

ALTERNATIVE MORTGAGE INSTRUMENTS: THEIR
DISTRIBUTIONAL EFFECTS ON HOMEOWNERSHIP,
HOUSING CONSUMPTION, AND THE USE OF
MORTGAGE CREDIT

by

Kerry Dean Vandell

B.A., Rice University
1970

M.M.E., Rice University
1970

M.C.P., Harvard University
1973

Submitted in Partial Fulfillment
of the Requirements for the
Degree of Doctor of
Philosophy
at the
Massachusetts Institute of
Technology

July, 1977



Signature of Author
Department of Urban Studies and Planning,
July 26, 1977

Certified by
Thesis Supervisor

Accepted by *[Signature]*
Chairman, Ph.D. Committee

ABSTRACT

ALTERNATIVE MORTGAGE INSTRUMENTS: THEIR DISTRIBUTIONAL EFFECTS ON HOMEOWNERSHIP, HOUSING CONSUMPTION, AND THE USE OF MORTGAGE CREDIT

Kerry Dean Vandell

Submitted to the Department of Urban Studies and Planning on July 26, 1977 in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

This thesis examines the proposition that different mortgage instruments currently being suggested as alternatives to the current instrument of housing finance (the FRM), can have very different consequences for different classes of households, affecting their likelihood of becoming homeowners, their consumption of housing, and their use of mortgage credit. These consequences arise from certain mortgage-related characteristics affecting the cash-flow cost of mortgage credit. In particular, it is suggested that certain types of variable-rate mortgages (VRM's) may have quite adverse effects on lower-income or non-upwardly mobile households, whereas such instruments as the graduated-payment mortgage (GPM) and the price-level-adjusted mortgage (PLAM) would perform better than the current instrument for all households.

Chapter I develops this proposition. The current policy arguments against the introduction of the VRM are examined, and the extent to which these policy arguments have already been evaluated empirically is investigated. Little previous empirical work is found. Several alternative mortgage instruments suggested as replacements or supplements to the FRM are introduced and compared according to their present value and cash flow characteristics.

Chapter II develops from economic theory a structural model of the demand for homeownership, housing consumption, and mortgage credit. In an imperfect financial market, it is found that not merely the present value costs,

but also the cash-flow costs of mortgage credit consumption are important influences on demand. The theoretical model is applied to the scenario of the introduction of the VRM, either as a replacement or a supplement to the FRM. It is found that the effect of VRM introduction on different classes of households is dependent on supply and demand elasticities associated with certain mortgage-related characteristics. Finally, it is shown that in a competitive mortgage market situation with a number of instruments being offered as alternatives to the FRM, greater efficiency will result, but not all households will necessarily have greater access to lower cost credit than prior to alternative instrument introduction.

Chapter III develops the homeownership model. Ordinary-least-squares regression analysis is carried out on cross-sectional data derived from the 1970 Survey of Consumer Finances. Two mortgage-related characteristics--the initial payment level and the uncertainty in the expected payment burden trend--are found to be negatively related to the probability of homeownership. Alternative instrument simulation using the model suggests that the GPM and the PLAM would encourage slightly higher rates of homeownership among all household classes than currently exist under the FRM. On the other hand, the VRM, especially a VRM indexed to a short-term interest rate series, is predicted to reduce homeownership rates.

Chapter IV develops the model of housing consumption by homeowners. The initial payment level is found to be the only mortgage-related variable tested which affects housing consumption levels. Again, simulation results suggest that the GPM and the PLAM would be superior to the FRM in encouraging housing consumption and the VRM would be inferior. Furthermore, the VRM is predicted to have an adverse impact upon lower-income, young, elderly, and poor households.

Chapter V develops the models of mortgage credit usage and down payment levels. The initial payment level and the expected trend in mortgage payment burden are suggested to be influences upon mortgage credit usage, whereas only the expected payment burden trend is suggested as an influence upon the down payment level. The comparative size of the mortgage-related coefficients in these models identifies the degree of household sensitivity to mortgage characteristic changes and provides evidence about household response to them in its home purchase and

financing decisions. Alternative instrument simulation results again suggest that the GPM and PLAM will induce the highest per-household mortgage consumption levels with little redistributive impact. However, the FRM is predicted to require the lowest down payment. The VRM, again, does not perform well, and is predicted to result in little use of mortgage credit and high down payments.

Chapter VI summarizes the estimation and simulation results of the previous three chapters. Each instrument (including the FRM) is ranked according to its predicted impact on homeownership levels, housing consumption, mortgage credit usage, and debt-equity ratios. Predicted distributional impacts are also tabulated. Certain types of instruments, especially the GPM and the PLAM, are found to perform better than the FRM in several categories with little redistributive effects. The VRM, on the other hand, is found to perform significantly worse and to adversely affect lower income, young, elderly, and black households. The chapter concludes with a series of policy recommendations based upon results of the preceding analysis.

Thesis Supervisor: Arthur P. Solomon

Title: Associate Professor of Urban Studies and Planning

ACKNOWLEDGEMENTS

My years spent at M.I.T. and the Joint Center for Urban Studies have been without doubt the most enriching and satisfying of my life. They were also enjoyable, thanks in large part to my wife, Debbie, who provided support, encouragement, and a sympathetic ear during those years in Cambridge while we struggled through our respective doctoral programs. She deserves the first and greatest thanks.

To Art Solomon, my dissertation advisor and mentor since my admission to M.I.T., goes my deepest gratitude for his advice, recommendations, and help in negotiating the path through graduate school and through this thesis. Acting as his teaching assistant and working with him on consulting activities provided me with strengthened understanding of housing policy and applied research. His constant insistence on quality work and rigor in analysis considerably improved my research skills. His comments on earlier drafts of this thesis were invaluable.

To my dissertation committee also must go a special thanks. My discussions with Don Lessard and his enlightened comments on my earlier drafts greatly enhanced my understanding of issues associated with residential

finance. Rich Cohn was always available to respond to ideas. Kent Colton provided considerable insight into the institutional realities of the mortgage market.

Several faculty members not on my committee also aided in the conceptualization and evaluation of this dissertation. Most particularly, I wish to thank Mike O'Hare and Stan Fischer. Ben Harrison of M.I.T. deserves special credit for his continuous encouragement of my research efforts through graduate school.

I also appreciate the association I have had with my colleagues at M.I.T. and the Joint Center. Howard Bloom, Eric Brown, Ken Rosen, Margie Dewar, Lynn Sagalyn, and Penny Schaefer all provided help in a variety of areas associated with this work.

The National Science Foundation, the Bemis Fund, and the Joint Center for Urban Studies helped finance my graduate education. Additional funding for computations was provided by the Department of Urban Studies and Planning. Vicki Davidson is gratefully recognized for her excellent typing of the final draft.

Finally, I wish to express my gratitude to both my parents and my parents-in-law for their support and encouragement during my years of graduate school.

TABLE OF CONTENTS

ABSTRACT	ii
ACKNOWLEDGEMENTS	v
TABLE OF CONTENTS	vii
INDEX OF FIGURES	xii
INDEX OF TABLES	xv
Chapter	
I. INTRODUCTION	1
The Importance of Distributional Considerations in Alternative Mort- gage Introduction.	1
The Inadequacies of Past Research. . .	3
The Present Study.	6
Alternative Instruments Considered	10
Conclusion	16
Footnotes--Chapter I	18
II. MODEL DERIVATION AND USE IN EXPLAINING THE EFFECTS OF ALTERNATIVE MORTGAGE INTRODUCTION	22
Theoretical Development.	22
The Household's Opportunity Set. . .	22
The Cost of Mortgage Credit.	25
Present Value Component	26
Cash Flow Component	29
Weighting of Present Value Versus Cash Flow Costs	30
Mortgage Cost Response to Supply and Demand Changes.	32
Supply Changes.	32
Demand Changes.	33
The Cost of Equity Financing	34
Present Value Component	34
Cash Flow Component	35
The Optimum Debt-Equity Locus.	36
The Optimum Level of Housing Consumption	36

TABLE OF CONTENTS--(Contd)

IV.	AN EMPIRICAL INVESTIGATION OF THE EFFECT OF ALTERNATIVE MORTGAGE INSTRUMENTS UPON HOUSING CONSUMPTION.	153
	Introduction	153
	Short-Run Models	155
	Long-Run Equilibrium Models	159
	The Model	162
	Issues	162
	Model Theory	163
	Model Specification	165
	Estimation Procedures	169
	Estimation Results	170
	Income and Asset Influences.	171
	Socioeconomic and Housing Market Influences.	174
	Mortgage-Related Influences.	175
	Simulation Results: The Introduction of Alternative Mortgage Instruments.	176
	Aggregate Results.	179
	Distributional Results by Income	183
	Distributional Results by Age.	186
	Distributional Results by Race	188
	Summary of Findings and Policy Implications	190
	Footnotes--Chapter IV	192
V.	AN EMPIRICAL INVESTIGATION OF THE EFFECTS OF ALTERNATIVE MORTGAGE INSTRUMENTS UPON THE FINANCING OF RESIDENCES.	193
	Introduction	193
	The Model	198
	Issues	198
	Model Theory and Specification	199
	Estimation Procedures.	203
	Estimation Results	203
	Income and Asset Influences.	206
	Socioeconomic and Housing Market Influences.	208
	Mortgage-Related Influences.	209
	Simulation Results: The Introduction of Alternative Mortgage Instruments.	211
	Aggregate Effects.	216
	Mortgage Credit	218
	Down Payment Levels	219
	Distributional Effects by Income	222
	Mortgage Credit	222
	Down Payment Levels	225
	Distributional Effects by Age of Head	228

TABLE OF CONTENTS--(Contd)

Mortgage Credit.	228
Down Payment Levels.	230
Distributional Effects by Race.	234
Mortgage Credit.	234
Down Payment Levels.	234
Summary of Findings and Policy Impli- cations	238
Footnotes--Chapter V.	242
VI. CONCLUSIONS AND POLICY IMPLICATIONS	245
Empirical Results	245
Homeownership	249
Purchasing and Financing Adjustments.	250
Simulation Results	253
Policy Recommendations.	262
Footnotes--Chapter VI	264
APPENDIX I	
Continuous Time Stochastic Processes.	266
APPENDIX II	
Derivation of Mortgage-Related Parameter Expressions for Alternative Mortgage Instruments	278
APPENDIX III	
Mathematical Derivation of the Models for Homeownership, Housing Consumption, and Mortgage Versus Down Payment Financing	293
APPENDIX IV	
Variable Derivation from Computer Data-Tape	304
APPENDIX V	
Auxiliary Regressions: Determinants of Mortgage-Related Variables.	320
APPENDIX VI	
Tables: Aggregate and Distributional Mortgage-Related Variable Values and Simulation Results	325

TABLE OF CONTENTS-- (Contd)

BIBLIOGRAPHY. 334
BIOGRAPHICAL NOTE 343

INDEX OF FIGURES

		<u>Page</u>
2-1	Household Opportunity Set for Home Financing	24
2-2	Marginal Cost of Mortgage and Down Payment Financing of Homeownership as a Function of the Level of Financing	28
2-3	Marginal Cost of Capital for Homeownership as a Function of Unit Price	37
2-4	Locus of Optimal Financing Combinations vs. Level of Borrowing and Down Payment	38
2-5	Total Return to Homeownership as a Function of Unit Cost	40
2-6	Marginal Return to Homeownership as a Function of Unit Cost	40
2-7	Optimal Level of Housing Consumption as the Intersection of the Marginal Return to Homeownership and the Marginal Cost of Capital	42
2-8	Market Adjustment to the Exclusive Marketing of the VRM by Higher-Income Upwardly Mobile Households	51
2-9	Market Adjustment to the Exclusive Marketing of the VRM by Lower-Income, Non-Upwardly Mobile Households	52
2-10	Market Adjustment--FRM, Higher-Income Upwardly Mobile Households: The Case of Concurrent Marketing with the VRM	62
2-11	Market Adjustment--FRM, Lower-Income, Non-Upwardly Mobile Households: The Case of Concurrent Marketing with the VRM	62
2-12	Market Adjustment--VRM, Higher-Income, Upwardly Mobile Households: The Case of Concurrent Marketing with the FRM	63

INDEX OF FIGURES--(Cont'd)

	<u>Page</u>
2-13 Market Adjustment--VRM, Lower-Income, Non- Upwardly Mobile Households: The Case of Concurrent Marketing with the FRM	63
3-1 Predicted Change in Homeownership Rates (from FRM Rates) by Instrument as a Function of Family Income	131
3-2 Predicted Change in Homeownership Rates (from FRM Rates) by Instrument as a Function of Age of Household Head	134
3-3 Predicted Change in Homeownership Rates (from FRM Rates) by Instrument as a Function of Race	138
4-1 Predicted Change in Housing Consumption Levels Among Homeowners (from FRM Levels) by Instrument as a Function of Family Income	184
4-2 Predicted Change in Housing Consumption Levels Among Homeowners (from FRM Levels) by Instrument as a Function of Age of Household Head	187
4-3 Predicted Change in Housing Consumption Levels Among Homeowners (from FRM Levels) by Instrument as a Function of Race	189
5-1 Predicted Change in Per-Household Mortgage Credit Usage (from FRM Levels) by Instrument as a Function of Family Income	223
5-2 Predicted Change in Down Payment Levels (from FRM Levels) by Instrument as a Function of Family Income	226
5-3 Predicted Change in Per-Household Mortgage Credit Usage (from FRM Levels) by Instru- ment as a Function of Age of Family Head	229

INDEX OF FIGURES--(Cont'd)

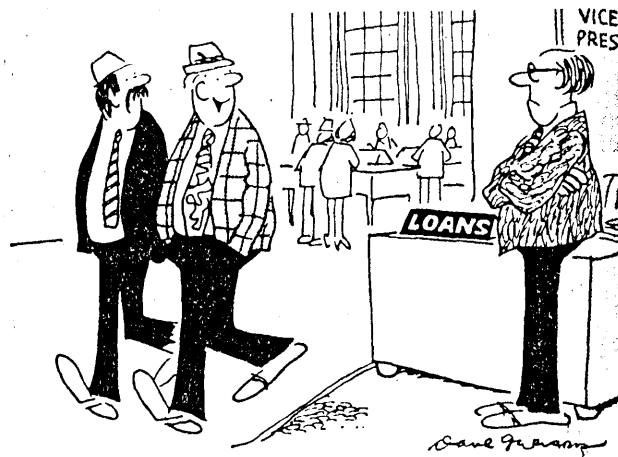
	<u>Page</u>
5-4 Predicted Change in Down Payment Levels (from FRM Levels) by Instrument as a Function of Age of Family Head.	232
5-5 Predicted Change in Per Household Mortgage Credit Usage (from FRM Levels) by Instrument as a Function of Race.	235
5-6 Predicted Change in Down Payment Levels (from FRM Levels) by Instrument as a Function of Race	236
A1-1 Price (p) as a Continuous Time Stochastic Process	269

INDEX OF TABLES

		<u>Page</u>
3-1	Summary of Previous Econometric Homeownership Studies	78
3-2	Aggregate Simulation Results: Predicted Equilibrium Rate of Homeownership (OWN) by Mortgage Instrument	127
4-1	Comparative Model Structures: The Demand for Housing	157
4-2	Aggregate Simulation Results: Predicted Housing Consumption Levels by Instrument	180
5-1	Comparative Model Structures: The Demand for Mortgage Credit	195
5-2	Mean Values for Initial Payment Level (P) and Expected Trend in Payment Burden (π) and Predicted Mortgage Credit Usage (MORT), Down Payment Level (DOWN), and Debt-Equity Ratio by Mortgage Instrument.	217
5-3	Equilibrium Debt-Equity Ratios by Instrument for Selected Household Groups.	224
6-1	Estimated Coefficients, Beta Values, and Elasticities of Mortgage-Related Variables for Homeownership, Housing Consumption, Mortgage Financing, and Down Payment Equations.	248
6-2	Mortgage Instrument Performance Ranking by Instrument and Merit Class	254
A1-1	Assumed Stochastic Processes for Component Variables	270
A6-1	Mean Values of Initial Payment Level by Income, Age, and Race for All Instruments	326

INDEX OF TABLES--(Cont'd)

	<u>Page</u>
A6-2 Expected Change in Future Payment Burden by Income, Age, and Race for All Instruments	327
A6-3 Uncertainty in Future Payment Burden by Income, Age, and Race for All Instruments	328
A6-4 Simulation Results--Predicted Homeownership Levels by Income, Age, and Race for All Instruments.	329
A6-5 Simulation Results--Predicted Per-Household Housing Consumption by Homeowners by Income, Age, and Race for All Instruments	330
A6-6 Simulation Results--Predicted Per-Household Mortgage Credit Usage by Homeowners by Income, Age, and Race for All Instruments	331
A6-7 Simulation Results--Predicted Per-Household Down Payments by Homeowners by Income, Age, and Race for All Instruments	332
A6-8 Simulation Results--Predicted Debt-Equity Ratios by Income, Age, and Race for All Instruments	333



"He hates me. I've got a 6¼ percent mortgage and it still has 10 years to go!"

CHAPTER I

INTRODUCTION

The Importance of Distributional Considerations in Alternative Mortgage Introduction

On three separate occasions since 1969, the Federal Home Loan Bank Board (FHLBB) has asked Congress to allow it to permit federally chartered savings and loan associations to offer variable-rate mortgages (VRM's) as an alternative to the standard fixed-nominal-interest rate level-payment instrument (the FRM).¹ These efforts have been spurred by thrift institutions seeking to remedy periods of disintermediation, initiated by tight money conditions and exacerbated by the inflexible yield of the FRM. On all three occasions the FHLBB proposals have been rejected by Congress, largely due to the potential of adverse distributional consequences to certain groups of households seeking to obtain credit for homeownership.²

Opponents of the introduction of the VRM and other alternative mortgage instruments postulate that these distributional consequences would occur both on the supply and the demand sides of the mortgage credit market. On the

supply side, certain alternative instruments could produce a change in default risk as perceived by lenders among certain borrower groups. This would be caused by expectations of changes in the level and uncertainty of future payment burdens and rates of equity accumulation under these instruments. For those instruments and borrowers among whom default risk expectations would increase, lenders would revise their underwriting practices--requiring higher down payments, lower maximum monthly payments or loan amounts as a fraction of income, or stricter credit standards. This would have the effect of rationing many households, now barely capable of sustaining homeownership under the FRM, out of the mortgage market.³

The major demand-side arguments against the introduction of alternative mortgage instruments are that many of these instruments alter the mortgage payment stream and rate of amortization and shift some or all of the risk associated with future interest rate changes from the lender to the borrower. The increased risk must be borne by the borrower in the form of increased uncertainty in future payment levels, and rates of amortization.⁴ Many potential borrowers would find these new conditions difficult to budget around and would naturally respond by lowering their demand for housing, mortgage credit, and homeownership.

The Inadequacies of Past Research

We have established that distributional arguments, whether they are valid or not, are acting as major roadblocks to alternative mortgage instrument introduction. What evidence exists to provide a basis for these arguments? Plausible theoretical hypotheses, such as those in the previous subsection, have been formulated both to support and refute the possibility of adverse distributional consequences.⁵ However, theoretical analyses, although they are certainly important in presenting the logical possibilities, can only go so far. As one researcher has noted:

Clearly, most of these issues [associated with alternative mortgage instrument introduction] ultimately can only be resolved empirically, for there is no other way to choose between the logical possibilities presented.⁶

It is clear that the development of empirical models relating mortgage instrument characteristics to equilibrium levels of homeownership, housing consumption, mortgage credit usage, and down payment levels is necessary before any more definitive conclusions can be drawn about the possible distributional effects of alternative mortgage instrument introduction. However, because of data limitations and the lack of experience with alternative instruments in this country, such empirical work has not been forthcoming:

°No regression studies which have estimated the determinants of homeownership have investigated the effect

of any mortgage-related variables, in spite of the fact that lenders' underwriting standards are widely recognized to be major constraints upon homeownership. Recently some computer simulation work has been carried out which attempts to determine the relationship between mortgage characteristics and homeownership. Most of these studies (e.g., Gelfand (1970)) are concerned with the FRM only; therefore, the form of the mortgage parameters (loan-to-value ratio, interest rate, amortization period) are useful only in evaluating changes in the terms of the FRM and not in evaluating the impact of alternative instruments. The loan-to-value ratio, the contract interest rate, and the amortization period could be identical for two types of mortgage instruments; yet the demand and supply response to these instruments could differ radically, owing to differences in the expected trend and uncertainty in their payment streams and their rates of equity accumulation over time. One recent study by Follain and Struyk (1977) simulates homeownership increases under alternative instruments. However, it only considers the lowered-initial payment-level effect of such instruments and then only indirectly by assuming that the lowered payment is equivalent to an increase in income and then observing the income effect on homeownership.

°Regression studies which have related housing consumption to mortgage-related variables have been longitudinal aggregate studies which are incapable of investigating the microeconomic impact of changing debt payment streams under alternative instruments on individual households, whose income streams are subject to variation and uncertainty. Moreover, as discussed above, the mortgage-related parameters used in these studies are capable of evaluating changes in the FRM only. These studies are also all "short-run" in that they are primarily interested in explaining the role of mortgage terms in temporary credit rationing during tight money periods. All long-run equilibrium longitudinal studies except one have not included mortgage-related variables, according to the conventional wisdom that pure inflation-produced changes in the terms of mortgage credit should have no long-run impact on housing consumption or mortgage credit usage.⁷ The sole exception is Kearl (1975) who includes a measure of the "tilt" in the real payment stream under inflation in a simulation of the macroeconomic effects of alternative mortgage instrument introduction.

°Regression studies which have related mortgage credit usage to mortgage-related variables have uniformly been longitudinal aggregate studies and, again

with the exception of Kearn (1975), have not included those mortgage-related variables which could be used to evaluate the effects of alternative instrument introduction. There are no empirical studies of the effect of mortgage conditions on an individual household's down payment decisions.

The Present Study

The purpose of this dissertation is to address the above expressed void in research efforts through an empirical evaluation of the impact of alternative mortgage instrument introduction upon the levels of homeownership, housing consumption, and mortgage vs. down payment financing by individual households. The primary hypothesis of the study is that different instruments can have very different consequences for different classes of households depending upon the way in which mortgage characteristics interact with individual household income and income expectations. To test this hypothesis two major tasks will be undertaken:

1. Model Derivation and Estimation: A series of models will first be derived theoretically and estimated using multiple regression techniques. These will relate the probability of homeownership and the levels of housing consumption, mortgage credit usage, and down payment to income, assets, and other socioeconomic characteristics of the household and to certain parameters associated with

mortgage credit. The objective of this estimation will be to show that in an imperfect credit market, mortgage parameters other than the contract rate can affect homeownership, housing consumption, and mortgage credit usage.

The data set to be used for analysis is the 1970 Survey of Consumer Finances, which is disaggregated and cross-sectional, making possible the estimation of micro-economic impacts on individual households.⁸ This data set also allows computation of income and price expectations, income and price uncertainty, household liquid assets, and housing finance parameters such as down payment, contract interest rate, amortization period, and house value.

The mortgage-related characteristics to be included in the models are the initial annual payment per \$100 borrowed, the expected trend in payment burden (payment-to-income ratio), and the uncertainty in the expected trend in payment burden. The trend and uncertainty variables have been defined as the trend and stochastic terms of a continuous time stochastic process for the payment burden.⁹

2. Model Simulation: The estimated models will then be used in a simulation exercise to predict the impact of a set of alternative mortgage instruments upon homeownership, housing consumption, and mortgage vs. down payment financing. This task will be carried out by calculating

the mortgage-related characteristic values for each instrument and substituting these values into our estimated models.¹⁰

Three important points should be emphasized at this time which affect the strength and interpretation of our simulation results. The first is that our empirical estimations will represent structural demand relationships only and not general or even partial equilibrium results. A general equilibrium analysis would require a macro-economic model of the U.S. economy, and would be an extremely complex undertaking. A partial equilibrium model would require separate supply relationships. Such relationships cannot be adequately constructed in our model due to limitations on data availability. Thus the contract rate, period of amortization, and other mortgage-related parameter values are not determined endogenously. This means that upon alternative instrument introduction, we must make certain judicious assumptions about these parameter values after the economy adjusts to the new instruments. The strength of the simulation results is reduced accordingly.

The second point which affects the strength of our simulation results is that because of data limitations they are incapable of completely taking into account both cash flow and present value influences on borrower demand. Present value influences reflect the "price" of mortgage

credit and would be the only mortgage-related influences which matter in a perfect financial market. Cash flow influences reflect the disutility associated with the mortgage payment stream as it relates to the borrowing household's income stream. Such influences can be highly important in imperfect financial markets and are the justification behind those arguments concerning differential reaction to alternative instrument introduction. Thus our simulation results will be somewhat biased as a result except under certain restrictive assumptions. This issue will be discussed in depth in Chapters II and III.

The third point affecting interpretation of our simulation results relates to the likelihood that any alternative mortgage introduction would be a supplement rather than a replacement for the FRM. When considering the effects of alternative instruments upon homeownership, housing consumption and mortgage credit usage, the really relevant question is the impact of a mix of mortgage instruments, rather than a single instrument. To properly attempt to answer such a question, general equilibrium information must be available about the relative interest rate and maturities at which such a mix of instruments would be offered after the economy adjusts to the introduction. Such an analysis is extremely complex and beyond the scope of this research. We show later that our analysis makes possible a crude estimation of the most desirable type

of instrument for each household after judicious assumptions about contract rates and maturities are made. However, our basic analysis remains the evaluation of the impact of a single instrument if it alone were offered. Thus, if we wish to interpret our results in terms of a mix of instruments, rather than concluding a certain instrument would have a very adverse impact on a certain class of households, we should conclude that that instrument would very likely not be chosen by such households.

Alternative Instruments Considered

The set of alternative instruments to be simulated included (1) the standard variable-rate mortgage (VRM), (2) the graduated payment mortgage (GPM), (3) the price level adjusted mortgage (PLAM), and (4) the income-linked mortgage (ILM). The first three instruments--especially the VRM--have been most often suggested as supplements or replacements for the FRM. The ILM has been little discussed and will very likely never be introduced. However, it presents an interesting case in our simulations and has been included on that basis. Following is a brief definition and discussion of each instrument according to differences in debt payment streams and expected impacts on borrowers and lenders.

(1) The standard VRM has a fixed contract maturity, as does the FRM, but the payment level fluctuates

according to changes in the mortgage interest rate over time, which is tied to an "index" short-term rate (VRMS) or long-term rate (VRML). This variation in the payment stream is the characteristic of this instrument sought after by lenders, since payment levels would tend to increase during high interest-rate, tight-money periods when disintermediation ordinarily becomes a problem under the FRM. Increased payment levels imply less of a squeeze on the lender's cash flow, hence making possible more mortgage loans. In addition, they make possible a higher interest paid on savings, thus further reducing disintermediation.

The VRM is potentially undesirable to certain borrower groups for the same reason it is desirable to lenders. The uncertainty in future payment levels under the VRM makes budgeting by borrower households more difficult, especially if their income fluctuations are great or are highly uncorrelated with the payment fluctuations. This increased uncertainty could also affect lending behavior insofar as it adversely affects default risk by certain groups.

The initial payment level of the standard VRM would very likely be somewhat lower than that for the FRM at equilibrium, since the instrument would theoretically have to be offered at a "discount" to entice borrowers to accept the increased interest-rate risk. In California,

where the VRM has been offered by some state-chartered thrift institutions for years, this discount in the constant rate was originally one-fourth to one-half percentage point, although more recently, VRM's are being offered at the same rate as the FRM.

(2) The GPM would, like the FRM, be a fixed nominal-interest-rate, fixed-maturity instrument. However, it differs from the FRM in that it specifies an a priori graduated, rather than level, nominal payment stream. The graduation rate can theoretically be adjusted for individual household needs: the lender could lower the initial payments to help low-current-income households such as young professionals, or lower later payments to help high-current-income, but low-expected-income households, such as those about to retire. These adjustments, of course, would change the expected trend in future payment burdens in a direction which would tend to offset the effects of the adjusted initial payment level. However, if the graduation rate is properly chosen, the net advantage can be maximized for each household. Regardless of the graduation rate chosen, the uncertainty associated with future payment burdens under the GPM is identical to that under the FRM, since the payment stream is fixed a priori. Taking all those considerations together, we conclude the GPM is superior to the FRM from the standpoint of the borrower and would be expected to have a positive demand effect.

The Department of Housing and Urban Development has recently allowed introduction of the GPM on a trial basis.¹¹

From the standpoint of the lender, the GPM would have no advantage over the FRM, and could even prove slightly inferior. Payment levels under the GPM, like those under the FRM, would not adjust according to unforeseen monetary or inflationary conditions. In fact, if the lender's mortgage portfolio were somewhat undiversified with respect to mortgage origination period and rate of graduation, cash flows to the lending institution could become quite volatile under the GPM. A lender would presumably be even less willing to give a positively-graduated GPM during--or just prior--to an expanded tight money period than he would an FRM, since his immediate cash flow benefits would be lower. These points suggest the possibility that there might be negative cyclical supply effects associated with the GPM.

A second way in which the GPM could prove inferior to the FRM from the lenders' standpoint is its effect on default risk. Lower initial payments under the GPM imply not only a lower initial payment burden, which tends to reduce default risk, but also a lower rate of equity accumulation, which tends to increase default risk. The net effect of these two influences is uncertain a priori.

(3) The PLAM is characterized by initially lower nominal monthly payments which float upward according to

a price index. Due to its construction, the PLAM can be offered at the "real" interest rate. For a required nominal yield of eight percent under expected six-percent inflation, it could be offered at somewhere around two percent. As under the FRM and the standard VRM, the maturity is held constant.

The PLAM would be more desirable than the VRM to borrowers for three reasons. First, the initial payment levels would be lower than those under the VRM. Second, the expected payment stream would very likely not fluctuate as much, since prices are generally less volatile than interest rates. Finally, the PLAM could offer a relatively fixed payment burden over the life of the mortgage if nominal income rises at the rate of inflation. However, the PLAM would also prove undesirable to borrowers in one respect. It would not offer the inflationary hedge of the FRM and would not be desirable to less-upwardly-mobile households or those on fixed income because payments would increase with prices rather than remaining fixed as under the FRM.

The PLAM would be of some advantage to lenders since it would compensate for inflation-produced increases in nominal rates. In addition, to the extent that periods of inflation are correlated with tight-money periods, it would also provide some increase in cash flows during tight-money periods, thus counteracting disintermediation

and the "lending-squeeze." Individual households, however, could experience adverse lender reaction to the PLAM in those cases in which default risk is increased by the increased trend and uncertainty in expected payment burden, offsetting decreased risks due to the lower initial payment.

(4) The ILM is a nominal-interest-rate mortgage with payments indexed to each individual's income stream. Thus the maturity of the instrument necessarily floats to allow for differences in income streams over time. A household with increasing income over time would pay off a given mortgage much sooner than one with decreasing income.

The flexible maturity of this instrument does not strictly allow the ILM to be simulated in the framework we will establish. Our framework was not successful in evaluating the effects of maturity adjustments. This restriction is acceptable as long as maturities are invariant, as they are for the VRM, the GPM, and the PLAM; and as long as the maturity effect is primarily a cash flow effect. For an instrument in which these conditions are not true, it is necessary, in order for our analytic framework to be valid, to assume maturities only vary slightly or households discount highly future mortgage payments and care little about equity accumulation rates. Such an assumption would be valid for

households interested in the consumption--rather than the investment--objective of homeownership. To analyze the ILM we have therefore necessarily made this assumption, keeping in mind, however, the above caveats.

The ILM would be very desirable to the borrower, since it totally transfers risk of future payment burden increases to the lender. If a single fraction of income were set as the index for all borrowers, it would be proportionately more beneficial to lower-income households, since they currently, on the average, spend a higher proportion of their income on housing under the FRM than do higher-income households.

The lender, however, would be less satisfied with the ILM, since he must bear full risk associated with individual income fluctuations. Thus there could be adverse supply consequences for certain groups of borrowers if the ILM were introduced as the sole replacement for the FRM (a possibility which is highly unlikely). These supply consequences, however, may be mitigated by the fact that: (1) cash flows overall could tend to increase during periods of credit stringency to the extent that nominal incomes were correlated with interest rates, and (2) controlling the payment burden could serve to reduce default risk.

Conclusion

It is hoped that this analysis will contribute toward a resolution of the debate over consumer

acceptability of alternative mortgage instruments. Empirical estimation of the sensitivity of homeownership levels, housing consumption, and mortgage vs. down payment financing the type and terms of the credit instrument could render valuable assistance in formulating public policies aimed both at fostering a healthy thrift industry and at equitable treatment of all classes of households.

The remainder of this dissertation shall be organized as follows. Chapter II shall theoretically derive the models to be estimated empirically and shall use these models to formally outline the major contentions set forth by opponents of alternative mortgage introduction. The third through fifth chapters shall present the estimation and simulation results for the models of homeownership, housing consumption, and mortgage-vs.-down payment-financing respectively. In the final chapter, conclusions will be drawn about the overall desirability of certain alternative instruments for meeting consumer needs, and policy implications of the research will be noted.

FOOTNOTES--CHAPTER I

¹In 1969; on August 10, 1972; and on August 1, 1974.

²In 1969 the FHLBB withdrew the proposal to authorize federally chartered savings and loan associations to introduce VRM's after extended correspondence with Congressional Banking Committee members. The 1972 proposal, backed by recommendations of a 1969 study of the savings and loan industry (the Friend Report) and the 1971 Report of the President's Commission on Financial Structure and Regulation (the Hunt Commission Report), again was rebuffed by Congress. The 1974 proposal was turned down after extensive hearings in both houses of Congress, at which numerous representatives of consumer groups testified against the measure. Congressman Ferdinand St. Germain (D., R.I.), Chairman of the House Banking Subcommittee on Financial Institutions Supervision, Regulation, and Insurance, which considered the proposal, condemned it as "a cruel hoax on the consumer."

³See, for example, the testimony of Steven M. Rohde, in U. S. Congress, House of Representatives, Committee on Banking, Currency and Housing, "Variable Rate Mortgage Proposal and Regulation Q," Hearings before the

Subcommittee on Financial Institutions Supervision, Regulation, and Insurance, 94th Congress, 1st Session, April 8, 9, and 10, 1975, pp. 374-376.

⁴Ibid., pp. 376-377.

⁵For a theoretical argument in favor of alternative instruments, see Cohn and Fischer (1974), pp. 54-57, and U. S. League of Savings Associations (1974).

⁶Prell (1971), p. 19; see also Kearl (1975), p. 15.

⁷For a discussion of short-run versus long-run studies of housing and mortgage credit demand, see Kearl, Rosen, Swan (1974).

⁸Described in Katona, et al., (1971).

⁹See Appendix I for a brief introduction to the use of continuous time stochastic processes in mortgage research.

¹⁰See Appendix II for a formal derivation of these parameter values for each instrument.

¹¹Under the Housing and Community Development Act of 1974, HUD can undertake an experimental financing program by insuring innovative mortgage instruments with

amortization plans which correspond to anticipated variations in family income (Section 245 of the National Housing Act). In August, 1976, the Senate Subcommittee on Housing and Urban Affairs of the Senate Banking Committee held hearings on the need to use this power to restructure the traditional mortgage instrument to meet current needs. HUD testified at those hearings on their public solicitation of alternative mortgage proposals and their serious consideration of the experimental introduction of some form of the GPM.

¹²In the extreme, a household with a low enough expected income stream paying a small enough fraction of its income as mortgage payment would never pay off the principal on its mortgage and, in fact, could build up ever-increasing interest charges. The permitted income fraction and the expected income stream of each borrower, therefore, impose an effective limit on the permitted lending ceiling which would allow the mortgage to be fully amortized in a reasonable period of time (30-40 years).

¹³Consider the following example, which illustrates the possibility of erroneous conclusions by making this assumption in extreme situations: a household paying a certain percentage of its income for mortgage payments under an ILM would find all loan amounts equally desirable under our model, in spite of the fact that above a certain

loan ceiling the household will never amortize the mortgage and at loan amounts above this ceiling will continue to build up an ever-increasing balance due to unpaid accumulated interest.

CHAPTER II

MODEL DERIVATION AND USE IN EXPLAINING THE EFFECTS OF ALTERNATIVE MORTGAGE

INTRODUCTION

This section (1) will develop using economic theory the models of homeownership, housing consumption, and mortgage and down payment financing to be estimated and (2) will use this theoretical framework to summarize the arguments of proponents and opponents of alternative instruments about reaction to these instruments by different household types.

Theoretical Development¹

The Household's Opportunity Set

Consider a household which is evaluating the home-purchase decision. It must answer three interrelated questions: (1) whether it wants to rent or own, (2) the expenditure it wishes to make on a home, and (3) the extent to which it wishes to invest its own equity in the house or finance through borrowing.

Figure 2-1 indicates its universe of options for financing a home, with the level of borrowing (B) indicated on the vertical axis and the level of equity funds (E) on the horizontal axis. Any given level of total

housing expenditures $V_0 = (E_0 + B_0)$ can be represented by a straight-line isoquant with a slope of minus one, since the levels of borrowing and down payment are perfect substitutes for financing a given volume of housing.

The household's opportunity set is limited by several constraints. First, the level of its liquid assets A_0 prevents a down payment beyond that level. Second, its income, Y_0 , is an absolute limit on the monthly mortgage payments it can make and hence the level of borrowing it can incur ($B(Y_0)$). The asset constraint is more likely to be effective than the income constraint, since a household generally spends 25 percent or less of its income on mortgage payments but often spends virtually all of its liquid assets on a down payment.²

A second set of institutionally imposed supply constraints may also effectively limit the opportunity set of the household. On the equity side, the lending institution, to lower its risk exposure, may require the down payment to be a certain fraction of the total unit price ($E_0 = \beta V_0$). This fraction for conventional loans is generally in the 10- to 25-percent range. This constraint is shown as the radial labeled D_{\min} in Figure 2-1 with a slope of $\frac{1-\beta}{\beta}$.

On the borrowing side, again to reduce its risk exposure, the lending institution may set a maximum ceiling on the level of monthly mortgage payment burden the

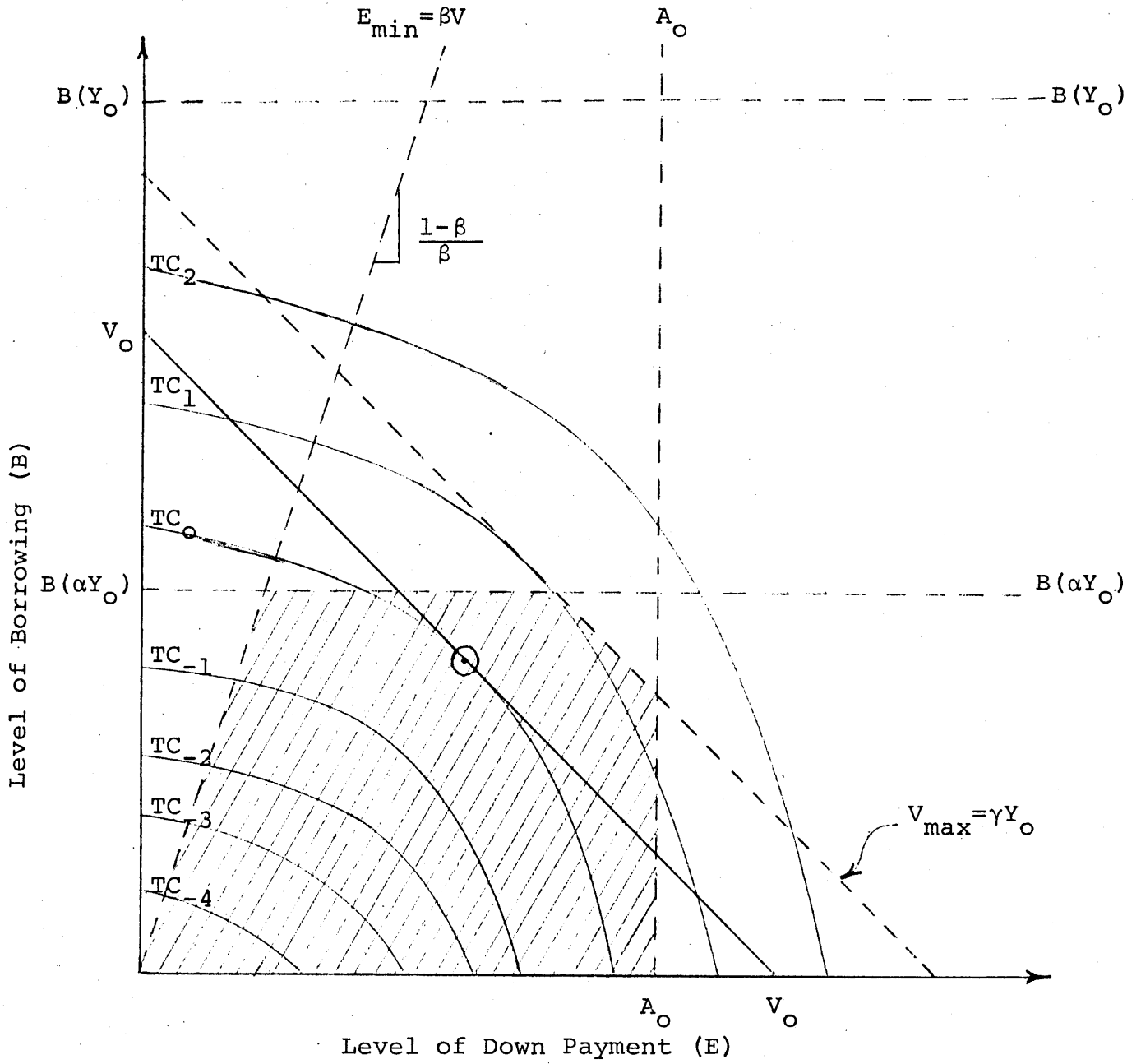


Fig. 2-1 Household Opportunity Set for Home Financing

household may incur, usually as a certain fraction α of monthly income. The general rule-of-thumb for this constraint is usually one week's pay or 25 percent. This constraint is shown as the horizontal line labeled B (αY_0) in Figure 2-1.

Finally, on both the borrowing and equity side, the lending institution may seek to limit its risk exposure by setting a maximum ceiling on the size home the household may purchase, usually as a certain multiple γ of annual income. γ is generally considered to be in the 2.0 to 2.5 range. This constraint is shown as the isoquant $V_{\text{Max}} = \gamma Y_0$ in Figure 2-1.

Note that all constraints can vary for different individuals and over time, depending on lenders' rules-of-thumb, borrowers' income and wealth positions, and mortgage terms. The constrained opportunity set for the household is shown as the shaded area in Figure 2-1.

We shall next consider the costs of equity and borrowed funds.

The Cost of Mortgage Credit

When we use the term mortgage cost in this dissertation, we are describing a household's perceived disutility associated with present and future mortgage payments. This disutility arises from two sources which we shall call the present value and the cash flow components.

Present Value Component

The present value or yield component is the disutility associated with the present value of future expected mortgage payments (net after income tax reductions) discounted at a discount rate which is characteristic of each household along with any uncertainty in that present value. It is this component which is the only component relevant in a perfect financial market. In fact, in a perfect financial market, if the household discount rate is equal to the market rate, the cost of mortgage credit is equal to the amount borrowed, and the cost of homeownership collapses to the price of the house (down payment + mortgage principal = price of house). The present value component totally ignores the pattern of future mortgage payments (except for tax treatment effects) as they relate to the household's income stream. If this component were the only component being considered as the "cost" of mortgage credit, then such instruments as the FRM, ILM and GPM offered at the same contract rate would only differ according to the time preference of individual households and according to the slightly different income-tax reduction patterns under each instrument. The VRM and PLAM would differ from the FRM also according to their respective risks associated with their present values, since the future cash flow streams are unknown a priori. The present value component may be represented by the following variables: normalized initial payment level, expected trend in payments, uncertainty in future payments, expected duration of payments and uncertainty

in that duration, and finally permanent income, assets, and demographic characteristics which proxy for the household's discount rate and the shape of its present-value utility function.³

It would be expected that the marginal present value cost of mortgage credit would rise with the level of borrowing, both for a constant debt-equity ratio and for a constant total purchase price. ($MC_B|_{B/E=Constant}$ and $MC_B|_{B+E=Constant}$ in Figure 2-2.) This would be because of supply considerations. In the first case, lenders would perceive higher risk of default from a household which commits itself to a larger mortgage, hence a larger payment burden, and would respond by increasing the contract rate on mortgage credit available to the household. In the second case, not only is the household committing itself to higher payment burdens, the debt-equity ratio is increasing with an increase in borrowing. This would imply the household would have a lower equity stake in the household thus increasing the risk of default, and the lender would be exposed to a higher risk of loss in case of default. The lender would therefore respond by increasing his contract (gross) interest rate to yield him an expected net yield to offset the risk.

The terms of mortgage credit would not only be functions of the level of borrowing. Lenders would also be expected to adjust their contract rates and allowed maturities according to current and permanent income, assets, and demographic characteristics of the household, characteristics of the housing stock and neighborhood,

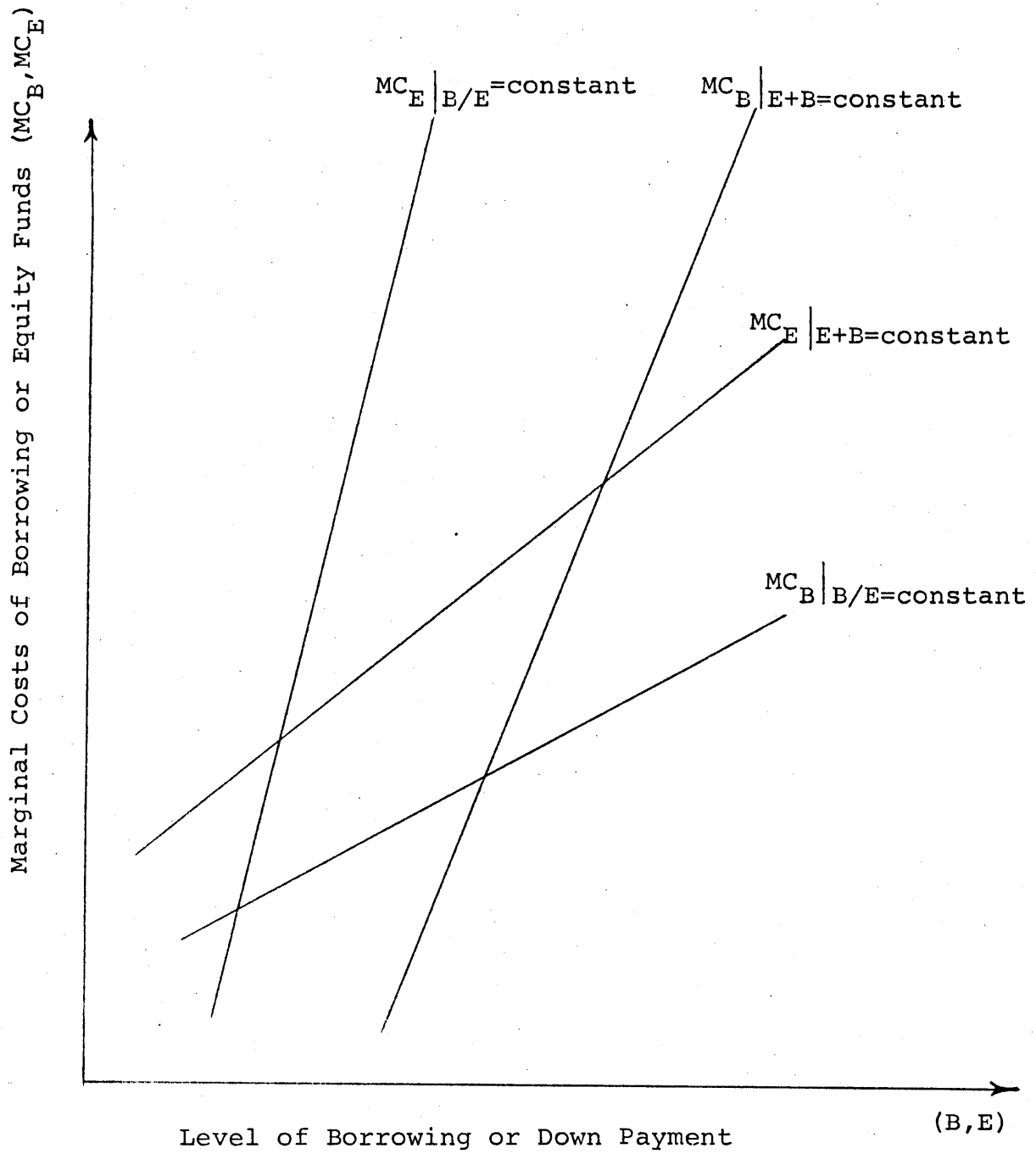


Fig. 2-2 Marginal Cost of Mortgage and Down Payment Financing of Homeownership as a Function of the Level of Financing

and characteristics of the mortgage payment stream which might affect the risk of default. In the case of the mortgage payment stream, the cash flow characteristics of each instrument type and the rate of equity accumulation become relevant. A final factor which affects lender behavior with respect to setting contract rates and maturities is the yield in the market. To be offered on the market, the mortgage must be competitive in terms of net yield relative to its risk for instruments of comparable liquidity.

