.60	0.60	-1.50
MOSL	1.00	0.80	0.80	0.70	4.20	13.30	9.10	0.70	-1.60
MTOTAL	3.40	3.30	3.40	3.20	7.90	19.90	17.60	15.00	16.20
MINT	0.34	1.68	2.02	2.39	4.39	3.06	-2.49	-0.37	9.45
DINT	0.09	0.08	0.06	0.11	1.17	1.43	1.18	0.57	0.27
TRANSFERS	0.21	1.38	1.68	1.97	2.98	1.27	-2.98	-0.72	6.34
RESERVES	0.09	1.47	2.42	4.13	6.83	8.53	8.13	7.21	12.60
EH$	0.00	0.60	0.90	1.70	2.80	3.40	-2.10	1.30	3.10
KH1	0.80	1.30	1.90	2.90	4.20	5.80	7.10	8.00	9.30
HS1$	0.08	0.16	0.24	0.40	0.53	0.47	0.41	0.28	1.09

B. Simulation IN.3A: PLAM With Deposit-Rate Spread (Deviations from Table 1.B)

	1965:IV	1966:IV	1967:IV	1968:IV	1969:IV	1970:IV	1971:IV	1972:IV	1973:IV
RSL	0.24	1.09	1.30	0.98	2.26	0.66	0.51	0.30	3.13
RSL[1]	0.30	1.09	1.30	0.95	1.58	0.13	-0.04	0.02	2.98
RM[2]	-1.44	-2.68	-3.10	-3.81	-4.99	-4.97	-3.85	-3.07	-5.57
RM	0.00	-0.17	-0.19	-0.24	-0.44	-0.40	-0.08	0.03	-0.33
DESL	9.90	21.10	26.00	34.50	52.40	57.50	40.70	21.10	56.40
MOSL	9.90	19.90	25.10	33.70	48.80	59.90	44.30	27.60	50.20
MTOTAL	14.90	30.40	41.60	58.40	85.70	107.60	99.00	90.40	131.60
MINT	0.83	2.90	3.77	4.82	8.20	6.64	-1.05	1.19	14.17
DINT	0.70	2.38	3.06	3.18	6.34	4.41	3.07	1.98	10.06
TRANSFERS	0.11	0.62	0.76	1.58	2.11	1.50	-3.69	0.82	3.61
RESERVES	0.56	-0.18	0.21	1.41	3.25	4.97	4.55	3.50	5.67
EH$	0.70	2.20	1.40	2.60	3.70	3.20	-4.60	0.50	9.00
KH$	1.30	2.20	3.20	4.70	6.60	8.60	9.90	10.70	12.7
HS1$	0.12	0.31	0.39	0.57	0.73	0.50	0.39	1.01	1.77

[1] Deviation calculated against "no Regulation Q" value of Table 2A.

[2] Deviation calculated as rm level value (not shown minus RM value Table 1.B).

Table 9

STABILITY OF HOUSING INVESTMENT
WITH ALTERNATIVE INSTRUMENTS[1]

Instrument Code No.	Instrument Description	Standard Deviation Around Time Trend 1962:I to 1972:IV
History	Actual Value of EH	3.53
Simulation of History	With Deposit-Rate Ceilings	3.62
Simulation of History	Without Deposit-Rate Ceilings	3.08
GP.1	Fixed Graduated Payment	3.09
GP.2	New-Issue Graduated Payment	2.71
VR.1	Basic, Short-Term VRM	3.42
VR.1A	VR.1 with Deposit-Rate Spread	3.13
VR.2A	VR.1A with "Dual-Rate" Feature	2.88
VR.1B	VR.1 with Reserve Constraint	3.04
VR.3	FHLBB Contract ($\alpha = .25$)	4.08
VR.3	FHLBB Contract ($\alpha = .75$)	2.81
IN.1	Constant-Payment-Factor VRM	3.41
IN.1A	IN.1 with Deposit-Rate Spread	3.12
IN.2A	IN.1A with "Dual-Rate" Feature	2.77
IN.3	PLAM	2.90
IN.3A	IN.3 with Deposit-Rate Spread	2.45

retained in the reserve accounts. It should be recalled here also that we have not attempted to simulate indexed time deposits, although clearly this would be a natural match with the PLAM.

We have simulated two types of PLAMs. The first of these is shown in Table 8A with the notation IN.3. The results are shown as deviations from the historical simulation with deposit-rate ceilings. For IN.3, the deposit-rate setting of depository intermediaries follows the standard equations of the MPS model. The variable rm in the table shows the difference between the real rate simulated for the PLAM and the nominal rate RM simulated in the historical standard. The large negative values for rm indicate that rm is significantly below RM, as one would expect. The variable RM shows how much the nominal mortgage rate would have changed between the PLAM and the historical standard. The values shown are quite small and frequently positive. This is due to the fact that a similar pattern prevails for deposit rates, and thus deposits and mortgages are slightly lower at the end of the simulation. In contrast, the implications for the SLAs and for housing are much stronger and more positive. In terms of SLA reserves, we simulate a gain of $12.16 billion by the end of the simulation. This is due to the large gain from the inflation that occurred late in the sample period. In terms of housing, the stock of real housing has increased by $9.3 billion at the end of the simulation. This is due to the low value of PAYO that prevails under PLAM contracts, which in turn is due to the level value for the real rate rm.

Table 8B shows a similar simulation of the PLAM, but with a fixed spread between the deposit rate and the mortgage rate (the latter being translated into nominal units for this purpose). This involves the same procedures adopted in Section III.C.2 above, and we denote the contract as IN.3A. The results of IN.3A differ considerably from the results of IN.3 because the deposit-rate spread condition has the effect of forcing the intermediaries to pay out the inflation gains to their depositors. Indeed, by the end of the simulation, deposits at SLAs are up by $56.4 billion and mortgages are up by $50.2 billion. This in turn creates downward pressure on the mortgage rate and stimulates housing, so that there is a net gain in housing of $12.7 billion at the end of the simulation.

Finally, turning to Table 9, we can compare the stability of housing investment under the PLAM with our previous mortgage instruments. The standard deviations for IN.3 and IN.3A are 2.90 and 2.45 respectively. These values indicate exceptionally good stabilization properties.

IV. CONCLUSIONS AND AGENDA FOR FUTURE RESEARCH

It is hoped that the presentation of the simulation results in this study has served several purposes. First, the necessarily concrete setting of a simulation experiment provides a force toward more precise definitions of the alternative instruments to be considered. In the early stages of this study we found that many proposed contracts had not been rigorously defined in terms of the detail necessary to simulate them. Consequently, a significant part of our effort, in conjunction with the other studies of the MIT mortgage project, was to provide specific and detailed definitions for the contracts.