Cash Flow Component

The cash flow component of mortgage cost is the present value of the disutility associated with expected mortgage payments as they relate to future borrower income, discounted at each household's discount rate, along with any uncertainty in that present value. This component is relevant in an imperfect financial market where borrowers cannot readily and costlessly convert income to assets, assets to income, current income to future income, or future income to current income. It may represent insolvency due to cash flow mismatch, a forced adjustment of other desired expenditures to offset adverse payment/income outcomes, or simply the inconvenience and discomfort of having to engage in further financing in order to match income and housing expenditures.

The cash flow component may be represented by the following variables: initial payment level, current income, expected trend in payment burden (payment-to-income ratio), uncertainty in future payment burden trend, expected duration of payments and uncertainty in that duration, and, finally, permanent income, assets and demographic characteristics which proxy for the household's discount rate and the shape of its cash-flow utility function. These variables completely describe the disutility associated with the stream of mortgage payments as they relate to income and any uncertainty in that stream.⁴ The factors discussed above, which affect the terms of mortgage credit offered by lenders are relevant here also, since an increase in the contract rate and shortening of maturity also affect cash flow costs (see the MC_B schedules in Figure 2-2).

Weighting of Present Value Versus Cash Flow Costs

We conclude that a complete description of mortgage cost must include both the present value and cash flow components. The relationships between these components and the various variables which make them up may be very different for different instrument types.

It is also important to recognize that these relationships might vary for different households. Different households might place very much different emphasis on

either the present value or the cash flow component in their demand for homeownership, housing, and mortgage credit. Homeownership as a good has both investment and consumption aspects. The stock of housing is an asset with a certain risk and return associated with it. The flow of housing services is a consumption good. Certain households, for example mobile households headed by business executives, place greater emphasis on the investment, hence the present value, aspect. Others, for example blue-collar households with expectations of a long period of tenure, are concerned more with the flow of services over time from the stock and the neighborhood, possibly with little or no perception or concern about a monetary return from their asset. Hence they would place greater emphasis on the cash flow component.

This implies that household characteristics (permanent income, wealth position, and demographics) can have an additional influence on homeownership, housing, and mortgage credit demand apart from their indirect influence upon discount rates. This influence is the relative weighting of present value (or investment) versus cash flow (or consumption) cost components. It may be taken into account through inclusion of a present-value versus cash-flow weighting function, proxied by permanent income, assets, and demographic variables or, equivalently, by generalizing discount rates to make them functions not

only of time but also of the source of the cost (present value versus cash flow).

Mortgage Cost Response to Supply and Demand Changes

Now that our cost of mortgage credit relationship has been developed, let us observe how this relationship behaves in response to changes in supply and demand conditions.

It would be expected that the marginal cost of mortgage credit would rise with the level of borrowing both for a constant debt-equity ratio and for a constant total purchase price. ($MC_B|_{B/E=Constant}$ and $MC_B|_{E+B=Constant}$ in Figure 2-2.) Both supply and demand changes influence this trend.

Supply Changes

On the supply side, lenders would perceive higher risk of default from a household which commits itself to a larger mortgage, hence a larger payment burden, and would respond by increasing the contract rate on mortgage credit available to the household. The increase in the contract rate in turn raises both the present-value and cash-flow cost to the household.

Lenders would respond differently to different households according to each household's current and permanent income, assets, and demographic characteristics, its credit record, the characteristics of the housing stock and neighborhood, and the way in which its income interacts with the mortgage payment stream.

Note that the slope of the marginal cost schedule representing a constant debt-equity ratio in Figure 2-2 is less steep than that representing a constant purchase price. This is because in the first case, the down payment level is also increasing, keeping the borrower's equity stake in the residence constant as a proportion of the house price, which acts as a disincentive for default and reduces the lender's default risk premium. In the second case, however, not only is the household committing itself to higher payment burdens, the debt-equity ratio is increasing with an increase in borrowing. This would imply the household would have a lower equity stake in the household thus increasing the risk of default and the lender would be exposed to a higher risk of loss in case of default. The lender would therefore respond by increasing his contract (gross) interest rate to yield him an expected net to offset the risk.

Demand Changes

On the demand side, the greater the amount borrowed, the greater the mortgage payments and the resulting cash flow "squeeze" experienced by the borrower, ceteris paribus. These cash-flow effects increase the perceived disutility associated with borrowing. Again, this perceived disutility would be very different for different types of households.

The Cost of Equity Financing

Like mortgage "cost," when we speak of equity "cost" we are also describing a household's disutility associated with using current assets as a down payment. Like with mortgage cost, equity costs arise from both present value (or yield) and cash flow components.

Present Value Component

A household using current assets for a down payment sacrifices a certain return on alternative uses of those funds. The greater use it makes of equity financing, ceteris paribus for a given amount of housing, the higher the opportunity cost of returns foregone, since the household will substitute for its lower yielding returns first ($MC_E | E+B=Constant$ schedule in Figure 2-2).⁵ Such present value effects are the only effects relevant in perfect financial markets. They are concerned only with the pure investment alternative uses of assets. They are totally independent of the form of mortgage credit used for purchase. Their only relationship to the household's income and other characteristics is the effect these characteristics have on the household's discount rate. The equity present value cost component may be represented by the level of equity funds committed, since ceteris paribus the opportunity cost of equity funds rises for each household with the level of investment, and by the permanent income,

assets, and demographic characteristics of the household which proxy for the household's discount rate. The opportunity cost of equity funds would be expected to vary over time according to conditions in the economy.

Cash Flow Component

The equity cash flow cost component recognizes that households hold liquid assets as a contingency hedge against certain unforeseen circumstances (i.e., loss of job, sudden increase in expenses) as well as for investment purposes. An increase in down payment would lower liquid assets accordingly and reduce this contingency hedge, thus increasing perceived risk and household disutility. Note that the equity cash flow cost component would be dependent upon mortgage instrument characteristics as they relate to borrower income, since loss of a contingency hedge would be more serious in the event of an expected large or highly volatile payment burden. Thus, the equity cash flow cost component may be represented by the following variables: the level of down payment, the level of liquid assets, the initial payment level and current income, the expected payment burden together with any uncertainty in that burden, the expected duration of payments, and the discount interest rate, proxied by permanent income, assets, and demographic characteristics.

The Optimum Debt-Equity Locus

The above characteristics of the marginal cost relationships for mortgage and down payment financing imply that the isocost lines C_i drawn into our opportunity set in Figure 2-1 have the shape shown, bowing outward from the origin. Furthermore, demand theory tells us, given a level of housing consumption V_0 , the household will consume optimally at that combination of mortgage and down payment financing which will minimize its costs; that is, at the tangent of the isocost line to the isoquant line. Since the isoquant slope is minus one, at this point the marginal cost of equity funds equals the marginal cost of borrowed funds and their common value is the marginal cost of capital with a slope of minus one.⁶

As we increase the level of housing consumption, the marginal cost of capital increases (MC_C in Figure 2-3), and the ratio of debt to equity funds changes according to the configuration of the isocost surface (locus C in Figure 2-4), which in turn is dependent upon the relative supply elasticities of the two types of funds.

The Optimum Level of Housing Consumption

Now we turn to the question of the optimal level of housing consumption. In demand theory, the consumer will increase his consumption of a good to that point

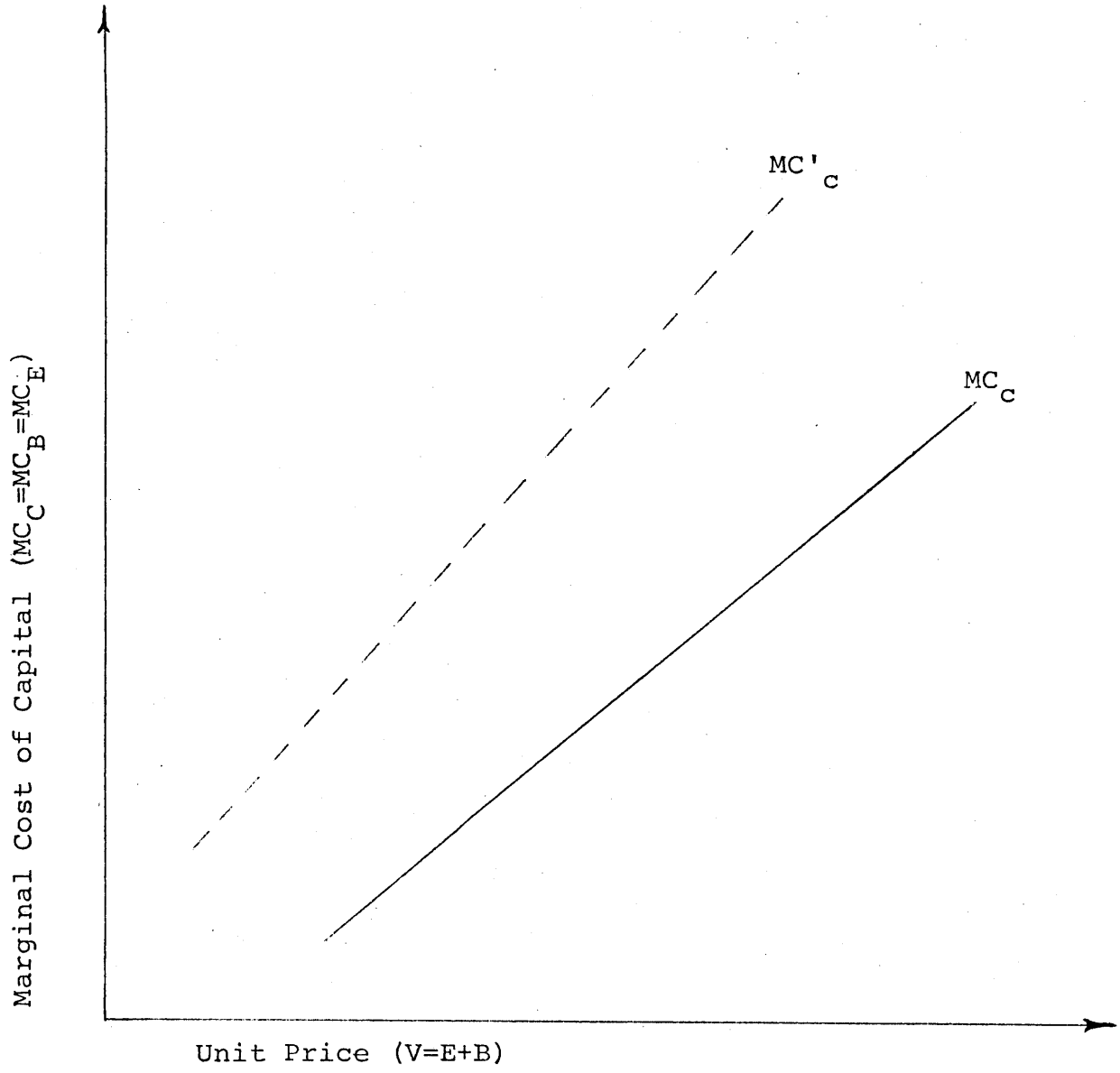


Fig. 2-3 Marginal Cost of Capital for Home-ownership as a Function of Unit Price

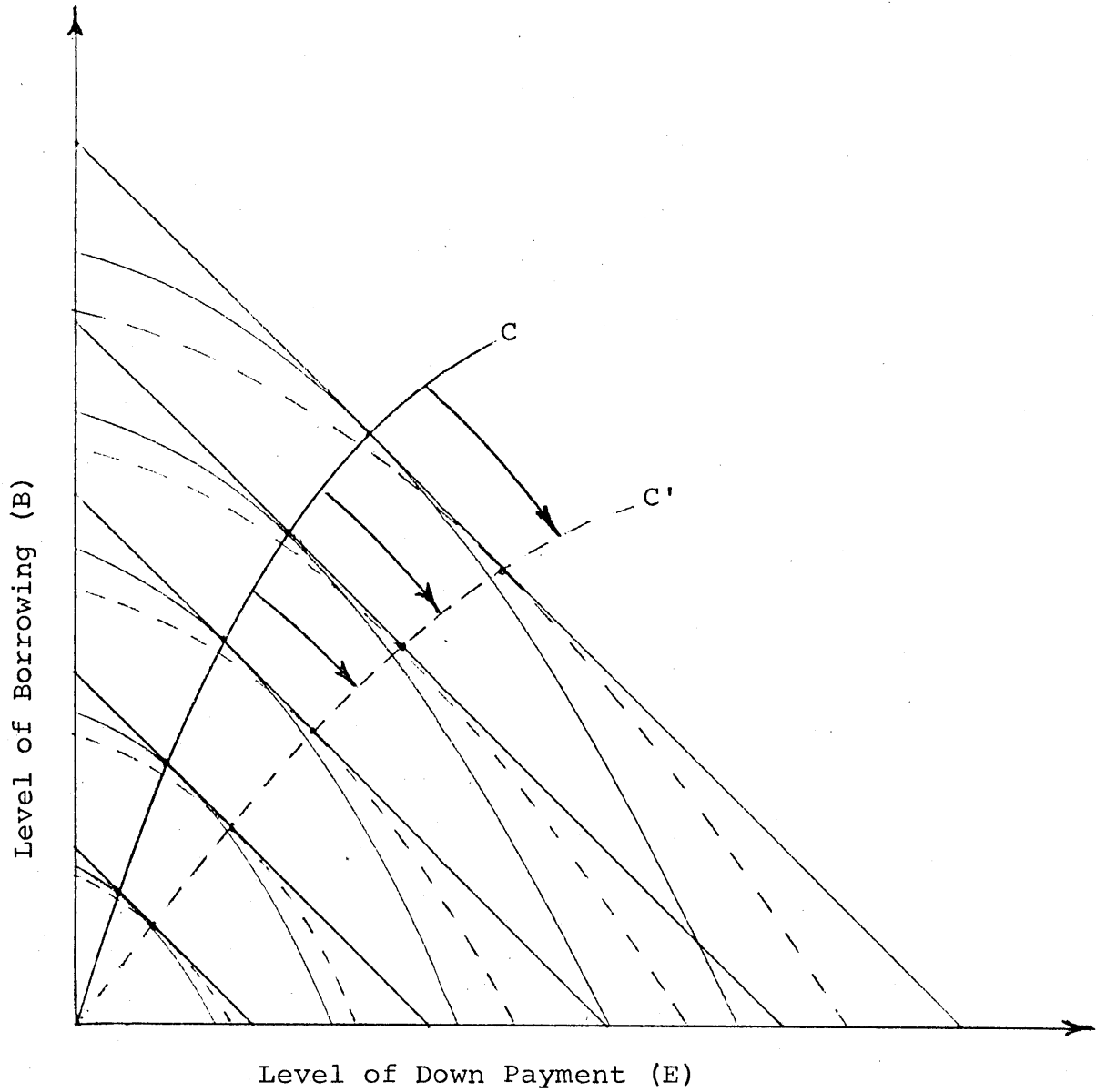


Fig. 2-4 Locus of Optimal Financing Combinations vs. Level of Borrowing and Down Payment

where his marginal cost equals his marginal return from consuming an additional unit of the good. The marginal return to owner-occupied housing in our theoretical treatment can be thought of as the present value of the stream of future net utility associated with homeownership together with any uncertainty in that present value. Such utility has two components. The first is an investment component associated with the appreciation of the stock. The second is a consumption component associated with the owner's level of satisfaction derived from consumption of housing services over time and from the state of homeownership.⁷ The non-mortgage costs of homeownership, including the opportunity cost of renting, are also relevant considerations in determining the net investment and consumption utilities associated with the return on homeownership. As discussed previously, different households might weight the investment and consumption components differently.

To derive the characteristics of the marginal return to homeownership function, we shall first examine the total return to homeownership. The total return to homeownership schedule is assumed to have the S shape shown in Figure 2-5, with a gradual slope in the lower price range which rapidly increases in the middle price range as neighborhoods become more stable, stock quality increases, and the net consumption utility associated with homeownership and the consumption of housing services (gross

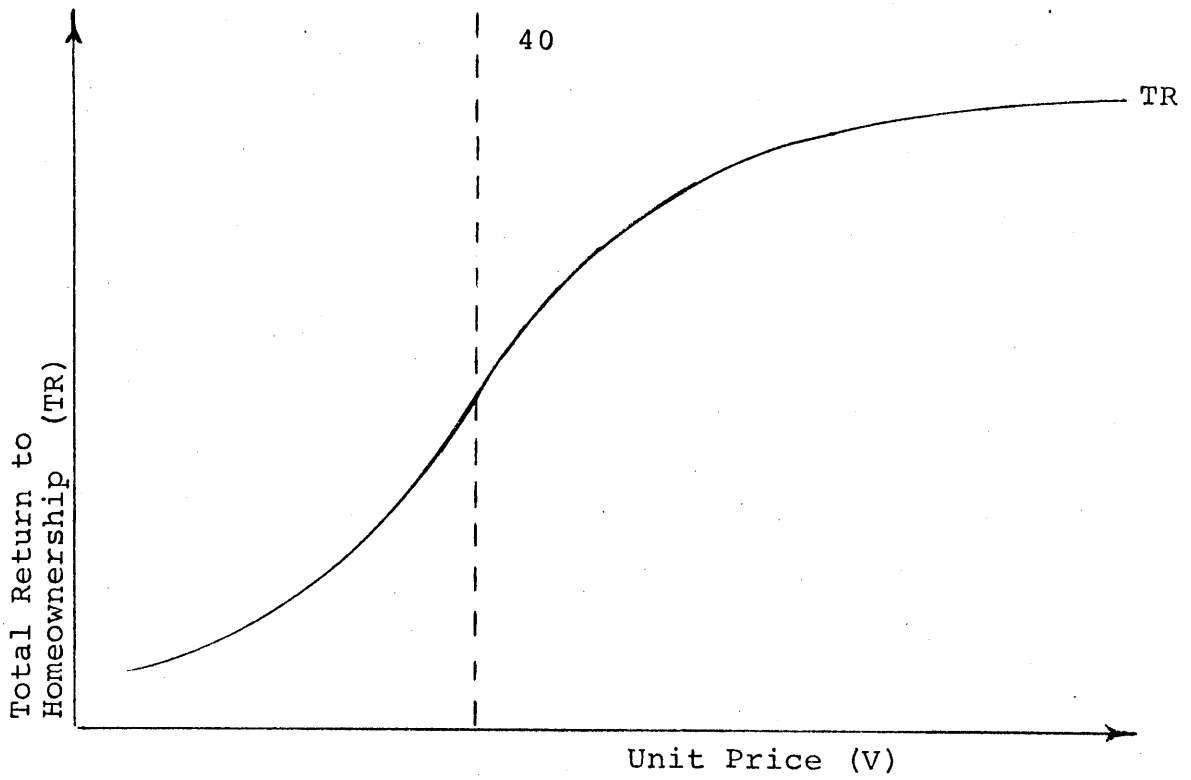


Fig. 2-5 Total Return to Homeownership as a Function of Unit Cost

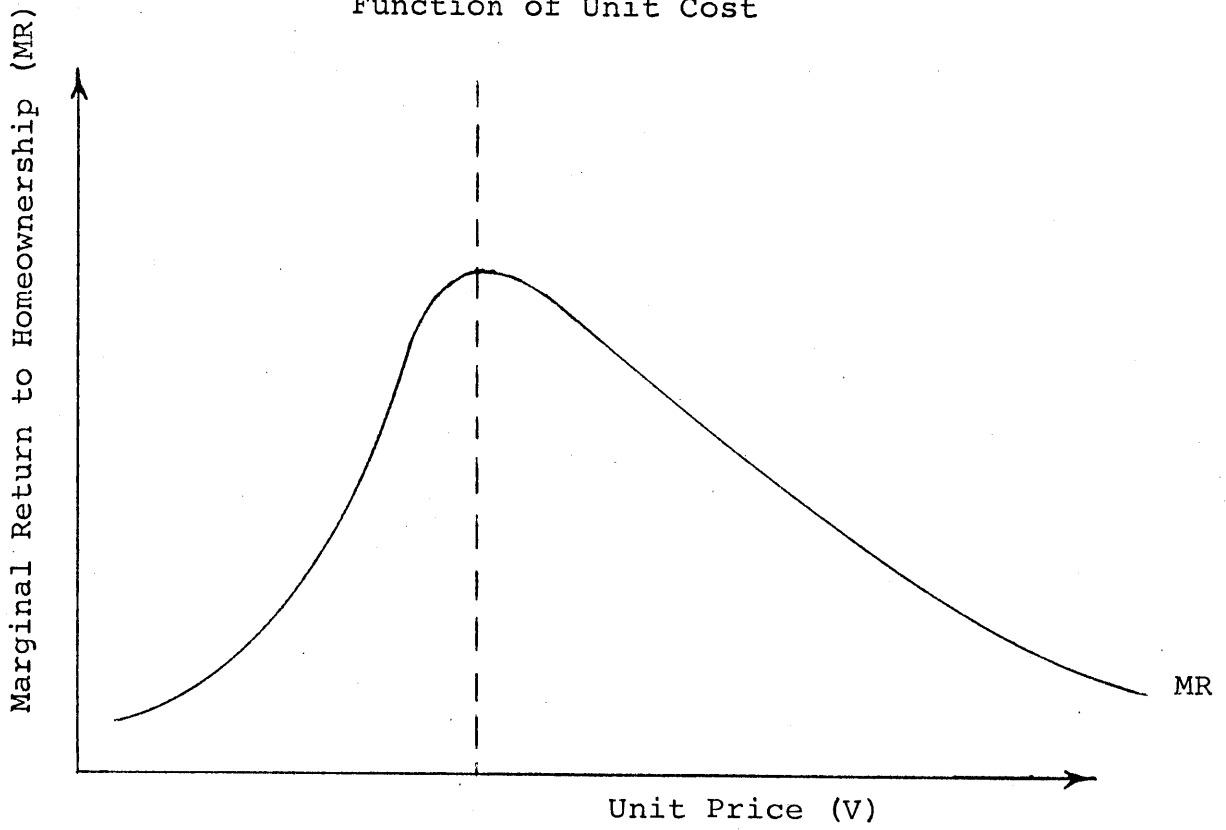


Fig. 2-6 Marginal Return to Homeownership as a Function of Unit Cost

utility less the non-mortgage costs of homeownership, including the opportunity cost of renting) experiences increasing returns to scale. It then rises at a lower rate and even declines in the higher price brackets after neighborhood stability and stock quality have been realized and after the non-mortgage costs of homeownership become burdensome to the household with limited income. Note that this total return relationship differs for each household, housing market, and housing unit and tends to fluctuate with the opportunity cost of renting.

This total-return relationship can be transformed by differentiation into the marginal-return relationship shown in Figure 2-6, with a peak in the middle price range where homeownership becomes significantly desirable. The marginal return schedule is in no way associated with the method of financing home purchase.

Combining Figure 2-3 and 2-6, and equating the marginal return to homeownership (MR) to the marginal cost of financing homeownership (MC_C) according to demand theory, we obtain the optimal level of housing consumption V_O (Figure 2-7). Note that, had the marginal cost been high enough, say at MC'_C , the marginal cost schedule would have been everywhere above the marginal return schedule, and the household would at equilibrium choose to spend zero on homeownership, instead choosing to rent. Note also if one or more of the supply constraints upon

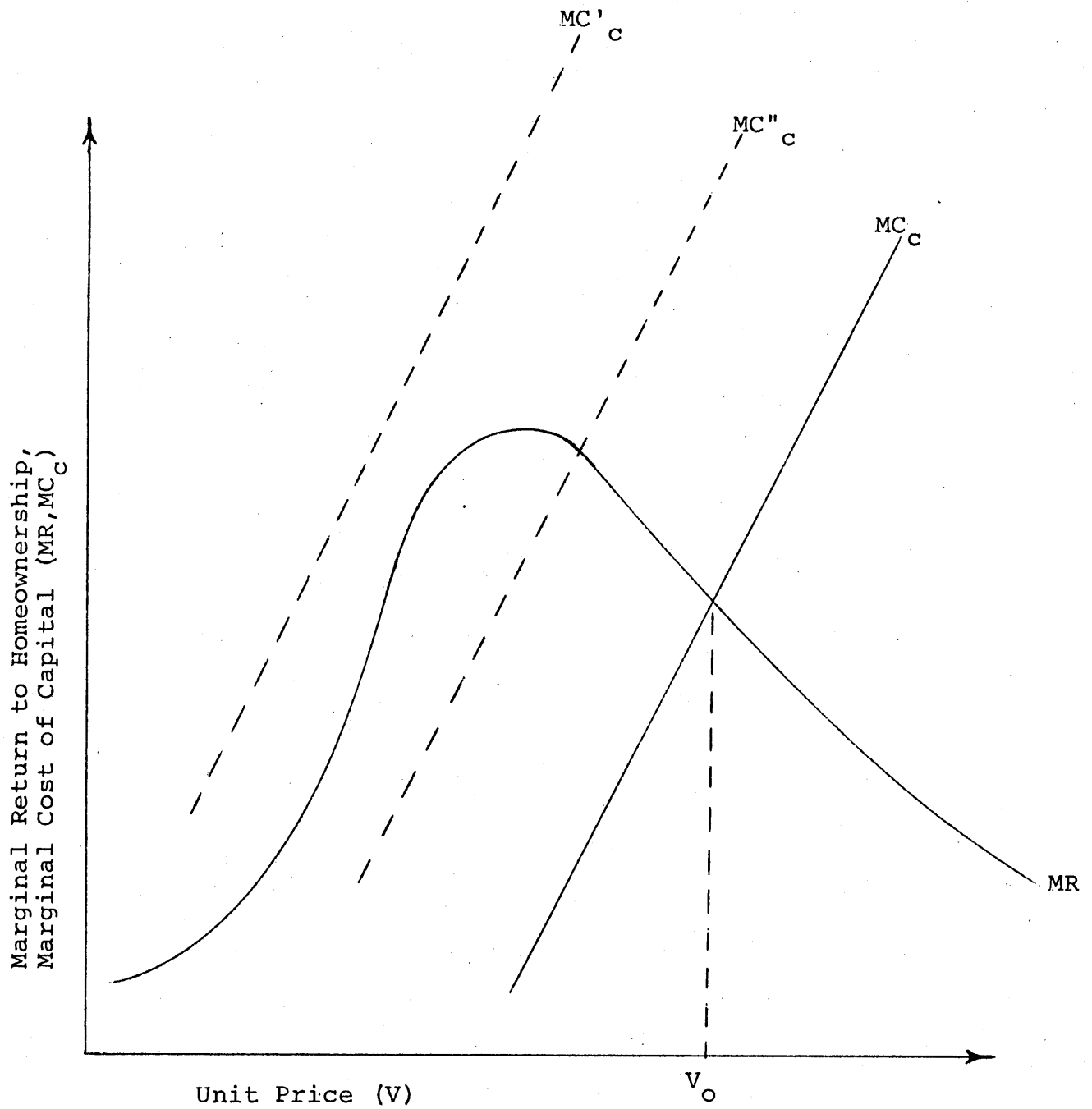


Fig. 2-7 Optimal Level of Housing Consumption as the Intersection of the Marginal Return to Homeownership and the Marginal Cost of Capital

household financing, such as required minimum down payment or maximum loan size, were effective, the marginal cost curve would in general be raised from the equilibrium level, which again would lower the quantity of housing consumed or possibly render homeownership unattractive altogether.

Thus, each household's tenure choice, optimum housing consumption level, and optimum balance of mortgage-versus-down payment financing can be determined uniquely. Theoretically, the total use of mortgage credit and level of homeownership can be obtained by aggregating these results over all households. A generalized mathematical reformulation of this conceptual development, relating homeownership, housing consumption, and mortgage and down payment financing to household income, assets, other socioeconomic variables and to mortgage credit parameters can be found in Appendix III.

Using the Theoretical Framework to Examine Market Reaction to the VRM

In this section we first present a heuristic discussion of the advantages and disadvantages of the FRM versus the VRM from the points of view of the borrower and the lender as developed in the literature and policy debates. We specifically examine the VRM since most policy debate has concerned this instrument, and the hypotheses are most articulated for the VRM. It is left

to the reader to modify this discussion for the other alternative instruments.

This discussion is intended to serve as a background to the second objective of this section, which is an outline of the theoretical hypotheses about aggregate and distributional market reaction to the VRM using the conceptual framework developed in the previous section. In this outline, we shall consider two cases--the situation in which the VRM is marketed exclusively and the situation in which it is marketed concurrently with the FRM.

VRM Versus FRM: Advantages and
Disadvantages from the Point
of View of Borrowers

The FRM offers two distinct advantages to borrowers. First, on the present-value cost side, the borrower bears no risk of future interest rate increases under the FRM. Thus there is no uncertainty associated with the present value cost of mortgage credit originating from mortgage instrument characteristics. A risk-averse household interested primarily in the investment aspects of homeownership would find this characteristic of the FRM particularly attractive.

Second, on the cash-flow cost side, the borrower under the FRM enjoys a constant nominal payment stream and maturity. He can, therefore, budget his other

expenditures with greater confidence. He experiences some uncertainty in his expected future payment burden, hence in his cash flow cost, only to the extent that his income fluctuates over time. Such a characteristic would be especially desirable to a risk-averse cash-flow constrained household.

However, the FRM offers one major disadvantage to borrowers during periods of high inflationary expectations and interest-rate volatility. To insure an adequate yield on their capital during these periods, lenders are forced to increase nominal interest rates on mortgages. This has the result of increasing the initial nominal payment level and the "tilt" of the real payment stream, as documented by Kearl (1975) and Tucker (1974), which increases the effective "cost" of mortgage credit to borrowers.

Under the VRM borrowers experience several disadvantages. First, on the present-value cost side, all risk of future interest rate increases shifts from the lender to the borrower. Thus there is a great deal of uncertainty about the present value cost of mortgage credit, making homeownership a riskier investment.

Second, on the cash-flow cost side, for the standard VRM, the future nominal payment, tied to an interest rate index is not constant and fluctuates

with credit conditions. The uncertainty the borrower faces in his expected payment burden, hence in his cash-flow cost, in general is expected to increase since his mortgage payment, in addition to his income, fluctuates, and not necessarily in unison. This increase in risk is not equally distributed across all borrower groups. Those types of borrowers whose income fluctuation is systematically less correlated with fluctuations in interest rates can expect differentially greater uncertainty in their payment burdens.⁸

There are two advantages of the VRM over the FRM. First, since interest rates and cash flows under the VRM are automatically adjustable, lenders are not forced to increase nominal interest rates in anticipation of future inflation and interest rate volatility. Thus the "tilt" of the real payment stream is reduced. Second, the VRM might be offered at a lower initial interest rate, hence a lower initial monthly payment level. This is possible because lenders would no longer have to add an interest rate risk premium.⁹

VRM Versus FRM: Advantages and Disadvantages from the Point of View of Lenders

The disadvantages the FRM offers to lenders during periods of increasing inflationary expectations or volatility in interest rates have been well documented. First, on the present-value cost side, since lenders bear full

risk of future interest rate changes under the FRM, they must lend at a rate which will yield them an adequate rate of return on their capital over the term of the mortgage. If they underestimate this rate, as lenders did during the 1950's and early 1960's, they, not the borrowers, must ultimately bear this capital loss. Thus they are "locked in" to the yield of the FRM. Second, on the cash-flow cost side, cash flows from an FRM portfolio can increase during tight money periods only to the extent that new mortgages can be made at high enough interest rates. This has the effect of both reducing the supply of funds available for new lending and driving up new mortgage rates, thus exacerbating the cyclicity of mortgage credit availability and terms. The VRM promises to remove these disadvantages by allowing interest rates and cash flows to float upward during these periods, thus allowing continued lending at only "temporarily" high rates without the interest-rate risk premium built in.

However, the FRM offers one advantage to the lender over the VRM which has received less discussion. Lenders bear not only interest-rate risk but also default risk; both of these risks affect the availability and terms of mortgage credit. Default risk under the FRM is relatively low for most borrower classes because of the decreasing real payment burden over time, the small

uncertainty in future payment burdens, and the guaranteed gradual build up of equity which provides a borrower "stake" in the home. However, under the VRM future payment burdens could become high and uncertain for certain borrower household classes. The rate of equity accumulation would also become less certain. Thus, default risk could be increased for certain groups of households under the VRM. To minimize its default risk exposure, the lender would be expected to increase contract rates and/or to redistribute borrowing opportunities away from the affected households.

We have explained in the preceding two sections how both the FRM and the VRM have certain advantages and disadvantages on both the demand and supply sides of the mortgage credit market. These supply and demand effects together determining ultimate market reaction to any instrument of mortgage finance. In the next section, we shall apply our theoretical framework to the issues discussed here to show how different household types will be affected differently by the introduction of the VRM.

Applying the Theoretical Framework:
Two Scenarios

We shall examine two situations postulated as consequences of the introduction of the VRM. The first is the situation in which the VRM is offered exclusively; the second in which the VRM and FRM are both offered in a competitive market.¹⁰ We shall see how in either case, depending upon empirical estimates of various demand and supply elasticities, certain groups could be adversely affected by the introduction of the VRM, even in a competitive market situation.¹¹

Exclusive Marketing of the VRM

In the first case, assume there are two classes of borrowers, higher-income-upwardly-mobile (H), and lower-income-non-upwardly-mobile (L), and that the VRM is offered exclusively after its introduction. Under the FRM, prior to the introduction of the VRM, assume the supply and demand for mortgage credit equilibrated at

price (interest rate) r_{H_1} for higher income households and r_{L_1} for lower-income households, and at volume q_{H_1} for higher-income households and q_{L_1} for lower-income households (Figures 2-8 and 2-9). Because of the increased default risk by lower-income households, their contract interest rate is usually higher. Income and price effects and, quite possibly, taste differences dictate that the quantity of mortgage credit available is greater for higher-income households than for an equal number of lower income households.

Supply Adjustments

Upon the introduction of the VRM, both supply and demand shifts would occur for both types of households. On the supply side, introduction of the VRM could first affect the supply constraints under which debt financing is made. To the extent that the VRM increases default risk, especially among lower-income households, lenders would tend to decrease the maximum loan-to-value ratio, the maximum allowable fraction of income to be spent on mortgage payments, and the maximum home value as a fraction of income. In Figure 2-1, such an increase in β , the required down payment factor, would tend to rotate E_{\min} clockwise; such a decrease in α , the maximum payment burden, would tend to drop $\beta(\alpha Y_0)$; and such a decrease in γ , the maximum house value-income multiple, would tend

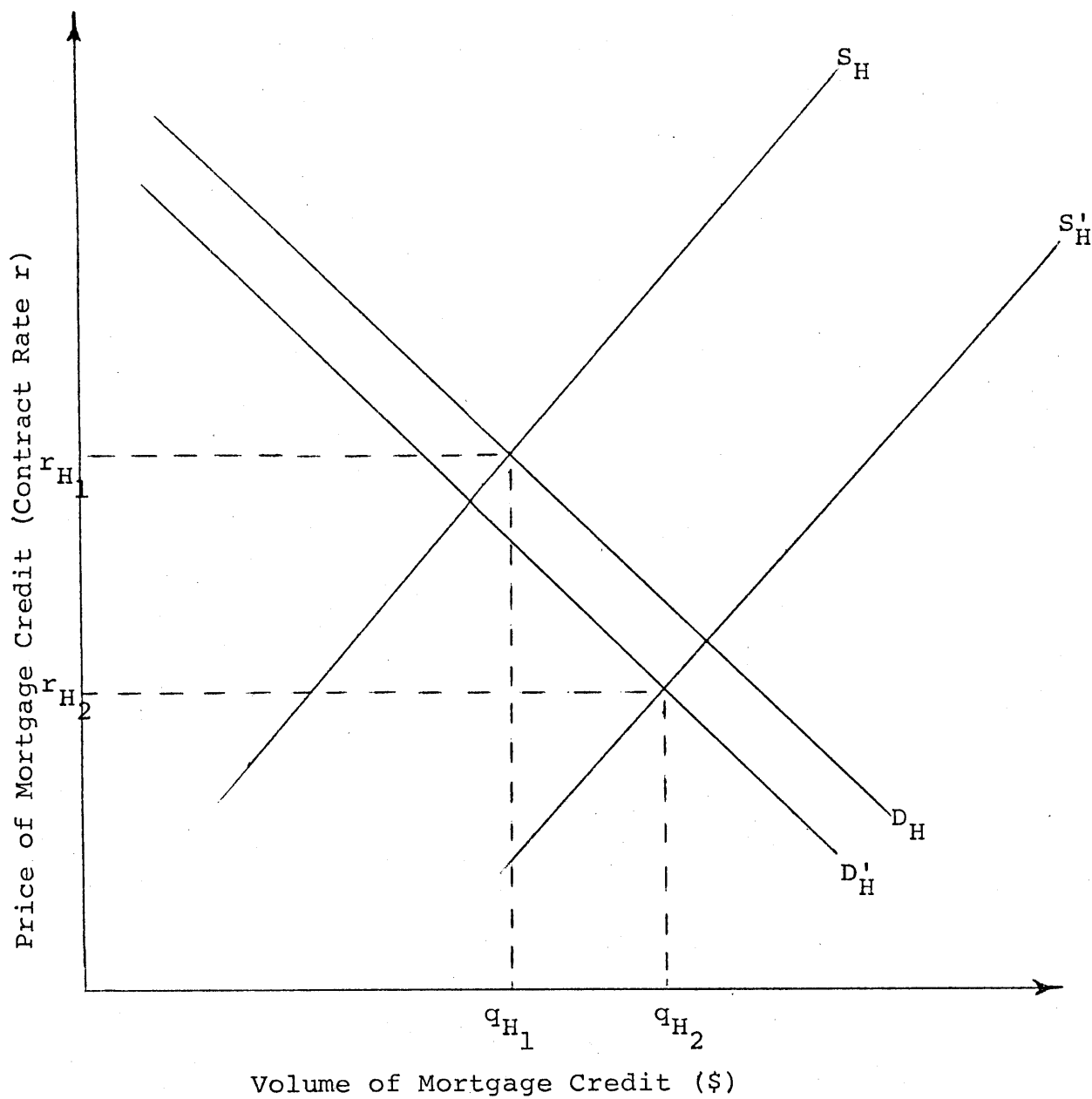


Fig. 2-8 Market Adjustment to the Exclusive Marketing of the VRM by Higher-Income Upwardly Mobile Households

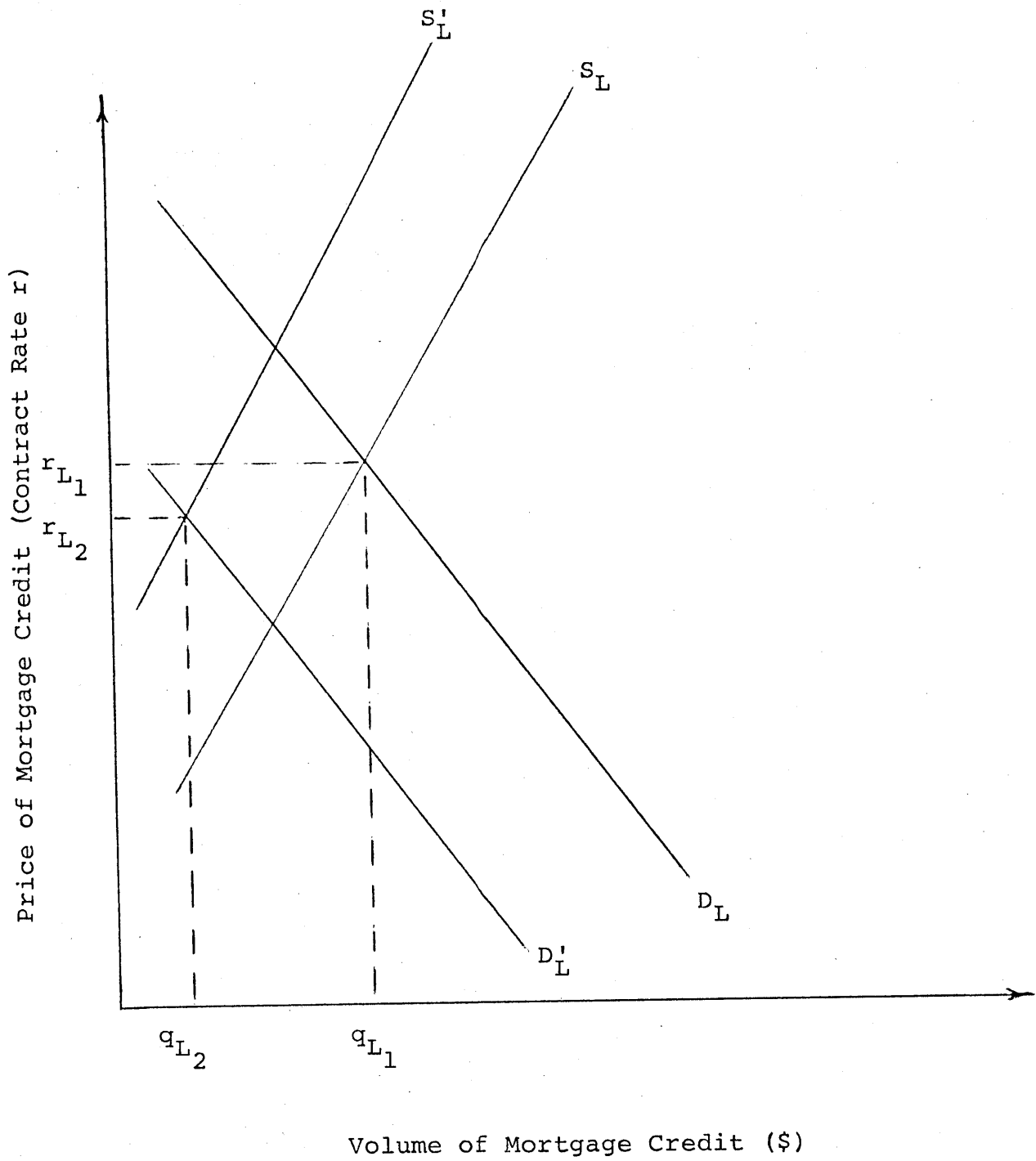


Fig. 2-9 Market Adjustment to the Exclusive Marketing of the VRM by Lower-Income, Non-Upwardly Mobile Households

to bring $V_{\max} = \gamma Y_0$ closer to the origin. These adjustments would be more extreme for lower-income than higher-income households. They combine to reduce the opportunity set for the household, but may or may not be effective constraints on consumption depending upon the shape of the isocost contour, the marginal cost level, and the extent of the constraint adjustments.

A further supply adjustment by lenders would affect the marginal cost of borrowed funds (MC_B in Figure 2 -2). This adjustment would be initiated both by the more desirable yield characteristics of the VRM (elimination of interest rate risk to the lender) and the modified risk of default by each borrower group. The more desirable VRM yield characteristics would tend to lower the marginal cost of borrowing, since lenders would no longer have to hedge against interest rate risk. The VRM default risk characteristics would tend to increase the marginal cost of borrowing, especially for lower-income households whose increased level and uncertainty of future payment burdens and higher uncertainty of equity accumulation would increase their probability of default.

These supply adjustments and resulting upward or downward shifts in the marginal cost of borrowing schedule would adjust the marginal cost of capital schedule. An upward shift in the marginal cost of borrowing curve would rotate the optional debt-equity focus clockwise (schedule

C' in Figure 2-4) and shift the marginal cost of capital curve upward (schedule MC'_C in Figure 2-3). According to our assumptions about default risk and lender supply constraints, lower-income households would be the most likely group to experience upward shifts in their marginal cost of capital schedules.

How do the shifts in the marginal cost of capital schedule transform to shifts in the supply schedules in Figures 2-8 and 2-9? A given contract interest rate for a VRM or an FRM corresponds to a certain marginal cost level on the marginal cost schedule for each instrument. This defines a particular optimal housing supply level, which in turn corresponds to a certain optimal mortgage credit supply level in Figures 2-8 and 2-9.

We have shown in Figure 2-8 a significant outward shift of the mortgage credit supply curve for higher-income households (S'_H) under the assumptions that little increased default risk is borne by these households and that the default-risk effect is more than compensated for by the reduction in interest rate risk under the VRM. Lower-income households' increased default risk, however, is assumed to dominate the interest-rate-risk reduction effect and result in a net decline in mortgage credit availability (S'_L , Figure 2-9). This is the situation postulated by opponents of the VRM, but as we have seen, it is by no means based on a priori reasoning,

but instead on empirical assumptions about supply elasticities.

Demand Adjustments

Let us turn now to consideration of the demand side. Several characteristics of the VRM would cause a perceived shift by borrowers in the marginal cost of capital (MC_c) schedule in Figure 2-7. An increased uncertainty in future mortgage payment burdens or an expected increased trend in payment levels under the VRM would tend to cause households to reduce their demand for homeownership and housing and mortgage credit consumption. This would be manifest as an increase in the marginal cost of capital (MC_c) in Figure 2-7 and a consequent decline in the optimal housing consumption level V_o . On the other hand, a lowered initial payment level under the VRM would shift the MC_c schedule downward and increase V_o .

Each of these characteristics affect lower-income and higher income households differently. We probably would expect lower-income households to have a higher initial payment elasticity of demand since they are more income-constrained. However, their expected demand response to an increased expected payment burden trend is more complex and depends upon two factors--their payment elasticity of demand and their discounting of future versus present payments. The future payment burden (payment-to-income

Thus we perceive a predominant upward shift in borrowers' marginal cost of capital schedules upon VRM introduction, with the greatest upward shift, very likely among lower-income households. Again, we should at this point mention how those shifts transform to shifts in the demand schedules in Figures 2-8 and 2-9. A given set of mortgage-related conditions corresponds to a certain marginal cost of capital (MC_c) schedule for each household. At the intersection with the marginal return to homeownership (MR) schedule, MC_c defines a particular optimal housing consumption level, which in turn corresponds to a certain optimal mortgage credit demand level in Figures 2-8 and 2-9.

The net effect of VRM introduction on the demand for mortgage credit by higher-income and lower-income households under the VRM is indicated by the schedules labeled D'_H and D'_L in Figures 2-8 and 2-9. We have indicated the condition postulated by opponents of the VRM:

1. A slight drop in demand by higher-income households (due predominantly to somewhat increased risk exposure and increasing trends in the expected payment burden), overcoming the increased demand induced by the lower-initial-payment "sweetener."

2. A more pronounced drop in demand by lower-income households (due to significantly increased risk

ratio) under the VRM would tend to be higher for non-upwardly mobile households since their expected income stream would be more level or even declining, implying a greater future payment elasticity of demand for these households. On the other hand, lower-income households might be expected to discount more heavily future payments in favor of current consumption. Which of these two effects dominates is an empirical question; however, it is clear that an expected upward trend in the payment level would reduce demand by both lower- and higher-income households.