Second, we feel we have shown that it is practical and useful to simulate the macroeconomic effects of the proposed mortgage instrument innovations. Generally we found that the MPS econometric model was adequate for this purpose. At the same time, a variety of issues do stand out as requiring more work, both in terms of estimating a more complete model, and in terms of more complete simulation procedures. A list of these issues is provided here:

— More complete specification of the mortgage and housing sectors to allow for all dimensions of the alternative instruments.
— Further study of the deposit-rate setting of the depository intermediaries, with emphasis on the competitive response of commercial banks and the mutual response of savings and loan associations when they receive higher profit margins.
— More precision in the definition of the alternative mortgage instruments, like, for example, constraints on the frequency and size of changes in the rate on variable-rate mortgages.
— General equilibrium simulations of the alternative mortgage contracts with particular regard to alternative settings for monetary policy.
— A more complete attempt to "validate" the results. This is probably best done by running the simulations on alternative econometric models.

A third purpose of our simulation results, of course, was to provide at least a guide as to whether implementation of the instruments would be useful. Also, it was felt that simulation experiments would help clarify a number of questions about the properties of the alternative instruments. On both of these levels we feel the study has been successful. In terms of implementation, we found that almost all the results suggested the contracts could be used without disruption, and indeed generally with beneficial outcomes. On the other hand, the simulation results did indicate a variety of effects that are not frequently taken into account, or at least not accorded the empirical significance they seem to have.

More specifically, the results do point to the value of a new contract that would combine the features of graduated payment and variable rates. Both the constant-payment-factor VRM and PLAM contracts that we simulated have these features. In addition, other contracts of a similar nature have been reported elsewhere in this volume.

Finally, we must end with a strong caveat concerning the preliminary nature of these results. As indicated at several points in the text, we have had to make guesses, educated as they might be, on some key parameter values. Consequently, we cannot claim even the level of precision that might be normally associated with common simulation studies of various multiplier values. Also, simulations of a distinctly new environment add a full new dimension of uncertainty since it is difficult to cover all the possible ways in which the economy may or could adjust to the changes.

V. PROGRAMMING AND OTHER NOTES ON THE SIMULATIONS

A. *Summary of the New Instrument Equations*

As developed in the text, the key equations necessary for simulating the new instrument plans are PAY (payment on mortgages), INT (interest on mortgages) and REP (repayments of principal). In addition, PAYO (the payment size on a standardized house) must be calculated for use in the housing equations. Equations (1) to (4) below define these variables in a form that is general enough to cover all instruments. Then, for each simulation, three parameters — y, u, z — must be set at values appropriate for the particular instrument. *y* is the interest rate used in calculating PAY and PAYO and will equal RM, RMS or rm (see definitions of symbols just below). *u* is the graduation rate and is set according to the terms of the graduated contract. *z* is the interest rate used for calculating INT and will equal y except for "dual-rate" mortgages. *v*, the vintage, is the quarter in which the mortgage is initiated (first payments come in the following quarter), and t is the current quarter.

Symbols are defined as follows:

M(v, t-l)	remaining principal at end of period t-l of mortgages of vintage v
RM(v)	long-term mortgage interest rate (on mortgages of vintage v)
RMS (t)	short-term, variable rate, mortgage interest rate (same for all v)
rm(v)	real, indexed, mortgage interest rate (on mortgages of vintage v)
RP (t)	inflation rate during quarter
$\overline{RP}(v)$	average inflation rate over four quarters ending in quarter v
$\overline{\overline{RP}}$	average inflation rate over full sample
T(v)	quarter of final maturity of mortgages of vintage v
P(v)	price level during quarter v
PH(v)	price of standard house during quarter v
LVR(v)	loan-to-value ratio enforced during quarter v

The basic equations are:

(1) $PAY(v, t) = (y\text{-}u)[1\text{-} \left(\frac{1+y}{1+u}\right) (T(v)\text{-}t\text{+}1)]^{-1} M(v, t\text{-}1)$ (defined for $v \lessdot t$)

(2) $INT(v, t) = (z)\ M(v, t\text{-}1)$

(3) $REP(v, t) = PAY(v, t) — INT(v, t)$

(4) $PAYO(v) = PH(v)\ LVR(v)\ PAY(v,v)\ /\ M(v,v)$

The aggregate amounts for PAY, INT and REP are determined by summing over v. Then REP and INT are separated, where required, into the various intermediary proportions using the lagged mortgage stocks as the weights.

The parameter settings, and brief comments, on the mortgage instruments are:

GP.1

$y = RM(v)$

$u = u_o = \overline{\overline{RP}}$

$z = RM(v)$

Formula (1) is logically equivalent to setting the initial payment as PAY(v, v+1) and then graduating this amount quarter by quarter at the rate u.

GP.2

$y = RM(v)$

$u = u(v) = \overline{RP}(v)$

$z = RM(v)$

VR.1, VR.1A, VR.1B

$y = (RMS(t\text{-}1)$
$u = 0$
$z = RMS(t\text{-}1)$

All vintages pay the same interest rate RMS under our plan. They must be treated by vintage, however, since the payment also depends on the quarters to maturity.

VR.2, VR.2A

$y = RM(t\text{-}1)$
$u = 0$
$z = RMS(t\text{-}1)$

VR.3

$y = \partial\ RM\ (t\text{-}1) + (1\text{-}\partial)\ RMS(t\text{-}1)$
$u = 0$
$z = \partial\ RM(t\text{-}1) + (1\text{-}\partial)\ RMS(t\text{-}1)$
$\partial = .25$ or $.75$

IN.1, IN.1A

$y = RMS(t\text{-}1)$
$u = u_o + RMS(t\text{-}1) - RMS_o;\ u_o = \overline{RP}_o$
$z = RMS(t\text{-}1)$

The constant-payment-factor VRM has the effect of keeping the variable y-u equal to the constant value determined by initial conditions.

IN.2, IN.2A

$y = RM(t\text{-}1)$
$u = u_o + RMS(t\text{-}1) - RMS_o\ ;\ u_o = \overline{RP}_o$
$z = RMS(t\text{-}1)$

The values determined in this way are real values. We must thus also index the mortgage stock base used in calculating (1) to (4). That is, we define NM(v, t-1) = M(v,t-1) P(t-1)/P(v), and use NM instead of M in the equations. Care must also be taken to account for the lender's capital gain in determining his income, and the outstanding value of the mortgage stock.

IN.3, IN.3A

$y = rm(v)$
$u = 0$
$z = rm(v)$

In addition to this basic coding, several other changes and points should be noted. First, we account for *prepayments* of mortgages as well as standard *repayments*. With regard to prepayments, we assume if a mortgage vintage has initial maturity TT (in quarters), then each quarter 1/TT is prepaid. This has the effect of changing the effective maturity for the vintage from TT to TT/2. This is roughly in line with the observed facts, where initial maturities run 20 years, but average effective maturities are on the order of 10 years. In this context it should also be noted that the variables T(v), LVR(v), and PH(v) are all currently treated as exogenously determined. Part of the proposed revisions of the mortgage and housing sector would make these variables endogenous.