An increased uncertainty in future payment burden under the VRM would also be expected to affect different household types differently. Any household facing a large degree of uncertainty in the proportion of its income it will have to pay for mortgage credit in the future will tend to hedge by limiting its consumption of housing and use of mortgage credit and by increasing its equilibrium level of liquid assets to take care of future unforeseen high burdens. However, this factor can impact differently on different households in the following three ways:

1. One household type may be more risk averse than another for the same level of risk. It is not clear on a priori grounds whether higher-income or lower-income households would tend to be more risk averse. Higher-income households would more likely have greater liquid asset resources from which to draw in the event of a

realized increased payment burden, hence, would be expected to be less risk averse. However, if lower-income households are less "conservative" in their risk hedging behavior because they discount future risks more heavily, the reverse could be true.

2. If the expected payment burden trend is higher among lower-income households, we would expect their sensitivity to risk to be higher, since they have less financial maneuverability from their current income.

3. The two household types offered the VRM may be faced with quantitatively different levels of risk in the case in which the income of one household type is systematically less correlated with interest rates. It is true that an income stream perfectly correlated with monthly payment fluctuations could actually decrease risk exposure from that incurred under the FRM. However, in the more general case, income would not be perfectly correlated with payments, and uncertainty would originate both through the income and payment components. In such a case, for both higher-income and lower-income households, risk exposure would tend to increase under the VRM and demand for mortgage credit would tend to be lowered. Preliminary empirical work indicates lower-income households would most likely experience the most severe increase in risk exposure, hence would reduce their mortgage credit demand most severely ceteris paribus.¹²

exposure and significantly increasing trends in the expected income burden), which dominates the increased demand induced by the lower-initial-payment "sweetener."

This representation of demand effects is plausible, but the degree of influence of each factor is again an empirical question, the answer to which is not derivable on a priori grounds but will be sought in this study.

Equilibrium Adjustments

What is the net effect of the interaction of the above-described supply and demand effects on households? The answer to this question is determined by the point of intersection of the new marginal cost-of-capital schedule (MC_C in Figure 2-7) with the original marginal return to homeownership schedule (MR). To the extent that lower-income households are most likely to experience an upward shift in their marginal cost of capital, through both supply and demand effects, they are most expected to experience reduction in housing consumption and the use of mortgage credit under the VRM and, in fact, in the case of severe enough lender supply constraints (the case in which the constrained opportunity focus in Figure 2-1 becomes a null set), could be denied the opportunity for homeownership altogether.

This effect can be restated in terms of the supply and demand framework in Figures 2-8 and 2-9. If the

situation hypothesized by the opponents of the VRM is correct, higher-income households would enjoy a higher volume of mortgage credit at a lower price under the VRM, but lower-income households would experience a significant decrease in mortgage credit availability at a higher or lower price, depending on the relative strengths of the demand and supply effects. The decrease in mortgage credit usage by lower-income households would very likely, through a substitution effect, result in these households drawing more from their liquid assets for increased down payments, reducing their level of housing consumption, and reducing their rate of homeownership. The opposite would be true of higher-income households.

Competitive Marketing of Both
the VRM and the FRM

The case in which the FRM is not entirely replaced by the VRM but continues to coexist with it is one which many analysts argue is the most likely occurrence, especially considering the mandate given the Federal Home Loan Bank Board by Congress in past policy debates to require continued offering of the FRM if by some chance their VRM proposal were ever approved.¹³ In this case the scenario of supply and demand adjustments to the new instrument is similar to that described above with minor modifications.

The overall supply of mortgage credit at a given interest rate would be higher after VRM introduction than before because of the more desirable interest-rate-risk characteristics of the VRM (Figures 2-10 through 2-13). Most of this supply increase would accrue to higher-income households because of their less undesirable default-risk characteristics. The supply of VRM mortgage capital would be drawn partly from outside the mortgage market, but predominantly from the previous supply of FRM mortgage credit, resulting in a net decline in total FRM credit supply.

These credit supply adjustments would be broken down between higher-income and lower-income households in the following way, according to opponents of the VRM introduction. The bulk of VRM funds will flow to higher-income households because of their relatively more desirable default-risk characteristics under the VRM (Figures 2-12 and 2-13). The reduction in FRM credit supply will come primarily from lower-income households because their default-risk is higher than that for higher-income households under the FRM (Figures 2-10 and 2-11). The spread between VRM and FRM rates and non-price terms offered by lenders will be determined by those combinations of terms which render the two instruments equally desirable (in terms of expected yield versus risk versus liquidity) among lenders.¹⁴

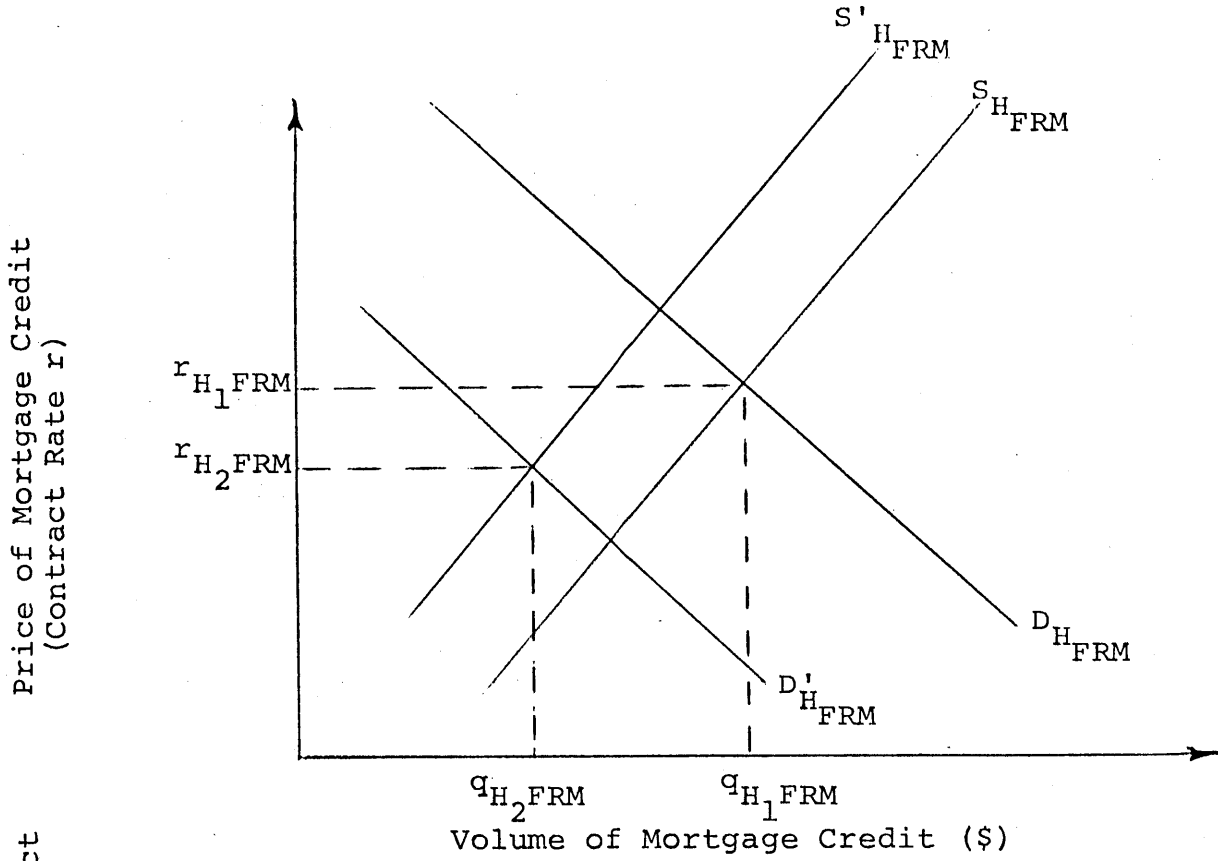


Fig. 2-10 Market Adjustment--FRM, Higher-Income Upwardly Mobile Households: The Case of Concurrent Marketing with the VRM

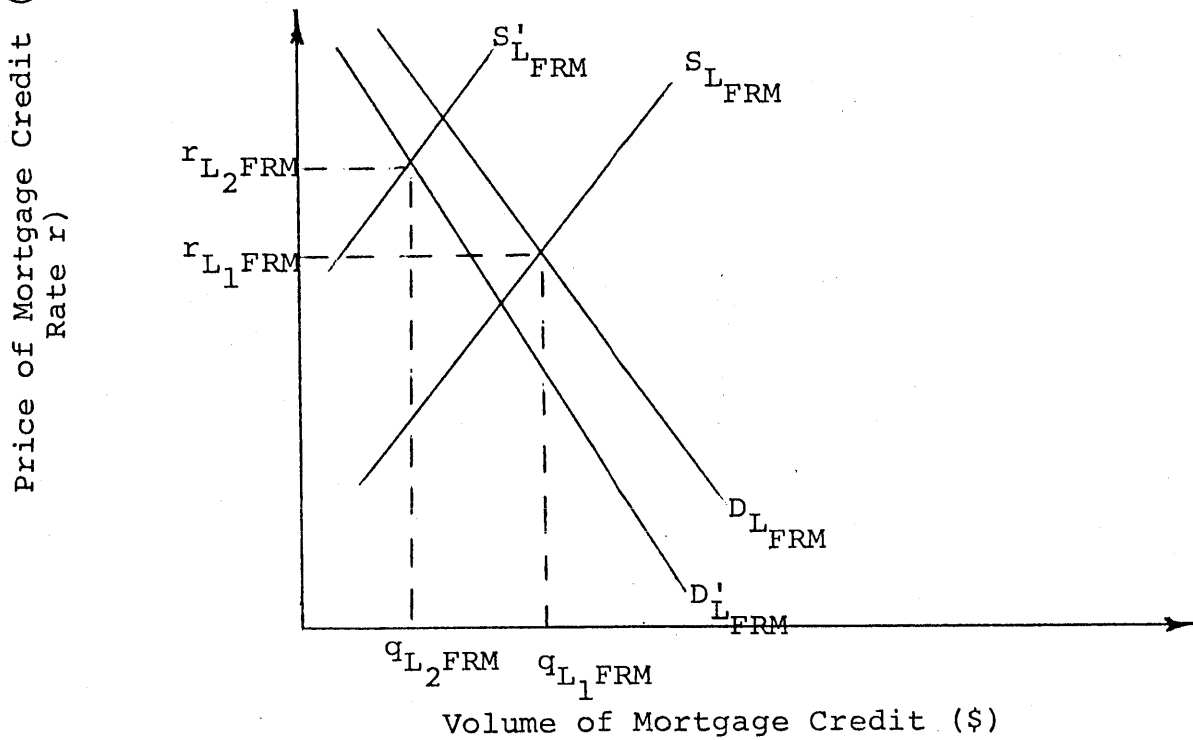


Fig. 2-11 Market Adjustment--FRM, Lower-Income, Non-Upwardly Mobile Households: The Case of Concurrent Marketing with the VRM

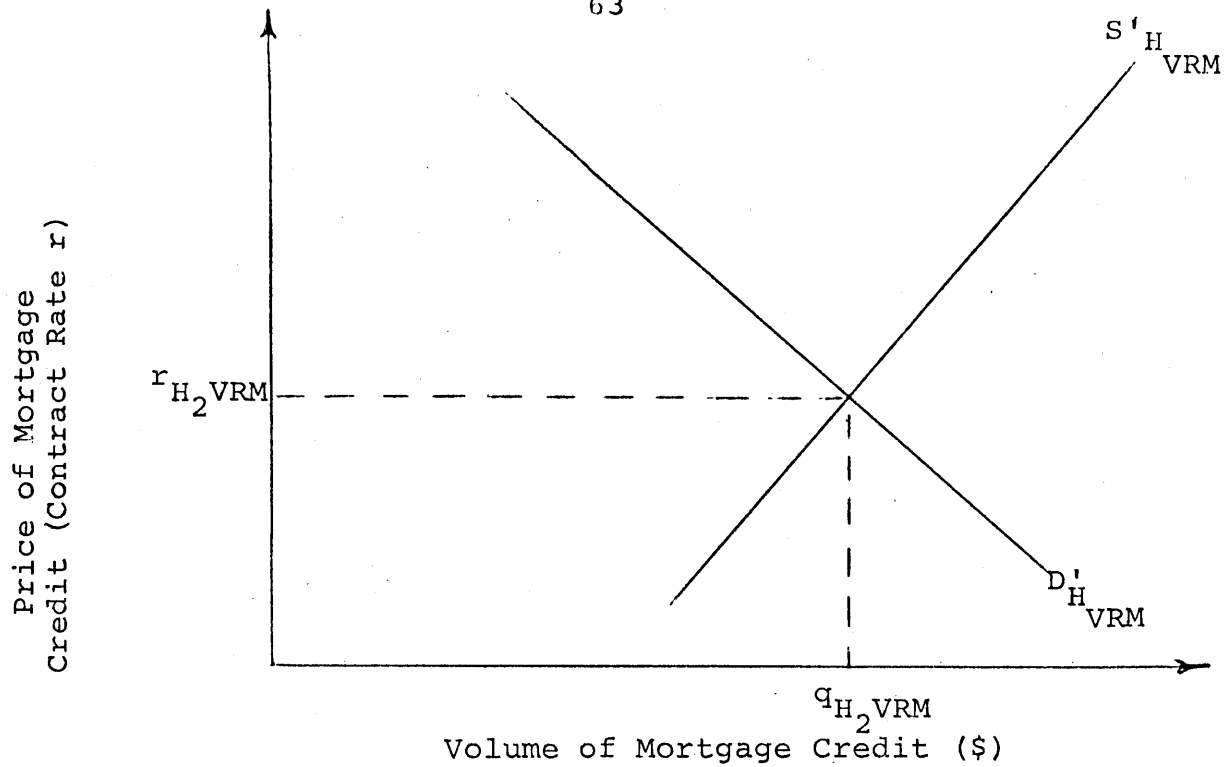


Fig. 2-12 Market Adjustment--VRM, Higher-Income, Upwardly Mobile Households : The Case of Concurrent Marketing With the FRM

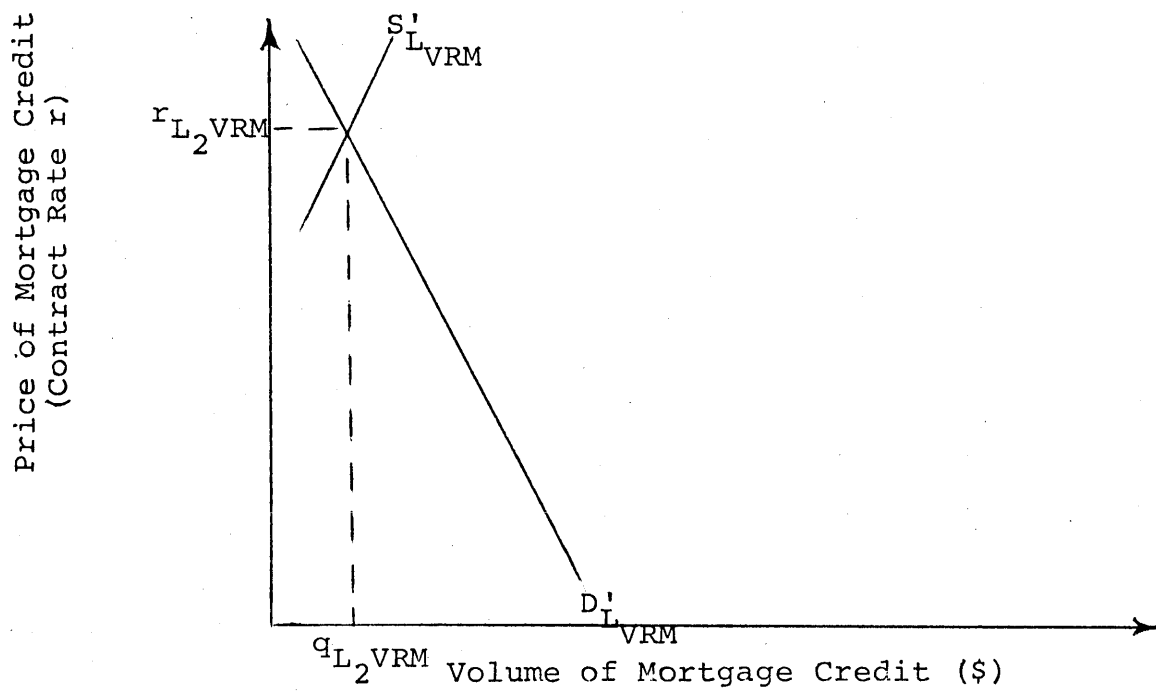


Fig. 2-13 Market Adjustment--VRM, Lower-Income, Non-Upwardly Mobile Households: The Case of Concurrent Marketing with the FRM

On the demand side, most lower-income households will continue to desire the FRM because of its more desirable payment burden and risk characteristics (Figures 2 -11 and 2-13). On the other hand, many higher-income households will demand the VRM, because their stronger income and asset position makes it possible to assume more easily the interest rate risk and a higher expected payment burden in return for lower initial monthly payments (Figures 2-10 and 2-12).

According to opponents of the VRM, the net result of these adjustments will be a drop in the volume of FRM credit consumed by both household types (Figures 2-10 and 2 -11). However, because of the relative strengths of the demand and supply effects in each case, FRM credit will be available to lower-income households only at higher prices, whereas for higher-income households it may be available more cheaply than prior to VRM introduction. The volume of VRM credit available to higher-income households will be much higher and lower priced than that available to lower-income households (Figures 2-12 and 2-13). The net result is a decrease in the use of mortgage credit among lower-income households at a higher average price and a more than offsetting increase in the use of mortgage credit among higher-income households at a lower average price. This would also imply corresponding shifts in down payment levels and in housing consumption and homeownership rates.

Before concluding we might repeat the point made in Chapter I concerning the interpretation of our simulation results for a mix of alternative instruments. Our simulations will basically analyze the first situation postulated in this section--that in which the alternative instrument is marketed exclusively, and not the second situation of concurrent marketing. If one is interested in the implications for a mix of instruments, then our results must be reinterpreted according to the analysis presented above for concurrent marketing. We show later how such a reinterpretation may be crudely carried out using our estimated models.

Conclusion

We have formally shown in this chapter how the levels of homeownership, housing consumption, mortgage financing, and down payment can be affected by the type and terms of mortgage credit and the interaction of mortgage credit characteristics with characteristics of the borrowing household and the economy in general. Furthermore, we have successfully applied this theoretical framework to explaining the scenarios for market adjustment to the introduction of the VRM presented in policy debates.

The lesson to be drawn from these scenarios can be stated as follows: the introduction of the VRM (or any other alternative instrument), even if the FRM continues

to be offered, does not guarantee every borrowing household will be made better off, simply because of increased "efficiency" in the mortgage market and the freeing up of a previous constraint.¹⁵ A condition in which society as a whole is rendered better off may be achieved through the introduction of the alternative mortgage instrument, but this does not guarantee that without a separate program of redistribution each member of society will be made better off.¹⁶ The question whether each is or not is an empirical question which cannot be answered on a priori grounds. The following three chapters attempt to answer this empirical question insofar as it applies to equilibrium levels of homeownership, housing consumption, and mortgage versus down payment financing.

FOOTNOTES--CHAPTER II

¹This conceptual framework is a fuller description and an extension of a theoretical treatment of mortgage capital allocation by Muth (1962).

²Of course, in a perfect capital market, future income can be discounted and converted into capital and current capital into future income through appropriate borrowing and annuity programs. It is the imperfect nature of the capital market which results in these constraints.

³For the FRM this present-value effect on mortgage cost may be represented as

$$TC_{PV_b} = U \left(\sum_{t=1}^T \frac{P}{(1+i)^t} \right)$$

where $P = \frac{r}{1 - (1+r)^{-T}}$ is the partial payment
(r is the contract rate)

T = contract maturity

$i = i(Y_p, A, F)$ is the household discount rate
(where Y_p is permanent income, A is assets,
and F is demographic characteristics)

U = household utility transformation of present value

Note that the initial payment level is P . The expected trend in payments is zero, since payments are constant.

Uncertainty in future payments is zero. The expected

duration of payments is T , and there is no uncertainty in that duration.

⁴For the FRM this cash flow effect on mortgage cost may be represented as

$$TC_{CF_b} = \sum_{t=1}^T \frac{U_t(P/\hat{Y}(t))}{(1+i)^t}$$

where $P = \frac{r}{1 - (1+r)^{-T}}$ is the partial payment (r is the contract rate)

$T =$ contract maturity

$i = i(Y_p, A, F)$ is the household discount rate (where Y_p is permanent income, A is assets, and F is demographic characteristics)

$Y(t) =$ current income in time period t and $\hat{\cdot}$ represents a random variable with attendant uncertainty

$U_t =$ household utility transformation of payment burden

Note that the initial payment level is P . The initial income is $Y(1)$. The expected trend in payment burden is the expected annual fractional change in $P/E(Y)$ where $E(Y)$ is the expected value of Y . Uncertainty in future payment burden arises from the uncertainty in future levels of income. (The expected trend and uncertainty variables will in our empirical analysis be represented as the trend and stochastic terms of a continuous time stochastic process).

The expected duration of payments is T , and there is no uncertainty in that duration.

⁵Since the purchase price of housing is held constant, an increase in down payment implies a decline in the level of mortgage financing and a drop in the debt-equity ratio, both of which combine to reduce the cost of mortgage credit and thereby to offset this increasing opportunity cost effect.

We would expect the marginal cost of equity funds schedule to increase at a steeper rate with the level of equity funding if the debt-equity ratio (B/E) is held constant, since in such a case the opportunity cost due to an increasing cost of borrowed funds is greater than if the debt-equity ratio were allowed to decline ($MC_E \Big|_{B+E=Constant}$ schedule in Figure 2-2).

⁶This is proven formally in Appendix III.

⁷This is not to say the investment and consumption components of the return to homeownership are totally independent. Some (if not all, in perfect financial markets) of the variability in a housing unit's value is due to a change in the expected cost of the stream of housing services from that unit. In this sense, owning a house is a hedge against unforeseen changes in the cost of housing services.

⁸We would probably expect non-union, blue-collar households to have income streams least correlated with inflation rates. To the extent that an inflation premium

is built into interest rates, this would mean these households would also have income streams least correlated with interest rates.

⁹Theoretically, in a competitive market, this equilibrium spread between the FRM and the VRM should occur. However, it is not certain at the present time whether it will occur. When California state-chartered S&L's began marketing the VRM in great volumes, they at first offered interest rate "sweeteners," which stabilized at about a spread of one-half percentage point. However, more recently this spread has tended to disappear.

¹⁰Some researchers contend that the VRM cannot be successfully marketed at the same time as the FRM. This argument goes as follows: at a rate spread between the VRM and the FRM that equates the expected yields, the borrower would prefer the FRM because of its decreased interest-rate risk relative to the VRM. Thus an increased risk premium must be offered to induce the borrower to accept the VRM. However, the lender may be sufficiently reluctant to sacrifice yield to hedge his risk position that he would not be willing to offer the VRM at this lowered price. The price demanded would remain below the supply price, resulting in few lenders offering VRM's and few borrowers accepting them. (Cf. Fisher (1967), Gramley (1972), Krupnik (1972), Nadler (1973), Epley

(1976). In a supply-demand schedule framework, this means the supply curve would be everywhere above the demand curve, with a resultant equilibrium of zero VRM consumption. One fact stands out to dispute this contention. That is that the VRM has been successfully marketed in the California market by state-chartered institutions for the last several years--at first under a 1/4-1/2 percent interest rate differential and more recently under no differential at all. Some researchers (cf. Cohn and Fischer (1974)) recognize this fact and agree both instruments will be offered in a competitive framework but contend that various depository lending institutions will each tend to specialize in one type of mortgage instrument.

¹¹Of course, in the case of a non-competitive mortgage market, certain groups of borrowers could be exploited. Many consumer-oriented interest groups contend a non-competitive mortgage market exists--perpetuated by a lack of perfect knowledge by borrowers (especially lower-income borrowers) (cf. testimony by Steven M. Rohde, in House VRM Hearings (1975), p. 377). We will not in this dissertation fall back on the non-competitive exploitation argument.

¹²The author has calculated the correlation coefficient between annual series of short-term bond rates and income for various occupations as recognized by the Census

Bureau. For recent years (since 1960) laborers clearly have had income streams least correlated with short-term rates ($\rho = -0.5$), whereas skilled (usually unionized) blue-collar workers have had income streams most correlated ($\rho = 0.6$ to 0.8), and professionals and other groups have been somewhere in between.

¹³The 1974 FHLBB proposal only "allowed" S & L's to continue to offer the FRM. This was severely criticized by several congressmen (cf. remarks by Congresswoman Spellman (D-Md) in floor debate over the VRM proposal, Congressional Record, House, p. H3832, May 8, 1975).

¹⁴For a formal analysis of the determinants of this spread, see von Furstenberg (1973).

¹⁵This contradicts previous researchers (Cohn and Fisher (1974), p. 57), who dismiss distributional questions by contending that in a competitive market situation with the continued existence of the FRM, since the opportunity set of the borrowing household has been increased by the introduction of the VRM, the household must be made better off. In their view, only if certain alternative instruments are offered exclusively would certain borrower classes be made worse off through their increased default risks and resultant negative shifts in demand and supply schedules.

¹⁶In welfare economics terms, the Kaldor-Hicks compensation criteria require that the gainers of any economic change be able to compensate the losers, though the compensations need not actually be carried out. In such a situation society is better off in the aggregate. Aggregate efficiency has been increased. This is a lower condition than pareto optimality, which requires that someone be made better off without anyone being made worse off. It attempts to separate questions of efficiency from those of distribution. The Kaldor-Hicks criteria are the theoretical support for proponents of the VRM.

However, recent researchers (cf. Freeman (1972), p. 244) regard the Kaldor-Hicks criteria to be insufficient for two reasons:

1. On the practical side, it is usually impossible to discover or legislate the required taxes and subsidies to effect redistribution to a paretian state.
2. On the theoretical side, taxes and subsidies would upset the efficiency of the original proposal by distorting the price structure and interfering with the efficient allocation of resources.

Thus opponents of the VRM contend without a meaningful program of redistribution, introduction of the VRM would have seriously adverse distributional consequences.

Moreover, it is not clear that freeing up a constraint in one market--the mortgage market--necessarily results in a more desirable state for society in the aggregate in the absence of a similar freeing up of constraints in other markets. Additional resources may be attracted to the mortgage market, but whether this renders society better off is debatable. (My thanks to Penelope Schaefer for suggesting this last point to me).

CHAPTER III

AN EMPIRICAL INVESTIGATION OF THE EFFECT OF ALTERNATIVE MORTGAGE INSTRUMENTS UPON HOMEOWNERSHIP OPPORTUNITIES

Introduction

The variable rate mortgage (VRM) has been widely supported by thrift institutions over the past eight years as a replacement or supplement to the familiar standard fixed nominal interest rate level-payment instrument (the FRM). Because of its cash flow and flexible yield characteristics, supporters say this instrument will eliminate or reduce the "lending squeeze" which occurs during tight money periods, thus stabilizing the flow of mortgage credit and helping stabilize the housebuilding industry. In addition, they contend borrowers would also be aided through the introduction of the VRM in at least three ways. First, since some or all of the risk of future interest rate or price changes is shifted from the lender to the borrower, equilibrium interest rates could be expected to drop with an overall increase in mortgage funds availability. Second, young households and other households with a low current income but expectations of higher incomes would not be priced out of homeownership through

the high initial payment which is caused by the "tilt" of the real payment stream under the FRM during inflationary conditions. Finally, prepayment penalties could be eliminated since a situation would no longer exist in which the borrower is both safe from interest rate increases during the life of the mortgage and can take advantage of interest rate declines by refinancing.¹

However, there are also negative aspects associated with the widespread introduction of the VRM. One of these considerations is its potential adverse impact upon the opportunity for homeownership, especially among lower-income non-upwardly mobile households. This argument is based primarily upon certain characteristics of the alternative instrument, such as the risk of future payment increases and decreased rates of equity buildup, which could adversely affect both the demand for mortgage credit and lenders' rules-of-thumb for supplying it.²

An empirical evaluation of this issue is an important prerequisite to alternative mortgage introduction.³ Such an evaluation requires the development of a model relating the probability of homeownership to both the type and terms of mortgage credit. Some attention has been paid to the relationship between the probability of homeownership and income, socioeconomic characteristics, and generalized housing price measures. However, no effort has investigated the effect of any mortgage-related variables.

The purpose of the present paper, therefore, is twofold: (1) to derive and test a model using multiple regression techniques which relates the probability of homeownership to household income and other socioeconomic characteristics and to certain characteristics of the mortgage instrument, and (2) to use model estimates to predict the impact of a sample of alternative mortgage instrument types upon the probability of homeownership, both in the aggregate and distributionally across household classes. We will consider more alternative instrument types than simply the VRM since public attention has only shifted recently toward these instruments and relatively little empirical evaluation of their merits has been carried out.

Like most other empirical tenure-choice studies (Li (1975), Roistacher (1974), Doling (1973), Lee (1965), Maisel (1966), Struyk with Marshall (1974), Kain and Quigley (1972)), the model is based upon a cross-sectional, individual household sample, but unlike many of these studies (Struyk with Marshall (1974), Kain and Quigley (1972), Li (1975), Doling (1973), Maisel (1966)), the sample is a national one and not for a single urban housing market (Table 3-1). Use of a national sample permits greater generalization of results, although it also reduces control of many housing market characteristics.

TABLE 3-1

SUMMARY OF PREVIOUS ECONOMETRIC HOME OWNERSHIP STUDIES

	Dependent Variable	Current or Permanent Inc.	Relative Price Measure	Present or Past Tenure Decisions	X-Sec. or Longi./ Aggregate or Individual Data	Financing Variables	Asset or Wealth Variables
Long-Run							
Struyk & Marshall	Prob.	Permanent	Income Equiv.	Past	X-Sec./ Aggregate	No	No
Struyk with Marshall	Prob.	Permanent	Fed. Income Tax Subsidy	Past	X-Sec./ Individual	No	No
Lee	Prob.	Current	Metro Area, New vs. Old	Present	X-Sec./ Individual	No	No
Kain & Quigley	0-1	Permanent	--	Both	X-Sec./ Individual	No	No
Doling	0-1	Current	Rent vs. Own Cost		X-Sec./ Individual	No	No
Roistacher	0-1	Average	City Size	Both	X-Sec./Longi. Individual	No	No
Li	Logit	Current	--	Past	X-Sec./ Aggregate	No	No

Two caveats relating to our simulation results should be stated at the outset. First, it must be understood that the simulation results can only be interpreted qualitatively in view of the complexities and assumptions associated with their development and serious data limitations. Secondly, as discussed in Chapter I, although any alternative instrument introduction would most likely be as a supplement rather than as a replacement for the FRM, our simulation results assume each instrument is the only instrument offered. This treatment follows that of Follain and Struyk (1977), the only other recent effort to estimate the effects of alternative mortgage instruments on homeownership. It implies that results must be reinterpreted if the impact of a mix of instruments is desired. We show later how this reinterpretation can be made from our results.

The three major findings from model estimation and simulation are:

1. One mortgage-related variable, the initial annual mortgage payment level per \$100 borrowed, has a significant negative impact upon the probability of homeownership. The elasticity at the mean is about $-.10$.
2. A second mortgage-related variable--the risk of future mortgage payment burden (payment-to-

income ratio) fluctuations--likewise has a significant negative impact upon the probability of homeownership with an elasticity at the mean of about -0.60.

3. As a result of these mortgage-related effects, certain alternative instruments, such as the variable-rate mortgage with a short-term interest rate index and payments adjusted annually, are predicted to have a significant negative impact upon the probability of homeownership, especially among certain classes of households, including young, elderly, lower-middle income, and black households. On the other hand, certain other instruments, such as the graduated payment, and price-level adjusted instruments, are predicted to be more beneficial for all household classes than the current method of housing finance.

The remainder of this chapter consists of four sections. In the first section the theoretical model is specified. The results of empirical estimation are presented in the second section. The third section uses these results to simulate the effects of alternative mortgage instruments. The final section offers some conclusions and policy implications.

The Model

Issues

Before we proceed with a description of our model, it is important that we mention two major issues which have arisen over the interpretation and specification of empirical models of the probability of homeownership.

1. The first of these issues has to do with interpretation of the results. There is a difference of opinion whether one-equation estimates of the probability of homeownership can be considered demand relationships. Struyk with Marshall (1974) specify their model in an explicit demand framework, claiming their elasticity coefficients represent demand elasticities. Kain and Quigley (1972), on the other hand, make no explicit reference to "demand," but rather concentrate on a more generalized "probability" of homeownership model with explanatory variables reflecting family size, family composition, employment status, household income, and race. Their coefficients are intended simply as policy multipliers, and not demand elasticities.

We shall generally follow Struyk and Marshall's interpretation. Our formal model derivation prescribed in Chapter II and Appendix III specifies our equations in structural demand terms. The mortgage-related parameter

values are determined exogenously to the models, however, and not endogenously through separate supply relationships. Separate supply relationships were not developed because of lack of availability of the major supply side variables in our data source.

The only problem with this structural demand interpretation of our estimates is in the case of non-interest rate rationing of mortgage credit by lenders. In such a case rationing would constrain the volume of mortgage credit if certain mortgage-related parameter values were above or below critical levels determined by lenders, resulting in a bias of our estimated coefficient values for these variables. This would not make the results any less usable for simulation purposes, however; such coefficients would represent the combined demand-supply effects but would still adequately describe market behavior.

2. The second issue which must be discussed relates to proper specification of the model. Two competing theories have emerged on the specification of models of tenure choice. The first asserts that one should be concerned only with measuring the demand of those households which have recently made a tenure choice, since they are the only ones at "equilibrium." In this view, a tenure choice made long ago should not be explained by current conditions of age, family size, and

composition, income, or assets since they do not correspond with the condition which influenced the tenure choice. An elderly couple may be still living in a large 10-room house bought 30 years ago to provide for the needs of their large family. However, now that their children have grown they may have no need for the large amount of space and may find the maintenance chores of homeownership burdensome. If it were not for the large monetary and psychic costs of moving, they would move into an apartment. Their characteristics should certainly not explain their choice of tenure 30 years ago.

An opposing view is most clearly expressed by Struyk with Marshall (1974) that households most likely consume not only according to their permanent-income expectations but also according to their expectations with respect to age, family composition, assets, and other important influences. Thus the most likely period of "equilibrium," when a household is most likely to be at the most desired tenure position, should be several years after tenure choice is made, after a household "grows into" its new residence. In this view, although it varies considerably with individual households, the tenure choice as currently exhibited on the average by all households is still an unbiased estimate of true equilibrium demand for homeownership. An example is a

young household, which would have to sacrifice financially to purchase a home at the present time, but which expects in several years to have a family, to build up its assets, and to make more money. Thus it is willing to "sacrifice" for a few years and "grow into" its home, knowing it will spend a roughly equivalent amount of time growing out of it later. Struyk and Marshall (1974, 1975) and Li (1975) have accepted this second theory, but Kain and Quigley (1972) and Roistacher (1974) have estimated equations under both assumptions. Our model is based upon this second theory and therefore considers the tenure choice of all households, not just those which have recently moved.⁴ We do, however, attempt to account for the degree of disequilibrium in current tenure choice by including consideration of permanent income, socioeconomic variables, and a variable indicating the time elapsed since the last move.

Specification of Variables

In Chapter II and Appendix III we formally derived our models of homeownership, housing consumption, and mortgage and down payment financing behavior. In this section we shall reexamine the homeownership model and respecify it in terms of component variables in preparation for estimation in the next section.

Initial Specification

Expression (A.3.33.) presents the formal homeownership model:

$$(3.1.) \text{ OWN} = \text{OWN} (p_r, \hat{R}, c, h, \hat{E}(h), P, \hat{E}(P), \hat{T}, \pi, \sigma, Y_c, r_A, \\ A, i_I, i_U, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

where OWN = probability of homeownership

p_r = relative price of housing

\hat{R} = rate of appreciation of housing stock (a random variable)

c = non-mortgage related costs associated with homeownership

h = level of housing services provided

$\hat{E}(h)$ = expected level of housing services (a random variable)

P = initial annual mortgage payment per \$100 borrowed

$\hat{E}(P)$ = expected mortgage payment level trend (a random variable)

\hat{T} = expected duration of mortgage payments (a random variable)

π = expected trend in mortgage payment burden (payment-to-income ratio)

σ = uncertainty in expected payment burden trend

Y_c = current income

r_A = alternative yields in the market

A = household assets

i_I = investment component discount rate for marginal return to homeownership

i_U = consumption component discount rate for marginal return to homeownership

i_{PV_b} = present value component discount rate for marginal cost of mortgage credit

i_{CF_b} = cash flow component discount rate for marginal cost of mortgage credit

i_{PV_e} = present value component discount rate for marginal cost of down payment financing

i_{CF_e} = cash flow component discount rate for marginal cost of down payment financing

Remember that the discount rates include consideration not only of discounting over time but also of the relative weighting placed on the present value versus cash flow components of marginal cost and the investment versus consumption components of marginal return.

Note that the independent variables break down into several categories: (1) $p_r, \hat{R}, c, h,$ and $E(\hat{h})$ relate to the marginal return to homeownership expression and can all be proxied by the stock (S) and neighborhood (N) characteristics of the housing unit (see discussion in Chapter II and Appendix III); (2) $P, E(\hat{P}), \hat{T}, \pi,$ and σ all relate to

the marginal cost relationships (present value or cash flow components or both) and are characteristics of either the mortgage instrument and terms, or the mortgage instrument and terms together with the household income stream. The discount rate (or taste) variables ($i_I, i_U, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e}$) and the current income (Y_C) and asset (A) variable are derived from either the marginal return or marginal cost relationships and represent household characteristics. The discount rate factors can all be proxied by permanent income, (Y_p), assets, (A), and household socioeconomic characteristics (F) (see discussion in Chapter II and Appendix III). Finally, r_A , the yield on alternative investments represents a condition in the economy at large.

By inserting the proxy variables in our model specification in place of the housing-unit and household-related variables, we obtain the following expression:

$$(3.2.) \quad OWN = OWN (Y_p, Y_C, A, F, S, N, r_A, P, E(\hat{P}), \hat{T}, \pi, \sigma)$$

This specification follows most previous studies by including as explanatory variables measures of household income, family size, family composition, employment status, race, life cycle variables, and other measures of socioeconomic status. It also includes certain explanatory variables not considered in most other studies-- variables relating to neighborhood, structure, and housing

market characteristics, and variables acting as measures of household assets and characteristics of the mortgage instrument. The first set of variables controls for housing market differences; the asset and mortgage-related variables become important in imperfect financial markets. Each class of variables will now be discussed in detail.

Variable Descriptions

1. The Homeownership Variable--The dependent homeownership variable (OWN) has in the literature been defined as the probability of homeownership within a given class [Struyk and Marshall (1975), Lee (1965)]; a dichotomous 0-1 dummy variable [Kain and Quigley (1972), Doling (1973), Roistacher (1974), Struyk with Marshall (1974)]; or as a logit relationship [Li (1975)]. Our model has measured homeownership as a dummy variable, the most typical form for non-aggregated data, and an acceptable form for aggregate, rather than individual, forecasting.

2. Income--In most homeownership studies, income Y is represented by current income [Doling (1973), Li (1975), Maisel (1966), Lee (1965)]; however, several recent studies [Struyk with Marshall (1974), Kain and Quigley (1972)] have used estimates of permanent income under the justification of the permanent-income hypothesis --that households make current tenure choices based at

least partly on future income expectations. Roischbacher (1974) uses five-year time series data from the Panel Survey of Income Dynamics to obtain a one-year income average, which eliminates some, but not all, the transitory components of income.

In our homeownership model, permanent income (Y_p) enters as a proxy for the various discount rates, affecting a household's discounting of future returns from the consumption of homeownership and the future cost of paying for it and affecting a household's weighting of the cash flow versus present value components of cost and the investment versus consumption components of return. According to demand theory permanent income is a primary determinant of demand. In addition, current income (Y_c) has a direct demand effect in our model specification affecting the cash flow component of the marginal cost of borrowing.

Our model estimations consider permanent income implicitly as a function of current income, occupation, education, and other demographic variables (F), and variables representing the expected trend and uncertainty in future income ($E(Y), \sigma_Y$) or

$$(3.3.) \quad Y_p = Y_p(Y_c, F, E(Y), \sigma_Y)$$

This specification would imply that these explanatory variables should be entered interactively and

not merely additively; that is, that separate regressions should be run for each $(Y_c, F, E, (Y), \sigma_y)$ subgroup, or at least that proper interactive terms should be entered. However, as explained earlier, the relatively small sample size of our data set did not permit estimation of a number of interaction effects. Thus the coefficients of these variables will necessarily reflect both direct demand effects and indirect permanent income effects. This interpretation of these coefficients should be kept in mind, as it will affect our simulation results later.

3. Assets--A major omission of previous studies is lack of attention to liquid assets or wealth (A) as a prime determinant of homeownership.⁵ Assets can be viewed, in part, as a supply constraint, limiting mortgage credit to those households which can meet the 5-, 10- or 15-percent down payment requirement. However, assets would be expected to play a major demand role, too, especially in those cases in which households are not affected by the asset supply constraint. A household wishes to balance its equity and debt financing of its home in such a way that it will not dig too deeply into its monthly income to pay off its mortgage. At the same time it does not wish to convert too high a proportion of its liquid assets into the nonliquid housing asset, depending on its degree of risk aversion and its expectations of future competing demands on its income. Given its

level and expectations of income and assets, if it cannot satisfactorily finance a "suitable" home, it may find renting more to its advantage.

Our model properly recognizes the effect of assets on the demand for homeownership. Assets enter the model in two ways: (1) as a proxy for the discount rates associated with the marginal return to homeownership and the marginal costs of borrowing and down payment financing (representing both time discounting and taste effects), and (2) directly through their effect on the cash flow component of the marginal cost of down payment financing (representing the "squeeze" associated with using part of one's assets for a down payment). Thus the coefficient for the asset variable will reflect both these indirect and direct effects.

In our model, we have measured assets by the level of liquid assets, including U.S. Government Savings Bonds, savings accounts, and certificates of deposit. Liquid assets at the time of purchase plus the equity accumulated in the existing home of a current homeowner are the most likely sources for down payments.

Unfortunately, since our data source does not provide a measure of liquid assets or of equity accumulated by previous homeowners at the time of purchase, we were forced to proxy these measures by current liquid assets and a time trend term in our model estimation. The

time trend term proxies for the accumulation of assets over time as the household rebuilds its savings after purchase.

To be entirely correct, household liabilities should also be considered along with assets as they represent competing cash flow needs (to pay off debts) and probably affect the household's risk aversion and expectations. However, such information was not available from our data source; hence it was omitted.

4. Socioeconomic Characteristics--Socioeconomic characteristics of the household (F) in previous studies included family size [Kain and Quigley (1972), Struyk and Marshall (1975), Li (1975), Roistacher (1974)], family composition [Kain and Quigley (1972), Struyk and Marshall (1975), Struyk with Marshall (1974), Doling (1973), Roistacher (1974)], age of head [Kain and Quigley (1972), Struyk with Marshall (1974), Li (1975), Struyk and Marshall (1975), Roistacher (1974)], race [Kain and Quigley (1972), Struyk and Marshall (1975), Struyk with Marshall (1974), Li (1975), Roistacher (1974)], and education of head [Kain and Quigley (1972), Roistacher (1974)]. Our model includes measures of each of these in the form of number of children, number of parents, occupation classification, age of head, race, and education of head.

Socioeconomic characteristics enter in our model both as proxies for the marginal cost and marginal return discount rates (representing time discounting and taste effects) and through our proxy for permanent income (see our discussion of the income variable). Thus the coefficients for these socioeconomic variables will represent both these direct demand and indirect permanent income effects.

It is possible that factor analysis or canonical regressions could have reduced our set of socioeconomic variables to a smaller set of orthogonal indices. This would have also reduced multicollinearity problems. However, since the number of significant socioeconomic variables in model estimations was not excessive and multicollinearity was not extreme, we did not undertake this task.

5. Housing Market Characteristics--Housing market characteristics, especially the relative cost of housing, were not included in most homeownership studies with observations confined to a single housing market under the justification that such characteristics are held constant. One exception is Doling (1973) who, in a 1973 cross-sectional study of tenure choice in an English local authority market, had access to actual comparative monthly costs of renting and owning the same structures. Struyk with Marshall (1974), in a study of the Pittsburgh SMSA, took

indirect account of relative price differences among households by including a federal income tax subsidy variable to indicate a differential advantage to wealthier households for homeownership ceteris paribus.

Cross-sectional studies across metropolitan areas, however, have generally employed some direct measure or proxy for housing market differences, especially the relative costs of owning versus renting. For example, in a 39-city cross-sectional study, Struyk and Marshall (1975) used an income equivalent for a given frequency of homeownership as a proxy for homeownership costs. Roistacher, using panel survey data, proxied the relative price of homeownership by the size of the largest city in the SMSA.

Our model uses stock (S) and neighborhood (N) characteristics to proxy for the following market-related characteristics: the relative price of housing (p_r), the expected rate of appreciation of the unit (\hat{R}), the level of housing service provision (h), the expected future trend in housing service provision ($\hat{E}(h)$), and the non-mortgage related costs of homeownership (c). The only stock or neighborhood characteristics available from the data which yielded consistently significant results in our estimations were dummy variables differentiating urban, suburban, and rural markets. Ceteris paribus one would expect the highest probability of homeownership in rural markets and the lowest in urban markets.

6. Alternative Market Yield (r_A)--According to our model specification, the alternative yield on investment available in the market acts as an opportunity cost of having assets tied up in homeownership. It affects the marginal cost of equity funding of home purchase through a pure present value effect. Attempts were made to proxy this market yield effect through the inclusion of a variable which measured the long term bond rate in the year of purchase. However, high multicollinearity with the mortgage contract rate (hence with the initial payment level P) prevented estimation of its independent effect. Therefore, the alternative yield variable was necessarily omitted in our estimations.

7. Mortgage-Related Characteristics--No previous homeownership studies have estimated the effects of the various characteristics of the mortgage instrument upon tenure choice. Our model includes consideration of five mortgage-related (or mortgage and income-related) variables: the initial annual mortgage payment level per \$100 borrowed (P), the trend in mortgage payment levels ($\hat{E}(P)$), the duration of mortgage payments or contract maturity (\hat{T}), the expected trend in payment burden (π), and the uncertainty in the expected trend in payment burden (σ). Note that $\hat{E}(P)$ and \hat{T} and both random variables, implying they have associated with them both an expectation and an uncertainty.

All of these variables affect the marginal cost of borrowing or down payment financing, according to model specification. In some cases they affect both. In addition, many of the variables have in the general case both present value and cash flow effects on marginal cost, hence on the demand for homeownership. We repeat here that in a perfect financial market only the present value effects (along with any uncertainty in present value⁶) would be important in determining the demand for homeownership, since appropriate financing mechanisms could offset cash flow peculiarities of different mortgage instruments with different maturities. However, in imperfect financial markets, cash flow as well as present value (or yield) characteristics of the instrument become relevant. Thus coefficients of certain of our mortgage-related variables would be expected to display both present value and cash flow effects. This point is important to keep in mind, as it will be significant in interpreting our later simulation results.

We will now discuss each of the mortgage-related variables in greater detail:

1. The Initial Payment (P)--To potential homeowners the initial cost of homeownership is effectively the initial monthly mortgage payment they must make on a given quantity of housing. We have measured this cost in terms of the initial annual

mortgage payment required per \$100 borrowed which includes consideration of not only the contract interest rate but also the amortization period. This variable in general reflects present value effects upon the cost of borrowing and cash flow effects upon both the cost of borrowing and down payment financing.

2. The Expected Payment (E(P))--The expected trend in mortgage payments (together with any uncertainty in this trend), independent of income trends, is a pure present value effect upon the cost of borrowing. The effects of this variable could not be estimated using our data set, since virtually all mortgage information in this set is FRM data and under the FRM the expected trend in future payments is level and certain by design. Hence consideration of this variable was necessarily omitted in estimation.
3. The Amortization Period (\hat{T})--The expected amortization period of the mortgage, together with any uncertainty in this period, represents a third mortgage-related variable which together with P and $\hat{E}(P)$ defines the mortgage payment stream, hence implicitly considers the present value of the mortgage, and which together with P, Y_c , π , and σ defines the payment burden stream, hence

implicitly considers the cash flow effects of the mortgage. Uncertainty in the amortization period could not be included in the model, however, since model estimation was based on the FRM which is designed with an a priori fixed maturity. We attempted to include consideration of the amortization period of the mortgage in model specification, but we were unsuccessful. Two factors were behind this failure. First, the quality of our cross-sectional individual household level data was apparently insufficient to pick up the amortization effect. Second, high multicollinearity between the initial payment level (P) and the amortization period prevented its isolation. Thus, the coefficient of P can be expected to be picking up both the initial payment and amortization period effect. If households are hypothesized to behave toward homeownership primarily on the basis of consumption instead of investment motives and/or if they discount highly future payments, then lack of explicit inclusion of this variable presents less of a problem. As we shall see in our simulations, in most cases we have assumed the alternative instruments are offered at the same maturity as the FRM, thus controlling for this variable.

4. Expected Trend in Mortgage-Payment Burden (π)--

In addition to the initial "cost" of mortgage credit (P), the future expected trend in that "cost" relative to the household's expected income (π) affects household demand for mortgage credit (hence homeownership). In our model π has both a pure cash flow effect on the costs of borrowing and equity financing and an indirect permanent income effect. The permanent income effect arises because permanent income is being proxied by several variables, including the expected trend in income $E(Y)$, and under the FRM π is composed only of income expectation, hence is equivalent to $E(Y)$.

Our measure for the expected payment burden trend variable has been derived as the trend term (π) of a continuous-time stochastic process for the payment burden payment-to-income ratio of the form:

$$(3.3.) \frac{d(q/y)}{q/y} = \pi dt + \sigma dz_{q/y}$$

where q/y represents the payment burden

dt is the time differential

σ is the stochastic term, a measure of uncertainty in the future payment burden trend (see discussion below)

$dz_{q/y}$ is a standard normal random deviate

A detailed discussion of continuous time stochastic processes and the empirical derivation of our trend variable is contained in Appendices I and II.⁷ Here we shall merely state that the payment burden trend term takes into account correlations between income and payment streams and is equivalent to the expected annual fractional change in the payment burden. A household with rising income expectations will display a more negative trend in its payment burden under the FRM, and, in fact, under any instrument other than one tied explicitly to income. A negative trend would be expected to encourage homeownership.

5. Uncertainty in Mortgage Payment Burden Trend (σ)--

The uncertainty in the expected mortgage payment burden trend is a relevant cash flow consideration for the household in an imperfect market (Kearl, Rosen, Swan (1974), Kearl (1975)). This uncertainty affects the cash flow components of the cost of both borrowed funds and equity funds in our specified model. Like the expected trend variable (π), the uncertainty variable also has a second, indirect permanent income effect in our model as estimated since permanent income is being proxied by several variables, including the uncertainty in future income σ_y , and under the FRM

σ is composed only of income uncertainty, hence is equivalent to σ_y . Our interpretation of the coefficient estimates for σ must be modified accordingly.

Our measure for the risk variable has been derived as the stochastic term (σ) of a continuous-time stochastic process for the payment burden (see discussion of π). It can be roughly interpreted as the standard deviation about the expected annual fractional change in the payment burden (π). A household with very little volatility in its expected future payment burden will display a smaller stochastic term. Such a situation would be expected to reduce risk hedging and encourage homeownership under any instrument.

Final Specification

The preceding discussion indicates that our model specification in (3.2.) must be further modified to handle data limitations, and the coefficients of the resulting specification must be reinterpreted as a result.

First, let us summarize the modifications in the non-mortgage related variables. Permanent income is entered implicitly as a function of current income, assets, socioeconomic conditions, and income expectations. Hence, these variable coefficients will display both

demand effects and indirect permanent income effects. This poses no problem for estimation purposes as long as the coefficients are properly interpreted. However, for simulation purposes, since under the FRM income expectations are functionally related to π and σ , this means the coefficients for these mortgage-related variables will also reflect permanent income effects. Such a mixing of effects biases simulation results. We will discuss this problem further in the simulation results section.

A second non-mortgage related variable which is omitted explicitly is the alternative yield available in the market (r_A), which was collinear with P , the initial mortgage payment level. This implies the coefficient for P will also be picking up the alternative yield effect and should be reinterpreted accordingly. This bias could also affect our simulation results.

Major changes and reinterpretations were also necessitated among the mortgage-related variables. The initial payment level P reflects both cash flow and present value effects. In fact, under the FRM, it reflects all of the present value effects since mortgage payments are constant and certain (hence $E(P)$ could not be entered), and since the amortization period (\hat{T}) was certain and collinear with P and therefore could not be entered. This means also that P is picking up in our model

the cash flow and present value effects of T and the present value effect of r_A (see above) in addition to its own direct demand effects.

The expected trend in payment burden and its uncertainty (π and σ) are picking up pure cash flow effects as specified in the model. However, they also are picking up permanent income effects, since under the FRM they are functionally related to income expectations ($E(Y)$ and σ_Y) which proxy for permanent income (see above).

We are left with the following specification of our model as it was finally estimated:

$$(3.4.) \text{ OWN} = \text{OWN} (Y_c, A, F, S, N, P, \pi, \sigma)$$

Estimation Procedures

The 1970 Survey of Consumer Finances, compiled by the Survey Research Center of the Institute for Social Research at the University of Michigan, served as the data source for empirical estimation of our model.⁸ The data is cross-sectional and based upon two surveys totaling 2576 families conducted in the first and second quarters of 1970. Available information included income and assets, as well as expenditures on durable goods such as housing and related major transactions. Detailed information on income history, income expectations, price expectations, types of assets, housing consumption,

and housing finance was also available, rendering the data set usable for the purposes of model estimation.⁹

Our model has been estimated by ordinary-least-square analysis using a binary dependent homeownership variable. It has been shown (Goldberger (1962)) that when a binary dependent variable is used in ordinary least-squares estimation, two problems can result: (1) prediction using the estimated model may result in values outside of the range 0 to 1, and (2) heteroskedasticity may reduce the efficiency of the coefficients. The first problem can be corrected only by use of a different dependent variable, such as a logit formulation, which has been used by Li (1975). The second can be remedied by the use of generalized least-squares (GLS), which has been shown to result in consistent and efficient estimates. This remedy has been used by Struyk with Marshall (1974) and Kain and Quigley (1972).

Struyk with Marshall (1974) argue quite convincingly that the first difficulty does not seriously affect analysis if the primary purpose is not prediction of individual tenure decisions. Thus our model has not gone to logit estimation. The second problem--that of heteroskedasticity--is potentially more damaging. However, Struyk with Marshall (1974) found no significant difference between their GLS and their OLS coefficients. Kain and Quigley's (1972) GLS and OLS estimates, too,

were close. This would be expected since only efficiency, and not consistency, is potentially lost using OLS. On the basis of this information, we have used OLS estimates.

In the absence of a priori knowledge of specific functional forms, we felt a linear specification for our homeownership model would be sufficient and least presumptuous (see also Kain and Quigley (1972), Roistacher (1974), Doling (1973)). Multicollinearity was somewhat of a problem with certain data, especially the socioeconomic variables, and almost certainly in some cases resulted in insignificance of coefficients which were actually influential. However, many specifications of the model were estimated, and in all specifications correlations among variables were used to select variables in such a way that problems associated with multicollinearity would be reduced. Furthermore, even in the case of high correlations, it is well known that the existence of multicollinearity reduces efficiency but does not bias the coefficient estimates (Johnston (1972)). The final preferred specification was purged of all insignificant coefficients--a necessary step before the results could be used for predictive purposes. As mentioned previously, factor analysis or canonical regressions could possibly have resulted in somewhat better groupings and slightly more descriptive equations. However, it was felt the additional analysis required would not be worth the gains,

since multicollinearity was not extreme. In addition, entering the variables directly permitted comparison of coefficients with earlier studies.

No interaction effects among the variables were examined. In other words, separate regression equations were not estimated for individual age, income, and race classes. This might possibly be a shortcoming of the present effort since age, income and race interaction have been shown to be important in determining the likelihood of homeownership in previous work (Li (1975)), and since our model derivation indicates that several variables, most notably those proxying for permanent income, should be entered interactively. However, estimating most interaction effects would have required a much larger data set than used in this study. (An attempt was made to consider income and demographic variables interactively, but sample sizes in many cases dropped to below 50 and results became volatile and meaningless.) In addition, the fact that significant results were obtained in the purely linear-non-interactive specification indicates the strength of the results and hints that any possible interactive effects are relatively minor.

Estimation Results

A number of model specifications within the basic framework were estimated, resulting finally in the following "best" specification:

$$\begin{aligned}
 (3.5.) \quad \text{OWN} &= -.09046 + .00367 Y_c + .01417 \text{ TENURE} \\
 &\quad \quad \quad (.00132) \quad \quad \quad (.00193) \\
 &+ .00715 \text{ AGE} + .26156 \text{ TWOPAR} \\
 &\quad \quad \quad (.00119) \quad \quad \quad (.03489) \\
 &+ .04493 \text{ CHILD} + .00874 \text{ EDUC} \\
 &\quad \quad \quad (.00924) \quad \quad \quad (.00429) \\
 &- .18933 \text{ URBAN} - .61560 \sigma \\
 &\quad \quad \quad (.03053) \quad \quad \quad (.31633)
 \end{aligned}$$

$$R^2(\text{adj.}) = .35187 \quad N = 751$$

Where $\text{OWN} = \begin{cases} 1 & \text{if homeowner} \\ 0 & \text{if renter} \end{cases}$

Y_c = current income (\$1000)

TENURE = period of tenure in unit

AGE = age of household head

TWOPAR = dummy variable indicating presence of two parents in household (1 = yes; 0 = no)

CHILD = number of children in household

EDUC = number of years of education of household head

URBAN = dummy variable indicating location (1 = urban; 0 = other)

σ = uncertainty in future mortgage payment burden (payment-to-income-ratio) trend

and where the standard errors of the coefficients are in parentheses.

These estimation results are discussed in three sections, which correspond to relationships of interest between tenure choice and certain independent variables.

The first section discusses the influence of income and asset position on tenure choice. The second reports on the effect of socioeconomic and market variables. Most attention will be given to the third section, which outlines the influences of the mortgage-related variables.

Income and Asset Influences on Tenure Choice

As expected, the probability of homeownership was positively affected by the level of current income. The coefficient of .00367 implies that for every \$1000 increase in current income a household is approximately 0.4 percent more likely to own its home. This is an elasticity of .0417 evaluated at the income mean, or, in other words, for every one percent increase in current income, there is an increase in the probability of homeownership of .04 percent. This estimated coefficient is rather low compared to that obtained by other studies [Kain and Quigley (1972), Struyk with Marshall (1974)]. However, our results are not directly comparable to theirs, because of their explicit consideration of permanent income, rather than current income as the income explanatory variable. The use of current income tends to bias the income coefficient downward.

The level of liquid assets did not prove significant in explaining homeownership. This could be due to any of three factors.

The first factor is a possible mis-specification of the assets variable. Liquid assets at the time of purchase (including equity accumulated in the previous home of homeowners) were proxied in our model by current liquid assets and a period-of-tenure term. A household which has just bought a home has very likely depleted its existing liquid assets to make a down payment. Therefore, its liquid asset position soon after purchase is low. As time goes on, the household rebuilds its liquid asset position as it also builds equity in its home. The current asset levels displayed in the data reflect this temporary "non-equilibrium" level, especially for households which have recently purchased their first home. It was felt the period-of-tenure term would control for this non-equilibrium effect; however, since it was necessarily entered for all households and not only for first time homeowners, its effect is diluted and biased.

A more appropriate but more complex method of estimating assets of homeowners at the time of tenure choice might have been to (1) estimate a predictive relation for current assets of homeowners as a function of current income, age, demographics, and period of tenure; (2) derive estimates of assets immediately after purchase by substituting in values of the independent variables for each household at the time of purchase into the above model with period of

tenure equal to zero; and (3) add to this amount our estimate of the down payment made on the home. For currently renting households, current assets could be used, as renting households may be assumed to be constantly making a tenure choice. Whether this method would have proven more successful than our simpler method is debatable since a regression of the expectation of homeownership by renters within two years upon our set of independent variables (see footnote 13) failed to reveal any significant asset effect.¹⁰

The second factor possibly affecting the lack of significance of the assets variable coefficient is that assets were highly collinear with the income variable and other demographic variables, such as the age of head, and number of children.¹¹ Their independent effect on homeownership, therefore, would be impossible to separate from the effect of these variables.

A third factor returns to the problems associated with not considering interaction effects. It is very possible that assets act as a serious constraint upon homeownership only on young and possibly lower-income households. This effect is absorbed by the age and income variables in our single-equation specification.

Socioeconomic and Housing Market Influences
on Tenure Choice

Demographic and locational coefficients were generally as expected. Every 10 years of age for a household head increases the probability of homeownership by over seven percent.¹² Husband-wife headed families on the average are 26 percent more likely to own than single-head families. Each child increases the probability of owning 4.5 percent. Each year of education, through both a "taste-for-homeownership" and an indirect permanent-income effect, increases the probability of homeownership 0.9 percent. Occupational type exhibits little influence on choice of tenure, after income and family characteristics are controlled for. As expected, a household in an urban area is 19 percent less likely to own its own home. There is little difference between suburban and rural homeownership probabilities.

One result of note is the fact that race was not found to be an effective influence upon tenure choice after income and family characteristics and urban location were controlled for in the final preferred equation. There was, however, some indication in another specification of the model using a sample of homes who had moved within the past year that black families were significantly less likely to own (about 20 percent less

likely) than white families. The results are thus mixed and tend neither to support nor refute Kain and Quigley's hypothesis of significant race effects. Since our major concern is not with the race coefficient, we shall not pursue this question further.

The final significant socioeconomic and market variable in our estimations was the time since movement into present home, entered to control for certain period-of-tenure correlates, such as the accumulation of liquid assets after home purchase and the secular positive trend in homeownership frequency with tenure period. This coefficient was positive as expected.

Mortgage-Related Influences on Tenure Choice

Let us turn now to the coefficients of primary interest--those for the characteristics of the mortgage instrument.

We were able to estimate the expected trend in payment burden (π) coefficient directly, since data on consumer price and income histories and expectations were available for all households (see Appendix IV).

It should again be pointed out here that the coefficient for π , according to our specification, is, in general, measuring both direct present value mortgage-related effects through the expected payment-to-income ratio and indirect permanent-income effects through the

expected trend in income. This is because under the FRM (which provides the basis for the Consumer Finances data), the expected payment burden is proportional to the inverse of expected income, since the payment is fixed over time which means π is closely related to $E(Y)$. This presents no problem in estimation, but if it is a powerful enough effect, in simulation it could mean effects attributable to mortgage characteristics alone actually are partially due to permanent income effects, which would be the same regardless of the form of the mortgage instrument. This would imply we would be overstating the impact of π in our simulation, since the permanent income effect reinforces the payment burden trend effect. This overstatement is minimal, however, if the other demographic variables are successful in picking up most of the permanent-income effect.

The above discussion is rendered moot by the results of our estimation since, in all specifications including those for recent movers only, the coefficient for π was insignificant, indicating that current expectations of future payment burdens are not significantly related to current tenure conditions entered upon in the past, at least in the range of expectations experienced.¹³

The uncertainty in the future payment burden trend variable (σ) was found to have a significant, though

small (on the average) negative effect on the probability of homeownership. Remember that σ can be roughly interpreted as the standard deviation about the expected annual fractional change in the payment-to-income ratio. The coefficient of $-.616$ indicates for every increase of $.01$ in the value of σ , the probability of homeownership drops 0.6 percent. The mean value for σ was $.0377$ (751 observations), although individual observations varied from 0 to about 0.3 . Thus, although the expected (mean) effect of σ on the probability of homeownership is only a drop of $(.616) (.0377) = 2.3$ percent, the effect in our sample data could be as high as $(.616) (.3) = 18.5$ percent. Since, in 1970, 66 percent of all households were homeowners, this result indicates that uncertainty in the future mortgage payment burden can have a significant effect on the level of homeownership. However, in the range of uncertainties experienced under the standard mortgage instrument, which is virtually the only instrument used in the Consumer Finance data, this effect is usually relatively small. As we shall see later, the small coefficient does not imply a minimal effect on homeownership, in the case of certain alternative instruments which produce a much higher level of payment-burden uncertainty.¹² Again, we repeat that the coefficient for σ , by our specification, is in general measuring both direct mortgage-related effects and indirect permanent

income effects, since the variation under the FRM is due entirely to fluctuations in income (σ_y) and not fluctuations in mortgage payment levels. Simulations of alternative instruments could therefore overstate the impact of these instruments if the permanent income effect is strong enough.

Since we only had available initial mortgage payment level (P) data for homeowners (OWN = 1) in our sample, it was not possible to estimate directly a coefficient for this variable. However, using a two-stage approach, we were able to obtain an estimate of the influence of P. From our first-stage regression, we obtained predicted homeownership probabilities (\widehat{OWN}) for each household as a function of a set of independent variables. These predicted values were then used as the dependent variable observations in a second-stage regression for owners on the initial mortgage payment level (P).

The fact that we regressed on P alone in the second stage regression does not imply our simulation considered only the effect of P, thus ignoring other mortgage-related effects. As shown in the simulation section, we heuristically combined our second-stage regression with our regression on the other dependent variables excluding P to take into account all significant mortgage-related influences on homeownership.

The resultant second stage equation is shown below:

$$(3.6.) \quad \hat{OWN} = .85236 - .00990 P$$

(.00269)

$$R^2(\text{adj.}) = .04225 \quad N = 285 \quad F\text{-Value} = 13.53 \quad \text{s.e.e.} = .79$$

The coefficient of P indicates that the initial payment level has a significant negative influence on the rate of homeownership ceteris paribus. For every \$1 per year per \$100 borrowed increase in the initial payment, the probability of homeownership drops about one percent. In elasticity terms, this means for every one percent increase in P (evaluated at the mean), \hat{OWN} drops .097 percent. By this measure a reduction in mortgage interest rates from 9 percent to 6 percent would reduce mortgage payments by about 23 percent for 25-year mortgages, implying an increase in equilibrium homeownership rates of 2.2 percentage points.

Again, we must emphasize that the coefficient for P is measuring a number of separate effects: both present value and cash flow mortgage-related effects (including the amortization period effect) and a non-mortgage related effect, namely the alternative yield on investments available in the market. In our specification, the coefficient for P is picking up all the present value mortgage-related effects. In simulation the net result of

these separate effects would be to bias the impact of alternative instrument introduction, although the direction of this bias is uncertain a priori because different of the effects bias in different directions. The present value and cash flow mortgage-related effects reinforce each other; in both cases a lowering of P would increase the probability of homeownership. This is true also for the alternative yield effect, since a lowering of P is correlated with a lowering of r_A , which would increase the attractiveness of homeownership as an investment. However, the amortization effect works in the opposite direction. A lowering of P is correlated with an increase in T which, ceteris paribus, would tend to reduce the incentive for homeownership. These biases must be kept in mind in interpreting our simulation results.

Simulation Results: The Introduction of
Alternative Mortgage Instruments

Results from simulating the introduction of several types of alternative mortgage investments using our estimated model will now be presented in four sections, which discuss the aggregate effects and the distributional effects by income, age, and race, respectively. The alternative mortgage instruments which will be simulated are (1) the standard variable-rate mortgage with payments tied to a short term (VRMS) or a long term (VRML) interest rate (the annually adjusted three-month treasury

bill rate and Aaa corporate bond rate, respectively; (2) the graduated-payment mortgage (GPM) with a fixed nominal interest rate similar to the standard instrument (the FRM), but with an a priori 5 percent per year graduated, rather than level payment stream; (3) the price-level-adjusted mortgage (PLAM), with a constant stream of real payments; and (4) the income-linked mortgage (ILM) with mortgage payment levels constrained at 10 percent of every borrower's income.¹⁴

Caveats

It is important to recognize that, although we have attached explicit numerical values to our results, it is not wise to accept these numerical estimates too freely. Rather it is the overall qualitative relationship and trend in results which is important. Several reasons are behind this caveat.

First, all coefficient estimates have been assumed to be point estimates in simulation calculations, whereas in reality any coefficient derived from regression analysis is actually a random variable subject to error.

Second, our simulations do not merely involve inputting alternative parameter values for the FRM upon which the model has been based. Rather, they involve inputting parameter values for alternative forms of mortgage finance which are outside of ranges experienced under the

FRM. Thus the alternative instrument projections are one step removed from ordinary policy simulations; they are "extrapolative" rather than "interpolative."¹⁵

Third, not only are mortgage-related parameter values outside of the range used in model estimation, in certain cases the parameters themselves are relevant only for FRM simulation, since the structure of the alternative instruments is entirely independent of model development. If the model could have been estimated as originally specified in (3.1.), with adequate variables available to measure each of the present value and cash flow mortgage-related effects separately, it could have logically been used for alternative instrument simulation with no shortcomings. However, since data limitations forced estimation instead of (3.5.), which omitted some mortgage-related variables, proxied several others, and combined the effects of still others, the ability of the model to adequately simulate alternative instrument introduction was seriously compromised.

The most serious shortcomings of the model for alternative instrument simulation include the following:

1. The initial payment effect (P) combines both direct cash flow and present value mortgage-related effects, indirect present value and cash flow amortization-period effects, and indirect alternative yield effects. The

introduction of an alternative instrument with the same amortization period and same contract rate as the FRM would logically be expected to have only a direct cash flow effect on homeownership demand.¹⁶ However, the effect predicted by our model by inputting the alternative instrument values of P would necessarily include all of the partial effects, hence would be biased. The direction of this bias is unclear, as discussed in the previous section.

2. The uncertainty or risk effect (σ) combines both direct cash flow mortgage-related effects and indirect permanent income effects (because of the association of σ and σ_y under the FRM). The introduction of an alternative instrument with a reduced risk would logically be expected to have only a cash-flow effect on homeownership demand, since permanent income (σ_y) remains constant. However, our model overstates the negative impact of risk on homeownership demand, since it takes into account both partial effects.
3. One mortgage-related variable--the expected payment level $E(\hat{P})$ --which has a present-value effect on the cost of mortgage credit, was necessarily omitted from consideration. Thus any alternative instrument with a changed expected payment stream

from that under the FRM will not have this potentially important present value effect considered by the model in simulation. For example, as our model is specified, a GPM of any rate of graduation is predicted to result in the same level of homeownership, a result which is contrary to intuition. The model predicts the cash flow effect of π to be insignificant, but the present value effect of $E(P)$ is not considered.

4. Finally, the structural relationship between many of the component variables and the present-value or cash-flow effects on the cost of mortgage credit is different, depending on the particular instrument under consideration. When these components are considered separately and their effects on homeownership estimated using FRM data the resulting relationships are valid for the FRM only. For example, under the FRM all of the present value effects were effectively bound up in the coefficient for P . This would not be expected to be true in general for other alternative instruments.

Where does the above discussion leave us with respect to the validity of our simulation results? There is no doubt it implies results must be interpreted more

cautiously, and then only qualitatively. However, there are several mitigating factors which argue for their acceptance.

First is the lack of a suitable alternative means of addressing the question. Without adequate experience with alternative instruments, such a simulation as presented here, based wholly upon FRM experience, is the only type of analysis possible.

Second is the lack of similar, but more thorough analyses. The simulation presented here takes into account many more considerations than does previous work addressing the same question (Follain and Struyk (1977)).

Third is the fact that the theoretical validity of the model increases significantly under certain assumptions. These assumptions are that (1) households primarily consider cash flow as opposed to present value cost components (or at least consider present value costs only as they affect cash flows) in the homeownership decision; (2) households discount highly future mortgage payments, hence ignore the amortization effect; and (3) households do not include short-term income expectations ($E(Y)$ and σ_Y) in their permanent-income calculation.¹⁷ Such assumptions would probably be more valid for lower-or-middle-income households which purchase more out of a consumption than an investment motive. In such a case, the P, π , and σ

variables would be adequate and relatively complete measures of all mortgage-related effects (which are all cash flow effects). Furthermore, their effects, as estimated under the FRM, would be transferable among instruments, and our simulations would be theoretically valid. Thus we argue for at least limited acceptance of our simulation results, but caution against coefficient biases and quantitative interpretations.

A Note on the Implications of Mixing Mortgage Instruments

A second point should also be made regarding interpretation of our simulation results. The really relevant question relating to alternative instrument introduction is what would be the net result of introducing the instrument as a supplement to the FRM, not as a replacement for it. Nevertheless, most simulation work (Field and Cassidy (1977), Follain and Struyk (1977)) has examined each alternative instrument as if it were the sole instrument offered. Our analysis has this shortcoming too, which implies a reinterpretation of results is necessary to evaluate the result of mixing. Specifically, if one instrument is shown to increase equilibrium homeownership levels in the aggregate or for a particular group while another is shown to reduce them, we must reinterpret this to mean that in the aggregate or within that group the first instrument would dominate the FRM and the second would be dominated by it.

Our analytic framework makes possible a more detailed analysis of the mixing situation, which we shall merely outline here, as it is beyond the scope of this dissertation. The probability of homeownership for each household under each instrument would first be predicted. We then would compare the probabilities and select that instrument for each household which predicts the maximum probability under the assumption that such an instrument is most desirable for that household. The instruments chosen and their attendant probabilities would then be tabulated in the aggregate and by household class.

Structural Demand Versus Equilibrium Analysis

A third point affecting interpretation of our simulation results relates to the fact that our one-equation model is only a structural demand analysis. Mortgage-related parameter values are not determined endogenously through separate supply relationships. Hence judicious assumptions must be made about the terms under which the new instruments would be offered at equilibrium. These are as follows:

- (1) GPM: The GPM is assumed to be offered at the same contract rate and maturity as the FRM and at a 5 percent graduation rate. This assumption is supported by the fact that the yield characteristics (in terms of risk versus return) are the same for the GPM as

for the FRM to lenders. The default risk is assumed to change little.

- (2) PLAM: The PLAM is assumed to be offered at the real interest rate at the time of issuance--a rate which would result in the same nominal yield as the FRM if inflationary expectations are realized. The rate of adjustment in payment levels is according to household price expectations. The maturity is assumed the same as that for the FRM (see Appendix IV).

The yield characteristics and default risk are assumed to be little changed from the FRM. Actually, the yield characteristics would probably be more desirable under the PLAM for lenders since lenders would bear that portion of interest rate risk arising from real interest rate fluctuations and not that arising from inflation. Hence the expected gross yield at equilibrium might be slightly lower for the PLAM than for the FRM, although this could be offset to some extent by possibly increased default risk.

- (3) VRMS and VRML: The variable rate instruments payments are assumed to be adjusted annually according to their respective indices. They are assumed to be offered at a one-half percentage point discount to the FRM, in accord with theoretical statements that the reduction in interest-rate risk borne by lenders

will make a slight drop possible. (This, however, ignores possibly increased default risk). The assumed one-half percentage point premium matches initial experience with VRM introduction in California, although more recently this premium has disappeared. The maturity of the variable-rate instruments is also assumed to remain unchanged from that under the FRM.

- (4) ILM: The ILM payments are assumed to be constrained at 10 percent of all households' incomes, hence there are no explicit assumptions as to contract interest rates. However, we implicitly must assume the maturity will be lengthened or shortened from FRM levels to amortize the instrument under the payment constraint. The extent of this maturity adjustment depends upon the contract interest rate and the household's income stream. Since we have no variable measuring maturity adjustment in our model, this adjustment is essentially ignored.

Aggregate Effects

Table 3-2 lists the mean values of P and σ and the predicted equilibrium rate of homeownership under the standard instrument and each of the alternative instruments.¹⁸ The GPM and the PLAM are seen to encourage homeownership more than the current standard instrument (69.9

TABLE 3-2

AGGREGATE SIMULATION RESULTS: PREDICTED EQUILIBRIUM RATE OF HOME OWNERSHIP (OWN)
BY MORTGAGE INSTRUMENT

Instrument	Initial Payment Level (P) (\$ per Year per \$100 Borrowed)	Uncertainty in Future Payment Burden Trend (σ)	Predicted Equilibrium Home Ownership Rate (%)	Deviation From FRM	
				Absolute	%
FRM	9.92	.0330	67.8	--	--
GPM	7.76	.0330	69.9	2.1	3.1
PLAM	8.05	.0407	69.2	1.4	2.1
VRMS	9.58	.1335	61.9	-5.9	-8.7
VRML	9.58	.0581	66.6	-1.2	-1.8
ILM	11.38	0	68.4	0.6	0.9

percent and 69.2 percent versus 67.8 percent). On the other hand, the VRML and especially the VRMS are predicted to reduce homeownership levels (to 66.6 percent and 61.9 percent respectively).

The GPM's encouraging performance is due entirely to the reduced initial payment level P (7.76 versus 9.92 for the FRM), since it manifests the same risk characteristics as the FRM. For a 25-year, 8-percent instrument, P is 27.6 percent lower for a 5 percent-per-year GPM than for a similar FRM.

Most of the PLAM's superior performance relative to the FRM can also be attributed to a lower initial payment level (8.05 versus 9.92 for the FRM). Its payment burden risk level is slightly higher than that of the FRM (.0407 versus .0330), which reduces the advantage of the lower initial payment.

The VRML and VRMS, as mentioned previously, are assumed to be offered to borrowers at a one-half percent interest savings and hence at a lower initial payment level (9.58 versus 9.92 for the FRM). This acts to encourage homeownership. However, this effect is far outweighed by the large increase in risk borne by borrowing households under these instruments (.1335 for the VRMS and .0581 for the VRML).

There has been very little public discussion of the ILM as an alternative to the FRM, and it is very

likely the ILM will never be adopted. However, since it represents the interesting case in which both π and σ are zero, for comparative purposes we examined it. The maturity effect is not controlled for the ILM. Since the ILM payment level is constrained, the maturity must necessarily be adjusted. Remember that our model is not successful at estimating an amortization period effect. Thus, unless a household highly discounts the future or the maturity adjustment is relatively small, we cannot ignore the potential effect of maturity change upon equilibrium homeownership levels. This effect would reduce the predicted positive impact upon homeownership demand among those households which enjoy a reduced payment burden under the ILM and vice versa. In the aggregate the ILM performed slightly better than the FRM in encouraging homeownership (68.4 percent versus 67.8 percent) but less well than the GPM or PLAM. These results should be interpreted with a great deal of caution in view of the caveats presented above.

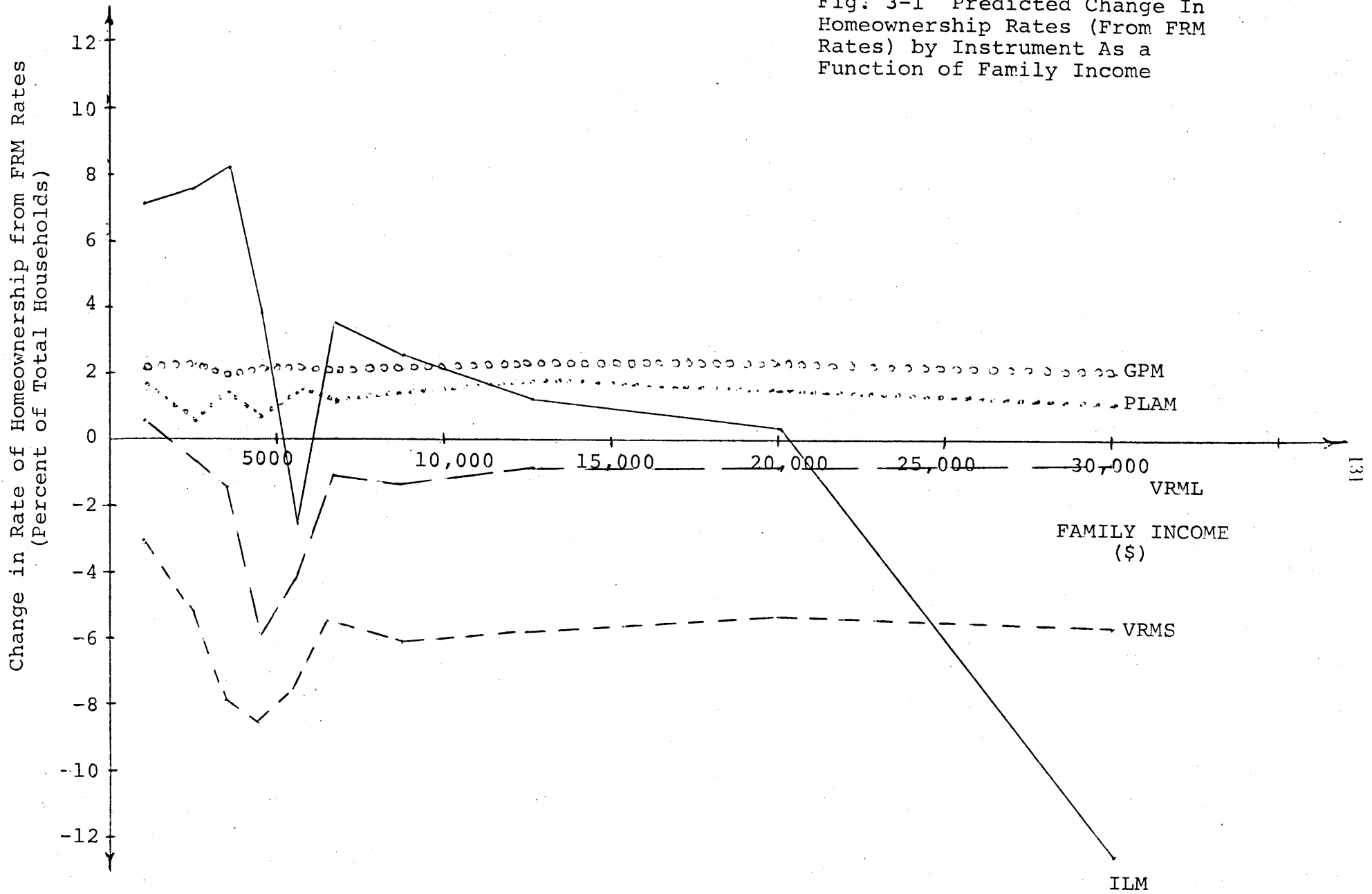
The aggregate effects upon homeownership are only part of the story, however; most of the reactions against alternative mortgage introduction are based upon distributional arguments. The next three sections will address these issues.

Distributional Effects by Income

We did not consider interaction effects in estimation of our homeownership model. That is, separate equations were not estimated for separate subgroups of households. This does not imply, however, that the model is incapable of providing some estimate of distributional effects across household types. Two sources of distributional effects are present; the first caused by households behaving differently to the same mortgage-related conditions and the second caused by households behaving the same but experiencing different mortgage-related conditions under each alternative instrument. Our simulation results report this second type of distributional effect only. Results are derived by substituting the mortgage-related conditions experienced by each household under each alternative instrument into our single homeownership equation.

Figure 3-1 is a plot of predicted equilibrium homeownership rate changes (from FRM rates) under each instrument as a function of income. The most striking result is the predicted negative impact of the VRM tied to the short term interest rate (VRMS) on homeownership rates, especially among lower-income and lower-middle-income families--a drop of up to eight percent. This is due to the large number of blue-collar families at this income level with volatile real income streams and

Fig. 3-1 Predicted Change In Homeownership Rates (From FRM Rates) by Instrument As a Function of Family Income



real income streams not positively correlated with interest rates and prices. The negative impact of the introduction of the VRMS on homeownership is even more dramatic when we consider that the present rate of homeownership for households in the \$4-5000 income range is only 48.6 percent. Thus an eight-percent drop in the homeownership rate would mean 16.5 percent or roughly one-sixth of the homeownership households in this category would in the long run become renters.

The effects of the VRM tied to the long-term interest rate (VRML) are similar, though less dramatic. Households in the \$4-5000 range lower their homeownership rate by up to six percent, but the average drop is only about 1.0 percent.

The ILM, as expected, is predicted to aid homeownership in the lower income ranges, increasing the equilibrium rate by over eight percent for lower-income households making less than \$4000 per year. Middle-income households with incomes up to \$15,000 per year would also see increased homeownership--from 1 to 4 percentage points over current rates. However, also as expected, higher income households would be adversely affected. The equilibrium level of homeownership among those households making over \$25,000 per year would be dropped by over twelve percent.¹⁸

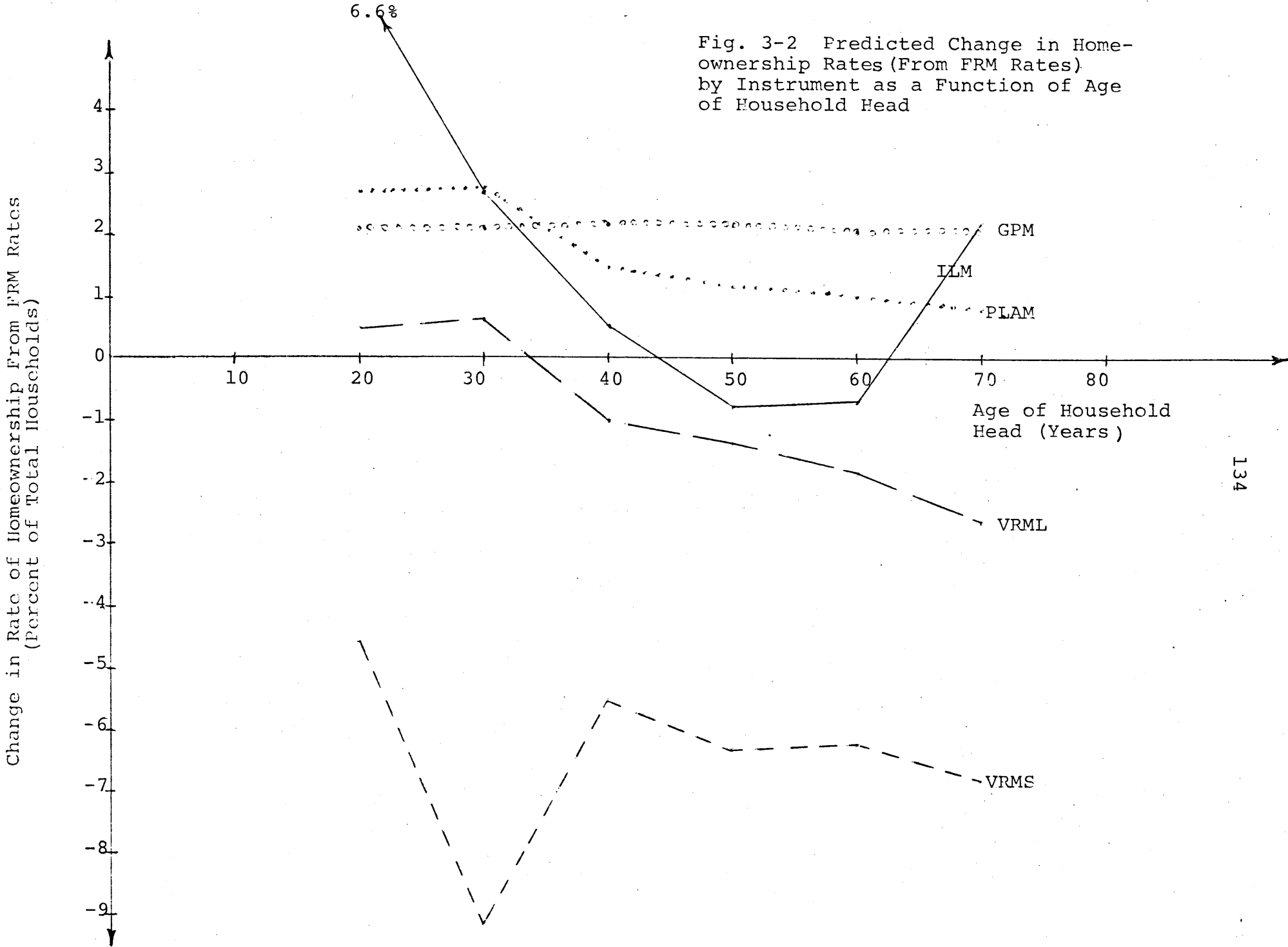
The PLAM and the GPM are predicted to have beneficial effects upon all income classes with little redistributive impact. Homeownership under the PLAM would range between one and two percentage points higher than under the FRM and homeownership under the GPM would vary between 2.0 and 2.5 percentage points higher than under the FRM for all income classes.

Distributional Effects By Age

The predicted homeownership rate changes under each instrument as a function of age of household head are plotted in Figure 3-2. There is a general negative sloping trend--that is, older households are less positively benefitted--under all instruments but the GPM and the ILM. This is due to two factors. First, the uncertainty values (σ) associated with all instruments but the GPM and the PLAM grow larger relative to the uncertainties associated with the FRM for older households. The negative uncertainty effect on homeownership, therefore, causes the trends for these instruments to slope downward. Second, the initial payment levels (P) for the PLAM relative to those for the FRM are larger for the older households, creating a negative PLAM trend.

Because of the constrained 5 percent graduation in payments under the GPM, we would a priori expect the GPM to be somewhat less desirable to older households

Fig. 3-2 Predicted Change in Home-ownership Rates (From FRM Rates) by Instrument as a Function of Age of Household Head



which expect their income to increase at a lower rate. However, the effect of the expected payment burden trend on homeownership was found to be insignificant in our estimations; thus this payment burden trend impact was assumed to be negligible. It is very likely that older households as a group might react to the expected payment burden trend and that a separate equation for a large group of such households might reveal this, but as explained earlier our data source was too small to make such a separate estimation possible.

Again, the VRMS is predicted to have the most negative impact upon all age groups, with the equilibrium homeownership rate dropping from five percentage points below FRM levels for younger households to about seven percentage points below FRM levels for older households. The trend for the VRML is similar but less negative, ranging from a negligible or slightly positive effect upon homeownership for younger households to a drop of about 2.5 percentage points below FRM levels for older households. The slight positive impact upon homeownership among younger households under the VRML is attributable to the lowered initial monthly payment rate and a relatively small σ_{VRML} . Thus younger households could actually benefit slightly through a VRM tied to a long-term interest rate, but households of all ages would be adversely affected through the introduction of a VRM tied to a short-term rate.

An absence of uncertainty in future payment burden trends and a low initial payment level combine to make the ILM attractive to younger households. According to our predictive relations, the equilibrium homeownership rate could be increased by over six percentage points above FRM rates among the youngest households (those under 25). Since only 15.4 percent of such households currently own homes, this represents a 39 percent increase in the number of these households to become homeowners. Older households also would be expected to benefit from the ILM since they also would enjoy both the absence of uncertainty in future payment burden and a reduced initial payment level. Households in the 65-75 year age group could expect to increase their rate of homeownership by about two percentage points above FRM rates. (This analysis ignores the likelihood that the ILM would never be offered to elderly households due to their low income levels and expectations. However, the recent proposal by the United States Savings and Loan League of a "negative" mortgage to be offered to elderly households to allow them to gradually withdraw equity from their home and use it as an annuity approaches the ILM concept.) Middle-aged households, from 45 to 65, would be expected to be slightly adversely affected by the introduction of the ILM because the elimination of payment burden uncertainty is offset by the increase in

initial payments. In accord with our earlier discussion, we could expect all ILM homeownership effects to actually be somewhat smaller than predicted by our model because of biases in estimation.

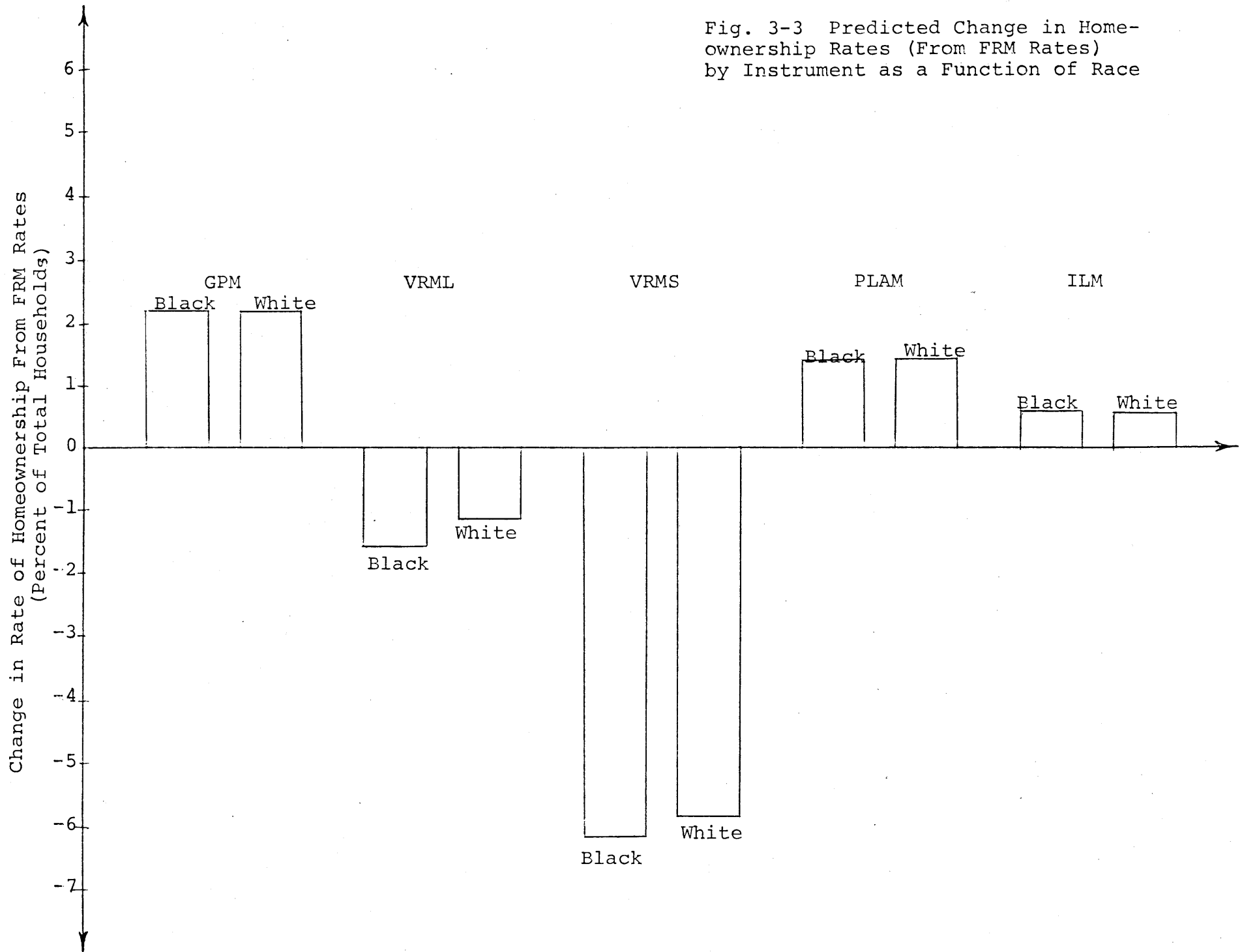
Again, the PLAM and the GPM are predicted to positively affect homeownership by about one to three percentage points above FRM rates. Households of all ages will be slightly encouraged toward homeownership under the GPM because of the lowered initial payment (P) requirement, with younger households (25-34) encouraged the most. The youngest households (under 25) will benefit more from the PLAM than from the GPM, but for older households the reverse is true.