Second, as noted in the text, deposit-rate setting by the intermediaries was treated differently for the alternative instruments. For GP.1, GP.2, and IN.3 the deposit-rate equations already in the MPS model were used. For VR.1, VR.1B, VR.2, IN.1 and IN.2 the MPS model equations were also used with RMS replacing RM. This change was made since for these simulations RMS, not RM, represents the appropriate yield variable on the mortgage contract. For VR.1A, VR.2A, IN.1A, IN.2A, IN.3A spread constraints were enforced between the mortgage interest rate and the deposit rate. Thus, instead of the equation of the MPS model, equations of the form RD = z-c were used, where z is defined for the individual instruments above, and c is the spread constant. For SLAs the value of c was set equal to 1.50 (percentage points). For the other intermediaries implied values for c were calculated so as to maintain the spread between the deposit rates of the respective intermediaries that would be generated otherwise by the MPS model. Finally, for the FHLBB simulations, VR.3, the MPS model equations were used, but with the appropriate value of z (see VR.3 above) replacing RM in the equation.

A third change involved the use of the so-called "reserve constraint" in simulations VR.1B and VR.3. The baseline for reserves was calculated from the historical simulation with deposit-rate ceilings. This is taken as representing the minimum level of reserves for SLAs to continue to function effectively. Then in the indicated simulations, the model was allowed first to generate the appropriate solution, including the level of reserves. However, whenever the level of simulated reserves exceeded the baseline, the excess was changed into an equivalent yield and paid out to depositors. In principle, therefore, the reserves finally generated by these simulations should never exceed the levels of the baseline. The observant reader may note, however, that small, but positive values do appear for reserves in Tables 5B and 6. This is presumably due to rounding error.

Fourth, technical care should be taken to distinguish quarterly and annual rates. Since the model period is quarterly, it is easiest to amortize contracts on a quarterly basis, and thus the resulting flows of payments, interest, and repayments are quarterly. To do this, however, interest rates and graduation rates must be set on a quarterly basis, although in model output they are given at annual rates. Similarly, in the Jaffee SLA sector (see V.C below), the equations are set for annual rates and variables must be appropriately transformed when used for those equations.

Finally, it is important to be clear on the timing assumptions used in generating the new instrument equations. We assume that all new mortgages are originated at the very end of each quarter and are reflected in the stocks outstanding listed for the end of the quarter. Mortgage payments, and the separation into repayments and interest, then occur in each quarter based on the stocks outstanding at the end of the prior quarter. The updating for inflation on PLAM contracts is also assumed to occur at the end of each quarter, following the payment, but preceding the flow of newly originated mortgages.

B. *Model Determination of RM, RMS, and rm.*

The text discussion assumed that mortgage interest rates, the long-term RM under graduation schemes, the short-term RMS under variable-rate schemes, and the real rate rm under PLAM schemes, would all be determined in the mortgage sector itself. This can be illustrated in the following way. A simplified version of the mortgage sector as currently available has the form (RCB is the corporate bond rate):

(5) $MS = a_o + a_1 (RM\text{-}RCB)$

(6) $MD = b_o - b_1 (RM\text{-}RCB)$

(7) $MD = MS$

The solution of this system for the mortgage rate RM* is given by:

(8) $RM^* = F[RCB] = (b_o - a_o) \,/\, (a_1 + b_1) + RCB = K + RCB$

This is how the current model works in its most simple interpretation.

To use this same system to generate a short-term mortgage rate RMS, following the discussion of the text, one would substitute RMS for RM and RCP for RCB (RCP is the short-term commercial paper rate). If this is done, then the solution for RMS* can be obtained in the same way:

(9) $RMS^* = F[RCP] = K + RCP$

It can also be observed from (8) and (9) that:

(10) $RMS^* = RM^* + (RCP\text{-}RCB)$

In the computer programming of the simulations we have taken advantage of (10) to achieve a short-cut. In particular, we have allowed the model in all simulations to generate RM directly, and have then used (10) to generate RMS. It is also for this reason that we have been able to present results for both RM and RMS. A similar procedure was used to generate the real rate rm. One substitutes in the basic model rm for RM and (RCB-$\hat{RP}$) for (RCB), and then solves for rm*. The equivalent relationship to (10) is then obtained as:

(11) $rm^* = RM^* - \hat{RP}$.

As presented so far, the method used in the computer programming is logically equivalent to the method proposed in the text, although the programming method has some operational advantages. Both techniques suffer, however, from the potential problem that the a and b coefficients (of equations 5 and 6) are being used to determine RMS or rm, whereas they were estimated and apply to a long-rate regime. This can be defended, and is rigorously correct, if under either variable-rate or price-level adjusted mortgages, both lenders and borrowers convert the quoted rate (RMS or rm) into their long-term nominal, equivalent, and then make their demand and supply decisions on this basis. Two alternative methods are possible. First, one could consider more complicated conversion equations than (10) and (11); that is, one could agree with the principle that participants convert rates to some standard measure, but argue that (10) and (11) are not the correct equations. Second, one could accept (10) and (11), but argue that some adjustment should be made to the a and b coefficients. For present purposes, however, the results of equations (10) and (11) are particularly easy to work with, and do not appear to contradict any reasonable *a priori* constraints one might impose on the relevant partial derivatives.

Turning next to a more complicated model, the actual MPS mortgage sector allows for rationing in the mortgage sector in that the mortgage rate RM adjusts only slowly to the market equilibrium of (8) — the speed of adjustment is, in fact about 1/2. It could be argued, particularly with RMS, that the adjustment might in fact be somewhat slower. That is, if a lender is slow to adjust a short rate, then he is off for one quarter; if he is slow to adjust a long rate, however, he must live with it for the full maturity of the contract. On the other hand, for our variable-rate mortgages, the rate RMS and the deposit rate RD will be closely tied. Moreover, given the interest elasticities of savers and the elimination of deposit-rate ceilings, lenders may be forced to respond quickly with their deposit rate as other short-term rates move, and this in turn would force a fast adjustment of RMS in order to generate the required income to pay RD. Thus, again, we agree with the principle that the speed of adjustment might change, but we see no strong case for the direction of the change. Thus, our simulations left this parameter unchanged.

Finally, the MPS model has one other quirk that should be noted. The specification of the mortgage demand equation was based, in fact, on the following model:

$$(12) \qquad MD = c_o - c_1 (RM - X_L)$$

where X_L is some unobserved rate that measures the opportunity cost of funds to households. We assumed, furthermore, that X_L is proportional to RCB, so that

$$(13) \qquad X_L = c_2 RCB$$

Combining (12) and (13), we then obtain

$$(14) \qquad MD = c_o - c_1(RM - RCB) - c_1 (1\text{-}c_2)RCB$$

This differs from the specification in (6) above in that RCB enters as a variable by itself. Moreover, it turns out that the two methods described above — (i) solving for RM and then deriving RMS and rm (the computer method); or (ii) directly solving for RMS and rm (the text method) — give different answers in these two cases because of the RCB term. Or more basically, it is clear that when we shift to a short-rate market, then the relevant X must change. When the text method is used, implicitly it is assumed that $X_S = RCP - c_1 (1\text{-}c_2)RCB$.[4] Neither technique can be known to be correct, however, and thus, as above, we opt for the simple coding aspects when RM is solved directly and RMS and rm are derived by (10) and (11).

[4]This comes about as follows:

$$X_L = c_2(RCB)$$
$$X_S = X_L + RCP - RCB$$
$$= RCP - (1 - c_2)RCB$$
$$- c_1(RMS - X_S) = - c_1(RMS - RCP) - c_1(1 - c_2)RCB$$

C. *The Jaffee SLA Sector.*

As noted in the text, it is important to measure how SLA reserve transfers respond to the various mortgage instruments since in the absence of deposit-rate ceilings it is possible that certain plans may not be feasible. The sector works as follows: Define:

MINT	interest income on mortgage portfolio
OINC	other income, net of all (non-interest) costs
FHLB	interest paid to FHLBB on advances
TAX	taxes paid
INCAT	income after taxes and FHLB interest
DINT	interest paid to depositors
TRAN	reserve transfers
RES	stock of reserves

When simulating a new mortgage the sector will behave as follows: MINT is determined as the SLA share of total mortgage interest (INT). OINC is determined from an estimated equation, which bases SLA income on the rate RCB, the share of deposits not invested in mortgages, and the flow rate of deposits, and which bases SLA costs on the stock of deposits and flow rates of deposits. FHLB is exogenous. TAX is derived by taking the SLA effective tax rate as exogenous, and properly defining the tax base using identities on the above variables. INCAT is then derived as an identity. Interest paid to depositors could be calculated as simply the deposit rate times the deposit base. However, the MPS model uses a *marginal rate* for the deposit rate, which in principle is highly weighted toward special accounts. The *effective* SLA deposit rate, in contrast, is much lower. Thus we adjust the model's marginal rate to the effective rate, by using the historical (exogenous) conversion ratio. TRAN and RES are then determined by identities. The estimated equation for OINC is:

$$\underset{(1.4)}{\text{OINC} = -.04} - \underset{(9.4)}{.01\text{DESL}} + \underset{(4.4)}{.03\Delta\text{DESL}} + \underset{(3.1)}{.004(\text{RCB})(\text{DESL})} - \underset{(2.3)}{.003(\text{RCB})(\text{MOSL})}$$

$R^2 = .92$, D.W. = 2.56, $S_c = .04$, Sample: 1953-1970;
(Absolute value of t-statistic in parentheses);

DESL = deposits of SLAs;
MOSL = mortgages of SLAs.

In running the standard (historical) simulations, with conventional mortgages and deposit-rate ceilings enforced, we also used the Jaffee SLA sector, since it provided the model's benchmark for TRAN and RES. The above description remains valid, except that INT must now be calculated on the basis of standard mortgages. The Jaffee SLA sector has separate equations for INT under conventional mortgages, and these were used only for the standard simulations. They are slightly complicated because they take into account the fact that some SLA loans are of very short maturity — being improvement or construction loans — and an attempt was made to incorporate this. Basically, however, a variable YBAR, the average yield on the portfolio is determined in a recursive fashion, and this is applied to the outstanding stock. Also note that for new instrument simulations there will still be interest income from the old standard mortgage stock. The rate of return on these is fixed as an initial condition (no new standard mortgages are made). See also Jaffee (1973) for the use of this model in simulations that evaluate the impact on SLAs of removing deposit-rate ceilings.

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Discussion

Henry J. Cassidy*

One of the most difficult tasks in econometrics is to forecast what would take place differently if a new option becomes generally available to economic participants, in this case involving one of a number of nonstandard mortgages. This task amounts to defining a new set of structural arrangements heretofore not in existence, and to providing quantitative estimates for the parameters. Given the high degree of difficulty of this task, Dwight Jaffee and James Kearl are to be congratulated for the insight they have brought to bear on it. However, many questions remain unanswered, and perhaps my function as discussant would be best fulfilled by highlighting these questions. In this sense, I am supplementing the many caveats about the simulation results made by the authors themselves.

1. No Forecasts of the Likely Amounts of Each Kind of Nonstandard Mortgage

Jaffee and Kearl simulate each type of alternative mortgage instrument separately under the assumption that only one type was issued throughout the simulation. Thus they did not attempt to forecast the likely amounts of each kind. Someone not familiar with simulation techniques might interpret the results as forecasts, irrespective of the authors' caveats: if a given instrument were to be allowed, the simulation results are not forecasts of the likely end results.

While the authors believed that such a procedure would highlight transitional as well as long-run implications, it failed to do so. As shown in the computer output supplied by the authors, by the end of 1965 the "transitional" period was essentially over. For example, in the VR.3 simulation with α=.25 (reported in their table 6A), by 1965, fourth quarter, over 60 percent of the mortgage portfolio was in this kind of instrument (by 1973, fourth quarter, it was about 93 percent). What is more likely is that the proportion of nonstandard mortgages will remain at less than 50 percent of the mortgage portfolio over a much longer period of time, and in a period involving a much richer assortment of interest rate changes than in the Jaffee-Kearl 1962-65 transition period.

*Economist, Office of Economic Research, Federal Home Loan Bank Board. The author's thanks are due to members of the OER staff and to Professors Jaffee and Kearl for frank and open discussion of their paper. The views expressed here are those of the author and not of the FHLBB.

This implies three things. First, while the simulated impacts (if correct) would exist, they would be drastically reduced in magnitude. Second, the transitional problems associated with the assumed removal of Regulation Q would be exacerbated. The authors do not appear to appreciate the potential magnitude of this problem. Third, the authors' conclusion that "the contracts could be used without disruption" has insufficient empirical justification.

Such a forecast would be extremely useful for planning purposes. There are two major problems in producing such a forecast. The first concerns forecasting the political acceptance of these plans. I do believe the authors are correct in ignoring this problem, but because of the problems cited above, they might have taken more of an interest in forecasting the public's acceptance of the various types, given the ability to choose among alternative instruments.

2. The Inadequacy and Perversity of the Initial Mortgage Payment (PAYO)

All nonstandard mortgages have in common variations in the amount of the (nominal) mortgage payments over the life of the loan (or a change in maturity, which shall be ignored here). The authors select just one of those payments, the initial one (PAYO), as being representative of the whole stream. They assumed (without empirical justification) that an increase in PAYO causes a decrease in housing expenditures.