Distributional Effects by Race

Simulation results by race generally support those obtained above, although it is apparent homeownership differences among instruments were far greater than those between black and white households.

Figure 3-3 plots the expected change in homeownership rates for each instrument by race. The VRMS is seen again to most adversely affect homeownership among both black and white subgroups (a drop of 6.2 and 5.8 percentage points below FRM rates, respectively). The VRML has a lesser negative impact (a drop of 1.6 and 1.2 percentage points below FRM rates). Note in

Fig. 3-3 Predicted Change in Homeownership Rates (From FRM Rates) by Instrument as a Function of Race



both cases black households are slightly more adversely affected than white households.

The ILM is predicted to slightly aid both black and white homeownership rates about equally. About a one-half percentage point average increase above FRM rates is predicted for both races. This is due primarily to the balancing of the large negative impact of the ILM upon the relatively few high-income households and the smaller positive impacts of the ILM upon the relatively many middle-and-lower-income households.

Finally, both the PLAM and the GPM again are predicted to be superior to the FRM, inducing slightly greater homeownership rates than under the FRM among both black and white households. The GPM is predicted to be slightly superior to the PLAM. Neither has serious distributional effects with respect to race.

Summary of Findings and Policy Implications

The following major findings were derived through model estimation and simulation:

1. Certain mortgage-related characteristics are found to significantly influence the demand for homeownership. In particular, the initial monthly payment level and the risk associated with future mortgage payments as a fraction of income are both found to

negatively affect the likelihood a household will enter into homeownership. The expected trend in the payment-to-income ratio, however, does not seem to be important in tenure choice. These findings can have important implications both for policies affecting the current instrument of mortgage finance and for the design of new instruments.

2. Of the various alternative mortgage instruments proposed as replacements or supplements to the current standard mortgage (the FRM), the graduated-payment mortgage (GPM) and--to a lesser extent--the price-level adjusted mortgage (PLAM) are predicted to perform superiorly, although simulation results must be interpreted with a great deal of caution. Both raise homeownership above current levels (by about one million households) and neither instrument is predicted to have any negative distributional affect. The standard variable-rate mortgage (VRM) with annually adjusted payments, however, is predicted to adversely affect the equilibrium of homeownership, especially among young, elderly, lower-middle income, and black households. The variable-rate instrument tied to a volatile short-term interest rate is especially undesirable in this respect.

These empirical results generally support the theoretical arguments of opponents of the VRM and indicate

from the borrower's standpoint the VRM, if it were offered alone, would discourage homeownership opportunity. However, they also suggest the GPM and PLAM would prove superior to the current instrument of mortgage finance--making them worthy of further evaluation and testing.

FOOTNOTES--CHAPTER III

¹See for example U. S. League of Savings Associations (1974), a study of the impact of VRM introduction on consumers.

²See for example the testimony of Steven M. Rohde, in U. S. Congress, House of Representatives, Committee on Banking, Currency, and Housing, "Variable Rate Mortgage Proposal and Regulation Q," Hearings before the Subcommittee on Financial Institutions, Supervision, Regulation, and Insurance, 95th Congress, 1st Session, April 8, 9 and 10, 1975, pp. 374-377.

³That is, if it is accepted that a proper role of government is to restrict mortgage availability on the basis of possible adverse distributional consequences to consumers.

⁴However, additional regressions were also run predicting the expectation of homeownership among current renters. Thus the first theory has not been totally ignored (see Footnote 13).

⁵Kain and Quigley (1972) are the only researchers to mention assets as a possible influence on homeownership. However, they dismiss the importance of differences

in asset and wealth positions in explaining differences in homeownership rates between white and black households. They acknowledge their data was insufficient to test directly this influence since they had no measures of asset holdings, but they contend that their inclusion of income, years-on-the-job, and life-cycle variables adequately proxies for wealth holdings.

Even if it is true that they have adequately proxied for asset holdings, their conclusion of no asset influence is not necessarily warranted. The income, years-on-the-job, and life-cycle coefficients were all significant in their estimations. These coefficients had bound up within them both direct influences on demand and unknown indirect influences through the asset effect. Thus the asset effect could still be important; we just do not know how important it is.

Furthermore, their primary conclusion of significant race effects could be endangered through their omission of an asset variable. They implicitly make the assumption that the level of assets is determined by the income, years-on-the-job, and life-cycle variables alone, and not at all by race differences. It is very possible that ceteris paribus blacks could experience lower asset positions than whites because of taste differences or as a consequence of discriminatory practices. In such a case, their race coefficient could largely represent the

indirect influence on demand through the asset effect. Therefore, in the case of taste differences, race per se would have little or no direct influence on homeownership. In the case of discriminatory practices, race would still influence homeownership, but only through the inability of blacks to acquire sufficient assets for a down payment. To evaluate this possibility, an additional equation is needed which estimates the determinants of asset accumulation.

⁶The inclusion of risk or uncertainty as an influence on demand and supply in perfect markets has been formally developed in the theories of portfolio choice (Tobin (1958), Markowitz (1952)) and financial intermediation (Pyle (1971)).

⁷For an example of the use of continuous-time stochastic processes in mortgage research, see Cohn and Fischer (1974).

⁸Described in George Katona, Lewis Mandell, Jay Schmiedeskamp, 1970 Survey of Consumer Finances, Survey Research Center, Institute for Social Research, The University of Michigan, Ann Arbor, Michigan, 1971.

⁹Unfortunately, only one-year income and price histories and expectations were available using the data set. Additional periods would have been desirable for purposes of synthesizing the risk variable. Such

multiperiod information is available in the 5-year Panel Study of Income Dynamics (Morgan (1974)) also prepared by the Survey Research Center, which replaced the Survey of Consumer Finances after 1970. However, the Panel Study data exhibited one major shortcoming which made it unusable for this analysis: the available residential finance information was inadequate to derive an estimate of the original levels of debt and equity financing of a home. Thus I was forced to use the Consumer Survey data, while acknowledging its shortcomings. In subsequent work I will verify its estimates of income and price level uncertainty with those obtained from the panel survey. No other large data source that I am aware of has the necessary information to estimate our derived demand equations. Other data sources investigated included Projector and Weiss, Survey of Financial Characteristics of Consumers, Board of Governors of the Federal Reserve System: Washington, D.C., 1966; a sample of individual state income tax return data from the state of Wisconsin; and U. S. Census material, especially 1970 Census of Housing, Volume V: Residential Finance, U. S. Government Printing Office: Washington, D. C., 1972.

¹⁰One other point should be made which affects proper consideration of the assets variable. The level of assets not only acts as a constraint on home purchase

at the time of home purchase; it also affects the household's consumption versus investment opportunity set, both currently and in the future. Thus there is some question whether assets at the time of purchase are the appropriate variable to be included if we are to continue to hold that expectations of future household conditions rather than current conditions at the time of tenure choice are the true determinants of tenure choice. In such a case current assets would on the average be an adequate proxy for expected assets at the time of tenure choice. This would, however, possibly incorrectly deny their supply constraint role at purchase. The most desirable specification would most likely take into account both assets at the time of purchase and expected asset levels.

¹¹The correlation coefficients between the asset variable (A) and the homeownership, income, and other selected demographic variables are as follows:

$$\rho_{A \cdot OWN} = .119$$

$$\rho_{A \cdot Y} = .152$$

$$\rho_{A \cdot AGE} = .320$$

$$\rho_{A \cdot CHILD} = -.194$$

The fact that the correlation with OWN is lower than that with the other variables is an indicator of potential multicollinearity problems.

¹²This compares to a range of between 0.7 percent and 30.9 percent found by Li (1975) through regression estimates stratified by age and to a range of between -6.0 percent and 31.4 percent found by Struyk with Marshall (1974) by a similar method. Our linear specification ignores the break point in homeownership rates during latter middle-age when "empty nest" households begin moving back into apartments.

¹³To determine whether current payment burden expectations would affect current homeownership decisions, we ran an auxiliary regression of E(OWN) (the expectation of owning within two years by current renters) upon our income, asset, demographic, locational and mortgage-related variables. The result is shown below:

$$\begin{aligned}
 E(\text{OWN}) &= .150 + .0143 Y - .00259 \text{ AGE} \\
 &\quad (.0034) \quad (.00165) \\
 &+ .103 \text{ TWOPAR} + .0679 \text{ CHILD} \\
 &\quad (.056) \quad (.0179) \\
 &- .167 \text{ RACE} + .134 \text{ OCCUP} \\
 &\quad (.066) \quad (.059) \\
 &+ .0948 \text{ SUBURBAN} - .778 \pi + 1.55 \sigma \\
 &\quad (.0589) \quad (.365) \quad (.53) \\
 R^2(\text{adj.}) &= .224 \quad \text{s.e.e.} = .412 \quad N = 282
 \end{aligned}$$

The current income coefficient (.0143) is almost four times as large as the current income coefficient our preferred homeownership demand equation (.00367). This

indicates a greater impact of current income on the decision to move than on the status of homeownership entered into at some time in the past. The size of this coefficient is the same magnitude as that obtained by Kain and Quigley (1972) in their estimation of the determinants of the "probability of purchase given move" using cross-sectional St. Louis data (.013-.017), although results are not directly comparable since they used permanent and not current income.

Again, as in the homeownership equation, the asset coefficient was not significant in any specification even though the liquid assets are not artificially depressed through purchase as in the homeownership equation. This still does not necessarily imply that asset position is unimportant as a determinant of the decision to own. The asset variable is highly collinear with income, age, number of children, and race, and these variables very likely absorbed the asset influence in the equation.

Among the demographic-variable coefficients, those for AGE and RACE deserve special mention. The coefficient for AGE is negative, unlike that for AGE in the homeownership equation. This is expected because ceteris paribus we could expect an older household to have more likely entered into homeownership; yet if they have not done so, we would also expect them to be less likely to expect to do so. The RACE coefficient is

negative, indicating a disproportionate number of black renter households planning homeownership. It is felt this coefficient is measuring the impact of the availability of the subsidized mortgage credit during the 1960's, which for the first time made homeownership possible for large numbers of urban black households.

The mortgage-related variables displayed both expected and unexpected results. The coefficient of the expected payment burden trend (π) is negative, as we would expect, since a household's expected payment burden trend is more negative the higher its income expectations. For every one percent decrease in the expected payment burden trend, a household is 0.8 percent more likely to plan on owning in the near future.* The coefficient for this variable was insignificant in the homeownership equation, implying that current payment-burden-trend expectations do affect current homeownership behavior, but that this effect is diluted when we use current conditions to explain past homeownership behavior.

The coefficient for the uncertainty-in-future-payment-burden trend variable (σ) is positive. This would not be expected a priori, as households would be

* From the available survey data, for 777 observations, the mean of π was $-.0314$ and the standard deviation $.0678$, implying in about two-thirds of the cases the effect upon homeownership was within the range $\pm 5.4\%$.

expected to hedge against future uncertainties by refusing to commit themselves to homeownership. A satisfactory explanation for this occurrence is elusive. However, one plausible possibility is the following: remember that the homeownership equation (3.4.) displayed the expected negative sign for this coefficient. The homeownership equation might actually be displaying the results of supply rationing, in which only those households with income stability are allowed to enter into homeownership, even though the current equation indicates that proportionately more unstable-income households actually desire homeownership. This still leaves the cause of such "negative hedging" behavior unresolved, however.

The final mortgage-related variable, the initial mortgage level (P), unfortunately could not be included directly in the equation. Information was not available on the payment levels available to renters. A two-stage procedure similar to that used to estimate the P coefficient in the homeownership demand equation will be left as a future exercise. In such a procedure, either P for home owners will be regressed on a set of explanatory variables, and an "estimated" P for each renter will be entered into the homeownership expectation equation or an "estimated" ownership expectation will be derived from regression on a set of explanatory variables and then regressed on observed values of P for homeowners.

¹⁴Two sets of simulations were actually carried out--an "unadjusted" set without consideration of P and an "adjusted" set which included consideration of P, although in a necessarily ad hoc manner. The adjustment for P was made in our original equation by adding .00990 \bar{P} and subtracting .00990 P, where \bar{P} is the average initial FRM payment level in our estimated model (9.7727). If \hat{OWN} is our original estimate of the equilibrium level of homeownership without consideration of P, and if \hat{OWN}' is our estimate modified by the inclusion of P, then including P in this manner results in the following identity:

$$\hat{OWN}'(\bar{P}) \equiv \hat{OWN}$$

or at the average value of P, the new estimate is identical to the old estimate. This method, therefore, does not bias the modified estimates at the mean, as required under ordinary-least-squares analysis. According to the characteristics of ordinary-least-squares (OLS) estimation $\overline{OWN} = a + b\bar{X}$, where the bar represents the mean value and X denotes the vector of explanatory variables excluding P. An OLS estimate with P included must then have the following characteristic:

$$\overline{OWN}' = a' + b\bar{X} + c\bar{P}.$$

Since $\overline{OWN}' = \overline{OWN}$ to be unbiased, this implies $a' + c\bar{P} = a$ or $a' = a - c\bar{P}$.

¹⁵Kearl (1975) was faced with this same difficulty in his alternative mortgage simulations, which focused upon macroeconomic impacts rather than the microeconomic impacts addressed here. His caveat (pp. 219-220) is essentially the same as mine. Follain and Struyk (1977) also faced this problem; it is inescapable when FRM data must be used for simulation of alternative instruments.

¹⁶It would also still have a present value effect if the discount rate of each household is not equivalent to the contract rate.

¹⁷Under such a set of assumptions, the decline in home purchase activity during high-interest-rate periods is due primarily to the increase in the monthly payment, causing lender rationing and budgeting problems, rather than to the increased present value cost of mortgage credit. If such a hypothesis is true, then increasing amortization periods to bring monthly payments back to previous levels would bring home purchase activity back close to previous levels.

¹⁸The anomolous drop in the \$5-6000 income range is caused by a high initial ILM payment rate (P_{ILM}) for households in this income category.

CHAPTER IV

AN EMPIRICAL INVESTIGATION OF THE EFFECT OF ALTERNATIVE MORTGAGE INSTRUMENTS UPON HOUSING CONSUMPTION

Introduction

The previous chapter examined the question of what effect the introduction of various alternative mortgage instruments would have upon homeownership opportunity. A second major issue relating to alternative instruments of residential mortgage finance, which must be addressed prior to their introduction, is their effect upon the long-run equilibrium level of housing consumption. This issue has not been addressed to the extent that the issue of possible adverse redistribution of homeownership opportunities has been addressed in recent public discussion of alternative instrument introduction.¹ Nevertheless it is equally important since it could also heavily influence the activity of the mortgage, land, and housing markets and, in particular, could affect the construction and lending industries, the stability of urban neighborhoods, and the welfare of individual households. To the extent that certain classes of households are affected more than others through

reduced housing consumption under certain instruments, this issue could also have serious distributional implications.

What does economic theory say about the way in which different instrument types should affect equilibrium housing consumption levels? Demand theory (as extended by the theory of portfolio choice [Markowitz (1952), Tobin (1958)]) and the theory of financial intermediation (Pyle (1971)) say the demand for and supply of mortgage credit are affected by both the present value or yield characteristics and the cash flow characteristics of the mortgage credit instrument in imperfect financial markets. But how do changes in the demand for and supply of mortgage credit affect the demand for and supply of housing? Traditionally, most studies of mortgage credit demand have treated the demand for mortgage credit as a derived demand of the long-run demand for housing (Huang (1969), Sparks (1967), Kearl and Rosen (1974), Clauretie (1973), Silber (1968), Jaffee (1972))

meaning the demand for mortgage credit would be affected more by long-run housing demand than vice versa. However, several recent researchers (Kearl (1975), see also Chapter II of this dissertation) have contended that the availability and terms of mortgage credit can also restrict long-run equilibrium housing consumption levels.

The foregoing discussion suggests that a proper analysis of alternative instrument effects upon housing consumption requires the development of an empirical model in which various explanatory variables, including the present value and cash flow characteristics of the mortgage credit instrument, are used to predict housing consumption levels. Have such models been developed? There have been many studies of the determinants of housing consumption levels, primarily in the form of demand estimations of one of two major types. Unfortunately, as we shall see, these studies either do not consider any mortgage-related influences upon housing consumption--in agreement with the conventional wisdom that mortgage-credit demand is a derived demand--or consider them in a form and at a level of aggregation, which makes it impossible to simulate the introduction of alternative instruments upon individual households.

Short-Run Models

The first type of housing demand study which has been carried out is a longitudinal aggregate model using housing starts as a dependent variable. This model is short-run in that it attempts to explain the cyclical behavior of housing starts rather than the long-run equilibrium level of housing consumption.

Recent short-run models of housing demand almost always have included the mortgage interest rate as an

important determinant of home building (Maisel (1963), Swan (1972), Smith (1969), Fair (1972), Table 4-1). In this view temporary increases in interest rates result in postponed demand.

A study which considers the interest rate alone among the possible mortgage influences on demand implicitly assumes a housing market always in equilibrium and perfect financial markets. However, a realization of the imperfection of financial markets leads to a presumption among researchers that the mortgage market rate is not an equilibrium rate, and that various forms of non-rate rationing of mortgage credit occur to account for this fact. Thus several studies have also included various non-rate terms of the mortgage credit instrument as rationing measures. Rosen (1974) and Kearl-Rosen (1974) have included the loan-to-value ratio, while Brady (1967) and Huang (1969) have also added the amortization period. In all cases, the non-rate terms, representing the availability of mortgage credit, were found to be important determinants of housing starts.

These studies are inadequate for our purposes for two reasons. First, they are instrument-specific; that is, the mortgage-related parameters considered are valid in describing reaction to the standard instrument of mortgage finance (the FRM) only. An alternative instrument offered at the same contract interest rate,

TABLE 4-1

COMPARATIVE MODEL STRUCTURES: THE DEMAND FOR HOUSING

	Dependent Variable	Current or Permanent Income	Relative Price Measure	X-Sec. or Longi./ Aggregate or Individual Data	Financing Variables	Asset or Wealth Variables
<u>Long Run</u>						
Muth	Average Value	Permanent	C	X-Sec./Aggreg.	No	No
Reid	Market Value Housing Expense Contract Rent	Permanent	--	X-Sec./Aggreg.	No	No
Lee	House Value & Rent Payment	Permanent	--	X-Sec./Indiv.	No	No
Winger	House Value	Permanent	--	X-Sec./Aggreg.	No	No
deLeeuw	Average Value & Rent Payment	Permanent	R/p	X-Sec./Aggreg.	No	No
<u>Short Run</u>						
Maisel	Starts	Current (Disposable)	R/p_H (wtd. past)	Longi./Aggreg.	r (Wtd. past)	Aggregate Savings
Swan	Starts	--	--	Longi./Aggreg.	r (Lagged)	Aggregate Savings
Fair	Starts	--	--	Longi./Aggreg.	r (lagged)	No
Kearl-Rosen	Starts	Permanent	$(P_H/C)_{-1}$	Longi./Aggreg.	$r, L/V$	No
Brady	Value of Starts	--	R/p	Longi./Aggreg.	$r, L/V, T$	No
Huang	Starts	Current (Disposable)	C/p	Longi./Aggreg.	$r, L/V, T$	No

TABLE 4-1 (Continued)

	Dependent Variable	Current or Permanent Income	Relative Price Measure	X-Sec. or Longi./ Aggregate or Individual Data	Financing Variables	Asset or Wealth Variables
Kearl	Starts	Permanent	$P_H / p, R/p$	Longi./Aggreg.	$r, Q_0/Y_0, \text{tilt}$	Deposits

Key :

- C = Construction Costs
- L/V = Loan to Value Ratio
- P = Price Index for new housing
- p^H = Consumer Price Index
- Q_0/Y_0 = Initial Payment-to-Income Ratio
- R = Rent Index
- r = Contract Rate
- T = Amortization Period
- Tilt = Tilt in Real Payment Stream

loan-to-value ratio, and maturity as an FRM could have a very different effect on housing demand owing to imperfections in the mortgage market, especially the effects of cash flow influences. Second, all data used in these studies is aggregate longitudinal data which is not capable of investigating individual life-cycle, income, wealth, and risk influences on housing consumption.

Long-Run Equilibrium Models

The second type of housing demand study is a long-run equilibrium model using investment in housing stock as measured by stock prices or demand for housing services as measured by rents as a dependent variable. Both cross-sectional and longitudinal studies have been carried out in the long-run tradition, concerned primarily with the price and income elasticities of demand for housing services (Muth (1960), Reid (1962), Lee (1968), Winger (1968), deLeeuw (1971), Maisel (1963), Morgan (1965), Malone (1966)). Several of these studies (Lee (1968), Morgan (1965), Malone (1966), Winger (1968)) used individual, rather than aggregate, data. However, all long-run studies, with the exception of one, have ignored mortgage credit influences, according to the conventional wisdom that in the long-run, if relative prices do not change, credit terms and availability do not affect housing consumption. Instead, households merely shift tenure status and postpone

buying decisions. In this view, pure inflation-produced increases in the nominal interest rate should have no effect upon the long-run demand for housing.

The one recent long-run study which contradicts this assumption of lack of credit influence upon housing demand deserves special mention. Kearl (1975), using quarterly time series data, has perhaps most thoroughly investigated the influences of credit terms on housing demand. His three-equation model of demand for housing services, housing stock, and housing starts using an asset-pricing framework successfully evaluates the influence of the interest rate, initial payment burden, and the "tilt" in the real payment stream under the standard instrument. However, he does not consider such important cash-flow influences as household risk associated with future payment burdens or the expected trend in future payment burdens. Furthermore, his use of longitudinal aggregate data makes the influence of individual price and income expectations upon housing demand impossible to evaluate. This is not a criticism of his model since he is not concerned with explaining "the microeconomic impacts of changing debt payment streams on individual households, whose income streams are subject to variation and uncertainty," but rather with "the general macroeconomic impacts likely to result from mortgage innovation."²

Thus we must conclude from our review of the literature that a model able to analyze at the micro-economic level alternative mortgage effects upon individual long-run housing demand has not yet been developed. This study attempts to develop such a model. The model is disaggregated to the individual level and is cross-sectional, making possible the estimation of microeconomic relationships in a long-run equilibrium framework. It considers both present-value and cash flow characteristics of the credit instrument, following the findings of Kearl (1975) and others that in an imperfect financial market non-price credit terms can affect long-run equilibrium housing consumption levels. Finally, the mortgage-related variables used as explanatory variables are not instrument-specific and can be used to distinguish certain classes of alternative instruments, allowing simulation of the effect of introduction of these instruments upon housing consumption.

The remainder of the chapter consists of four sections. The first section presents the details of model specification. The second section contains the results of model estimation and examines the implications of these results for housing market behavior. The third section presents the results of simulating the introduction of alternative mortgages using the model. The final section offers some conclusions.

The Model

Issues

Two major issues which relate to the specification of a single-equation model of housing demand should be examined prior to discussion of our specification.

First, our model is intended as a single-equation structural demand model. However, it uses as a dependent variable the level of housing consumption observed in the market, which is the net result of the action of both supply and demand forces. Thus, in estimation, our error term is very likely correlated with those explanatory variables which would also appear in a supply relation. The necessary conditions for ordinary-least-squares (OLS) estimation, therefore, break down, and coefficient estimates for these variables are subject to "simultaneous equations bias" and are usually biased toward zero.

This bias is ignored in most of the long-run single equation models of housing demand (Reid (1962), Lee (1968)), although deLeeuw (1971) handles it by estimating two equations, alternately using the price and quantity variables as dependent variables to obtain a range for the price coefficient (formally justified in Harberger (1953)). Of course, this problem does not exist for simultaneous equation system models, such as

Kearl (1975), estimated using two-stage least squares (2SLS) or some other simultaneous equations estimation technique.

We recognize this possible bias in our model; it implies that in certain cases the derived elasticities could be conservative estimates of the true demand elasticities.

The second issue relates to the use of current conditions to explain a housing consumption decision made in the past. This specification is justified under the assumption that households make their durable good demand decisions based not only upon current conditions but also upon income and demographic expectations (see also discussion in Chapter III).

Model Theory

A household which has decided to become a home-owning household must make several interrelated decisions about home purchase. It must decide how large a home to purchase, and since it virtually always does not pay cash for the home, it must decide how to finance the home--the amount of down payment or equity payment, usually taken out of existing home equity or liquid assets, and the mortgage amount. These decisions are not separable. Given its socioeconomic characteristics, current income and income expectations, and assets available for down

payment, it shops in nearby housing submarkets for a preferable property. In a perfectly competitive housing market (see Olson (1969)), the price per unit of housing services is constant across all submarkets and corresponds to a given price per unit of housing stock. The number of units of housing stock the household selects depends on the way the household wishes to balance (or is constrained to balance by lenders' requirements) (1) its current (and future) expenditure for housing (via the mortgage payment, taxes, etc.) versus other goods and services and (2) its investment of its liquid assets in housing stock versus other uses (including the holding of cash balances) in its asset portfolio.

The first decision--the monthly payment decision--requires consideration of (1) the household's current and future tastes and needs; (2) its present and expected future income levels; (3) the current and future periodic cost of homeownership in terms of the total monthly outlays required to support it (mortgage payment, taxes, maintenance costs, etc.), and (4) the risk associated with future housing expenditures, both alone and as they relate to income. The second decision--the down payment decision--requires consideration of (1) the household's total assets available for down payment; (2) opportunity costs in terms of the returns available on alternative investments; and (3) its future discretionary income and

uncertainties in that income, which influence the use of liquid assets as a contingency hedge against future consumption needs. These two sets of considerations may together be considered the marginal cost of owner-occupied housing. They have bound up within them both present value or yield considerations (the only considerations of importance in perfect financial markets) and cash flow considerations.

Both the monthly payment and down payment decisions are also affected by the expected marginal return to owner-occupied housing, which in turn is affected by the rate of equity accumulation in the stock from both amortization and appreciation and the utility derived from homeownership and consumption of housing services. Homeownership is affected both by investment and consumption objectives, weighted differently by different households. Thus both the equity accumulation and consumption utility are relevant measures of return.

Model Specification

In Chapter II and Appendix III we formally derive our model of housing consumption (VALUE) based upon the above considerations. The resultant specification is presented in expression (A.3.29.) which we repeat here:

$$(4.1.) \quad \text{VALUE} = \text{VALUE} (p_r, \hat{R}, c, h, E(\hat{h}), P, E(\hat{P}), \hat{T}, \pi, \sigma, Y_c, r_A, \\ A, i_I, i_U, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

- where VALUE = value of unit
- p_r = relative price of housing
- \hat{R} = rate of appreciation of housing stock
(a random variable)
- c = non-mortgage related costs associated
with homeownership
- h = level of housing services provided
- $E(\hat{h})$ = expected level of housing services (a
random variable)
- P = initial annual mortgage payment per \$100
borrowed
- $E(\hat{P})$ = expected mortgage payment level trend
(a random variable)
- \hat{T} = expected duration of mortgage payments
(a random variable)
- π = expected trend in mortgage payment burden
(payment-to-income ratio)
- σ = uncertainty in expected payment burden
trend
- Y_c = current income
- r_A = alternative yields in the market
- A = household assets
- i_I = investment component discount rate for
marginal return to homeownership
- i_U = consumption component discount rate for
marginal return to homeownership

i_{PV_b} = present value component discount rate for
marginal cost of mortgage credit

i_{CF_b} = cash flow component discount rate for
marginal cost of mortgage credit

i_{PV_e} = present value component discount rate for
marginal cost of equity financing

i_{CF_e} = cash flow component discount rate for
marginal cost of equity financing

This complex expression is simplified through the use of proxies and through constraints imposed by data limitations in Chapter III, resulting in the following expression used in estimation:

$$(4.2.) \text{ VALUE} = \text{VALUE} (Y_c, A, F, S, N, P, \pi, \sigma)$$

where VALUE = value of unit

Y_c = current income

A = household assets

F = household demographic characteristics

S = housing stock characteristics

N = neighborhood characteristics

P = initial annual mortgage payment per
\$100 borrowed

π = expected trend in mortgage payment
burden

σ = uncertainty in expected payment burden
trend

The housing consumption level (VALUE) is measured by current house value, in agreement with Reid (1962), Deleeuw (1971), Lee (1968), Muth (1960), and Winger (1968). We refer to Chapter III for detailed definition and discussion of each of the independent variables and caveats about interpretation of their coefficients in estimation.

In general, we can say that the specification of our model is similar to the specification of other cross-sectional models of housing demand with the addition of the assets variable (A), which relates to the down payment decision, and the mortgage-related variables (P, π, σ), which relate to the monthly payment decision.

It was also necessary to include a period-of-tenure variable in the model to control for two influences:

1. The Disequilibrium Housing Consumption Influence--Current housing value does not necessarily represent the equilibrium level of housing consumption. Households normally "grow into" their home, buying a somewhat larger home than really optimal at first, which becomes the optimally-sized unit several years down the road as the unit depreciates and the household's income and needs increase. Finally in the last few years of habitation the household "outgrows" its home. Theoretically, we expect the household to buy that size unit

which maximizes its discounted present value of the utility from the unit. Since current consumption data is unadjusted for this expectation effect, it becomes necessary to add a control variable in the form of period of tenure to the list of explanatory variables.

2. The Disequilibrium Asset Level of Influence-- One problem with the liquid asset variable is that household asset positions decline immediately upon home purchase and do not rebuild to "equilibrium" levels for several years. The inclusion of a period of tenure variable is therefore necessary to control for this disequilibrium situation (see also discussion in Chapter III).

Estimation Procedures

The data used for estimation is taken from the 1970 Survey of Consumer Finances, a sample of 2576 households interviewed during the third and fourth quarters of 1970.³ This data set is unique in that, not only does it contain information on income, household composition, and socioeconomic status, it yields measures of (1) asset holdings (2) credit terms and down payment levels, and (3) price and income volatility and expectations.

The method of analysis used is linear ordinary-least-squares (OLS) regression analysis. All variables are input in a linear form. For the purpose of this

study, no interaction effects are investigated. Strong first-order non-interaction effects indicate that second and higher order interaction effects may be relatively less significant. Results are presented in the next section.

Estimation Results

The results of our "preferred" specification are shown below:

$$\begin{aligned}
 (4.3.) \quad \text{VALUE} = & 2.36192 + .44065 Y_c + .23950 A \\
 & (.08325) \qquad \qquad \qquad (.08390) \\
 & + .12030 \text{ AGE} + 3.69461 \text{ TWOPAR} \\
 & (.06948) \qquad \qquad \qquad (2.46805) \\
 & + .74404 \text{ EDUC} + 3.77034 \text{ OCCUP} \\
 & (.23315) \qquad \qquad \qquad (1.41700) \\
 & + 2.46499 \text{ SUBURB} - .25266 \text{ TENURE} - .57136 P \\
 & (1.27493) \qquad \qquad \qquad (.11404) \qquad \qquad \qquad (.17257)
 \end{aligned}$$

$$R^2(\text{adj.}) = .35941 \quad N = 295 \quad \text{s.e.e.} = 10.30574$$

Where VALUE = current house value in \$1000

Y_c = current income in \$1000

A = liquid assets in \$1000

AGE = age of head in years

TWOPAR = dummy variable representing presence
of two parents (1 = yes, 0 = no)

EDUC = education of head in years

SUBURB = dummy variable representing suburban
location

TENURE = period of tenure

P = initial mortgage payment in dollars per
year per \$100 borrowed

The standard errors of each coefficient are shown in parentheses. All coefficients are significant at the 95 percent level of confidence with the exception of TWOPAR, which is significant at 90 percent.

Our discussion of these results is organized into three sections, each of which corresponds to the influences of a particular group of explanatory variables. The first section reports on the influences of income and assets. The second discusses socioeconomic and market variables. The final section outlines the effect of our mortgage-related variables, the major items of interest in this analysis.

Income and Asset Influences

Current income, as expected, is found to be a significant positive influence on the level of housing consumption for homeowners. For every \$1000 a homeownership household earns per year it consumes an additional \$441 worth of housing. Evaluated at the mean levels of income and house value, this implies an elasticity of 0.278. This estimate is considerably lower than the income elasticity of demand as estimated by deLeeuw (1971), Muth (1960), Reid (1962), and Lee (1965). These tend to

cluster at the 0.8 to 1.0 range. However, a recent study by Maisel, et al., (1971) claims that grouping of data has led to an upward bias in past estimates of income elasticity and concludes that the elasticity is in the 0.52 to 0.70 range. Kearl's estimate in his multi-equation longitudinal model using mortgage-related variables is even lower than Maisel's at 0.25, which corresponds closely to ours. Furthermore, a cross-sectional study by Roistacher (1974) using panel survey data derives estimates of an income elasticity between 0.18 and 0.83 for owners and 0.29 to 0.91 for renters, depending on income class--figures within a reasonable distance of our own. Thus, although our elasticity estimate is somewhat lower than the current wisdom would indicate, several recent studies have indicated that the true elasticity might be somewhat lower and very possibly could be within the range of our estimate.

Two other factors, however, might account for a possible downward bias in our elasticity estimates. First, current, rather than permanent, income is the income variable entered in our model, whereas most other studies were measuring the elasticity of permanent income. Permanent income is expected to have a much lower range of variability than current income since the transitory components of income have been controlled for. Thus the permanent income elasticity is expected

to be higher. Second, as mentioned previously, our coefficient estimates could be subject to simultaneous equation bias. Since we do not have a multi-equation model separately estimating supply and demand schedules and since we have not resorted to certain other methods (see deLeeuw (1971)) to obtain an unbiased estimate, our income elasticity estimate would be expected to be somewhat downward biased.

The level of liquid assets significantly influences the level of housing consumption. For every \$1000 a household holds in current liquid assets, it consumes \$240 more in housing, an elasticity of .0422, evaluated at the means. This elasticity is one of the first to be made measuring the influence of assets on housing consumption.

There are several problems associated with the specification of the assets variable. First is the use of current assets to predict a housing consumption decision made in the past (see Chapter III). A period-of-tenure term was entered in an attempt to control for this and for the disequilibrium level of assets for some years after home purchase caused by making the down payment. The coefficient for this variable is negative as expected.⁴

A potentially more serious shortcoming associated with the assets variable is the failure to include consideration

of equity built up in the previous home of a previous homeowner at the time of purchase--an important component of total assets available for down payment. However, this measure was unavailable from existing data. It is expected much of this effect is picked up by income, age, and other demographic variables and by current assets.⁵

Socioeconomic and Housing Market Influences

Socioeconomic and market variables generally affect the level of housing consumption as expected. A family with an older head and a two-parent family consume more housing; taste differences can easily explain this fact. The number of children in the family does not affect housing consumption levels. This is expected if the increase in other expenditures required with additional children results in a less "housing-intensive" consumption bundle. The level of education and a white-collar occupation are associated with increased housing consumption, as is a suburban location. Race is not significantly related to an increase in housing expenditure, supporting the hypothesis that tastes for housing do not differ between black and white households.

Mortgage-Related Influences

Of the mortgage-related variables, only the initial mortgage payment level P shows any significant relationship to the level of housing consumption. The coefficient of this variable indicates that for every \$1 additional initial mortgage cost per year per \$100 borrowed, the household will decrease its housing consumption by \$571. This is an elasticity of $-.243$, evaluated at the means. Thus mortgage payment requirements do appear to affect stock consumption levels. An increase in mortgage rates from 8 percent to 9 percent, for example, means for a 25-year mortgage a decrease in housing consumption of \$462.

Here we should repeat our caveat about the proper interpretation of the P coefficient (see also Chapters II and III and Appendix III). P is picking up both present value and cash flow mortgage-related effects upon housing consumption (including the effect of the amortization period since it could not be entered separately due to collinearity with P). In addition, P is picking up the effects of a non-mortgage-related effect, the alternative yield on investments available in the market (r_A), which could also not be entered separately due to collinearity with P . These separate effects must be kept in mind in interpreting our simulation results.

The lack of significance of the coefficients for the expected trend in payment burden (π) and its uncertainty (σ) says that homeowners do not significantly hedge in their housing consumption decisions based upon future expectations of increased payment burdens or upon uncertainty in these expectations, at least within the range of uncertainty currently experienced under the standard mortgage instrument. Note that this does not say anything about their substitution of debt for equity-financing, which is seen in Chapter V to be quite significant.

Simulation Results: The Introduction
of Alternative Mortgage
Instruments

In this section we present the results of simulating the introduction of four types of alternative mortgage instruments using our estimated model of housing consumption. The four instruments are (1) the standard variable-rate mortgage with payments indexed either to a short-term interest rate series, namely, the three-month treasury bill rate (the VRMS), or to a long-term interest rate series, namely, the Aaa corporate bond rate (the VRML); (2) the graduated payment mortgage (GPM), similar to the standard instrument (the FRM) but with an a priori graduated (5 percent per year) rather than level payment stream, (3) the price-level-adjusted

mortgage (PLAM) with constant real, rather than nominal, payments over time; and (4) the income-linked mortgage (ILM) with payments constrained to be a certain fraction (in our case, 10 percent) of borrower income.

For each instrument type the values of P , π , and σ were calculated for each household and the results substituted into our model to estimate predicted changes in housing consumption under each instrument in the aggregate and distributed by income, age, and race. We follow Kearl (1975) in warning against interpreting too strictly the results of these simulations. Our coefficients are not point estimates but random variables subject to error. In addition, the parameter values input for the alternative instruments are oftentimes beyond the range of experience under the FRM. Hence the simulations are extrapolative and not interpolative.

Most importantly, because of data limitations on specification and estimation, the effects reflected in our mortgage-related coefficients are not "pure" present value or cash flow effects which are transferable among instruments. They contain mixed present value and cash flow effects and even permanent income and alternative yield effects. The relationships between these variables and the "pure" effects are very different depending on the instrument. Thus, in spite of our attempts to evaluate mortgage-related demand effects which are not

instrument-specific, we were still not wholly successful, and our simulation results must be qualified accordingly. A more complete discussion of these limitations is presented in Chapter III. The reader is warned to interpret the simulation results qualitatively only and with a great deal of caution in spite of our quantitative presentation of the results.

One additional comment should be made relating to interpretation of our simulation results. As discussed in Chapters II and III, proper analyses of alternative mortgage instrument introduction should consider the instruments as alternatives rather than replacements for the FRM. Most simulation work, including this study, however, examines each instrument as if it were the only instrument being offered. Thus our results must be reinterpreted if we are to evaluate the result of mixing. Specifically, if one instrument is shown to increase housing consumption within one group of homeowners and decrease it within another, we must reinterpret this to mean that within the first group that instrument would dominate the FRM and the second would be dominated by it. See Chapter III for discussion of a further simulation exercise which could crudely evaluate the degree of dominance.

We shall divide our discussion of the simulation results into four sections. The first presents aggregate

results. The next three present the distributional implications for each instrument by income, age of head, and race.

Aggregate Results

Table 4-2 lists the mean values for P under the standard instrument and each of the alternative instruments (column 2), the predicted mean level of housing consumption under each instrument (column 3), and the absolute and percentage difference between the predicted level under each alternative instrument and the standard instrument (columns 4 and 5).

As in our analysis of homeownership, it was necessary to make judicious assumptions about the terms under which the new instruments would be offered at equilibrium, based upon supply characteristics. These assumptions are:

- °The GPM is offered at the same contract rate and maturity as the FRM and at a 5-percent annual graduation rate.
- °The PLAM is assumed to be offered at the real interest rate at the time of origination--a rate which results in a nominal return equivalent to that for the FRM if inflationary expectations are realized. The maturity is assumed to be equivalent to that of the FRM, and the graduation rate is set by the consumer price index.

TABLE 4-2

AGGREGATE SIMULATION RESULTS: PREDICTED HOUSING CONSUMPTION
LEVELS BY INSTRUMENT

Instrument	Initial Payment Level (P) (\$ per Year per \$100 Borrowed)	Predicted Housing Consumption Level (\$1000)	Change from FRM (\$1000)	Percent Change from FRM
FRM	9.92	22.804	--	--
GPM	7.76	24.040	1.236	5.4
PLAM	8.05	23.856	1.052	4.5
VRMS	9.58	23.000	0.196	0.9
VRML	9.58	23.000	0.196	0.9
ILM	11.38	21.972	-0.832	-3.6

°The variable-rate instruments are offered at the same maturity as the FRM and at a one-half percent initial contract rate discount. The interest rate indices are adjusted annually.

°The ILM payments are assumed to be constrained at 10 percent of all households' incomes. There are no explicit assumptions as to contract rates, but the maturity must adjust to amortize the mortgage principal.

See Chapter III for a justification for each of these assumptions.

Since housing consumption is predicted in the model to be affected only by the initial payment level P among all the mortgage-related variables, it is expected that the instrument with the lowest initial payment level will most encourage housing consumption. This is the GPM, with an initial payment on the average 22 percent lower than that for the FRM due to its graduated character. The GPM is predicted to increase housing consumption by 5.4 percent over current levels. The PLAM is in second place due to its initial monthly payment being 19 percent below the FRM level, which increases housing consumption among homeowners by 4.5 percent. Both the GPM and the PLAM are therefore predicted to perform superiorly to the current FRM if increased housing consumption among homeowners is seen as a desirable goal.

The assumed one-half percent reduction in the initial contract rate for the two variable-rate instruments results in an average 3.4 percent reduction in their initial payment levels. The housing consumption level is thereby increased by 0.9 percent at the mean, indicating an overall advantage to these instruments under the housing consumption criterion. However, it must be remembered increased average housing consumption among homeowners does not indicate these instruments are desirable on other grounds--such as accessibility to homeownership opportunities and increased use of mortgage financing. Indeed, other results (Chapters III and V) indicate quite the opposite.

The remaining instrument, the ILM, does not appear to hold a great deal of promise for increasing housing consumption above current levels. As constructed, with the initial payment for all households restricted to 10 percent of income, it increases the mean initial payment 15 percent over the FRM level, thus reducing housing consumption by 3.6 percent (of course, a different mortgage design would have resulted in a different initial payment level). Simulation of the ILM, with its extended maturity feature, is not entirely justified in our model framework, since our model takes no account of maturity changes, unless we assume that households highly discount payments far in the future. Thus results for this

instrument must be accepted with the greatest tolerance of any instrument.

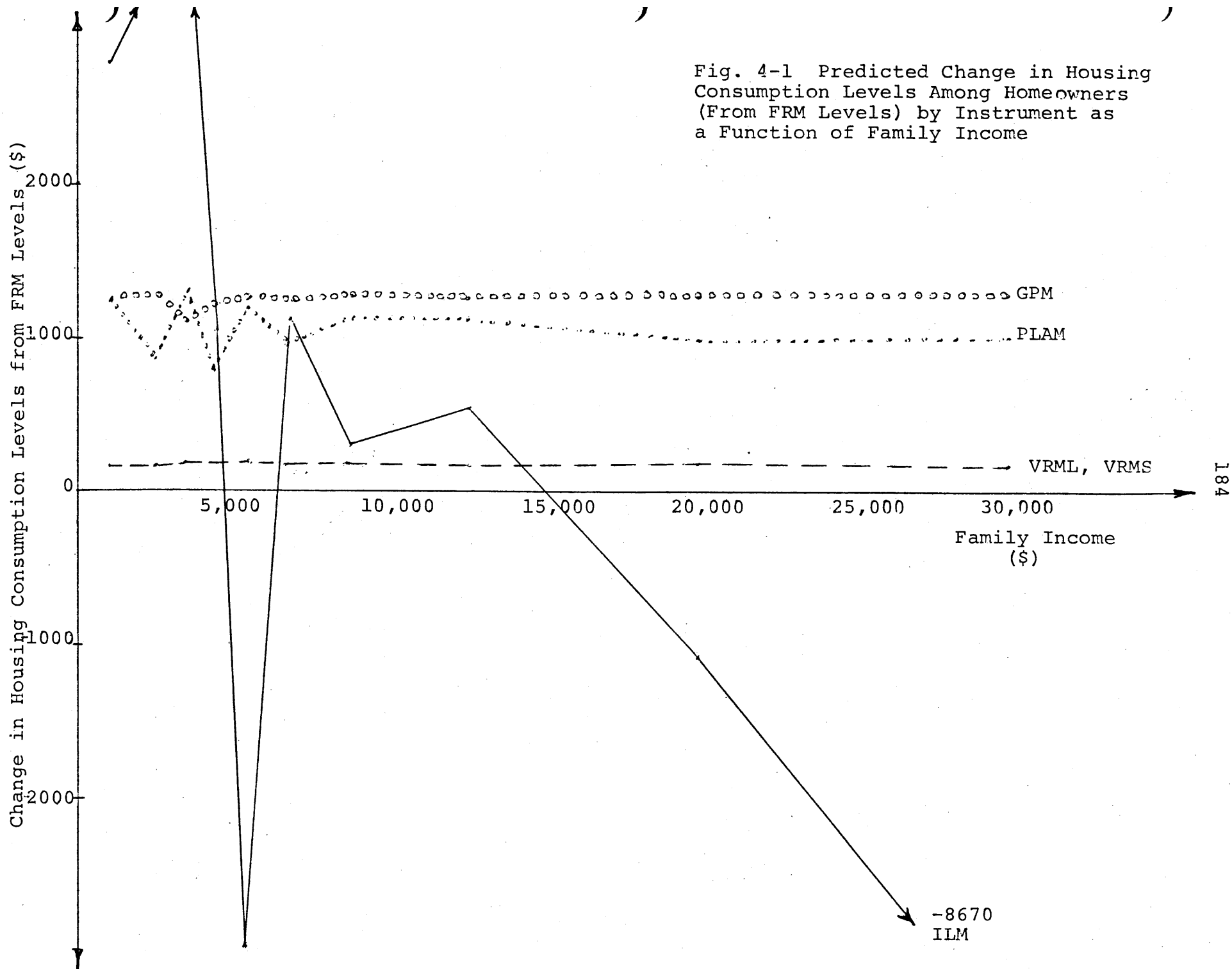
This completes our discussion of the aggregate effects of alternative mortgage instruments upon housing consumption by homeowners. However, most arguments against the introduction of alternative instruments are based not upon their aggregate effects but upon their distributional effects across population classes. The next three sections discuss these distributional implications as predicted by our simulations.

Distributional Results by Income

Figure 4-1 plots the expected increase or decrease in housing consumption among homeowners under each alternative mortgage instrument relative to that under the FRM as a function of income. An ordinate value of \$3000 for a certain household income class and a certain instrument in Figure 4-1 indicates that homeowners in that income class offered that instrument are predicted to increase their equilibrium housing consumption level an average of \$3000, or equivalently to buy homes worth \$3000 more than those they own under an FRM. Table A6-5 in Appendix 6 presents these simulation results in tabular form.

The VRML and VRMS, because of their assumed one-half percentage-point reduction in the initial contract rate and consequent reduction in the initial payment

Fig. 4-1 Predicted Change in Housing Consumption Levels Among Homeowners (From FRM Levels) by Instrument as a Function of Family Income



-8670
ILM

level, are predicted to result in a slight (\$190) increase in housing consumption over that under the FRM. This figure is approximately the same across all income groups.

The ILM, as expected, because of the lowered P for lower-income groups and the raised P among higher-income groups, predicts that those households making below \$10,000 per year will increase their housing consumption (up to \$3500 in the lowest income ranges), but those making more will decrease their consumption (by up to \$8700 for those making over \$25,000 per year). Since a household making \$3-4000 under the FRM owns a unit worth \$13,100, a \$3500 increase would mean a 27 percent per-household housing consumption increase. Likewise households making over \$25,000 per year, which under the FRM consume housing worth \$46,300 on the average, would drop their housing consumption 19 percent.

The PLAM and the GPM appear to most positively affect housing consumption across all income groups. The GPM is slightly superior to the PLAM. The drop in the initial payment level under this instrument is responsible for an approximate \$1200 per-household housing consumption increase across all income groups. The decreased initial payment level for the PLAM increases housing consumption by about \$1000 per household across all income groups.