By ignoring the whole payment stream, this variable PAYO, as specified in the housing expenditure equation, is inadequate and can even behave perversely. For example, if the initial rate on a variable-rate mortgage (VRM) is high because the index to which the current rate is tied is expected to fall, borrowers will anticipate lower future payments, and thus consider the initially high payments as temporary, impacting little on their demand for housing. The authors' use of PAYO, on the other hand, acts to curtail current housing expenditures (under the assumption of a household liquidity constraint). Moreover, if the fixed-rate option were available, and borrowers opted for the VRM, then by definition they believe they are receiving a better deal, implying that their demand would be *increased* instead of decreased.

In addition, PAYO is pre-tax as opposed to after-tax. Because of the deductibility of interest payments, the percentage change in the initial payment of a given instrument as compared to the fixed-rate mortgage is exaggerated. For example, compare the first payment on a 30-year fixed-rate loan at 9 percent to that on one at 8 percent. The result is a pre-tax decrease of 8.8 percent, but at a marginal tax rate (Federal plus state) of 30 percent, the decrease is 7.9 percent, for a "β" (the percentage change in initial payments) that is 10 percent less.

Also, the claim that graduated payment mortgages, for example, will aid housing ignores a response of the mortgage markets that could be very rational. As the initial payment decreases (as the rate of graduation increases), the loan-to-value ratio may decrease to offset the increased risk of the lower initial borrower's equity that the lower initial payments imply. Thus, the variable PAYO may change little (since the loan-to-value ratio is included in its analytical structure), as opposed to the amount of change used by the authors. Combining the effects of the after-tax analysis and the potential change in the loan-to-value ratio, the change in PAYO would not be nearly as great as they simulated. When added to this the lack of consideration of the whole payment stream and the lack of the empirical justification for the initial payment in the housing expenditure equation, the use of the PAYO variable becomes quite suspect.

3. Treatment of S&L Reserves

Under the various mortgage schemes, S&L reserves are affected. The question not adequately answered by the researchers is: How do S&Ls respond to a change in reserves? Since most S&Ls are mutuals, one such response would be to alter interest payments to depositors. A few of their simulations imposed the condition that reserves are unchanged, but it is possible that reserves would fluctuate other than historically (actually, differently from the way they would in the control solution), because the institutions' assets are of a different effective maturity, and their size is different (in the various simulations). Thus, how much the deposit rates would change is a moot question, but an extremely important one in determining the level and timing of the flow of funds into the housing market. Most of the simulations simply let reserves change with absolutely no feedback. Surely the two extremes are covered; the unanswered empirical question is: Which is the "correct" procedure?

4. Initial Pricing of Variable-Rate Mortgages (VRMs)

Of all the alternative mortgage types studied, the VRM is the one currently receiving most of the publicity, and this form of nonstandard mortgage has been actively pursued by many S&Ls, most recently in California. Jaffee and Kearl attempted to simulate the FHLBB proposal and found that it stabilized the housing market better than any of the other proposals investigated (for one assumption of α — part of the pricing mechanism), over the simulation period (see their table 9). However, they employed a rather arbitrary mechanism to assign an initial price (interest rate) to the VRM, using a term structure model of expectations. This model has the initial rate higher than a hypothetical (or artificial) rate on a fixed-rate mortgage whenever the short market rate (the rate on commercial paper) is greater than the long market rate (the rate on corporate bonds). There is some reason however, to suspect that even with this negatively sloping yield structure,[1] VRMs may be sold at a discount instead of at a premium, as compared to the fixed-rate mortgage rate. The reason has to do with lender strategy: if the index to which the VRM rate is tied

[1]Jaffee and Kearl in places refer to the yield structure as "ascending," or "descending," though no analytic use is made of this concept (as opposed to the shape of the yield curve).

is expected to fall, and the index itself is the long-term mortgage rate (as simulated and reported in their table 6), then in order to prevent refinancing with a fixed-rate contract at a future date when all rates are cyclically low, an initial discount is included. For this reason, when all rates drop temporarily, many borrowers would be unwilling to refinance with a higher rate fixed-rate contract, and thus they become "locked-in" to the VRM through the trough.[2] (In the Jaffee-Kearl simulations, borrowers do not have the option of selecting one of the VRM or the fixed-rate contracts.) In any event, the pricing question needs to be analyzed in more detail.

5. Other Aspects of the VRM Analysis

The analysis of the pricing of the VRM when its index is the new issue VRM rate was very well handled, but several questions remain. They allow this VRM short rate to clear the mortgage market. Using their same expectations framework, I wonder if the rate clearing the mortgage market should not be the long mortgage rate. Borrowers and lenders would look at the expected (as opposed to the current) rate of interest that is effective over the expected life of the loan commitment in assessing their demands for and supplies of mortgages, respectively. Use of the short interest rate implies that borrowers and lenders are rather short-sighted; it is the same kind of assumption of short-sightedness that applies to the use of PAYO in the housing demand equation (see Section 2 above).

Jaffee and Kearl state that ". . . for VR mortgages . . . the reserves of S&Ls should improve and our results bear this out." I might point out that this conclusion is based solely on the fact that over the simulation period interest rates trended upwards. Had they remained stable, for example, and the yield curve had been positively sloped (so that VRMs sold at a discount), the earnings of S&Ls would have been lower. This scenario is one of many that could be forecast for the future. The use of the evidence from the simulations as a basis for inductive reasoning, in other words, is not valid, at least not here.

Another point is that if VRMs had been compared to fixed-rate mortgages, then the expected changes in the price of the house would have no place in the analysis of risk (the authors make such an analysis at the end of Section C), because this remains the same regardless of which instrument is selected, and thus is not relevant to the analysis.

6. Concluding Remarks

In conclusion, the questions raised here and by Jaffee and Kearl themselves are of sufficient importance to merit rethinking of many of the assumptions and procedures. To me, the most important point is that the

[2]For more analysis of the initial pricing of VRMs, see Henry J. Cassidy and Josephine M. McElhone, "The Pricing and Marketability of Variable Rate Mortgages," FHLBB/OER Working Paper No. 53, May, 1975.

simulations are not forecasts. One way to make them look more like forecasts, as well as to be able to understand better the economic effects of the alternative instruments, is to use the MPS model in much the same way as a physical scientist uses a laboratory to conduct controlled experiments. Once the model has been estimated over a wide variety of economic conditions, a researcher could hypothesize alternative scenarios for the movements of the exogenous variables: e.g., steady growth, stagflation, regular cycles, to name a few. Then the researcher could investigate separately the transitional and longer-run consequences of each alternative mortgage contract. As it happened, the transitional impacts were not studied, and the longer-run results are very conditional upon the one given set of mixed economic occurrences over the simulation period. Strengths and weaknesses of instruments could be highlighted by simulating their effects separately for different phases of the cycle, for different longer-run movements of interest rates, and so on. Finally, a forecast is easier to provide given this kind of analysis, since the most likely and alternative scenarios (regarding the exogenous variables) could be selected by anyone desiring to make a forecast.

Discussion

James S. Duesenberry*

Simulations are very useful for a variety of reasons. They teach us a great deal, even though the results depend upon the inputs which we provide.

First, as we go through the process of trying to simulate the effects of any kind of a new policy, we are forced to consider changes in the structure of our financial system, or any other system for that matter. We discover that there are a lot of questions which we didn't even know were there until we tried to run the simulation. Dwight has already mentioned a number of things which just wouldn't have occurred to him had he not run the simulations. Secondly, as we work through the simulations we find that there are a lot of dynamic processes for third and fourth order effects which we never would have thought of if we had taken the numbers and tried to compute the consequences of a particular action. There is a kind of three-cushioned effect here, and the ball doesn't go where we expect it some of the time. I think that it's very valuable to discover those unanticipated effects.

Finally, as Dwight and Mr. Cassidy have already mentioned, it is quite clear that the results of any simulation depend on interaction between the parameters of the model, the economic policies, and the environments which we use as a baseline. To get anything out of the model, a large number of simulations are required in order to test the sensitivity of the conclusions to assumptions about the parameters, to parameter changes or to differences in the kinds of policies that are being used outside the model and to different environments. Part of our problem is that by the time we have enough simulations to search that universe, we have some problem of digesting the results because we wind up with about 200 pages of tables like the ones we had. Nonetheless, I think that's what we have to do.

Let me make one more general point which applies to all these financial models, the one to which Mr. Cassidy alluded at the end of his talk, but which I want to put in a slightly different perspective. In many of these exercises we are engaged in a process of asking whether some policy will remove some of the rationing effects, for instance, from the

*Professor of Economics, Harvard University.

housing market, and therefore provide more cyclical stability into the housing market. When we conduct those simulations on the basis of a given monetary policy, described let's say in a pattern for unborrowed reserves, or M_1 or whatever it is, or as in this case just taking some series of short rates as being given data, we then assume that the central bank is going to be satisfied to have a result which emerges. However, with the new structure it may turn out, for instance, that if they stabilize housing somewhat more, the demand pattern will also change. But if they are looking for deflationary effects and they get a smaller deflationary effect out of housing, then they will provide less unborrowed reserves which will lead to higher interest rates and more feedbacks. A full application of these simulations has to be taken with a realistic view of what are the stabilizers' objectives. Sometimes they only care about M_1, in which case it's perfectly appropriate to simulate the results that way.

Now let me say a couple of things about the problems of this particular set of simulations. I think the first comment I should have made, of course, is that Dwight said he chose this particular model because it was the most structural model. That's open to dispute. But in view of the hour I will just raise two substantive points.

One of them is that in this type of operation the model is structured so that, in effect, the long-run demand for housing is incorporated into one of the equations. Now I think that as a general proposition, and something that Frank DeLeeuw was saying, in the environment in which we've been operating, it seems difficult to learn very much about the underlying demand for housing from the data we have. This is precisely because by underlying demand I mean the response of the unconstrained or unrationed demand for housing to the relative prices, the interest rates, the taxes and all the other things that you might expect to affect the demand for housing. In a world in which the financial constraints, to my mind anyway, have had such an overwhelming influence on the short-run fluctuations in housing, it seems difficult to me to sort out from the data the long-run movements of the demand. We may be better off if we try to get long-run estimates out of entirely different sorts of data, including data from different cities and or other cross sections; or to divide the problem and say that what we're going to look for are things which have to do with short-term variability, and then try to find some devices which free us of the task of trying to estimate the long-run demand simultaneously with the short-run demands.

There are a number of specific problems about the way in which PAYO and such variables enter into the long-run determinants. I want to mention just one point in that connection, which goes back to the earlier discussion about problems of consumers' cash flow in relation to the price-adjusted mortgages. As was said earlier, those are problems for people who are subject to a liquidity constraint. They are the group of people who want to own houses rather than rent them, but who don't have enough net savings to be able to deal with the current cash flow problem. I would think that that's not such a big group, but that it's important to note here that there is another market for them — the rental market. In the rental market some of the inflationary effects which are bad for the mortgage borrower's cash flow are good for the developer's position, partly because of tax effects, so that it may turn out here that what you're doing by changing the payment rates for mortgages is shifting people out of the owner market into the rental market. The timing may be a little bit different, but over a long period I'm not sure that this should have such an enormous effect on the total demand for housing.

Of course there are also problems here of estimating the response of potential homeowners to the different risks that are involved when they are asked to take one of these mortgages which varies with the price level or with the interest rate. It's not that it's no risk against some risk, but it's a different set of risks, and we really have very little information to tell us how they would respond.

That's one aspect of the problem. The other aspect is one about the market clearing process. I think the way these models are built amounts to finding a rationalization for the pattern of rate adjustments which the institutions made both to their deposit rates and the rates they charge on mortgages, in an environment with a certain set of fluctuations, where the institutions were taking a certain set of risks in that process, and had a certain set of expectations. Now I think one has to be very careful, and I'm not sure the authors have been quite careful enough in examining the question of whether the rate-setting process is a new structural environment in which they are going to be setting the rate on something different, will involve the same time pattern of adjustments to rates as before. So I suspect that there's some danger of inconsistency between the supply and demand equations which go into the calculations for how many mortgages and how many houses people want, and the market clearing process which establishes what the mortgage rate is.

Discussion

Patric H. Hendershott*

Dean Pounds speculated at the outset today that we would probably not hear a single good word for the standard fixed-payment mortgage. I am afraid I must disappoint him. The potential social costs in 1974 of rising mortgage payments due to graduated-payment and/or variable-rate mortgages undoubtedly far outweighed the benefits. During a normal "demand-pull" inflation, such as we experienced in the 1966-68 period, rising mortgage payments seem appropriate. Real incomes are increasing so the payments can easily be made. However, in a year like 1974, when sharp increases in payments to foreigners result not only in increases in prices but also in declines in real incomes, rising mortgage payments could be disastrous to many households. In fact, it was the constancy of the mortgage payment that allowed many of us to afford the rising food and energy prices. Consumer credit lenders, as well as mortgage lenders, were, I am sure, grateful for the general absence of graduated-payment and variable-rate mortgages and the resultant lower levels of delinquencies and foreclosures. While it would obviously be erroneous to base our assessment of the desirability of alternative mortgage instruments on the events of 1974 alone, neither should we be misled into believing that one particular instrument is optimal for all periods.