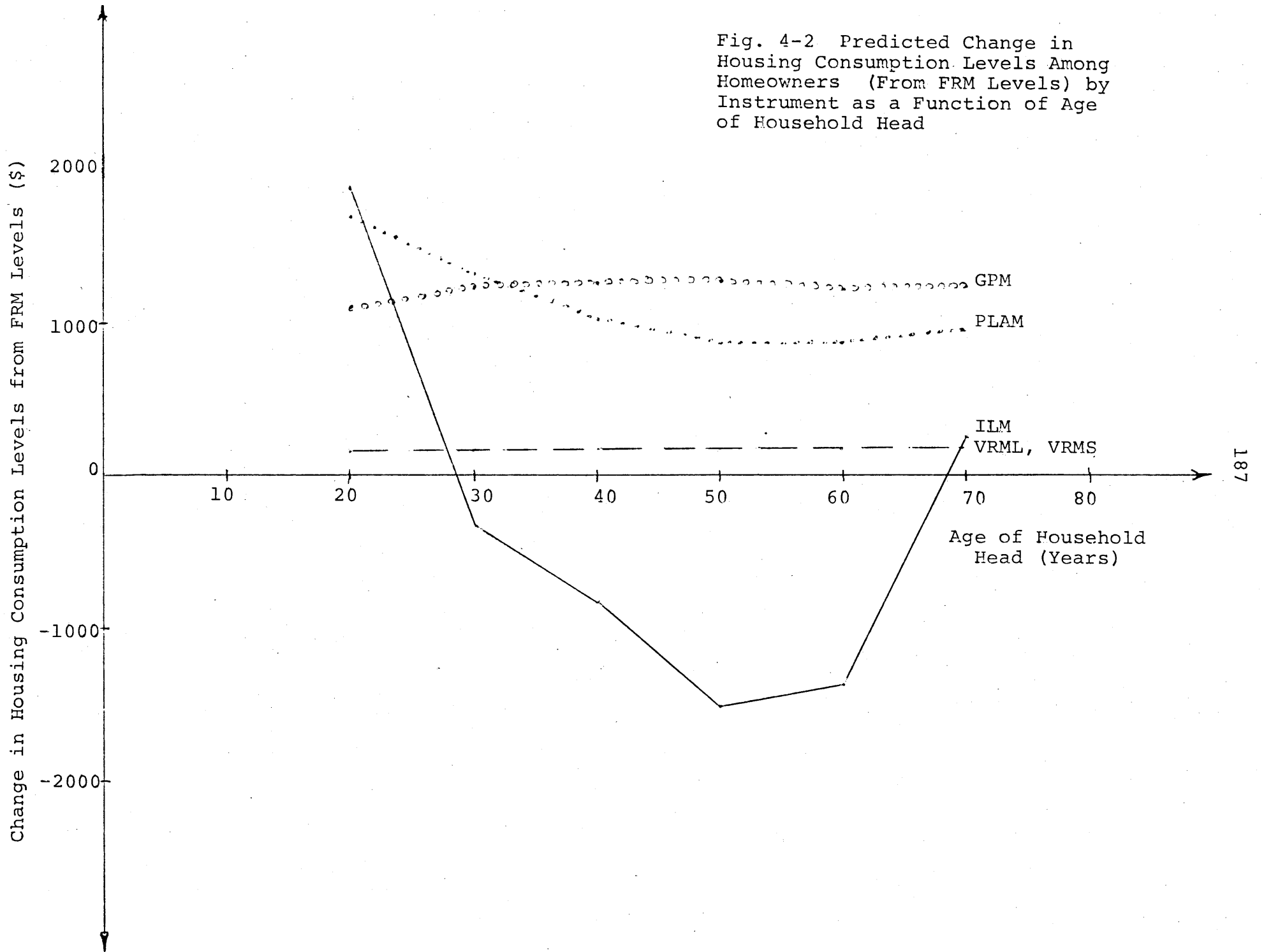
Distributional Results by Age

The increase or decrease in housing consumption by age of household is plotted in Figure 4-2. Again, the VRML and VRMS predict a uniform \$190 increase in housing consumption across all income groups.

The ILM again looks quite attractive to young households, primarily because these households have lower incomes and currently pay a higher fraction of their income in mortgage payments. Thus they would enjoy a significant drop in the initial payment level under the ILM. On the average, households in the under-25 year age bracket are predicted to increase their housing consumption by \$2000. Middle-age households, at the height of their earning power, however, are forced to pay initially higher payments under the ILM than they currently enjoy under the FRM and as a result drop their housing consumption by up to \$1500. Older households above 65, usually retired and with lower incomes, again enjoy some relative benefit from the ILM, according to our analysis, although it is likely our analysis does not take into account supply constraints which would limit ILM availability to such households (see discussion in Chapter III).

The GPM and PLAM again appear to be the most uniformly desirable instruments from the standpoint of both increased housing consumption and equitability of

Fig. 4-2 Predicted Change in Housing Consumption Levels Among Homeowners (From FRM Levels) by Instrument as a Function of Age of Household Head



that increase across age groups. The PLAM dominates for the youngest households, while the GPM dominates for households with heads above 35 years of age. Increased housing consumption under both instruments is between \$800 and \$1600 per household.

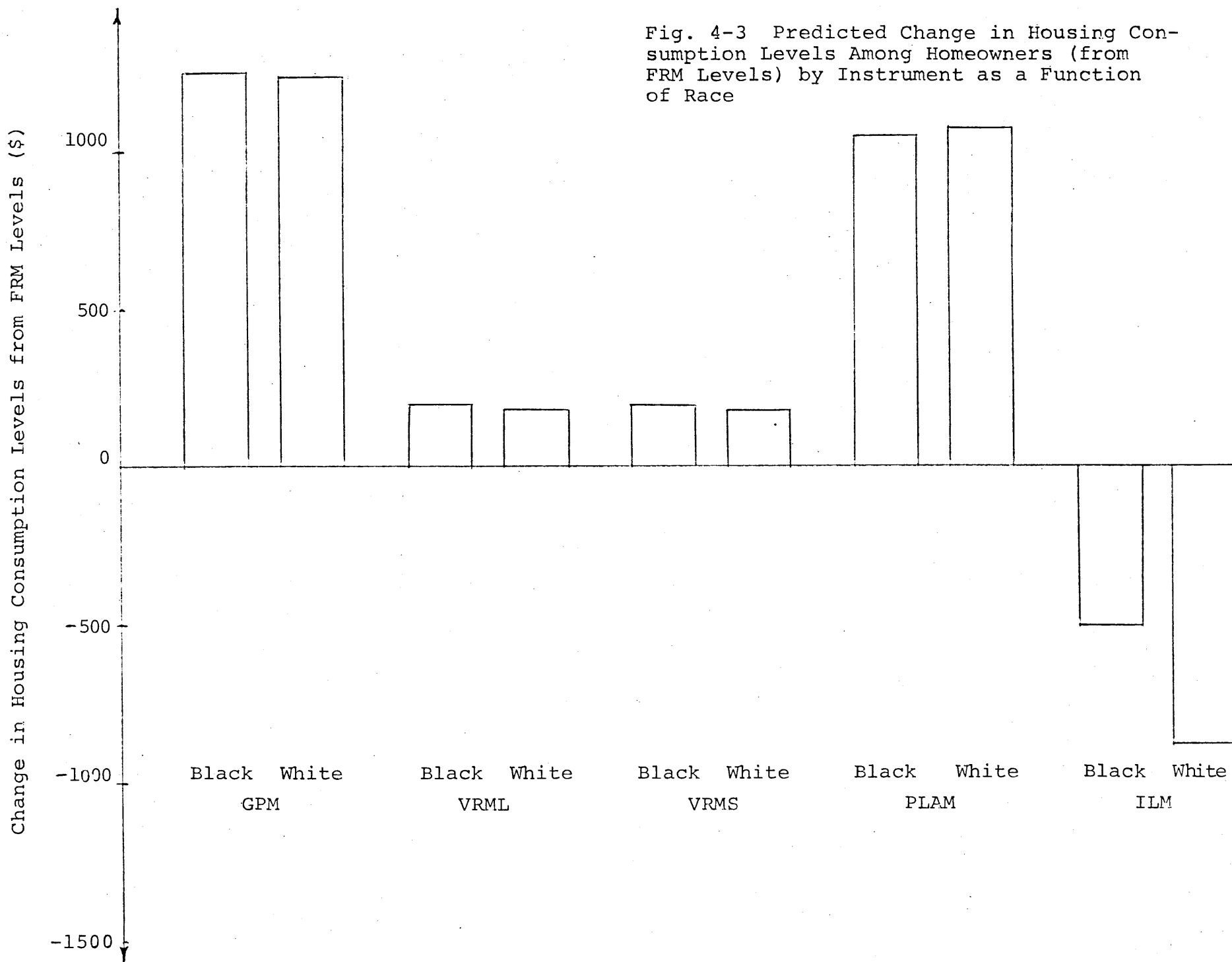
Distributional Results by Race

Figure 4-3 represents the housing consumption differential for our five alternative mortgage instruments by race. In most cases, there is greater difference among instruments than between black and white households.

The ILM is the only instrument which is predicted to result in a decrease in housing consumption by both black and white households. Because of their lower current payment-to-income ratio, white households would decrease their housing consumption by the largest amount (almost \$900, compared to just over \$500 for black households).

The VRML and VRMS again predict roughly \$190 increases in housing consumption for both black and white households. The GPM and PLAM again appear to dominate when both aggregate increases in housing consumption and the equitability of these increases are considered. The PLAM predicts an increase in per-household housing consumption demand of over \$1000 while the GPM predicts an increase of over \$1200. Neither

Fig. 4-3 Predicted Change in Housing Consumption Levels Among Homeowners (from FRM Levels) by Instrument as a Function of Race



has any significant distributional consequences with respect to race.

Summary of Findings and Policy
Implications

Our estimation and simulation exercises have derived for us the following major findings relating to the effects of mortgage characteristics and the effects of the introduction of various alternative mortgage instruments upon equilibrium housing consumption levels:

1. One mortgage-related variable--the initial annual payment per \$100 borrowed--significantly influences the size of home purchase. This conclusion supports hypotheses by Kearn (1975) and others that the long-run level of housing consumption can be influenced by credit conditions. Households, however, do not appear to significantly adjust their housing consumption levels according to their expectations of future mortgage payment burdens or uncertainty in those burdens. This result contradicts a risk "hedging" hypothesis which says households will tend to protect themselves against future contingencies by adjusting their housing consumption levels.

2. Although simulation results must be accepted with caution, the graduated-payment mortgage (the GPM) and--to a lesser extent--the price-level-adjusted mortgage (the PLAM) are predicted to perform better than the

current instrument of mortgage finance (the FRM) in the sense that they are predicted to encourage a higher level of housing consumption by all classes of homeowners with little adverse redistributational effect. The standard variable-rate mortgage (the VRM), tied to either a long-term or a short-term interest rate, is predicted also to slightly increase per-household housing consumption by all homeowners above current levels, since it is assumed to be offered at a one-half percent interest rate discount. (Note this says nothing about the proportion of total households which would be homeowners under this instrument or the extent to which they finance out of a mortgage or a down payment. The income-linked mortgage (the ILM), on the other hand, in the aggregate is predicted to slightly reduce housing consumption. The ILM is predicted to have significant positive distributional effects, however; it substantially increases housing consumption by lower-income, young, and elderly households.

These results in general support those in the previous chapter in recommending the GPM and PLAM as desirable alternatives to the current instrument of mortgage finance.

FOOTNOTES--CHAPTER IV

¹See discussions during Congressional hearings on the introduction of the VRM held in 1975.

²Kearl (1975), p. 218.

³Described in Katona, et al. (1971).

⁴If TA_p is the total assets available at purchase, E_p is the equity accumulated in the existing home, A_p is the liquid assets available at purchase, DOWN is the level of down payment, A_o is the level of liquid assets left after down payment, and A_c is the current asset level T years after purchase, then the following relationships are true, if we assume a household accumulates liquid assets at a constant rate b after purchase:

$$TA_p = E_p + A_p = \text{DOWN} + A_o = \text{DOWN} + A_c - bT$$

Since DOWN is shown in our formal derivations to be dependent on the same variables as VALUE, including TA_p , we can proxy TA_p by these variables, A_c , and T. The coefficient for A_c is expected to be positive and that for T is expected to be negative.

CHAPTER V

AN EMPIRICAL INVESTIGATION OF THE EFFECT OF ALTERNATIVE MORTGAGE INSTRUMENTS UPON THE FINANCING OF RESIDENCES

Introduction

The previous two chapters have investigated what influence the introduction of various alternative instruments of mortgage credit can be expected to have upon homeownership opportunities and housing consumption among homeowners. A third--and no less important--question, which will be addressed in this chapter, is to what extent these alternative instruments will affect the level of mortgage versus down payment financing of residential properties. It has been argued that the changed payment stream, equity build-up, and default risk characteristics of these instruments will lead to (1) home purchasers relying more heavily on their equity funds to reduce their use of these instruments, and (2) lenders significantly increasing their down payment requirements to reduce their default risk exposure.¹ To the extent that different classes of borrowing households exhibit different responses

to each instrument, this argument can also have significant distributional implications.

A proper empirical evaluation of this argument requires the development of a model relating various present value or yield characteristics and cash-flow characteristics of the mortgage credit instrument to the equilibrium level of mortgage and down payment financing. What empirical models of this type currently exist? No studies have examined the determinants of down payments. However, two types of longitudinal aggregate mortgage credit demand studies have been carried out relating the volume of mortgage credit to the demand for housing, the relative price of mortgage credit, and in some cases, certain non-price terms of mortgage credit.

The first type is a short-run model which explains the fluctuations in mortgage credit demand over business cycles. Several short-run studies (Huang (1966), Sparks (1967), Kearl and Rosen (1974)) have included only the mortgage interest rate among their mortgage-related explanatory variables (Table 5-1.) Others (Huang (1966), Clauretie (1973)) have also included several non-rate mortgage credit characteristics, such as the amortization period and the loan-to-value ratio.

The second type of mortgage credit demand study is a long-run equilibrium model which, by using the accumulated stock of mortgages as a partial adjustment

TABLE 5-1

COMPARATIVE MODEL STRUCTURES: THE DEMAND FOR MORTGAGE CREDIT

	Dependent Variable	House Value Explicit or Implicit	Current or Permanent Income	Relative Price Measure	Longi. or X-Sec./ Aggregate or Individual Data	Financing Variables	Asset or Wealth Variables
Long run							
Silber	Change in mortgage stock	Implicit	Change in Permanent	--	Longi. Agg.	Δr	No
Jaffee	r	Explicit	--	Aaa Bond Rate Value Stock	Longi. Agg.	r(as dep)	No
Kearl	r	Explicit	--	Aaa Bond Rate	Longi. Agg.	r(as dep.) (W/HH)/(1-L/V)	$\frac{W/HH}{1-L/V}$
Short run							
Huang	Mort. Flows	Implicit	Current (Disposable)	$\frac{R}{P}$	Longi. Agg.	r, ΔT	$\frac{\Delta \text{Mortgage Stock}}{\text{Total Fin. Assets}}$
Kearl-Rosen	Mort. Flows	Explicit	--	r_{Aaa-1}	Longi. Agg.	r	No
Huang (S&L Study)	Mort. Flows	Explicit	--	--	Longi. Agg.	$\frac{(L/V)}{T}$	$\frac{\Delta \text{Mortgage Stock}}{\text{Total Assets}}$
Clauretje	Mort. Flows	Implicit	Permanent	$\frac{R}{P_H}$	Longi. Agg.	r,L/V,T	No
Key:	L/V = Loan to Value Ratio		T = Amortization Period				
	p = Consumer Price Index		W/HH = Wealth Per Household				
	P_{HI} = Price of housing						
	R = Rental Cost Index						
	r = Mortgage Contract Rate						
	r_{Aaa-1} = Aaa Bond Rate (lagged 1 period)						

mechanism, attempts to explain secular (not cyclical) influences on mortgage credit demand (Silber (1968), Jaffee (1972), Kearl (1975)). All of these studies have included the mortgage interest rate as an explanatory variable. Most do not include non-rate terms under the justification that in the long run in perfect financial markets, only the rate is a determinant of mortgage credit demand. Silber attempts to include non-rate mortgage characteristics. However, he is prevented from doing so by multicollinearity problems. Only Kearl has been successful in an OLS estimation in finding a function of a non-rate variable, the loan-to-value ratio, to have a significant influence on mortgage credit volumes.

All of the above studies are inadequate for the purpose of answering our question about the influence of alternative mortgage instruments upon mortgage vs. down payment financing. First, they are all instrument-specific for the FRM. The mortgage-related variables considered by them are the interest rate, the loan-to-value ratio, and the amortization period, or some function of these. The interest rate may be an acceptable proxy for the yield characteristics of the mortgage (although the present value of the mortgage discounted at the household's own discount rate would probably be better.) However, it is not the interest rate, the loan-to-value ratio, or the

amortization period which is important when evaluating responses to alternative instruments, but instead how these interact to affect the time stream of payments relative to income (the cash flow effects). The form of this interaction is different for each instrument type. Second, risk of future payment increases, extensions in maturity, changes in the rate of equity accumulation, and default are all important considerations in evaluating response to alternative instruments which these studies did not address. Finally, these studies used aggregate longitudinal data in all cases, placing limitations on investigating distributional consequences and the effects of individual income, price, and risk expectations at the microeconomic level.

This paper will present a simple econometric model which attempts to respond to many of the above shortcomings. The mortgage-related characteristics which will be included as explanatory variables will be the initial payment level, the expected trend in payment burden (payment-to-income ratio), and the uncertainty in the payment burden trend--all of which under certain assumptions and with certain caveats can be used to simulate alternative instruments as well as the FRM. The uncertainty variable takes into account one very important component of risk. Finally, the study is a cross-sectional one, disaggregated at the individual level to properly evaluate microeconomic behavior.

The remainder of the chapter consists of four sections. The first section introduces the models for mortgage and debt financing and provides theoretical justification for their specification. The second section reports upon the results of empirical estimation. The third section uses these results to simulate the effects of alternative mortgage instruments. The final section offers some conclusions and policy implications.

The Model

Issues

Again, as in the previous two chapters, we must briefly mention several issues relating to interpretation and specification of our model. First, ours will be a one-equation structural demand model relating the level of mortgage or down payment financing to our chosen explanatory variables and not a multi-equation system of equations separately estimating supply and demand schedules. Therefore, it is possibly subject to "simultaneous equations bias," which would tend to bias the coefficients toward zero, resulting in conservative estimates of impact. Second, our model uses current socioeconomic and other conditions to explain a mortgage-or-equity-financing decision made some time in the past. This is justified if we assume households make their long-term investment

decisions based not only upon current conditions but also upon their expectations with respect to future income and socioeconomic conditions.²

Model Theory and Specification

When a household decides to buy a home and settles upon a particular unit, it must decide how to split the purchase price between a down payment and mortgage financing. In Chapter IV we outlined the considerations which are important in making the "monthly payment" or financing decision and the "down payment" decision. They are also discussed more formally in Chapter II and Appendix III. We will only outline them briefly here.

Since the household must first settle on a level of housing consumption before it decides on a down payment, one of the primary determinants of the level of debt or equity financing is the size of the home purchased. The more expensive the home, the higher will be both mortgage and down payment financing, all other things being equal. We saw in Chapter IV that the important determinants of housing consumption in turn are variables relating to current and permanent income, assets, socioeconomic characteristics proxying for tastes and discount rates, market and stock characteristics proxying for relative prices and expected appreciation, alternative yields available in the market, and characteristics of the mortgage payment and payment burden streams.

In addition to the size of the home, there are other direct influences on mortgage vs. down payment financing affecting their marginal costs. These also include current and permanent income and assets; socioeconomic characteristics proxying for tastes and discount rates; alternative yields available in the market; and characteristics of the mortgage payment and payment burden streams. The household considers the marginal costs of equity and borrowed funds for a given level of housing consumption and splits its mortgage and down payment financing in such a way that these marginal costs are equal. These marginal costs may be considered marginal disutilities associated with debt or equity payments which arise from both present value or yield and cash flow considerations.

The formal descriptions of these relationships are presented in expressions (A.3.23.) and (A.3.24.). There are repeated here in slightly modified form:

$$(5.1.) \quad \text{DOWN} = \text{DOWN} (\text{VALUE}, P, \hat{E}(P), \hat{T}, \pi, \sigma, Y_p, Y_c, r_A, A, F)$$

$$(5.2.) \quad \text{MORT} = \text{MORT} (\text{VALUE}, P, \hat{E}(P), \hat{T}, \pi, \sigma, Y_p, Y_c, r_A, A, F)$$

where DOWN = down payment

MORT = mortgage principal

VALUE = unit value

P = initial annual mortgage payment per
\$100 borrowed

$\hat{E}(P)$ = expected trend in mortgage payments
(a random variable)

\hat{T} = mortgage amortization period (a random variable)

π = expected trend in payment burden

σ = uncertainty in expected payment burden trend

Y_P = permanent income

Y_C = current income

r_A = alternative yield available in the market

A = assets

F = socioeconomic characteristics proxying for tastes and discount rates

These complex expressions may be simplified considerably through judicious assumptions. Assuming housing consumption is considered implicitly; all discount rates are proxied by permanent income, assets, and socioeconomic characteristics; and relative prices, expected appreciation, and other characteristics of the housing unit are proxied by market (N) and stock (S) characteristics (see expression A.3.29.), we have

$$(5.3.) \quad \text{DOWN} = \text{DOWN}(S, N, P, \hat{E}(P), \hat{T}, \pi, \sigma, Y_P, Y_C, r_A, A, F)$$

$$(5.4.) \quad \text{MORT} = \text{MORT}(S, N, P, \hat{E}(P), \hat{T}, \pi, \sigma, Y_P, Y_C, r_A, F)$$

which are also presented in expressions (A.3.30.) and (A.3.31.) in slightly modified form.

Expressions (5.3.) and (5.4.) were not estimated directly however. The following modifications were made prior to estimation:

- °Permanent income was proxied by current income socio-economic characteristics, and income expectations
- °Income expectations, in turn, were identical to π and σ under the FRM
- °The expected mortgage payment trend variable (E(P)) was constant under the FRM, hence its effect could not be determined
- °The amortization period T and the alternative yield r_A could not be entered because of high collinearity with P.

We were left with the following relationships for estimation:

$$(5.5.) \quad \text{DOWN} = \text{DOWN}(Y_c, A, F, S, N, P, \pi, \sigma)$$

$$(5.6.) \quad \text{MORT} = \text{MORT}(Y_c, A, F, S, N, P, \pi, \sigma)$$

Note that since we are considering several variables implicitly, many of our coefficients will reflect both direct and indirect influences on debt versus equity financing. Kearl, Rosen, Swan (1974) contend that one desirable implication of considering the level of housing consumption implicitly is that if the actual housing consumption level is out of equilibrium, an indirect

measure will represent more closely the "desired" amount of housing. More importantly, several of our mortgage-related variables reflect both cash-flow and present value influences and in some cases also permanent income, alternative yield, or amortization period influences. These mixed influences affect interpretation of our estimation results and the usefulness of alternative instrument simulations. See Chapters II, III, and IV for detailed discussions of this point.

Estimation Procedures

Again the 1970 Survey of Consumer Finances is the data source for empirical estimation of our model. Ordinary-least-squares (OLS) estimation procedures are used to estimate both the mortgage and down payment equations. A linear specification is again used, and no interaction effects are examined, largely because of sample size limitations and instability of interaction results. Our OLS estimation is successful at obtaining strong-first-order noninteraction effects, however, without resorting to consideration of possible interaction among the variables.

Estimation Results

Several specifications for both our mortgage credit and down payment equations were experimented with, resulting finally in the following "preferred" specifications:

$$\begin{aligned}
 (5.7.) \quad \text{DOWN} &= -.44627 + .25561 Y_c + .25785 A \\
 &\quad (.07123) \quad (.07685) \\
 &\quad -2.48048 \text{ URBAN} + 3.61746 \text{ RACE} \\
 &\quad (1.33451) \quad (2.06228) \\
 &\quad + 1.66877 \text{ OCCUP} + 13.87714 \pi \\
 &\quad (1.15194) \quad (8.45311)
 \end{aligned}$$

$$R^2(\text{adj.}) = .17272 \quad N = 259 \quad \text{s.e.e.} = 8.79363$$

$$\begin{aligned}
 (5.8.) \quad \text{MORT} &= 11.2378 + .18056 Y_c - .11107 \text{ TENURE} \\
 &\quad (.04465) \quad (.06188) \\
 &\quad + .44946 \text{ EDUC} + 2.26820 \text{ SUBURB} \\
 &\quad (.12425) \quad (.73088) \\
 &\quad + 3.21487 \text{ OCCUP} - .57702 P - 9.80900 \pi \\
 &\quad (.88137) \quad (.09744) \quad (5.32755)
 \end{aligned}$$

$$R^2(\text{adj.}) = .39408 \quad N = 285 \quad \text{s.e.e.} = 5.85154$$

where MORT = mortgage credit (in \$1000)

DOWN = down payment (in \$1000)

Y_c = current income (in \$1000)

A = liquid assets (in \$1000)

TENURE = period of tenure in unit (years)

EDUC = number of years of education of household head

URBAN = dummy variable indicating location of unit (1 = urban, 0 = other)

SUBURB = dummy variable indicating location of unit (1 = suburban, 0 = other)

RACE = race (1 = white, 0 = black)

- OCCUP = occupation of head (1 = white collar,
0 = blue collar)
- P = initial mortgage payment level (dollars
per yr. per \$100 borrowed)
- π = expected trend in mortgage payment burden
(fraction increase/decrease per year)

Standard errors of the coefficients are in parenthesis. All coefficients are significant at the 95 percent confidence level, with the exception of the coefficient for OCCUP in the down payment equation, which is significant at the 90 percent confidence level.

Note that summing the two estimated equations for MORT and DOWN roughly approximates the equation for VALUE in Chapter IV. We would expect this since the sum of down payment and mortgage principal always equals the price of the home. In fact, if we had used the same observations and set of explanatory variables in all three equations, the third equation would be an exact linear combination of the other two.

Our estimation results will be discussed in three sections, which correspond to certain explanatory variable classifications of interest. The first section discusses the influences of income and asset positions on mortgage and down payment financing. The second reports on the effect of socioeconomic and market variables. The third,

where we will focus most of our attention, outlines the influence of our mortgage-related variables.

Income and Asset Influences

The income coefficients for debt and equity financing indicate that the increase in housing consumption of \$440 for each \$1000 increase in income, reported in Chapter IV, is split between an increase in the down payment of about \$260 and an increase in the level of mortgage credit of about \$180. Thus, although total housing consumption is increased \$440, only 41 percent of that increase is drawn directly from the income increase through an increased mortgage commitment. The remaining 59 percent is drawn from the household's accumulated liquid assets, which it feels less of a need now to use as a contingency hedge. Evaluated at the mean, the income elasticity of demand for mortgage credit (0.164) is therefore considerably lower than that for housing consumption (0.278), while that for equity financing (0.505) is considerably higher. This is a somewhat surprising result, since we would expect a household to draw most of its increased housing consumption expenditures directly from its increased income through mortgage payments rather than from its liquid assets which it then restores through the increased income.

The level of current liquid assets is found to affect the level of down payment financing but not that of

mortgage financing.³ For every \$1000 increase in current liquid assets, a household on the average has committed an additional \$258 to a down payment. Since the liquid asset coefficients for housing consumption and equity financing are of similar magnitudes, it appears that virtually all of the increase in housing consumption initiated by an increase in liquid assets acts through an increased down payment rather than through an increased consumption of mortgage credit. We expect a tendency toward substitution of down payment for mortgage financing in such a case, since down payment financing had lower opportunity costs to the household. There is no indication of an "induced demand" for mortgage credit created through a buildup of liquid assets as there was an indication of an "induced demand" for down payment financing created through an increase in current income.

These findings have important implications for the mortgage credit market. If the income of households is increased, they naturally enough tend to increase their level of housing consumption. However, only a part of this increased housing consumption is due to an increased level of mortgage financing; most is drawn from their savings. Similarly, if the assets of households are increased, they will tend to increase their level of housing consumption. However, virtually none of this increase is a result of increased use of mortgage

credit. Mortgage credit usage is therefore relatively inelastic with respect to income and asset increases.

Socioeconomic and Housing Market Influences

Relatively few of the demographic and locational variables are significant determinants of either down payment or mortgage financing:

- ° Educational attainment positively influences the level of mortgage credit consumption. This is expected if education proxies for taste or level of confidence in entering the credit market and dealing with the complexities involved.
- ° An urban home results in a lower level of down payment financing. This quite possibly might be due to the availability of subsidized, low-down payment mortgage financing in urban areas during the late 1960's. A suburban home induces a higher level of down payment financing, on the other hand, possibly reflecting credit supply constraints in urban and rural areas. Virtually all of the increase in housing consumption associated with owning a suburban home can be accounted for through an increase in mortgage credit usage.
- ° A white collar occupation results in an increased level of down payment and mortgage financing. This is

especially true for mortgage financing, which again is expected if occupation is a proxy for tastes or sophistication in dealing in credit markets. In addition, the mortgage financing coefficient could reflect a supply constraint, which allows higher volumes of mortgage credit to those in higher status occupations.

- ° Race is a significant influence on the level of down payment financing. Even after controlling for income and asset levels, black households on the average put \$3617 less down on a home than white households. This could in part be accounted for by differences in tastes. It could also represent supply influences such as the low down payment homeownership subsidy programs in which black households disproportionately participate.

Mortgage-Related Influences

The mortgage-related variable coefficients produce some equally interesting results. The initial mortgage payment level (P) is seen to affect only the level of mortgage credit and not the level of down payment financing. The equivalence between the mortgage payment level coefficients for housing consumption (-.571) and mortgage credit usage (-.577) confirm that the influence of the initial payment level upon housing consumption

acts only through the level of mortgage credit usage. It would have been plausible to expect that in general an increase in the initial payment level results not only in a drop in the level of mortgage credit but in an increase in the level of down payment financing. As revealed by our results, this increase, if any, is slight; the initial payment elasticity of demand for down payment financing is near zero.

The expected trend in payment burden (π) acts in different directions upon the levels of mortgage and down payment financing. These effects essentially cancel each other out in affecting the level of housing consumption, since the trend coefficient in the equation for housing consumption (4.3.) is insignificant. As a household becomes more upwardly mobile (as its expected payment burden trend becomes more negative), it tends to put less money into a down payment and more into mortgage financing. The directions of these effects were uncertain a priori since two partial effects were acting in different directions. A household facing a lower future payment burden could feel less need to use its liquid assets as a contingency hedge, and thus could put more of its assets into down payment financing. At the same time it could substitute mortgage for down payment financing, since it expects to be better able to cover the increased mortgage payments in the future. Apparently, this second effect dominates the first.

Very likely a major factor affecting this influence is supply rationing by lenders.

The coefficient of the risk variable (σ) is not significant in either the mortgage or down payment-financing equations, leading us to a tentative conclusion that risk levels experienced under the standard instrument do not cause contingency hedging in mortgage vs. down payment financing decisions, just as they do not in housing consumption decisions.

Simulation Results: The Introduction of
Alternative Mortgage Instruments

We will divide our discussion of the results of simulating the introduction of various alternative mortgage instruments using our estimated models into four sections. The first will present the aggregate effects and the next three the distributional effects by household income, age, and race respectively. Again four types of alternative instruments will be considered in the simulation analysis: (1) the standard variable-rate mortgage with payments indexed to a short-term interest rate (VRMS) or a long-term interest rate (VRML) (the 3-month treasury bill rate and the Aaa corporate bond rate, respectively); (2) the graduated payment mortgage (GPM) with a constant nominal interest rate and fixed maturity but with an a priori graduated (5-percent increase per year) payment stream; (3) the price-level-adjusted mortgage (PLAM),

with a constant stream of real payments; and (4) the income-linked mortgage (ILM), with payments by design equal to 10 percent of gross income.

According to our estimated equations, the consumption of mortgage credit is positively affected both by the initial payment level (P) and the expected trend in payment burden (π). Constant-maturity instruments with a lowered P must have a higher π . Thus these two variables work against each other, and this conflict is expected to be reflected in our simulation results. The estimated relationship for equity financing, on the other hand, indicates that π , the expected payment burden trend, is the only mortgage-related variable affecting the down payment level. An instrument which significantly reduces the expected future payment burden trend below that for the FRM reduces the level of down payment financing, ceteris paribus.

Again, as in Chapters III and IV, we must repeat several caveats against interpreting our simulation results too literally. First, all coefficient estimates have been assumed to be point estimates in simulation calculations, although in reality regression coefficients are actually random variables subject to error. Second, parameter values calculated in many cases for the alternative mortgage instruments are outside the range of experience under the FRM, used in estimating the models.

Thus the simulations are extrapolative and not interpolative. Finally, in spite of our desires to do so, data limitations prevented our estimating "pure" cash flow or present value non-instrument-specific mortgage-related effects. Thus certain biases enter in our simulation results which must be taken into account.

A comment should also be made at this point about interpretation of the simulation results for mortgage and down payment financing. In Chapters III and IV an instrument was considered more desirable the more it increased homeownership and housing consumption. This is expected if we assume these are normal goods; an increase in consumption tends to increase a household's utility unambiguously. This line of reasoning is also valid when considering the demand for mortgage credit. If mortgage credit is a normal good, households will consume more of it as its desirability to the household increases via the type and terms of mortgage credit. This higher consumption unambiguously represents an increase in utility to the household and implies that the more mortgage credit consumption induced by a certain instrument, the more "desirable" that instrument is.

However, this line of reasoning does not apply to use of the good which we call a down payment. An increase in equilibrium down payment levels could represent an induced household demand due to

increased consumption of both housing and mortgage credit. It could also represent a substitution of down payment for mortgage financing and a reduction in housing consumption caused by mortgage instrument undesirability. In the first case the household is adjusting its use of liquid assets to maximize its utility, which is increased. In the second case, the household is making the best of a bad situation, and its utility is decreased.

The point to be made from this is that changes in the down payment level cannot be considered in isolation from changes in the consumption of housing and the use of mortgage credit when judging the desirability of each instrument. It is impossible to find one single measure which considers this interaction which can rank the desirability of each alternative instrument according to its effect on down payment levels.

However, in lieu of this perfect unambiguous measure, we have chosen the debt-equity ratio to rank our instruments. This measure recommends itself on several grounds. An increase in the debt-equity ratio represents a relative movement toward down payment financing as a result of instrument unattractiveness or possibly as a result of supply constraints by lenders. This adjustment is considered unambiguously undesirable in our framework as long as both housing and mortgage credit consumption are decreased.

For those cases in which none of the above conditions hold, we do not have an unambiguous measure of instrument desirability. However, heuristically, many observers would rank instrument desirability according to the effect on required down payments as a fraction of total housing cost. By this measure, an instrument which results in an average down payment fraction of only 10 percent would be superior to one with a down payment fraction averaging 20 percent, apart from its impact on housing or mortgage credit consumption. We adopt this heuristic line of reasoning in evaluating the down payment impacts of alternative instruments.

Notice that under our criterion the debt-equity ratio and therefore instrument desirability can still increase with an absolute increase in down payment levels. Such a situation could occur in the case of induced demand for down payment financing due to increased consumption of both housing and use of mortgage credit. An increase in desirability would not occur, however, in such a case if an absolute down payment level criterion were used to rank instruments. It is therefore not the absolute change in down payment levels but rather the change in down payment relative to the change in mortgage credit which is important.

Finally, we should mention again the fact that our simulations consider each instrument as a replacement

for rather than a supplement to the FRM, whereas most debate over alternative instrument introduction has assumed AMI's will be introduced as supplements. Thus we must reinterpret our simulation results if we are to evaluate the result of a mix of instruments. If a particular instrument has an adverse impact on mortgage credit usage or the debt/equity ratio within a particular group of households, it would imply that the instrument would be dominated by the FRM among those households and vice versa.

Aggregate Effects

In Table 5-2 we have listed the mean values of P and π and the predicted per-household mortgage credit level, down payment level, and debt-equity ratio under the standard instrument and each of the alternative instruments obtained as a result of our simulations. These results are also presented in Table A6-6 in Appendix 6. Again, we repeat our assumptions about the terms under which the new instruments would be offered at equilibrium, based upon supply characteristics:

- °GPM--FRM contract rate
- FRM maturity
- 5-percent annual graduation rate

TABLE 5-2

MEAN VALUES FOR INITIAL PAYMENT LEVEL (P) AND EXPECTED TREND IN PAYMENT BURDEN (π)
AND PREDICTED MORTGAGE CREDIT USAGE (MORT), DOWN PAYMENT LEVEL (DOWN),
AND DEBT-EQUITY RATIO BY MORTGAGE INSTRUMENT

Instrument	Initial Payment Level (P)	Expected Trend in Payment Burden (π)	Predicted Mortgage Credit Usage (MORT) (\$1000)	Diff. From FRM		Predicted Down Payment Level (DOWN) (\$1000)	Diff. From FRM		Predicted Debt/Equity Ratio (MORT/DOWN) (\$1000)	Diff. From FRM	
				Abs.	%		Abs.	%		Abs.	%
FRM	9.92	-.0322	15.645	--	--	7.446	--	--	2.10	--	--
GPM	7.41	.0178	16.571	.926	5.9	8.139	.693	9.3	2.04	-.06	-2.9
PLAM	8.05	.0187	16.227	.582	3.7	8.152	.706	9.5	1.99	-.11	-5.2
VRMS	9.58	.0794	14.747	-.897	-5.7	8.994	1.548	20.8	1.64	-.46	-21.9
VRML	9.58	-.0240	15.762	.117	0.7	7.559	.113	1.5	2.09	-.01	-0.5
ILM	11.38	0	14.489	-1.156	-7.4	7.892	.446	6.0	1.84	-.26	-12.4

- °PLAM--Real interest rate--rate which would result
in FRM nominal return if inflationary
expectations are realized
FRM maturity
Consumer price indexed payments adjusted
annually
- °VRM--FRM contract rate less 1/2 percent discount
as inducement
FRM maturity
Indices: VRMS--3-month treasury bill rate
VRML--Aaa corporate bond rate
Payments adjusted annually
- °ILM--Payments constrained to 10 percent of income
Adjustable maturities

Justification for these assumptions is found in Chapter
III.

Mortgage Credit

Note that the GPM and PLAM are predicted to increase mortgage credit usage above current levels (\$16,400 and \$16,200 versus \$15,600, an increase of 4.9 and 3.7 percent). The VRML is also predicted to slightly increase mortgage credit usage in the aggregate (to \$15,800, an increase of 0.7 percent over FRM levels.) On the other hand, the ILM and the VRMS are predicted to decrease mortgage credit usage (\$14,500 and \$14,700, respectively, representing drops of 7.4 and 5.7 percent).

The performance of the GPM and PLAM reflect the fact that the increase in mortgage credit usage due to their lowered initial payment levels more than offsets the decline due to their expected increased payment streams (This would not be true for a very steeply graded payment stream).⁴ The VRML performs comparably

to the FRM because its slightly decreased initial payment level (due to the assumed one-half percent interest rate discount) is sufficient to compensate for the effects of an expected slight increase in payment levels. The poor performance of the VRMS is due to large increases in the expected payment burden trend created by the volatile nature of the short-term interest rate index.

Again we must warn against too-literally interpreting results for the ILM, since it has a variable maturity and therefore requires an acceptance of the assumptions that households highly discount payments far in the future or that the variation in maturity is very small for all household classes. Its poor performance is seen to be due to a significantly increased initial payment level in the aggregate and a zero (rather than negative) expected trend in future payment burdens.

Down Payment Levels

The level of down payment financing and the debt-equity ratio predicted under each instrument in Table 5-2 indicate that the VRMS is predicted to result in the highest level of down payment (\$9880 versus \$7400 for the FRM) combined with the lowest debt-equity ratio (1.64 versus 2.10 for the FRM). This low debt-equity ratio would very likely be caused both by increased lender down payment requirements due to increased

default risk under the VRMS and increased borrower reliance on liquid assets to finance housing when faced with a highly undesirable instrument with future payment burdens expected to increase. Thus the VRMS again is ranked as the least desirable in the aggregate of all instruments tested. The high demands on liquid assets predicted would exceed the level of savings of many households, eliminating them from homeownership opportunities altogether.

The GPM and the PLAM are predicted to increase down payment levels the most, next to the VRMS (\$8100 and \$8200, respectively). However, their debt-equity ratios are predicted to decrease only slightly from FRM levels (2.02 and 1.99, respectively versus 2.10 for the FRM), indicating that most of this increased down payment is "induced demand" caused by increases in both housing consumption and mortgage credit usage.

The VRML actually performs the best of all instruments under our debt-equity criterion. In the aggregate, not only is it predicted to increase down payment levels only slightly (to \$7600); the debt-equity ratio under the VRML (2.09) is predicted to drop only insignificantly below that for the FRM. We shall see later, however, that these desirable aggregate results do not imply every household would benefit equally.

The slight drops in the debt-equity ratio for the VRML, the GPM, and the PLAM from that for the FRM, indicate a slight substitution of down payment for mortgage financing caused by borrower demand shifts or credit suppliers' minimum down payment restrictions. The FRM therefore is considered slightly more desirable than these three instruments according to our debt-equity criterion, since, among all the instruments, it is predicted to require the lowest fraction of down payment financing.

The ILM is predicted to perform worse than the VRML, the GPM, and the PLAM but better than the VRMS according to our debt-equity criterion. Down payment levels are predicted to be slightly increased from FRM levels (\$7900), but this is combined with a significant aggregate drop in mortgage financing, resulting in a decreased debt-equity ratio (to 1.84).

In summary, we can rank the instruments according to their ability to stimulate aggregate per-household mortgage credit usage in the following way: (1) GPM, (2) PLAM, (3) VRML, (4) FRM, (5) VRMS, and (6) ILM. According to their aggregate effect on down payment requirements through our debt-equity criterion they can be ranked as follows: (1) FRM, (2) VRML, (3) GPM, (4) PLAM, (5) ILM, (6) VRMS. The next three sections qualify these

rankings by investigating the distribution of mortgage credit and down payment level changes across household classes.

Distributional Effects by Income

Mortgage Credit

Figure 5-1, which plots the expected change in mortgage credit usage under each instrument as a function of income, indicates that the GPM and the PLAM are predicted to result in the least distributional effects relative to the FRM across income classes (see Table 5-3 and Table A6.6 in Appendix 6). These instruments are predicted to positively influence mortgage credit usage across all income classes. The VRML is the next least redistributive with a slight negative redistributional effect upon lower-middle income and high-income households. Among households in a broad middle-income range from \$10,000 to \$25,000, the VRML actually appears to be slightly preferable to the FRM. The ILM displays very strongly positive distributional effects among lower-income households and very strongly negative effects among higher-income households, dropping mortgage usage rates by households making over \$25,000 per year by 42 percent. Finally, the VRMS, possesses distributional characteristics similar to those of the VRML, but on the whole more negative, especially among

Change in Mortgage Credit Usage From FRM Levels (\$)

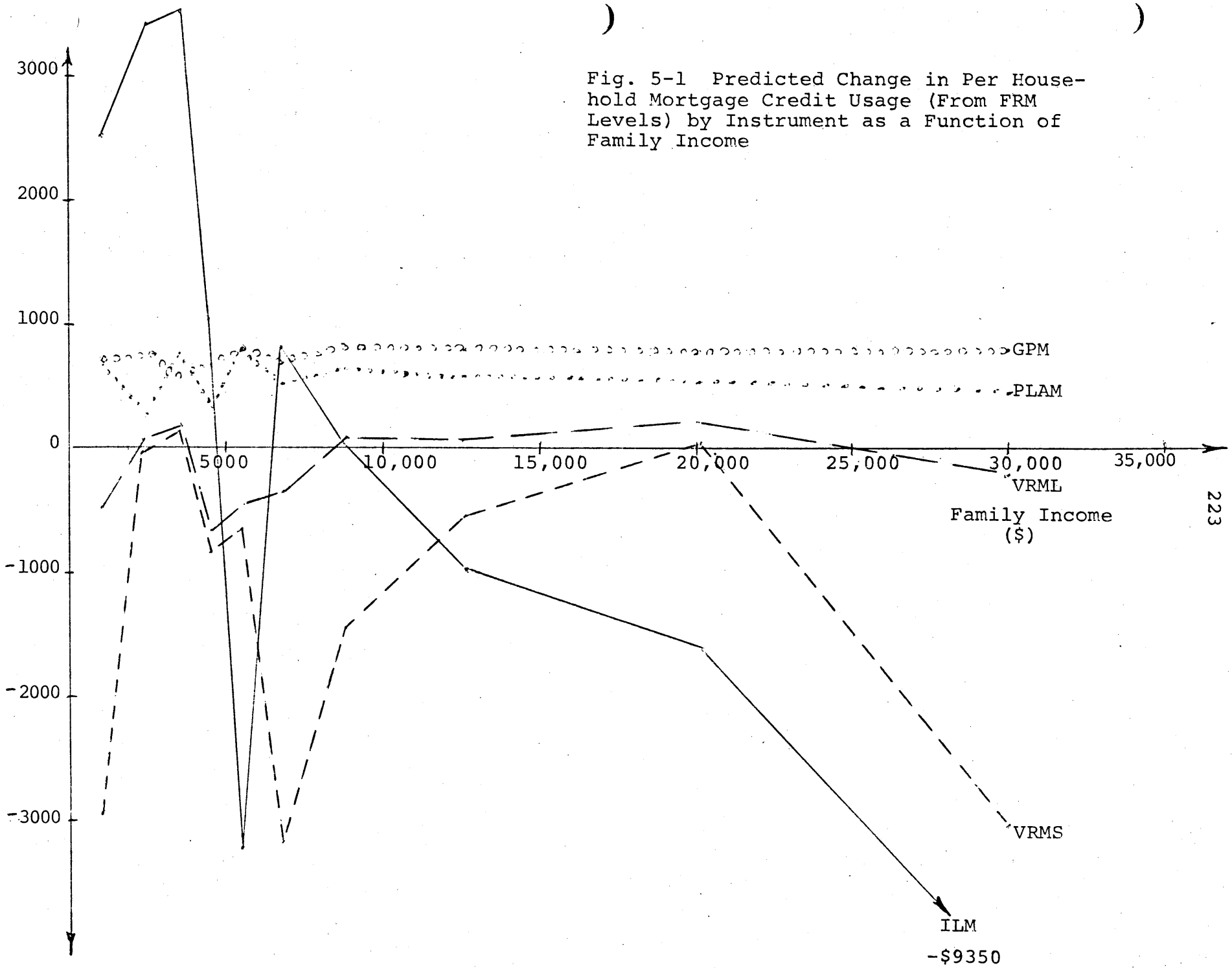


Fig. 5-1 Predicted Change in Per Household Mortgage Credit Usage (From FRM Levels) by Instrument as a Function of Family Income

TABLE 5-3

EQUILIBRIUM DEBT-EQUITY RATIOS BY INSTRUMENT FOR SELECTED HOUSEHOLD GROUPS

	Lower/Middle Income (\$6000-75000)	Upper Income (\$25000+)	Young (Under 25)	Middle Aged (45-55)	Black	White
FRM	2.44	1.37	5.41	2.28	56.27	2.15
GPM	2.27	1.36	4.57	2.18	15.62	2.06
PLAM	2.23	1.33	4.78	2.11	14.83	2.04
VRMS	0.95	0.92	-0.18	2.25	0.66	1.81
VRML	2.05	1.31	2.01	2.33	8.00	2.16
ILM	2.43	0.75	4.25	1.92	23.79	1.87

224

Note: Complete distributional debt-equity results are listed in Table A6-8 in Appendix 6.

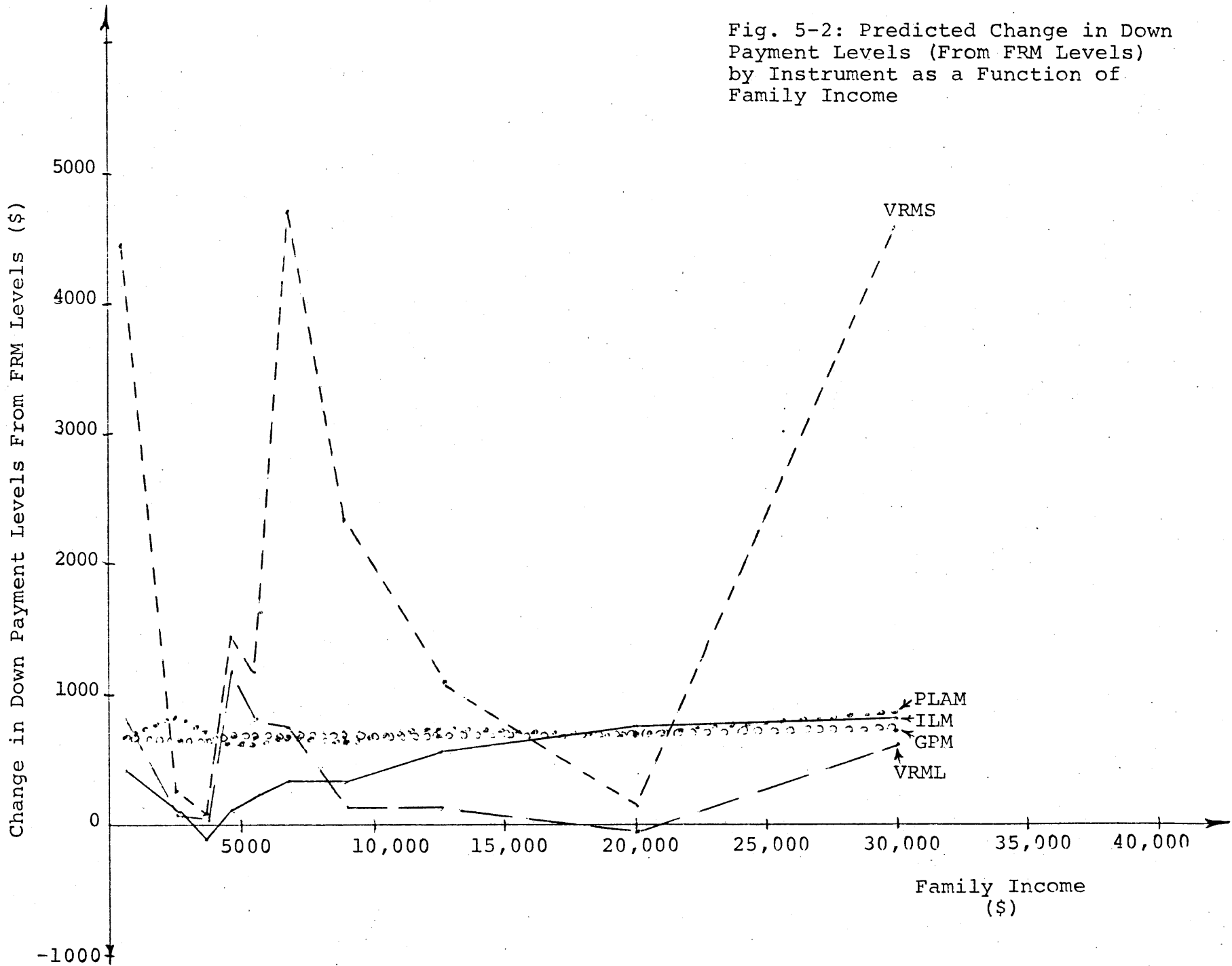
lower-middle income and upper-income households. Only for households in the \$15-25,000 income range does the VRMS promise to be competitive with the FRM.

Down Payment Levels

In Figure 5-2, we have plotted expected changes in down payment levels under each instrument as a function of income (see also Table A6-7 in Appendix 6). The VRMS and VRML are again the most volatile. The VRMS is predicted to most dramatically influence down payment financing, requiring down payments averaging \$4500 more than under the FRM for lower-middle income and very high-income households, although these results must be accepted with caution, since they represent conditions not experienced in the FRM world upon which the estimates were based. This increase could put very heavy burdens especially upon the lower-middle income households, since median liquid asset holdings among those homeownership households making \$5000-7500 per year are only \$570, not including the equity in their present home, which averages about \$7500.

The effect of the down payment increase under the VRMS is highly undesirable according to our debt-equity criterion for lower-middle and higher-income households since the debt-equity ratio decreases significantly from 2.44 and 1.37, respectively, for these households to

Fig. 5-2: Predicted Change in Down Payment Levels (From FRM Levels) by Instrument as a Function of Family Income



0.95 and 0.92 (Table 5-3; see also Table A6-8 in Appendix 6). Introduction of the VRML, on the other hand, only decreases the debt-equity ratio for lower-middle-income and higher-income households to 2.05 and 1.31, respectively. In fact, in a broad middle-income range, from \$7500 to \$25,000, the VRML is predicted to affect only nominally the level of down payment financing, and in the \$15-25,000 income group at least, actually to slightly increase the debt-equity ratio. This fact, combined with the slight increase in housing consumption and the small negative effect on homeownership rates under the VRML (see Chapters III and IV), make some form of this instrument a viable alternative to the FRM from the borrowers' point of view over this income range.

The down payment trend for the ILM again reflects the positive redistributive character of this instrument. In the lower-middle income range (\$6000-7500), a large housing consumption increase of about \$1100 and a continuation of high debt mortgage financing levels because of the relatively low payment levels results in a high 2.43 debt-equity ratio, essentially equivalent to the 2.44 debt-equity ratio under the FRM. For those households making over \$25,000 per year, the reverse is true. A significant per-household housing consumption decrease of \$8700 is predicted within this group, along

with a decrease in the debt-equity ratio to 0.75 (from 1.37 under the FRM), primarily because of the relatively high initial payment level.

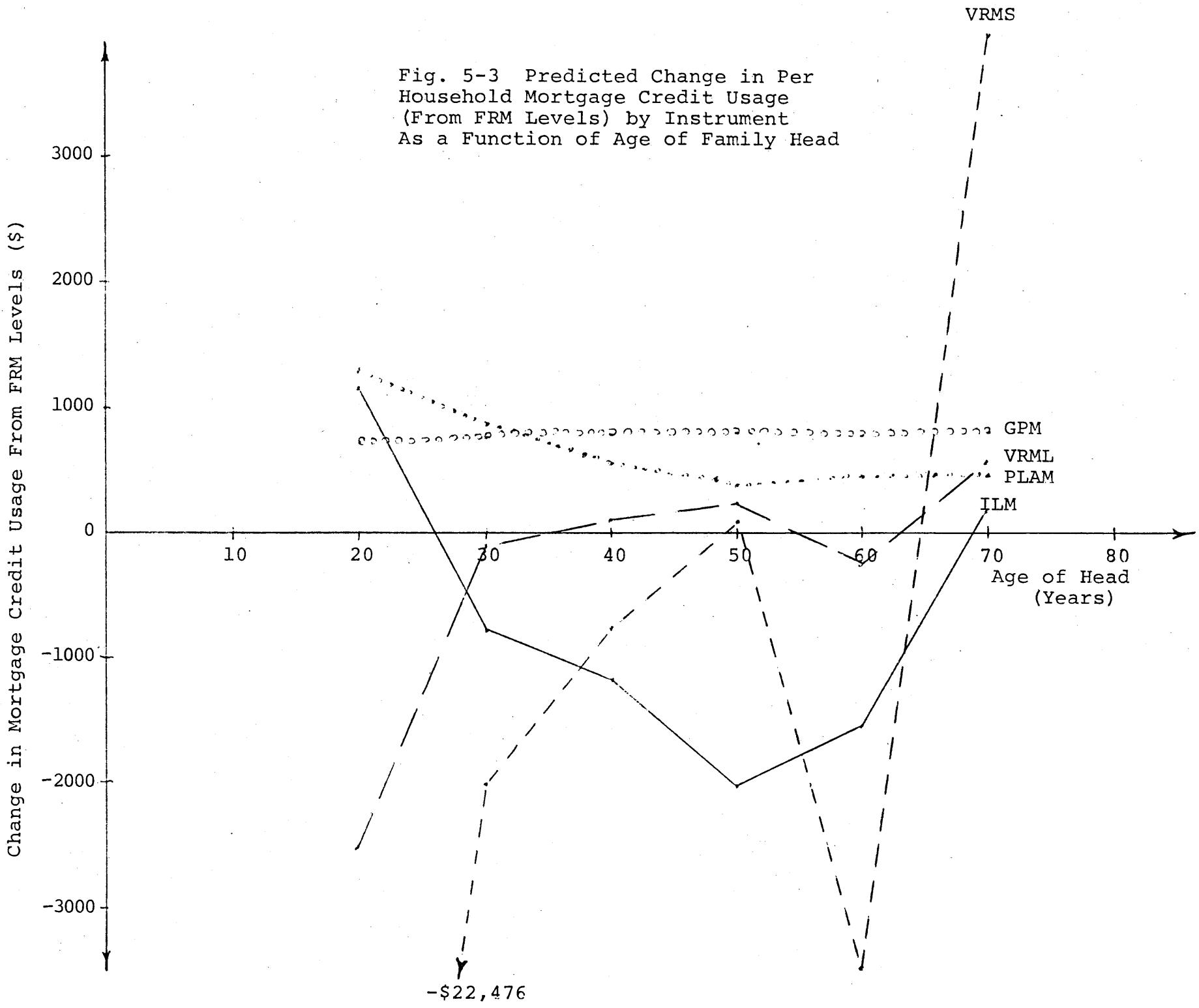
The PLAM and GPM appear again to have the most desirable distributional qualities of the alternative instruments. Both increase down payment levels by about \$690 across all income groups, but this is combined with a \$1200 increase in housing consumption for the GPM and a \$1000 increase for the PLAM. Thus the debt-equity ratio for the GPM drops only slightly for lower-middle income households (\$6-7500 per year) to 2.27 from 2.44 under the FRM, and for upper-income households (over \$25,000), it only negligibly drops to 1.36 from 1.37 (Table 5-3). The PLAM fares only slightly worse with debt-equity ratios dropping to 2.23 and 1.33 for lower-middle and higher-income households, respectively.

Distributional Effects by Age of Head

Mortgage Credit

Figure 5-3 plots the change in mortgage credit usage by age of household head. The VRMS and the ILM appear again to predict the most severe redistributive consequences. The VRML again displays a similar trend to the VRMS but with less volatility and with less extreme negative equity effects. The PLAM and the GPM appear to

Fig. 5-3 Predicted Change in Per Household Mortgage Credit Usage (From FRM Levels) by Instrument As a Function of Age of Family Head



offer the least distributional consequences with the greatest increase in the usage of mortgage credit.

The extreme predicted drop of \$22,500 in mortgage credit usage under the VRMS by younger households is unrealistic and is an example of the limitations of extrapolation and our linear specification. However, it does serve to indicate that such households could essentially be cut out of homeownership entirely under the VRMS due to the extreme undesirability of mortgage credit.

The negative--then positive--slope of the ILM mortgage credit trend as age increases roughly reflects the trend of income with age. Higher-income, middle-age families would necessarily be forced to increase their initial payment levels under the ILM, hence would tend to use a lower volume of mortgage credit and vice versa for young and elderly households.

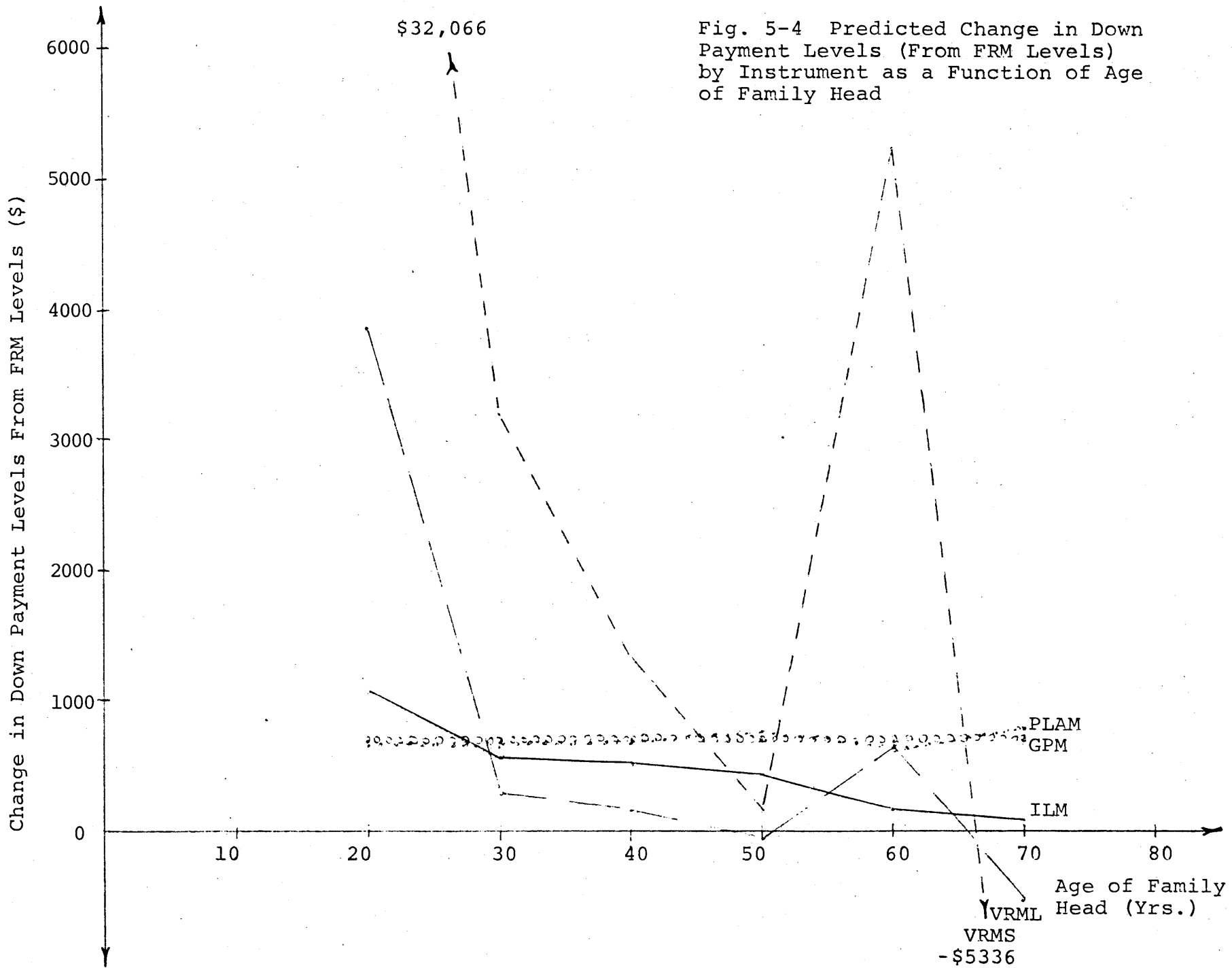
We note again the PLAM tends to dominate all instruments for younger households (under 35 years), while the GPM tends to dominate above that point. This is due to a greater relative drop in the initial payment level P and a more negative expected payment burden trend under the PLAM for younger households.

Down Payment Levels

Our debt-equity criterion was used to evaluate the age-distributional effects of down payment changes under

each instrument. It predicts that younger households would be seriously impaired under the variable-rate instruments, especially the VRMS. Down payment requirements increase dramatically (Figure 5-4) and the debt-equity ratio declines from 5.41 under the FRM to only 2.01 under the VRML and virtually to zero under the VRMS (Table 5-3). Thus young households are predicted to essentially be eliminated from homeownership opportunities under the VRMS. This is due to the extreme volatility in the expected VRMS payment burden trend for these households. Only for middle-aged households between 45 and 55 are the VRML and VRMS predicted to compare favorably to the FRM in their effect on borrowers.

The ILM's usually positive redistributive characteristics are only positive for elderly households. Elderly households, but not young households, would find the ILM attractive relative to the FRM. The trend in changes in down payment levels is downward with age (Figure 5-4), indicating younger households under the ILM would be induced to increase their down payment expenditures for housing the most of all age groups in absolute terms. This is also true in relative terms. Under the ILM younger households are predicted to increase their down payment expenditures by 36 percent, compared with less than one percent for elderly households (over 65).



According to our debt-equity criterion also, the ILM is predicted to more adversely affect young households. Households with heads under 25 experience a drop of 21 percent in their debt-equity ratios under the ILM (from 5.41 under the FRM to 4.25 under the ILM). However, elderly households actually experience a slight (one percent) increase in their debt-equity ratios (from 1.52 under the FRM to 1.54 under the ILM).

The GPM and PLAM again are predicted to have the most desirable age-distributional effects upon down payment requirements. Down payments increase about \$690 under both instruments across all age groups but are accompanied by roughly proportional increases in mortgage credit consumption. For young households (under 25), the PLAM is slightly more advantageous than the GPM, since the debt-equity ratio for the PLAM is 4.78 compared to 4.57 for the GPM (Table 5-3). For middle-aged households (45-55), the reverse is true--the debt-equity ratio for the PLAM is only 2.11 compared to 2.18 for the GPM. These two instruments are slightly inferior to the FRM, however, according to our debt-equity criterion, since the debt-equity ratios for these instruments are somewhat lower than those under the FRM for all age classes.

Distributional Effects by Race

Mortgage Credit

The major themes present in our distributional results for mortgage credit usage in the previous two sections carry over when we break down our results by race. As reflected in Figure 5-5, the GPM and the PLAM increase mortgage credit levels more than any other instrument (\$760 and \$550 above FRM levels, respectively) with little difference between black and white households. The other instruments all display distributional consequences by race. The variable-rate instruments both adversely affect black usage, relative to white, while the ILM adversely affects white usage relative to black. The VRMS and the ILM are inferior to the FRM for both black and white households in stimulating credit usage, while the VRML would decrease black household mortgage credit usage levels by \$800 but increase white levels by \$160.

Down Payment Levels

As Figure 5-6 indicates, the distribution of down payment-financing changes by race also generally follows past patterns. The VRMS and the VRML have the greatest distributional impact. Both have strongly negative implications for black households in the sense that these instruments would draw significantly greater amounts from their limited assets for down payments. Such

Fig. 5-5 Predicted Change in Per Household Mortgage Credit Usage (From FRM Levels) by Instrument as a Function of Race

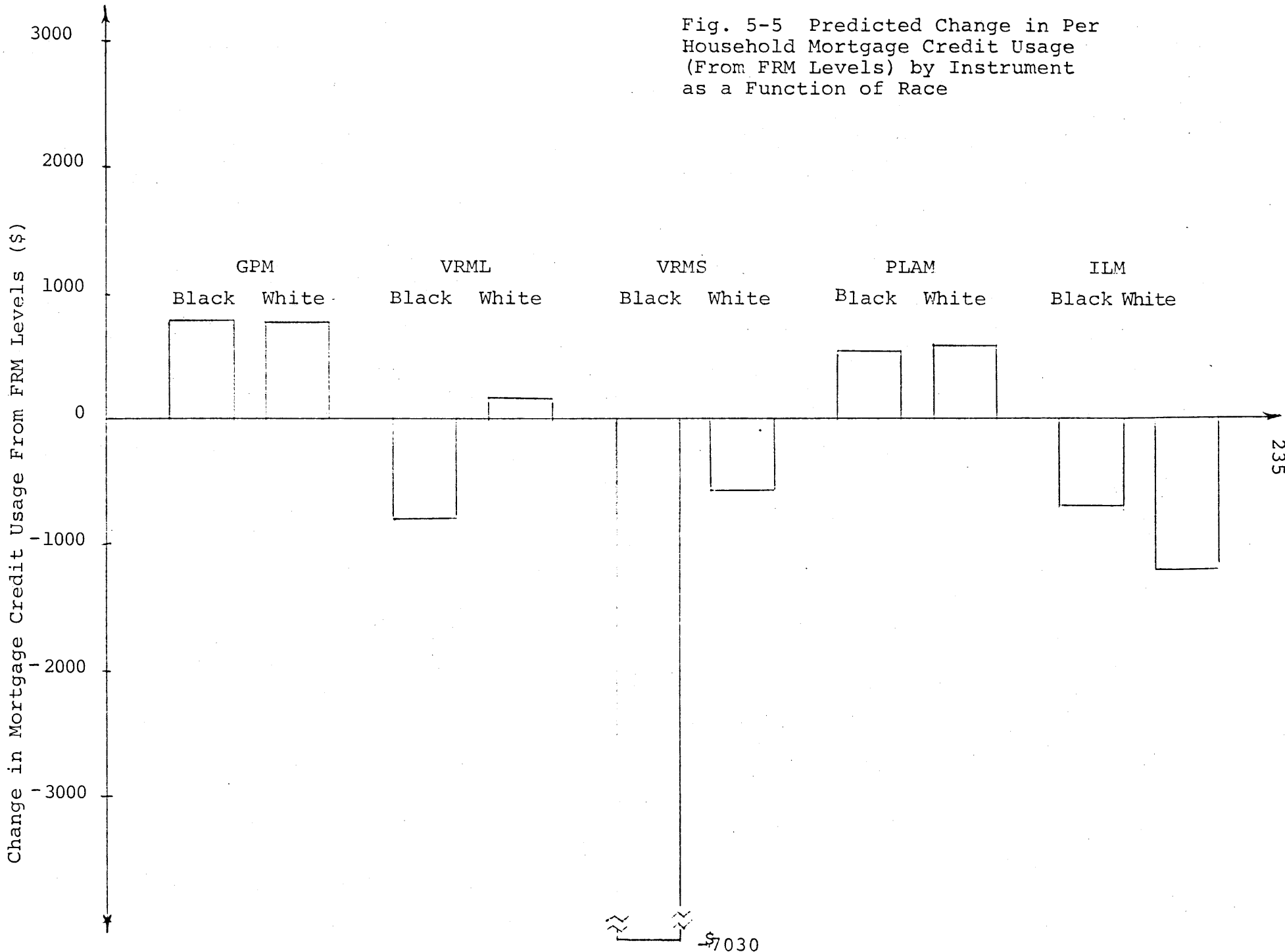
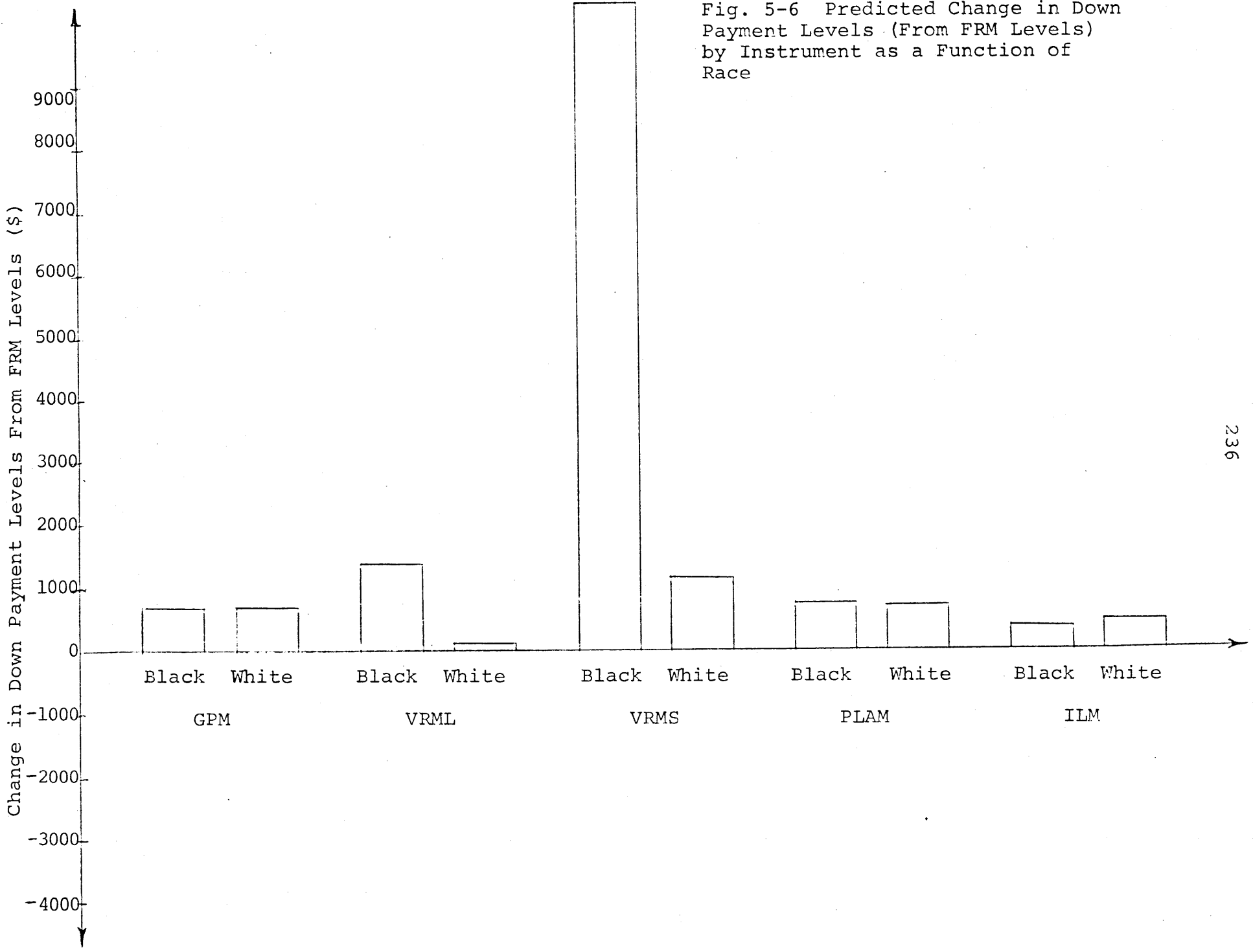


Fig. 5-6 Predicted Change in Down Payment Levels (From FRM Levels) by Instrument as a Function of Race



an extreme shift to down payment financing could severely limit the desirability of homeownership for these households. According to our debt-equity criterion, the VRMS would have a moderately negative impact on white households but a dramatically negative impact on black households. The VRML is actually predicted to slightly increase white debt-equity ratios, but to significantly lower black ratio values.

The remaining alternative instruments are predicted to have somewhat less negative implications for down payment requirements and debt-equity ratios. All are predicted to result in increased down payments relative to the FRM; however, in all cases these are combined with increased mortgage credit usage, thus resulting in less of a drop in the debt-equity ratio than would be anticipated otherwise. The ILM displays highly positive redistributational results. Its predicted increase in down payment requirements among black households is the lowest among the alternative instruments in absolute terms, and its debt-equity ratio for black households (23.79) drops the least from the ratio under the FRM (56.27) (Table 5-3). However, the debt-equity ratio among white households under the ILM (1.87) is the second lowest of any instrument, ranking just above the VRMS.⁵

Although overall the PLAM and GPM display somewhat more undesirable characteristics than the VRML because of

their somewhat greater drops in debt-equity ratio values, nonetheless they display far fewer redistributive consequences than the VRML. Their performance for black households is inferior to that of the ILM but superior to that of the variable rate instruments. White households are predicted to incur only slight drops in debt-equity ratios under these instruments from FRM values. Thus, again they must be counted as viable alternatives to the FRM.

Summary of Findings and Policy Implications

Estimation of our models of mortgage and down payment financing and simulation of alternative mortgage instruments using our model have resulted in three sets of major findings:

1. The first set of major findings relates to wealth and income effects on mortgage versus down payment financing of residences. Mortgage capital as a source of residential capital becomes relatively less important to households as their income or liquid assets increase, all other things being equal. An income increase induces increased housing consumption; however, only 41 percent of that increase comes from an increase in mortgage credit usage, whereas about 59 percent derives from the increased use of liquid assets for a down payment. Likewise an increase in liquid assets induces increased housing

consumption. However, virtually all of this increase is financed through an increased down payment. These results have important implications for the behavior of the residential mortgage capital market in periods of growing income and wealth. They say that mortgage credit usage is relatively inelastic with respect to income and wealth, but down payment financing is relatively elastic.

2. The second set of major findings relates to mortgage-related effects on mortgage versus down payment financing of residences. The initial annual payment per \$100 borrowed is found to negatively affect the level of mortgage credit usage as expected; however, it has no "induced demand" effect on down payment levels. Its net effect on the level of housing consumption is therefore negative. The expected trend in future payment burdens, on the other hand, affects both the levels of mortgage and down payment financing, but in opposite directions. An upwardly mobile household, with an expectation of future income availability for mortgage payments, tends to substitute mortgage for down payment financing and vice versa. These effects essentially cancel each other out in affecting the level of housing consumption. Uncertainty in the trend in future payment burdens does not appear to affect either mortgage or down payment financing significantly. These results imply that the shape of the payment stream for a mortgage instrument can have

a significant effect upon a household's choice of mortgage versus down payment financing of their residence.

3. The third set of major findings relates to the results of alternative instrument simulation using our model. The simulation results must be accepted with a great deal of caution in view of possible biases in certain of our coefficients and our incomplete set of mortgage-related variables. Nevertheless, we may report upon the following qualitative results: The PLAM, and especially the GPM, are predicted to induce a higher level of mortgage credit usage than is currently experienced under the standard instrument without a significant increase in the proportion of house value that is financed through a down payment (although the standard instrument is predicted to require the least commitment of liquid assets to a down payment of all instruments tested). The GPM and PLAM also promise few adverse distributional consequences for various groups of borrowers. The variable-rate instrument tied to a long-term interest rate (VRML) is in the aggregate actually expected to perform better than the FRM in inducing increased mortgage credit usage without requiring significantly increased down payments. However, the VRML has significant negative distributional implications for lower-middle income, young, and black

households which limit its desirability. The ILM promises significant positive redistributive effects, but in the aggregate performs rather poorly relative to the FRM with respect to encouraging mortgage credit usage without a significant decrease in the debt-equity ratio. The VRMS is predicted to have not only seriously adverse aggregate consequences for mortgage credit usage and down payment requirements. It is predicted to impact more adversely upon lower-middle-income, young, and black households.

These results in general support those in the previous two chapters and further encourage the continued investigation of the GPM and the PLAM as potential replacements for or supplements to the current instrument of residential finance.

FOOTNOTES--CHAPTER V

¹See testimony of Steven M. Rohde in U. S. Congress, House (1975), pp. 373-386.

²The permanent-income hypothesis supports this assumption for income. It seems plausible for other socioeconomic characteristics as well (see discussion in Chapter III).

³See Chapters III and IV for a discussion of problems associated with the specification of the assets variable as current liquid assets.

⁴If the GPM was designed differently--with a more or less steep payment stream, its effect on mortgage credit usage would be very different. It is possible to use our model estimation to "design" a GPM graduation rate which maximizes mortgage credit usage. We know the usage of mortgage credit (MORT) is a function both of the initial payment level P and the expected trend in payment burden π ($MORT = f(P, \pi, \dots)$). Both P and π are functions of g_Q , the graduation rate for the GPM. We know $\frac{\partial P}{\partial g_Q} < 0$ but $\frac{\partial \pi}{\partial g_Q} > 0$ and both $\frac{\partial MORT}{\partial P} < 0$ and $\frac{\partial MORT}{\partial \pi} < 0$. Therefore,

$$\frac{\partial MORT}{\partial g_Q} = \frac{\partial MORT}{\partial P} \frac{\partial P}{\partial g_Q} + \frac{\partial MORT}{\partial \pi} \frac{\partial \pi}{\partial g_Q} \approx 0$$

and the effect of adjusting the graduation rate upon per-household mortgage credit consumption is uncertain a priori.

There is thus an "optimal" g_Q at which MORT is maximized.

This point is the g_Q where

$$\frac{\partial \text{MORT}}{\partial g_Q} = \frac{\partial \text{MORT}}{\partial P} \frac{\partial P}{\partial g_Q} + \frac{\partial \text{MORT}}{\partial \pi} \frac{\partial \pi}{\partial g_Q} = 0$$

We know from our estimations $\frac{\partial \text{MORT}}{\partial P} = -.57702$ and

$$\frac{\partial \text{MORT}}{\partial \pi} = -9.809.$$

From relationship (A.2.21.):

$$\begin{aligned} \frac{\partial P_{\text{GPM}}}{\partial g_Q} &= \frac{\partial}{\partial g_Q} \left[\frac{P_{\text{FRM}}}{1-g_Q + \frac{g_Q}{r} \left(1 - \frac{TP_{\text{FRM}} e^{-rT}}{100}\right)} \right] \\ &= \frac{-P_{\text{FRM}} \left[\frac{1}{r} \left(1 - \frac{TP_{\text{FRM}} e^{-rT}}{100}\right) - 1 \right]}{\left[1-g_Q + \frac{g_Q}{r} \left(1 - \frac{TP_{\text{FRM}} e^{-rT}}{100}\right) \right]^2} \end{aligned}$$

which for a 25-year, 8-percent instrument is:

$$\frac{\partial P_{\text{GPM}}}{\partial g_Q} = - \frac{70.243}{57.517 g_Q^2 + 15.168 g_Q + 1}$$

Furthermore, we know

$$\frac{\partial \pi_{\text{GPM}}}{\partial g_Q} = \frac{\partial}{\partial g_Q} (-\pi - g + g_Q + \sigma_p^2 + \sigma_y^2 + \rho_{PY} \sigma_p \sigma_y) = 1$$

Substituting the above expressions into our relationship for $\frac{\partial \text{MORT}}{\partial g_Q}$ yields $g_{Q\text{max}} = .136$, or an optimal graduation

rate of 13.6 percent per year--a rate somewhat higher than both the rate of inflation and average nominal income increases over the past 10 years.

This type of procedure could also be followed to design "optimal" GPM's to maximize the demand for homeownership, per-household housing consumption, etc.

⁵The extremely high debt-equity ratios among black households reflect the dramatic impact subsidized, low-down payment mortgage credit availability had upon black households in the late 1960's.

CHAPTER VI

CONCLUSIONS AND POLICY IMPLICATIONS

In this concluding chapter we shall summarize and synthesize the results of the previous three chapters. Three separate topics will be addressed: (1) the extent to which mortgage-related characteristics affect the demands for homeownership, housing, and mortgage versus down payment financing (estimation results); (2) what these effects mean for the relative desirability of various alternative mortgage instruments proposed as replacements or supplements to the current standard instrument (the FRM) (simulation results); and (3) the implications of these results for public policies directed toward increasing homeownership opportunities and housing consumption levels (policy recommendations).

Empirical Results

One major hypothesis empirically tested and accepted in this dissertation is that the type and terms of mortgage credit affect the homeownership decision, the long run equilibrium levels of consumption of housing, and the levels of mortgage versus down payment financing of housing. In perfect financial markets only the interest rate or present value characteristics of the mortgage should be relevant influences on demand. However, in imperfect

markets we have shown various cash-flow related characteristics associated with mortgage credit--formed through an interaction of the payment stream with the household income stream over time--also are important. The effects of three such characteristics were investigated: (1) the initial mortgage payment level, (2) the expected trend in the future mortgage payment burden (payment-to-income ratio), and (3) the uncertainty in the future payment burden trend.

There are several shortcomings associated with the inclusion of these variables alone as a proper and adequate representation of the characteristics of the mortgage instrument:

°First, these variables are not an exhaustive list of the cash-flow mortgage-related variables. A measure of the duration of mortgage payments should also have been considered. However, collinearity and lack of significance in the estimations prevented such consideration.

°Second, these variables are not pure cash-flow, as opposed to present-value mortgage-related influences. The initial payment level, for example, is partially determined by the interest rate, a present-value influence. However, because of the high collinearity between the interest rate and the initial payment level, the interest rate could not be considered separately.

°Finally, these variables are not pure mortgage-related characteristics, but also in some cases represent certain nonmortgage conditions such as permanent income effects and the effects of alternative yields in the market. Again, multicollinearity prevented separate consideration of these effects.

A proper interpretation of our estimation results is thus necessary prior to their use in simulating alternative instrument introduction. However, for the purposes of estimation, regardless of their interpretation, they tell us an interesting story about household response to changes in these parameters.

The estimation results for our mortgage-related variables are summarized in Table 6-1. The top section of the table presents the coefficient values for each variable, also presented in expressions (3.5.), (4.3.), (5.7.), and (5.8.). The middle section presents the beta-values, which are the regression coefficients standardized by the standard deviation of the independent variable divided by the standard deviation of the dependent variable. The beta-values can be compared to determine the relative importance of each variable. The bottom section presents the elasticity estimates, calculated at the mean for each variable. These results will first be discussed for their effects on homeownership, then for

TABLE 6-1

SUMMARY TABLE

ESTIMATED COEFFICIENTS^a, BETA-VALUES^b, AND ELASTICITIES^c OF MORTGAGE-RELATED VARIABLES FOR HOMEOWNERSHIP, HOUSING CONSUMPTION, MORTGAGE FINANCING, AND DOWN PAYMENT EQUATIONS

	EQUATION				
	Homeownership	Housing Consumption	Mortgage Financing	Down Payment	
Coefficient Value					
Initial Mortgage Payment Level (P)	-.010 ^d	-.571	-.577	--	
Expected Trend in Payment Burden (π)	--	--	-9.809	13.871	248
Uncertainty in Future Payment Burden (σ)	-.616	--	--	--	
Beta Value					
Initial Mortgage Payment Level (P)	-.214 ^d	-.171	-.303	--	
Expected Trend in Payment Burden (π)	--	--	-.088	.096	
Uncertainty in Future Payment Burden (σ)	-.059	--	--	--	
Elasticity					
Initial Mortgage Payment Level (P)	-.097 ^d	-.243	-.357	--	
Expected Trend in Payment Burden (π)	--	--	-.621	1.877	
Uncertainty in Future Payment Burden (σ)	-.616	--	--	--	

Notes: ^a Unweighted regression coefficients b_{x_i} .

^b Standardized coefficients $\beta_{x_i} = b_{x_i} \frac{S_{x_i}}{S_y}$ where S_{x_i} and S_y are standard deviations for the independent variable and the dependent variable respectively. x_i

^c Coefficients transformed into percentage terms at the means.

^d Obtained from second stage equation (see discussion in Chapter III).

their effects on housing consumption and mortgage versus down payment financing levels.

Homeownership

The initial mortgage payment level and the uncertainty in future payment burden trend are influential in the homeownership decision, but the expected trend in the mortgage payment burden appears not to be. These very likely represent both demand and supply rationing effects. Mortgage-lending officers often are primarily interested in current income and the stability of income in evaluating credit worthiness but take less explicit account of the expected income trend.¹

The coefficient values for the initial payment level tell us that for every \$1 per year per \$100 principal drop in the initial payment level, the probability of homeownership drops one percent. This does not appear to be a very large influence at first glance, but the beta-value tells us it is actually relatively large--a standard deviation increase in the initial payment decreases the probability of homeownership by about one-fifth of a standard deviation.

The coefficient value for the uncertainty variable implies that for every one percent increase in the uncertainty of the payment burden trend the probability of homeownership drops roughly 0.6 percent. For example, if a household expected its payment burden to drop five

percent next year with an uncertainty of \pm two percent, it would be 0.6 percent more likely to own its own home than a similar household with an uncertainty of \pm three percent. This again seems like a relatively small influence, and the beta-value (-.06) confirms that it usually is. However, within our sample of data, σ ranged up to 0.3, which would imply a maximum influence of $(.616) (.3) = 18.5$ percent.

Public policy implications from the homeownership equation results are important. Any reform--whether through the introduction of alternative mortgage instruments or through changes in the FRM--which significantly lowers the initial monthly mortgage payment level can have a significant influence on the rate of homeownership, even if later mortgage payment levels are increased as a result. Reduction in future payment burden uncertainty only promises marginal improvements in homeownership levels, but any reform which substantially increases uncertainty could have a dramatic negative effect.²

Purchasing and Financing Adjustments

A second important result of our study is that mortgage-related variables can be influential in affecting the Homeowning household's housing consumption level and its mix of mortgage and down payment financing of its residence.

Only the initial mortgage payment level, of the three mortgage-related variables, appears to affect the size of home purchased. This indicates there is little contingency hedging by households or restrictions by lenders on maximum housing consumption levels because of future payment burden expectations or uncertainties, at least within the range of values experienced.³ The initial payment coefficient indicates its influence can be significant. For every \$1 per year per \$100 principal drop in the initial mortgage payment, the household drops its house value by almost \$600. In general, this represents both a present value and a cash flow effect.

We see from the mortgage financing and down payment financing equations that virtually all of this \$600 drop in housing consumption comes from a drop in the level of mortgage credit usage. This implies there is no initial payment cross-elasticity of demand for down payment financing--that is, there is no inducement toward using equity funds to substitute for the higher "cost" (in terms of higher monthly payment) mortgage funds. Instead there is only a drop in mortgage credit usage which translates directly to a drop in housing consumption.

This result could have several policy implications. First, it could mean, since down payments are drawn from household savings, that the level of saving might be little affected by lowering initial mortgage payment levels.

Second, it could mean that changes in payment levels could affect neighborhood dynamics by affecting housing consumption levels. Third, it could mean that the average size of loan transactions by financial institutions could be significantly affected by changes in initial mortgage payment levels.

Observing the expected trend in payment burden coefficients in the housing consumption and mortgage and down payment financing equations leads us to another important result. An increase in the expected payment burden, as expected results in a shift to financing through a down payment rather than through a mortgage. This is a reflection of contingency hedging by households against future strains on their income due to required mortgage payments (and very possibly also due to supply rationing and permanent income effects). The strength of this effect is moderate; for every one percent increase in the expected payment burden trend, a household will drop its level of mortgage financing and increase its down payment by about \$100. For example, a household with an expected drop in its payment burden of five percent will use \$100 more mortgage credit and pay a \$100 lower down payment than an identical household with an expected drop in its payment burden of four percent.

Note that the net impact of this shift in mortgage versus down payment financing upon housing consumption is

negligible. That is, there is no induced consumption of housing caused by adjustment of the expected payment burden trend, only an exchange between mortgage and down payment financing of a given quantity of housing.

These results could have the following policy implications: (1) the levels of savings and mortgage credit demand might be significantly affected by adjustment of the expected payment burden trend through alternative instrument introduction (a fact which would be important to financial intermediaries); and (2) the level of capital formation in residential real estate by homeowners might be relatively unaffected by adjustment of the expected payment burden trend (a fact of importance to builders and developers).

Simulation Results

Table 6-2 summarizes the simulation results of the preceding three chapters. Each instrument, including the FRM, is ranked according to its predicted aggregate ability to increase homeownership, housing consumption, and mortgage credit usage, and to increase the debt-equity ratio. A "T" designation indicates a tied ranking. Separate columns under each heading compare the equity characteristics of each instrument for each of our three distributional groupings--income, age, and race. The "+" and "-" designations are equity indicators. A "+" designation is assigned if the instrument displays significant positive

TABLE 6-2

MORTGAGE INSTRUMENT PERFORMANCE RANKING BY
INSTRUMENT AND EQUITY CLASS

INSTRUMENT TYPE	HOME OWNERSHIP				HOUSING CONSUMPTION				MORTGAGE CREDIT USAGE				DEBT-EQUITY RATIO			
	Aggregate	Income	Age	Race	Aggregate	Income	Age	Race	Aggregate	Income	Age	Race	Aggregate	Income	Age	Race
FRM	4				5				4				1			
GPM	1				1				1				3	-	‡	-
PLAM	2		±		2		‡		2		‡		4	-	‡	-
VRMS	6	-	±	-	3 ^T				5	-	‡	-	6	-	‡	-
VRML	5	-	±	-	3 ^T				3	-	‡	-	2	-	‡	-
ILM	3	+	‡		6	+	‡	+	6	+	‡	+	5	+	‡	-

Notes: "T" represents a tied ranking.
 "±" represents a positive redistributinal effect on the designated merit class (lower income, young, elderly, or black households).
 "- " represents a negative redistributinal effect on the designated merit class (lower income, young, elderly, or black households).

distributional effects--that is, if for example lower-income households are more positively benefited than higher-income households--and vice versa. A double designation, such as "+", is used for the age category in which there are two designated merit classes--young households and elderly households. The "+" in such a case represents the redistributive impact upon younger households and the "-" represents the redistributive impact upon elderly households relative to the impact on middle-aged households.

A glance at the results in Table 6-2 indicates that the rankings are generally quite consistent across equations. The following major results may be noted:

°The GPM appears to dominate overall in the rankings and to have very little redistributive impact. Only in the debt-equity ratio category does it rank slightly below other instruments. It has an additional advantage in its flexibility. Our analysis assumed a five-percent graduation rate, although it was shown in footnote 4 in Chapter V that the graduation rate can be adjusted to render the instrument even more advantageous from the standpoint of maximizing consumption of homeownership, housing, or mortgage credit. Moreover, graduation rates can be "tailored" to individual borrowers' needs (e.g., younger professional

families requiring a steep positive rate, but older families about to retire requiring a level or even negative rate), thus resulting in even greater attractiveness. The a priori nature of the GPM payment stream also renders it more politically acceptable. From the lender's standpoint, the GPM would have little positive impact on advance cash flow conditions during tight money periods. The graduated nature of its payment stream theoretically could also reduce equity accumulation rates, hence increase default risk and cause rationing. However, judicious "tailoring" of graduation rates would very likely keep any such increases in default risk to a minimum.

°The PLAM runs a close second to the GPM in aggregate rankings and has the additional advantage of slightly positive equity effects, especially among young and retired households. In fact, for younger households the PLAM is superior to the GPM. It is not as flexible as the GPM, nor is it as politically acceptable. From the lender's standpoint, the status of the PLAM relative to the GPM and FRM is uncertain. On the one hand, interest rate risk could be lower under the PLAM to the extent that inflationary periods are correlated with periods of tight money, thus reducing the lender's cash flow squeeze. On the other hand, uncertainty in the rate of inflation, combined with an increasing

payment stream, could increase default risk above GPM and FRM levels somewhat, especially among non-upwardly mobile households. The decreased debt-equity ratio under the PLAM could possibly translate into increased down payment requirements, which could adversely affect asset-constrained households.

°The FRM performance is only mediocre, ranking significantly behind the GPM and PLAM in all categories except the debt-equity ratio, where it appears to offer the best opportunity for reducing down payment requirements for a given level of mortgage financing.

°Of the variable-rate instruments, the VRML's performance is roughly comparable to that of the FRM overall. However, it presents significant undesirable equity effects. Only among upper-middle income, middle-aged white households does it appear to offer a desirable alternative to the current instrument of housing finance. The VRMS is clearly the most undesirable instrument tested in aggregate rankings, and it possesses the same undesirable negative equity effects as the VRML, only accentuated in their impact. This poor showing is due primarily to the volatility of the short-term rate, which creates high-risk conditions for both the borrower and the lender. From the lender's standpoint, the variable-rate instruments

would certainly reduce interest-rate risk, but the severe burdens placed upon borrower households indicate that default risk increases would very likely outweigh this advantage.

°The ILM performs almost as poorly as the VRMS. This is somewhat surprising since our analysis was biased in favor of the ILM since it did not take into account the fact that amortization periods would necessarily be lengthened for lower-income non-upwardly mobile households. Part of this undesirable performance is due to the 10-percent-of-income payment constraint imposed on all households, a requirement which results in the ILM's strongly positive equity characteristics but which forces higher income households to pay substantially higher mortgage payments than they pay under the FRM. If the ILM were ever actually offered (a possibility which is unlikely), its payment rate would very likely be tailored to suit the individual demands of each household within the risk constraints of the lending institutions. Such a design would enhance the performance of the ILM considerably over our estimates from the borrower's standpoint. From the lender's standpoint, cash flow volatility would very likely be considerably increased under the ILM due to the fact that incomes are not highly positively

correlated with tight money periods. Default risk would be affected by two factors: the fixed payment burden for all households would tend to lower it, but this reduction could be offset among lower-income non-upwardly mobile households by lower rates of equity accumulation.