One other general point regarding the overall conference before getting immersed in the issues at hand and the Jaffee-Modigliani-Kearl paper in particular. The papers before us today address important issues in a clear and concise manner. Cohn and Fischer lay out the implications of various mortgage contracts for real and nominal payment streams and analyze the desirability of the contracts from the viewpoints of borrowers and lenders; Kearl, Rosen and Swan explain how and why these streams should influence the demand for housing; and Jaffee, Modigliani and Kearl illustrate how the impact of the introduction of a variety of nonstandard mortgages on the mortgage and housing market might be analyzed in the context of an econometric model. The papers are all excellent and should be read as a set to gain the full flavor of the issues at hand.

*Professor of Economics and Finance, Purdue University and University of Florida

Inflation and Housing

Movement from a low- to a high-inflation economy (or from a high to a higher) and the resultant rise in nominal interest rates poses two problems for owner-occupied housing. First, given the standard fixed-payment mortgage contract, the demand for real owner-occupied housing falls even for households whose nominal disposable income is rising proportionately with the prices of houses and other goods. This is because the ratio of the monthly payment on new mortgage contracts to the price of houses increases due to the higher mortgage rate.[1] Second, given our financial structure, financial disintermediation occurs and funds shift away from the mortgage market, thereby reducing housing through higher mortgage rates, credit rationing, or both. This is the old portfolio mix problem of the nonbank depository intermediaries. The intermediaries cannot afford to raise their deposit rates by enough to keep funds because they have to pay the higher deposit rate on a greater portion of their liabilities than the proportion of their assets on which they are earning a higher mortgage rate. This problem is, however, only temporary (in the absence of deposit rate ceilings). At some point the intermediary's assets will all have rolled over at the higher mortgage rate, and the higher deposit rate will then be feasible. The first problem — the lower demand for real housing — is permanent and is thus more troublesome.

[1]The payment per period on a standard mortgage contract is computed from the present value formula equating the amount of the mortgage, M, with the discounted values of the future payments, P_s, which are themselves constant (for a standard mortgage) over the life, n periods, of the mortgage:

$$M = \frac{P_s}{1+R} + \frac{P_s}{(1+R)^2} + \ldots + \frac{P_s}{(1+R)^n}, \qquad \text{(i)}$$

where R is the interest rate on a per period basis. (While lenders may not be familiar with this equation, it is what underlies those tables listing the payment per thousand dollars for a given maturity and interest rate.) Collecting terms and solving for P_s, we obtain an explicit expression for the payment:

$$P_s = \frac{M}{\sum_{i=1}^{n} \frac{1}{(1+R)^i}} \qquad \text{(ii)}$$

Since the value of the mortgage itself can be written as the product of the loan-to-value ratio, M/V, and the value of price of the house, V, the ratio of the payment to the value of the house is:

$$\frac{P_s}{V} = \frac{(M/V)}{\sum_{i=1}^{n} \frac{1}{(1+R)^i}} \qquad \text{(iii)}$$

Given the loan-to-value ratio and the life of the mortgage, the ratio of the payment to the price of the house rises as R increases (each of the n terms in the denominator is smaller).

The intermediary problem of the cyclical shift in funds into and out of the mortgage market is also less troublesome because we have designed means of offsetting it. I refer specifically to the activities of the FHLB, FNMA, and all the other agencies recently created to aid the mortgage market. Table I suggests just how successful these activities have been in supporting the flow of mortgage funds. Column (1) indicates the net inflow of deposits at savings and loan associations (SLAs) and mutual savings banks (MSBs) and column (2) presents the net purchase of home mortgages by these two institutions and federally sponsored credit agencies (FSCAs). Note that the sharp decline in deposits flows in 1968 and 1969 was accompanied by a 40 percent increase in mortgage purchases. Also, the $17 billion decline in inflows in 1973, the largest on record, had virtually no impact on mortgage purchases.

In addition to modifying the cyclical impact on housing of the intermediation-disintermediation cycle, the activities of these government agencies have provided secular support for the home mortgage market during the last decade. The sum of the home mortgage holdings of the agencies and FHLB advances to SLAs has increased from $8.5 billion at the end of 1965 to $46.7 billion at the end of 1973. These activities have been responsible for the one percentage point decline in the home mortgage rate relative to the corporate bond rate that occurred during this period.[2]

Thus, policies have evolved to protect housing from many of the difficulties caused by inflation and cyclical movements in interest rates. The question arises, however, as to whether the protection is being provided in a reasonably efficient and equitable manner. Issuing nonmortgage securities and purchasing mortgages does lower mortgage rates, but it also raises costs to nonmortgage borrowers, including the Treasury itself. Mortgage rate subsidies are a direct drain on the Treasury. Regarding equitability, binding ceilings on deposits at savings institutions, in conjunction with restrictions against selling open market securities in small denominations (most specifically, the $10,000 limit on Treasury bills), result in low-income households earning a below-market interest rate. If revisions in the mortgage contract can lead to a reduction in the activities of FSCAs and Treasury subsidies more generally and a removal of deposit rate ceilings, a strong case can likely be made for the revisions.

The Model Simulations

The interim report by Jaffee, Modigliani and Kearl (JMK) I received was an unusually precise and candid discussion of the alternative methods of introducing different instruments into the MPS model and the possible difficulties and weaknesses inherent in the various methods. In contrast to the usual journal article, one could determine exactly what they proposed

[2]See Patric H. Hendershott and Kevin C. Villani, "The Impact of Governmental Financial Policies on Financial Markets and Housing Expenditures," presented at the Winter Meeting of the Econometric Society, San Francisco, December 1974.

Table 1

DEPOSIT FLOWS AND MORTGAGE PURCHASES
(billions of dollars)

	Deposit Inflows at SLAs and MSBs	Mortgage Purchases of SLAs, MSBs and FSCAs
1965	12.1	10.3
1966	6.1	7.4
1967	15.8	9.0
1968	11.6	10.3
1969	6.5	13.0
1970	15.3	13.2
1971	37.7	23.4
1972	42.7	32.2
1973	25.2	31.0

to do and all was not expected to be accompanied by wine and roses. The job was truly professional. I have since learned that this was an in-house working paper not meant for external consumption. I only hope that the final product does not degenerate into the customary obtuse and optimistic report.

Since the model simulations were not available to me before today, I will address myself to the general design of the experiments rather than the results. Two graduated-payment simulations were to be run. In the first the rate of graduation was set at the average inflation rate during the 1962-73 period; in the second the observed inflation rate during the previous year was employed. Neither of these seems to be the conceptually correct rate. The purpose of graduation is to make the initial mortgage payment independent of changes in the mortgage rate due to changes in the rate of inflation.[3] Since the inflation rate imbedded in the mortgage

[3]To see the impact of an inflation-induced rise in the mortgage rate on the initial payment, we rewrite (i) in footnote 1 as:

$$M = \frac{(1+u)Pg}{(1+R)} + \frac{(1+u)^2 Pg}{(1+R)^2} + \ldots + \frac{(1+u)^n Pg}{(1+R)^n},$$

where Pg is the initial graduated payment which is assumed to grow at rate u. Solving for Pg we obtain:

$$Pg = \frac{M}{\sum_{i=1}^{n} \left(\frac{1+u}{1+R}\right)^i} = \frac{M}{\sum_{i=1}^{n} \left(\frac{1}{1+\frac{R-u}{1+u}}\right)^i}$$

since $\frac{1+u}{1+R} = 1/\left(1+\frac{R-u}{1+u}\right)$ For large values of n and small values of u, equal changes in R and u have a negligible impact on Pg. Moreover, the payment on a similarly sized and maturity standard *fixed*-payment mortgage when R reflects no inflation is Pg.

rate should be the expected rate of the inflation over the life of the mortgage, the graduation rate should be equal to this rate. And as I understand it, the model generates such an expected rate based on past rates of inflation.

Two variable-rate simulations were also to be run. In the first, payments and interest were to be tied to the new issue "short-term" mortgage rate. In effect, the variable-rate mortgage is a one-period mortgage where the rate is closely tied to the commercial paper rate. In the second simulation, interest is still tied to the short-term mortgage rate, but the monthly payment varies with the more stable long-term mortgage rate. This reduces the risk to borrowers of large increases in payments.

A more useful experiment, I would think, would be to keep the monthly payment fixed entirely, simply adjusting the maturity of the mortgage as the short-term interest rate changes. This fixed-payment, variable-rate mortgage is, in fact, the only type of variable-rate mortgage that federally chartered SLAs are allowed to issue at the present time. Such an instrument eliminates the risk of varying payments to borrowers, while still allowing the interest income of lenders, and thus their interest expense, to move with market rates in general. Moreover, the default risk to lenders should not be that great. A sustained period of interest rate increases, such as we have experienced during the past two decades, is likely to be accompanied by accelerating inflation and thus considerable increases in prices of houses. Even if households were to repay none of the principal on their mortgage (their fixed payment were to be entirely interest), they would accumulate considerable equity in the house via inflation. And this is what is relevant to the lender.

The meaning of the long-term mortgage rate and the method by which it is determined is, I might add, somewhat uncertain. Since only variable-rate mortgages are assumed to be issued during the period, long-term conventional mortgages are virtually nonexistent by the end of the period. Further, since no conventional mortgages are issued and since the secondary market for mortgages is not active, few conventional mortgage transactions of any kind occur.

Before closing my discussion of the design of the experiments, I wish to comment on proposed modifications of the deposit rate-setting equations. If savings institutions purchase only the new short-term variable-rate mortgages and issue only one-period deposits and if savings institutions are profit-maximizers, then it seems appropriate to tie the deposit rate to the current short-term mortgage rate. The purchases are so limited by assumption, but we know that the liabilities of these institutions have been lengthened considerably in the last decade in an attempt to better match the maturity of assets and liabilities of SLAs. Over half of SLA deposits are in special accounts, many of which have a maturity of four years or more. Thus the deposit rate should still depend on past, as well as the current, mortgage rates. The appropriateness of the profit-maximizing assumption is also questionable. Well over half of SLA and almost all of MSB deposits are at mutual institutions that are legally required to pay virtually all of their income out as interest to depositors. It would be better to assume that nonbank institutions generally set deposit rates so as to equate average, not marginal, revenue and costs. Such behavior easily explains the observed long distributed lags on asset yields in most rate-setting equations. Moreover, given that conventional mortgages are assumed to coexist with the new variable-rate mortgage, a deposit rate equation based on *average* revenues and costs include past conventional mortgage rates (RM) as well as current and past new variable-rate mortgage rates (RMS).[4]

Whether or not one believes the results of the simulations depends on one's confidence in the underlying financial model as well as in the ingenuity of the authors in manipulating the model to reflect the introduction of the new instrument. While the ingenuity of the authors is beyond dispute, my confidence in the underlying model is limited. First, I have doubts about the workings of the mortgage market. For one thing, the exogenous treatment of FHLB advances and home mortgage purchases by FSCAs seems inappropriate. Advances are more determined by the endogenous desires of SLAs than by the FHLBs, and FSCA mortgage purchases are clearly responsive to developments in the home mortgage market.[5] For another, the mortgage market is defined broadly to include multifamily and even commercial and farm mortgages. Thus substitution between home and other mortgages has no impact on the home mortgage rate.[6] Even more discouraging are the unreasonable simulation results obtained by Jaffee himself. A purchase of mortgages by FSCAs leads the private financial intermediaries to sell more mortgages than were purchased.[7] Not only does this seem unreasonable by itself, it implies a reduction in the supply of mortgages in the face of a decline in the mortgage rate. Second, the failure of changes in relative security supplies to have *any* impact on the term-structure of interest rates in the MPS model is disturbing. The substitution of a new short-term mortgage instrument for the present long-term one is equivalent to a continuing "debt-management" operation of gigantic proportions. One would expect short-term rates (commercial paper, Treasury bill) to rise significantly relative to long

[4]An appropriate equation might be:

$$RD_t = \alpha_1 \Sigma_i w_i RM_{0-i} + \alpha_2 \Sigma_j w_j RMS_{t-j} - \alpha_3; \ t=0, 1, \ldots n,$$

where $\Sigma w_i = \Sigma w_j = 1$, $\alpha_1 + \alpha_2 = 1$ ($\alpha_1, \alpha_2 > 0$), and α_1 declines over time, reflecting the declining importance of conventionals in the portfolios of the institutions.

[5]Hendershott and Villani, *op. cit.*

[6]This is particularly bothersome for analysis of life insurance companies which liquidated $8 billion of home mortgages in the 1967-72 period, while purchasing $20 billion of other mortgages. The all-inclusive definition of the mortgage market also leads one to ask why the mortgage stock does not depend on components of capital other than housing.

[7]Dwight M. Jaffee, "An Econometric Model of the Mortgage Market," Chapter 5 in Gramlich and Jaffee (eds.), *Savings Deposits, Mortgages, and Housing* (Lexington: D.C. Heath and Company, 1972) pp. 170-72.

rates (corporate, municipal). Further, since interest payments on the variable-rate mortgage are effectively tied to the commercial paper rate, they would be significantly greater. Because the relation between long and short rates is purely "expectational" in form in the MPS model, the debt-management effect on interest rates and the resulting impact on interest payments of variable-rate mortgages will be missed entirely, even in the general equilibrium or total model simulations in which the commercial paper and corporate rates are allowed to vary. Analysis of the effects of introducing new mortgage instruments in the context of alternative financial models would be useful.