While our simulation results are reasonable, they must be accepted only qualitatively and then only with a great deal of caution and under certain assumptions. We discuss these caveats and assumptions in detail in Chapters II-V and repeat them briefly here:

°All coefficient estimates have been assumed to be point estimates in simulation calculations, whereas in reality regression coefficients are actually random variables subject to error.

°Parameter values calculated in many cases for the alternative mortgage instruments and used in simulations are beyond the range of experience for the FRM. Since the FRM was the only instrument used in our estimations, this implies our simulation results are "extrapolative" and not "interpolative" and therefore subject to an additional source of error.

°Data limitations prevented our estimating "pure" cash-flow or present-value non-instrument-specific mortgage-related effects. In fact, our coefficients

may also be reflecting non-mortgage-related permanent-income and general economic effects. The initial payment variable, for example, reflects both cash-flow and present-value mortgage-related effects under the FRM. In addition it is picking up the amortization period effect and is proxying for alternative investment yields available in the market. Since all of these effects would be predicted to have a negative impact on housing and mortgage credit consumption, they reinforce each other. If we were to simulate an alternative instrument with the same present value and maturity as the FRM but a different initial payment level, the only initial payment effect should be a cash-flow mortgage related effect. However, our estimations, picking up all of the partial effects, would overestimate the initial payment impact. Thus the simulation results would be biased. The extent of this bias depends upon the instrument type.

° Simultaneous equations bias of our single structural-demand equation could bias coefficients toward zero, resulting in further error, but possibly offsetting other biases.

° Certain plausible assumptions were necessarily made about the terms under which each alternative instrument would be offered at equilibrium, since these terms

were not determined endogenously in the model. Our simulation results were very sensitive to these assumptions.

Nevertheless, we argue that at least qualitative acceptance of the simulation results is justified for at least three reasons. First, without adequate long-term universal experience with many alternative mortgage instruments, such an analysis as presented here is the only type of analysis possible. Second, this analysis takes into account more considerations than does previous work addressing the same question.

Finally, under certain assumptions, the theoretical validity of the model increases significantly. These assumptions are (1) that cash flow and consumption, as opposed to present value and investment, considerations dominate in the bundle of homeownership decisions; (2) that households highly discount future mortgage payments, and (3) that short-term income expectations do not dominate a household's calculation of permanent income. These could be approximately true for at least certain classes of households, especially lower-income non-upwardly mobile households about which we are most concerned in alternative instrument introduction.

Policy Recommendations

The simulation results derived in this study, although they must be accepted qualitatively and with caution, generally support the theoretical arguments of opponents of the VRM. They indicate that the introduction of a standard variable-rate instrument with adjustable payments made annually, especially one tied to a short-term interest rate index, would impact negatively on all households, but especially upon lower-middle income, young, elderly, and black households. Such evidence does not support the introduction of such an instrument (although it says nothing about the possible introduction of a modified VRM, which is not capable of being evaluated in our model framework).

However, our results also suggest the desirability of approving the GPM and possibly the PLAM at least on a trial basis as acceptable instruments to be offered by federally chartered thrift institutions. Attention appears to be focusing increasingly upon some form of the GPM as an acceptable alternative to the FRM.⁴ It is recommended that this course be continued. We also make the following additional recommendations:

1. The PLAM, which was revealed to be almost as desirable as the GPM, should also be permitted.
2. A comprehensive monitoring program should be undertaken to evaluate the results of the

introduction of the alternative instruments
from the standpoint of:

- a. equity considerations
 - b. revision of lenders' rules-of-thumb due to increased default or interest-rate risk
 - c. aggregate changes in homeownership, housing consumption, mortgage credit usage, and down payments over time
3. A carefully controlled "design" experiment for the GPM should be undertaken to evaluate the optimal graduation rate, the effect of "rate tailoring," and the degree of borrower acceptance.

Such a conscientious explicit policy program could result in a significant improvement in the nation's home finance system and one additional step in the search to reduce the cost of housing and increase homeownership opportunities.

FOOTNOTES--CHAPTER VI

¹Maisel and Roulac (1976), pp. 300-301.

²Here it is necessary to assume that most of the effect reflected in the variable coefficients is a mortgage-related effect and not simply a permanent income or general economic effect which are independent of the mortgage instrument.

³One major problem with our simulations, however, is that the values are oftentimes beyond the range of experience. Contingency hedging and supply rationing could become important in this range.

⁴The Department of Housing and Urban Development, as a result of a nationwide search in early 1976, settled upon a variation of the GPM for future approval. The Federal Home Loan Bank Board approved the use of a modified flexible payment instrument, which permitted a lowering of monthly payments over the first five years. However, it was little used because the five-year restriction did not offer a large enough incentive to overcome the inertia and familiarity of the FRM. In August, 1976, Senate hearings were held on a proposal by Senator Edward Brooke (R., Mass.) to introduce a "flexible payment mortgage," On September 15, 1976, then-President Gerald

Ford announced he would soon by administrative action approve the introduction of the flexible payment instrument. That approval was later granted. As of this writing, implementation of the flexible payment instrument is proceeding.

APPENDIX I

CONTINUOUS TIME STOCHASTIC PROCESSES

Continuous time stochastic processes, also known as Markov processes in continuous time with continuous state space, have been used to describe physical phenomena for many years. The movement of particles in a fluid being buffeted by successive random impacts of neighboring particles was first noticed in 1827 and named Brownian motion after its discoverer. In 1905 Einstein advanced a satisfactory mathematical theory for such motion which was more fully developed into a rigorous theory in 1923 by Wiener.

However, it was not until 1969 that this theory was applied in the economics and finance literature by Robert Merton (1969, 1971, 1973), who used it to develop continuous-time models of consumption and portfolio selection. In 1974 Fischer applied the theory to a model of the demand for indexed bonds. Most recently, Cohn and Fischer (1974) have used continuous-time stochastic processes to describe the stochastic properties of various alternative mortgage types. The use of such processes in this dissertation parallels closely Cohn and Fischer's treatment. In this appendix we shall provide a non-rigorous discussion of the theory for such processes.

1. Assumed Forms of Component Variable Processes

The behavior of various variables--such as prices, interest rates, and income over time--is assumed in this dissertation to be describable by continuous-time stochastic processes. That is, the state space of these variables at each point in time is the continuum of real numbers, and changes of state are occurring in the general case constantly. The stochastic process for the variable X (sometimes known as an Itô process) is the solution to the stochastic differential equation

$$(A.1.1.) \quad dX = f(X,t) dt + g(X,t) dz$$

where $f(X,t)$ is the "trend" or "drift" term and $g(X,t)$ is the "stochastic" term. The term dz is obtained as the limiting process of a suitably defined random walk in discrete time and is often called "Gaussian white noise." It is a standard normal random variable (that is, with mean 0 and unit variance).

Let us consider the price variable p . A logical assumption is that prices can be expected to increase at a certain rate over time (namely, the rate of inflation π_p) with an uncertainty which increases linearly as we look further into the future. In such a case:

$$(A.1.2.) \quad X = p$$

$$(A.1.3.) \quad f(p,t) = \pi_p p$$

$$(A.1.4.) \quad g(p,t) = s_p p$$

Thus

$$(A.1.5.) \quad dp = \pi_p p dt + s_p p dz_p \quad \text{or}$$

$$(A.1.6.) \quad \frac{dp}{p} = \pi_p dt + s_p dz_p$$

This process is represented in Figure A1-1. The logarithm of the price level is expected to increase linearly over time with a linear increase in the confidence interval about the expected price level. It should be noted that the slope of $E[\log(p(t))]$ in Figure A1-1 is not π but $\pi_p - s_p^2/2$ because we are dealing with proportional rather than absolute changes in the price level over time.

Other variables are more logically described by other Itô processes. For example, interest rates (r) in general would in the long run in the case of constant inflation not be expected to increase or decrease over time, but their uncertainty could still be assumed to increase linearly. In such a case we would represent the movement of interest rates by the following Itô process:

$$(A.1.7.) \quad \frac{dr}{r} = s_r dz_r.$$

The complete list of descriptive stochastic processes assumed in our analysis for prices, interest rates, and incomes is listed in Table A1-1.

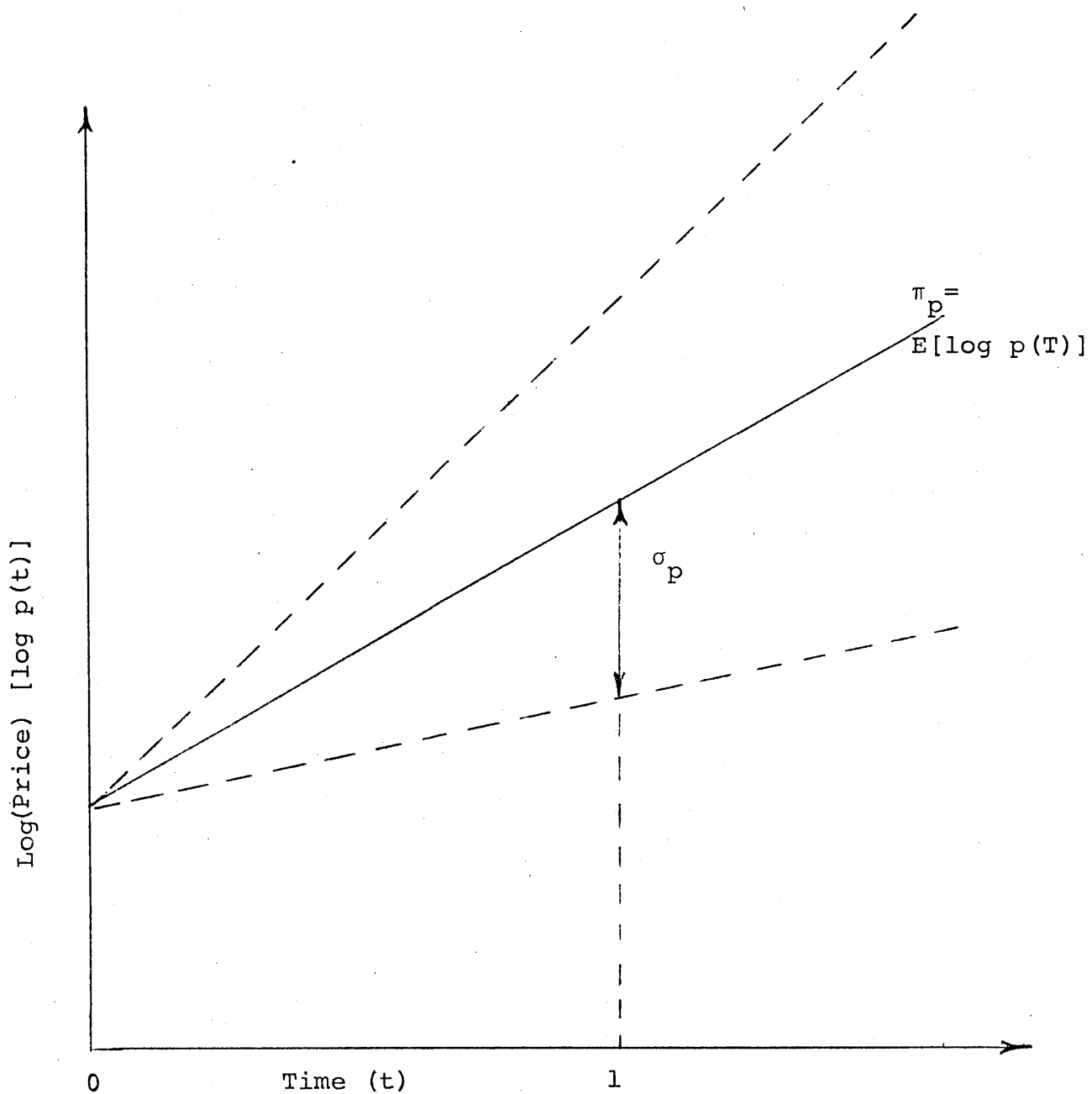


Fig. A 1-1 Price (p) as a continuous Time Stochastic Process

TABLE A1-1
 ASSUMED STOCHASTIC PROCESSES FOR
 COMPONENT VARIABLES

Variable

Price Level $\frac{dp}{p} = \pi_p dt + s_p dz_p$

Nominal Interest Rate
(short term) $\frac{dr_s}{r_s} = s_{r_s} dz_{r_s}$

Nominal Interest Rate
(long term) $\frac{dr_L}{r_L} = s_{r_L} dz_{r_L}$

Real Household Income $\frac{dy}{y} = g dt + s_y dz_y$

2. Applying Itô's Lemma to Derive Stochastic Processes for Functions of Component Variables

The expression which we are concerned with in this dissertation which may be described by an Itô process is the mortgage payment-to-income ratio, also called the payment burden. This variable is a function of two random variables, namely, the real mortgage-payment level (q) and real income (y). The real mortgage payment level, in turn, depending on the instrument under consideration, is a function of several of our other basic variables which may be described by stochastic processes. In the case of the FRM, only one random variable, the price level, affects the real payment level. In the case of the VRM, there are two--the price level and the nominal interest rate.

To derive stochastic processes of the form

$$(A.1.8.) \quad \frac{dX_i}{X_i} = \pi_i dt + s_i dz_i$$

for variables X_i which are functions of random variables describable by stochastic processes, we apply Itô's Lemma, sometimes called the Fundamental Theorem of the Stochastic Calculus. This theorem assumes we have a number of stochastic processes ($i = 1, \dots, n$) describable by the expression A.1.1. If ρ_{ij} is the correlation coefficient between the Wiener processes dz_i and dz_j , and $F(X_1, \dots, X_n, t)$ is a twice differentiable function of the component random variables and t , then Itô's Lemma says

$$(A.1.9.) \quad dF = \sum_{i=1}^n \frac{\partial F}{\partial X_i} dx_i + \frac{\partial F}{\partial t} dt \\ + 1/2 \sum_i \sum_j \frac{\partial^2 F}{\partial X_i \partial X_j} dx_i dx_j$$

is the stochastic differential of $F(\cdot)$. The product $dx_i dx_j$ is defined by:

$$(A.1.10.) \quad dz_i dz_j = \rho_{ij} dt \quad i, j = 1, \dots, n$$

$$(A.1.11.) \quad dz_i dt = 0 \quad i = 1, \dots, n$$

3. An Example: Calculation of the Payment Burden Stochastic Differential for the FRM

As an example of the use of Itô's Lemma, let us calculate the stochastic differential

$$\frac{d(q_{FRM}/y)}{(q_{FRM}/y)} \quad \text{for the FRM.}$$

First we must calculate the stochastic differential for the real payment q_{FRM} where

$$(A.1.12.) \quad q_{FRM} = \frac{Q_{FRM}}{p}$$

and Q_{FRM} is the nominal FRM payment. We know Q_{FRM} is constant for the term of the loan. We also know

$$\frac{dp}{p} = \pi_p dt + s_p dz_p.$$

Applying Itô's Lemma, we can find the stochastic expression for q_{FRM}

$$\begin{aligned}
 \text{(A.1.13.)} \quad dq_{\text{FRM}} &= d(Q_{\text{FRM}}/p) \\
 &= \frac{\partial(Q_{\text{FRM}}/p)}{\partial p} dp + \frac{\partial(Q_{\text{FRM}}/p)}{\partial t} dt \\
 &\quad + 1/2 \frac{\partial^2(Q_{\text{FRM}}/p)}{\partial p^2} dpdp
 \end{aligned}$$

We know

$$\text{(A.1.14.)} \quad \frac{\partial(Q_{\text{FRM}}/p)}{\partial p} = - \frac{Q_{\text{FRM}}}{p^2}$$

$$\text{(A.1.15.)} \quad dp = \pi_p p dt + s_p p dz_p$$

$$\text{(A.1.16.)} \quad \frac{\partial(Q_{\text{FRM}}/p)}{\partial t} = 0$$

$$\text{(A.1.17.)} \quad \frac{\partial^2(Q_{\text{FRM}}/p)}{\partial p^2} = \frac{2 Q_{\text{FRM}}}{p^3}$$

$$\begin{aligned}
 \text{(A.1.18.)} \quad dpdp &= \pi_p^2 p^2 (dt)^2 + 2\pi_p s_p p^2 dz_p dt + s_p^2 p^2 (dz_p)^2 \\
 &= s_p^2 p^2 dt
 \end{aligned}$$

Then

$$\begin{aligned}
 \text{(A.1.19.)} \quad dq_{\text{FRM}} &= - \frac{\pi_p Q_{\text{FRM}}}{p} dt - \frac{s_p Q_{\text{FRM}}}{p} dz_p \\
 &\quad + \frac{Q_{\text{FRM}} s_p^2}{p} dt
 \end{aligned}$$

$$= \left[-\pi_p \frac{Q_{FRM}}{p} + s_p^2 \frac{Q_{FRM}}{p} \right] dt - \left[s_p \frac{Q_{FRM}}{p} \right] dz_p$$

or

$$(A.1.20.) \frac{dq_{FRM}}{q_{FRM}} = (-\pi_p + s_p^2) dt - s_p dz_p$$

which gives us a stochastic expression for the real payment level under the FRM.

The next step is to find the stochastic expression for $\frac{d(q_{FRM}/Y)}{(q_{FRM}/Y)}$ by again applying Itô's Lemma:

$$(A.1.21.) \frac{d(q_{FRM}/Y)}{(q_{FRM}/Y)} = \frac{\partial (q_{FRM}/Y)}{\partial q_{FRM}} dq_{FRM} + \frac{\partial (q_{FRM}/Y)}{\partial Y} dy + \frac{1}{2} \frac{\partial^2 (q_{FRM}/Y)}{\partial q_{FRM}^2} (dq_{FRM})^2 + 2 \frac{\partial^2 (q_{FRM}/Y)}{\partial q_{FRM} \partial Y} dq_{FRM} dy + \frac{\partial^2 (q_{FRM}/Y)}{\partial Y^2} dy^2$$

We know

$$(A.1.22.) \frac{\partial (q_{FRM}/Y)}{\partial q_{FRM}} = \frac{1}{Y}$$

$$(A.1.23.) \quad dq_{FRM} = (-\pi_p + s_p^2) q_{FRM} dt - s_p q_{FRM} dz_p$$

$$(A.1.24.) \quad \frac{\partial (q_{FRM}/Y)}{\partial Y} = - \frac{q_{FRM}}{Y^2}$$

$$(A.1.25.) \quad dy = gy dt + s_y y dz_y$$

$$(A.1.26.) \quad \frac{\partial^2 (q_{FRM}/Y)}{\partial q_{FRM}^2} = 0$$

$$(A.1.27.) \quad (d q_{FRM})^2 = (-\pi_p + s_p^2)^2 q_{FRM}^2 dt^2 + s_p^2 q_{FRM}^2 (dz_p)^2 \\ - 2 (-\pi_p + s_p^2) q_{FRM}^2 s_p dz_p dt \\ = s_p^2 q_{FRM}^2 dt$$

$$(A.1.28.) \quad \frac{\partial^2 (q_{FRM}/Y)}{\partial q_{FRM} \partial Y} = - \frac{1}{Y^2}$$

$$(A.1.29.) \quad d q_{FRM} dy = (-\pi_p + s_p^2) q_{FRM} gy (dt)^2 \\ + (-\pi_p + s_p^2) q_{FRM} s_y y dz_y dt \\ - s_p q_{FRM} gy dz_p dt \\ - s_p q_{FRM} s_y y dz_p dz_y \\ = - s_p q_{FRM} s_y y \rho_{py} dt$$

$$(A.1.30.) \quad \frac{\partial^2 (q_{FRM}/Y)}{\partial Y^2} = \frac{2 q_{FRM}}{Y^3}$$

$$\begin{aligned}
 \text{(A.1.31.) } dy^2 &= g^2 y^2 (dt)^2 + 2 g y^2 s_y dz_y dt \\
 &+ s_y^2 y^2 (dz_y)^2 \\
 &= s_y^2 y^2 dt
 \end{aligned}$$

Then

$$\begin{aligned}
 \text{(A.1.32.) } d(q_{\text{FRM}}/y) &= \frac{1}{y} (-\pi_p + s_p^2) q_{\text{FRM}} dt - \frac{1}{y} s_p q_{\text{FRM}} dz_p \\
 &- \frac{q_{\text{FRM}}}{y} g dt - \frac{q_{\text{FRM}}}{y} s_y dz_y \\
 &+ 1/2 \left[2 \left(-\frac{1}{y^2} \right) (-s_p q_{\text{FRM}} s_y y \rho_{py} dt) \right. \\
 &\left. + \frac{2 q_{\text{FRM}}}{y^3} (s_y^2 y^2 dt) \right] \\
 &= \left[\frac{q_{\text{FRM}}}{y} (-\pi_p + s_p^2) - \frac{q_{\text{FRM}}}{y} g \right. \\
 &\left. + \frac{q_{\text{FRM}}}{y} s_y \rho_{py} s_p + \frac{q_{\text{FRM}}}{y} s_y^2 \right] dt \\
 &+ \left[-\frac{q_{\text{FRM}}}{y} s_p \right] dz_p + \left[-\frac{q_{\text{FRM}}}{y} s_y \right] dz_y
 \end{aligned}$$

or

$$\begin{aligned}
 \text{(A.1.33.) } \frac{d(q_{\text{FRM}}/y)}{(q_{\text{FRM}}/y)} &= \left[-\pi_p - g + s_p^2 + s_p s_y \rho_{py} + s_y^2 \right] dt \\
 &- s_p dz_p - s_y dz_y
 \end{aligned}$$

The trend term of this process, therefore, tells us the payment burden is expected to drop at a rate equal to the

sum of the rate of inflation and the rate of real income increase plus an adjustment for the stochastic properties of the component random variables.

The variance of this process can be obtained by squaring the stochastic terms:

$$\begin{aligned}
 \text{(A.1.34.) } \sigma_{q_{FRM/Y}}^2 dt &= (-s_p dz_p - s_y dz_y)^2 \\
 &= s_p^2 (dz_p)^2 + s_y^2 (dz_y)^2 + s_p s_y dz_p dz_y \\
 &= s_p^2 dt + s_y^2 dt + s_p s_y \rho_{PY} dt \\
 &= (s_p^2 + s_p s_y \rho_{PY} + s_y^2) dt
 \end{aligned}$$

Finally, the standard deviation of the process is calculated as the square root of the variance:

$$\text{(A.1.35.) } \sigma_{q_{FRM/Y}} = \left[s_p^2 + s_p s_y \rho_{PY} + s_y^2 \right]^{\frac{1}{2}}$$

Such trend and stochastic terms are also derivable for the payment burdens under all other mortgage instruments considered in this dissertation. It is obvious that these expressions often become quite complex. Appendix II lists the results of calculating these expressions for each mortgage instrument.

APPENDIX II

DERIVATION OF MORTGAGE-RELATED PARAMETER EXPRESSIONS FOR ALTERNATIVE MORTGAGE INSTRUMENTS

Our model estimation considered three mortgage-related variables: (1) the initial annual mortgage payment per \$100 borrowed (P), (2) the expected trend in future payment burden (π), and (3) the uncertainty in the expected payment-burden trend (σ). As mentioned in the main body of the dissertation, P is derived from formulae describing the payment stream for each instrument, and π and σ are derived as the trend and stochastic terms of a continuous-time stochastic process representing the payment burden (payment-to-income ratio):

$$(A.2.1.) \quad \frac{d(q/y)}{q/y} = \pi dt + \sigma dz$$

An explanation of the use of continuous-time stochastic processes is found in Appendix I.

Each mortgage instrument is therefore characterized by its own expression for P , π , and σ . These expressions for the standard instrument (the FRM) are derived in Appendices I and IV. The results are as follows:

$$(A.2.2.) \quad P_{FRM} = \frac{r}{1 - (1 + \frac{r}{1200})^{-T}}$$

$$(A.2.3.) \quad \pi_{FRM} = - (\pi_p + g - s_p^2 - s_Y^2 - \rho_{PY} s_p s_Y)$$

$$(A.2.4.) \quad \sigma_{FRM} = \left[s_p^2 + 2 s_p s_Y \rho_{PY} + s_Y^2 \right]^{1/2}$$

where r = annual contract interest rate (in percent)
 T = contract maturity (in months)
 π_p = price trend (fraction per year)
 g = real income trend (fraction per year)
 s_p^2 = annual variance in prices
 s_Y^2 = annual variance in real income
 ρ_{PY} = intercorrelation of prices and real income

The purpose of this appendix is to derive the expressions for P , π , and σ for each of the alternative mortgage instruments: (1) the standard variable-rate mortgage (VRM) with payments tied to a floating long-term or short-term interest rate index (VRML or VRMS); (2) the price-level-adjusted mortgage (PLAM), in which real payments are constant over time; (3) the graduated-payment mortgage (GPM), similar to the FRM, but with an a priori graduated, rather than level, nominal payment stream; and (4) the income-linked mortgage (ILM), in which payment levels are tied to the borrower's income. Each instrument will now be discussed in turn.

The Standard Variable-Rate Mortgages
(VRML and VRMS)

Let us first formally derive the three mortgage-related variables for the VRM. The expected payment burden trend (π_{VRM}) and the uncertainty in payment burden trend (σ_{VRM}) can be described as the trend and stochastic terms of an Itô process for the payment burden (q/y), where q is the real payment level and y is real household income. We assume the following Itô processes describe movements in prices, nominal interest rates, and real household income:

$$(A.2.5.) \quad \frac{dp}{p} = \pi_p dt + s_p dz_p$$

$$(A.2.6.) \quad \frac{dr}{r} = s_r dz_r$$

$$(A.2.7.) \quad \frac{dy}{y} = gdt + s_y dz_y$$

The Itô process for the expected payment burden then becomes, upon applying Itô's Lemma:

$$(A.2.8.) \quad \frac{d q_{\text{VRM}}/y}{q_{\text{VRM}}/y} = \pi_{\text{VRM}} + \sigma_{\text{VRM}} dz_{q/y}$$

where

$$(A.2.9.) \quad \pi_{\text{VRM}} = \alpha(x) s_r^2 - \pi_p + s_p^2 - \beta(x) s_r s_p \rho_{rp} \\ - g + s_y^2 - \beta(x) s_r s_y \rho_{ry} + s_p s_y \rho_{py}$$

$$(A.2.10.) \quad \sigma_{VRM} = [\beta^2(x) s_r^2 + s_p^2 + s_y^2 - 2\beta(x) s_r s_p \rho_{rp} - 2\beta(x) s_r s_y \rho_{ry} + 2 s_p s_y \rho_{py}]^{1/2}$$

$$(A.2.11.) \quad \alpha(x) = 1/2 \frac{x e^{-x}}{(1-e^{-x})^2} [(1+e^{-x}) - 2(1-e^{-x})]$$

$$(A.2.12.) \quad \beta(x) = \frac{1 - (1+x)e^{-x}}{1 - e^{-x}}$$

$$(A.2.13.) \quad x = r_t (T-t)$$

and r_t is the interest rate in time period t , T is the maturity, and ρ represents the correlation coefficient between two variables.

In the trend term, π_{VRM} , if the expressions other than π_p and g are relatively small, the expected payment burden trend under the VRM is essentially the same as that under the FRM ($-(\pi_p + g)$). However, if in certain circumstances the other terms grow relatively large, then π_{VRM} can be expected to deviate significantly from π_{FRM} .

The uncertainty term σ_{VRM} depends upon $\beta(x)$, s_r , s_p , s_y , ρ_p , ρ_y and ρ_{py} . $\beta(x)$ has the following properties:

$$(A.2.14.) \quad \lim_{x \rightarrow 0} \beta(x) = 0 \quad \lim_{x \rightarrow \infty} \beta(x) = 1 \quad \frac{\partial \beta(x)}{\partial x} > 0$$

Thus $\beta(x)$ starts out near one and declines over time to zero at maturity. Since $\frac{\partial \sigma_{VRM}}{\partial \beta(x)} > 0$, $\beta(x)$ has the effect

of initially increasing σ_{VRM} above σ_{FRM} and decreasing it to the level of σ_{FRM} at maturity.

We see also $\frac{\partial \sigma_{\text{VRM}}}{\partial s_r} > 0$, $\frac{\partial \sigma_{\text{VRM}}}{\partial s_p} > 0$, and

$\frac{\partial \sigma_{\text{VRM}}}{\partial s_y} > 0$, which means that in the case of household ex-

pectations of volatile prices and interest rates, uncertainty associated with the VRM will be increased. In addition, households with volatile real income streams will experience additional uncertainty.

Finally, we note $\frac{\partial \sigma_{\text{VRM}}}{\partial \rho_{rp}} < 0$, $\frac{\partial \sigma_{\text{VRM}}}{\partial \rho_{ry}} < 0$, and

$\frac{\partial \sigma_{\text{VRM}}}{\partial \rho_{ry}} > 0$, which says positive correlations between interest-rate and price and interest-rate and income fluctuations will tend to lower uncertainty, but a positive correlation between prices and real income will tend to increase it.

By subtracting σ_{FRM}^2 from σ_{VRM}^2 we can determine the conditions under which uncertainty under the VRM will be greater than that under the FRM. The result is

$$\begin{aligned} \text{(A.2.15.) } \sigma_{\text{VRM}}^2 - \sigma_{\text{FRM}}^2 &= \Delta \sigma^2 = \beta(x) s_r^2 - 2\beta(x) s_r s_p \rho_{rp} \\ &\quad - 2\beta(x) s_r s_y \rho_{ry} \\ &= \beta(x) s_r [\beta(x) s_r - 2 s_p \rho_{rp} \\ &\quad - 2 s_y \rho_{ry}] \end{aligned}$$

which is positive if $\beta(x) > 2 \left[\frac{s_p}{s_r} \rho_{rp} + \frac{s_y}{s_r} \rho_{ry} \right]$.

This says that VRM's will exhibit greater uncertainty than FRM's early in the future under conditions of (1) volatile interest rates relative to prices and incomes (s_r , s_p , s_y) and (2) small or negative correlations between interest rates and prices and income (ρ_{rp} , ρ_{ry} small or negative).

The final mortgage-related variable, the initial payment level, (P_{VRM}), is assumed to be equivalent to P_{FRM} less a one-half percentage point interest rate inducement, in accordance with initial VRM experience in California. This assumption is made in the absence of an endogenously determined price level in the model, an estimate which would be possible only with a much more complex macro model and with a different data set with greater supply information. The assumption of a 50-basis-point differential would be reasonable in the current economic environment but low in an environment of steeply increasing interest rates and vice versa.

As mentioned above, we will test variable-rate instruments tied to both long-term and short-term interest rate indices. In our empirical estimations for π_{VRM} and P_{VRM} , we use the Aaa corporate bond rate for the long-term rate and the three-month treasury bill rate for the short-term rate. Individual income and price expectations are used, as discussed in Appendix IV. Current mortgage contract rates for homeowners are used as the base for deriving P_{VRM} .

The Price Level Adjusted
Mortgage (PLAM)

Let us turn now to measurement of our three mortgage-related variables for the PLAM. Again, the expected payment burden (π_{PLAM}) and the uncertainty in expected payment burden (σ_{PLAM}) variables are given by the trend and stochastic terms of an Itô process for the payment burden over time:

$$\begin{aligned}
 \text{(A.2.16.)} \quad \frac{d(q_{\text{PLAM}}/Y)}{(q_{\text{PLAM}}/Y)} &= \pi_{\text{PLAM}} dt + \sigma_{\text{PLAM}} dz_{q/Y} \\
 &= - (g - s_y^2) dt + s_y dz_{q/Y}
 \end{aligned}$$

where all variables have been defined previously. Note from the first term that the expected burden becomes heavier for g more negative--that is for households which expect a decline in their real income--and for a large s_y --that is for households which have highly volatile real incomes. The second term indicates that those households with highly volatile incomes would experience the highest burden uncertainty under the PLAM.

Subtracting the trend and variance expressions for the FRM from those for the PLAM yields information about the conditions under which the PLAM would be preferable to the FRM from the standpoint of a lower expected payment burden and less uncertainty in expected payment burden:

$$\begin{aligned}
 \text{(A.2.17.) } \pi_{\text{PLAM}} - \pi_{\text{FRM}} &= \pi_p - s_p^2 - \rho_{\text{PY}} s_p s_Y \\
 &= \pi_p - s_p (s_p + \rho_{\text{PY}} s_Y)
 \end{aligned}$$

$$\text{(A.2.18.) } \sigma_{\text{PLAM}}^2 - \sigma_{\text{FRM}}^2 = -s_p^2 - 2\rho_{\text{PY}} s_p s_Y$$

Expression (A.2.17.) tells us the expected burden trend under the PLAM is higher for high rates of inflation (π_p), low price volatility (s_p), and a low or negative covariance between prices and real income. Since the second two terms are ordinarily of second order magnitude, we may conclude in most cases the burden trend is expected to be higher under the PLAM than under the FRM for positive rates of expected inflation.

Expression (A.2.18.) tells us that the uncertainty in future payment burden is actually lower under the PLAM, than under the FRM as long as there is not a strong negative correlation between prices and real income.

The third mortgage-related variable, the initial payment level, P_{PLAM} , is obtained for the PLAM in the following way: the rate of inflation during the year each homeownership household moved into its present home and incurred its present mortgage debt is obtained, and this rate is subtracted from its mortgage interest rate to yield a "real" mortgage rate (i).² The initial payment rate is then calculated using the formula:

$$(A.2.19.) \quad P_{PLAM} = \frac{i}{1 - (1 + \frac{i}{1200})^{-T}}$$

where T , the maturity in months, is assumed the same as that for the household under the FRM. This is an important assumption and makes a major difference in our simulation results. It is very possible that in long-run equilibrium, maturities could shift under the PLAM in response to altered default risks. Note that the lower the FRM mortgage interest rate and the higher the rate of inflation, the lower the initial payment level under the PLAM. For all positive rates of inflation $P_{PLAM} < P_{FRM}$. For a 25-year, eight-percent nominal interest rate mortgage under six percent inflationary expectations, $P_{FRM} = 9.262$ and $P_{PLAM} = 5.086$; the initial PLAM payment is 45 percent lower than that for the FRM.

The Graduated Payment Mortgage (GPM)

For the GPM, the expected payment burden (π_{GPM}) and the uncertainty in the expected payment burden (σ_{GPM}) are again estimated as the trend and stochastic terms of an Itô process for the payment burden over time:

$$(A.2.20.) \quad \frac{d(q_{GPM}/Y)}{(q_{GPM}/Y)} = \pi_{GPM} dt + \sigma_{GPM} dz_{q/Y}$$

$$= - (\pi + g - g_Q - s_p^2 - s_Y^2 - \rho_{PY} s_p s_Y) dt$$

$$+ (s_p^2 + 2\rho_{PY} s_p s_Y + s_Y^2)^{1/2} dz_{q/Y}$$

Note that the stochastic term for the GPM is identical to that for the FRM and the trend term is identical except for the addition of g_Q , the a priori graduated nominal payment rate. The greater the graduated rate, the higher the expected payment burden trend is expected to be. As with the FRM, the expected payment burden trend is also negatively related to the rate of inflation (π) and the rate of increase in real income (g) and is positively related to the volatility of real income and prices and their covariance. The uncertainty in payment burden is positively related to the volatility of prices and real income and their covariance.

The initial payment level under the GPM (P_{GPM}) is obtained by assuming a graduation rate of five percent per year and a maturity and nominal interest rate equivalent to that under the FRM, and then using the following relationship between P_{GPM} and P_{FRM} :³

$$(A.2.21.) \quad P_{GPM} = \frac{P_{FRM}}{1 - g_Q + \frac{g_Q}{r} \left[1 - \frac{TP_{FRM} e^{-rT}}{100} \right]}$$

Note that $P_{GPM} < P_{FRM}$ for $g_Q > 0$. For a 25-year, eight-percent, nominal-interest-rate mortgage and a five-percent graduation rate, $P_{FRM} = 9.262$ and $P_{GPM} = 6.716$; a decrease of 27.5 percent under the GPM.

The Income Linked Mortgage (ILM)

The Itô process for the payment burden over time for the ILM again supplies us with measures of the expected payment burden (π_{ILM}) and the uncertainty in the expected payment burden (σ_{ILM}):

$$(A.2.22.) \quad \frac{d(q_{ILM}/Y)}{(q_{ILM}/Y)} = \pi_{ILM} dt + \sigma_{ILM} dz_{q/Y}$$

$$= 0 dt + 0 dz_{q/Y}$$

Both π_{ILM} and σ_{ILM} are zero. There is no positive or negative expected payment burden trend since q_{ILM}/Y by construction is always constant. Similarly, q floats up and down with y , so σ_{ILM} is also 0.

Comparing these variable values to those for the FRM, we find $\pi_{ILM} > \pi_{FRM}$, except in cases of negative nominal income expectations (exemplified by non-upwardly-mobile or fixed-income households), and, in general, $\sigma_{ILM} < \sigma_{FRM}$.

The third mortgage-related variable, the initial payment level, P_{ILM} , is constructed by assuming all households are constrained to pay 10 percent of their income each month as a mortgage payment. In terms of dollars per year per \$100 borrowed, this becomes

$$(A.2.23.) \quad P_{ILM} = .10 \times \frac{Y}{M} \times 100$$

where Y is annual nominal household income (in \$1000) and M is total loan amount (in \$1000).

Comparing this value with empirical information available for the FRM, we see that it is substantially lower for lower-income households and substantially higher for higher-income households.

FOOTNOTES--APPENDIX II

¹Ordinarily, g would be expected to be an order of magnitude greater than s_y^2 .

²This procedure is only approximately correct, since the real rate actually requires knowledge of inflationary expectations rather than the current inflation rate. However, past inflationary expectations were not obtainable from the data. It would have been possible to derive a weighted average of future inflation rates for each year of purchase and to use this weighted average as a measure of inflationary expectations of each individual during the period. The major component of any such weighted average would have been the current rate of inflation, especially if consumers have relatively high rates of discount with respect to future prices. This fact supports the use of the current inflation rate alone.

³Assume the GPM is designed such that the payment level increases a constant amount each pay period. If Q_1 is the first payment level and $Q(t)$ is the payment level in time period t , then

$$Q(t) = [1 + g_Q(t-1)] Q_1$$

where g_Q is the annual rate of increase in payments.

We first are interested in finding Q_1 in terms of a given mortgage principal (M_0), yield (r), and maturity (T).

We know the present value of the stream of payments must equal the initial principal when discounted at the contract rate:

$$\sum_{t=1}^T \frac{Q(t)}{(1+r)^t} = \sum_{t=1}^T \frac{1 + g_Q(t-1)}{(1+r)^t} Q_1 = M_0$$

or

$$\begin{aligned} Q_1 &= \frac{M_0}{\sum_{t=1}^T \frac{1 + g_Q(t-1)}{(1+r)^t}} \\ &= \frac{M_0}{\sum_{t=1}^T \frac{1}{(1+r)^t} + g_Q \sum_{t=1}^T \frac{(t-1)}{(1+r)^t}} \end{aligned}$$

Normalizing on a per \$100 initial mortgage principal basis, this expression becomes

$$P_{GPM} = \frac{Q_1}{M_0} = \frac{100}{\sum_{t=1}^T \frac{1}{(1+r)^t} + g_Q \sum_{t=1}^T \frac{(t-1)}{(1+r)^t}}$$

Letting our expressions go to continuous time implies

$$\frac{1}{(1+r)^t} \rightarrow e^{-rt} \qquad \frac{t}{(1+r)^t} \rightarrow te^{-rt}$$

which says

$$P_{\text{GPM}} = \frac{100}{(1-g_Q) \int_0^T e^{-rt} dt + g_Q \int_0^T t e^{-rt} dt}$$

which yields upon solving

$$P_{\text{GPM}} = \frac{100}{(1-g_Q) \left[\frac{1-e^{-rT}}{r} \right] + g_Q \left[\frac{1}{r^2} (1-e^{-rT}) (rT+1) \right]}$$

Since in continuous time

$$P_{\text{FRM}} = \frac{100 r}{1 - e^{-rT}}$$

this implies

$$P_{\text{GPM}} = \frac{P_{\text{FRM}}}{1 - g_Q + \frac{g_Q}{r} \left[1 - \frac{T P_{\text{FRM}} e^{-rT}}{100} \right]}$$

APPENDIX III

MATHEMATICAL DERIVATION OF THE MODELS FOR HOMEOWNERSHIP, HOUSING CONSUMPTION, AND MORTGAGE VERSUS DOWN PAYMENT FINANCING

The conceptual model development outlined in Chapter II is expressed more formally in this appendix in generalized mathematical terms.

Isoquant Locus

The total housing consumption level (V) is the sum of the level of mortgage financing (B) and down payment financing (E), or

$$(A.3.1.) \quad V = B + E$$

Since mortgage and down payment financing are perfect substitutes for financing a given level of housing expenditure, we have

$$(A.3.2.) \quad dV = dB + dE = 0$$

which implies

$$(A.3.3.) \quad \frac{dB}{dE} = -1 \text{ for } V \text{ constant,}$$

which says the isoquant for a given level of housing expenditure has a slope of minus one.

Isocost Locus

The total cost of a given level of housing expenditure (TC) is the total cost of mortgage financing (TC_B) plus the total cost of down payment financing (TC_E), or

$$(A.3.4.) \quad TC = TC_E + TC_B$$

The change in total cost is simply the sum of the components of that change--a change in the cost of equity funds and a change in the cost of borrowed funds. The isocost locus is defined as the set of lines in E-B space in which the change in total cost is constant, or

$$(A.3.5.) \quad dTC = 0 = \frac{\partial TC_E}{\partial E} dE + \frac{\partial TC_B}{\partial B} dB$$

which implies

$$(A.3.6.) \quad \frac{dB}{dE} = \frac{-\partial TC_E / \partial E}{\partial TC_B / \partial B} = \frac{-MC_E}{MC_B}$$

This says for each (E,B) combination, which defines a certain housing price ($V = E+B$), the slope of the isocost line $\frac{dB}{dE}$ is equal to the negative of the ratios of the marginal costs of equity and borrowed funds at that point.

The Marginal Cost Schedules

Let us now look at the characteristics of the marginal cost schedules for equity and borrowing.

Borrowing

As explained hueristically in Chapter II, the marginal cost of borrowing is an increasing function of the present value (PV) and cash flow (CF) components of that cost:

$$(A.3.7.) \quad MC_B = MC_B (PV, CF)$$

The present value component is a function of the mortgage payment stream characteristics and a discount rate which is proxied by household permanent income, assets, and demographic characteristics:

$$(A.3.8.) \quad PV = PV (P, \hat{E}(P), \hat{T}, i_{PV_b} (Y_p, A, F))$$

where P = initial partial payment level

$\hat{E}(P)$ = expected payment level trend (a random variable)

\hat{T} = expected duration of payments (a random variable)

i_{PV_b} = present value component discount rate

Y_p = permanent income

A = assets

F = demographic characteristics

The cash flow component is a function of the payment burden stream characteristics and a discount rate which is proxied by household permanent income, assets, and demographic characteristics:

$$(A.3.9.) \quad CF = CF (B, P, Y_c, \pi, \sigma, \hat{T}, i_{CF_b} (Y_p, A, F))$$

where Y_c = current income
 π = expected trend in payment burden
 σ = uncertainty in expected payment burden trend
 i_{CF_b} = cash flow component discount rate

and the other terms are defined above.

We also saw in Chapter II that the terms upon which mortgage credit is offered, particularly the contract rate and the maturity (which affects P and T), are dependent upon a number of characteristics of the mortgage payment stream, the borrowing household, the unit and neighborhood, and conditions in the economy in general:

$$(A.3.10.) \quad P = P(B, \frac{B}{E}, Y_p, Y_c, A, F, S, N, P, \pi, \sigma, \hat{T}, \hat{C}, r_A)$$

$$(A.3.11.) \quad T = T(B, \frac{B}{E}, Y_p, Y_c, A, F, S, N, P, \pi, \sigma, \hat{T}, \hat{C})$$

where S = stock characteristics
 N = neighborhood characteristics
 \hat{C} = rate of equity accumulation (a random variable)

r_A = alternative yields in the market

and the other terms have been previously defined. In our models, we do not estimate (A.3.10.) and (A.3.11.) separately, but assume P and T are determined exogenously and enter them directly.

Equity Funds

The marginal cost of equity funds is an increasing function of its separate present value (PV) and cash flow (CF) components:

$$(A.3.12.) \quad MC_E = MC_E (PV, CF)$$

The present value component of equity cost is a function of the level of equity funds committed to a down payment, alternative yields available in the market, and a discount rate which is proxied by household permanent income, assets, and demographic characteristics:

$$(A.3.13.) \quad PV = PV (E, r_A, i_{PV_e} (Y_p, A, F))$$

The cash flow component is a function of the level of equity funds committed to a down payment, the level of liquid assets, the payment burden stream characteristics, and a discount rate which is proxied by household permanent income, assets, and demographic characteristics:

$$(A.3.14.) \quad CF = CF (E, A, B, P, Y_c, \pi, \sigma, \hat{T}, i_{CF_e} (Y_p, A, F))$$

Optimal Debt-Equity Locus

For any given level of housing consumption V , the cost-minimizing combination of mortgage and down payment financing (B^*, E^*) to finance V is determined by the point of tangency

of the isocost and isoquant lines, or from (A.3.3.) and (A.3.6.).

$$(A.3.15.) \quad -1 = - \frac{MC_E^*}{MC_B^*}$$

where * represents evaluation at the optimum debt-equity combination.

This is equivalent to saying, in the case in which institutional supply constraints are not effective, the locus of optimal debt-equity combinations for all levels of housing consumption is determined by the equivalency of the marginal cost of borrowing and the marginal cost of equity funds, both of which at the optimum equal the marginal cost of capital, or

$$(A.3.16.) \quad MC_E^* = MC_B^* = MC_C.$$

Using (A.3.16.) we may equate (A.3.7.) and (A.3.12.), our expressions for MC_E and MC_B , and, assuming E and B are separable, solve for the optimal level of down payment, given a level of mortgage financing, and vice versa.

$$(A.3.17.) \quad E^* = E^*(B^*, P, \hat{E}(P), \hat{T}, \pi, \sigma, Y_C, r_A, A, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

$$(A.3.18.) \quad B^* = B^*(E^*, P, \hat{E}(P), \hat{T}, \pi, \sigma, Y_C, r_A, A, i_{PV_b}, i_{CP_b}, i_{PV_e}, i_{CF_e})$$

The Marginal Return on Homeownership

Turning now to the marginal return on homeownership, we determined in Chapter II the marginal return is a function of two components--an investment component (I), associated with the price and expected rate of appreciation of the stock and the various non-mortgage costs associated with homeownership, and a consumption component (U), associated with the owner's utility derived from the consumption of housing services over time:

$$(A.3.19.) \quad MR = MR(I, U)$$

where

$$(A.3.20.) \quad I = I(V, p_r(S, N), \hat{R}(S, N), c(S, N), i_I(Y_p, A, F))$$

$$(A.3.21.) \quad U = U(h(S, N), \hat{E}(h)[S, N], i_U(Y_p, A, F))$$

and p_r = relative price of housing

\hat{R} = rate of appreciation of housing stock (a random variable)

c = non-mortgage related costs associated with homeownership

i_I = investment component discount rate

h = level of housing services provided

$\hat{E}(h)$ = expected level of housing services (a random variable)

i_U = consumption component discount rate

The remaining terms have been defined previously.

The Optimal Level of Housing Consumption

The equilibrium level of housing consumption is that level at which the marginal cost of capital equals the marginal return on owner-occupied housing, or

$$(A.3.22.) \quad MC_C^{**} = MR^{**}$$

where ** represents evaluation at the optimal housing consumption level.

Substituting $V^* = E^* + B^*$ in either (A.3.17.) or (A.3.18.) and solving for B^* and E^* , we have

$$(A.3.23.) \quad E^* = E^*(V^*, P, \widehat{E}(P), \widehat{T}, \pi, \sigma, Y_C, r_A, A, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

and

$$(A.3.24.) \quad B^* = B^*(V^*, P, \widehat{E}(P), \widehat{T}, \pi, \sigma, Y_C, r_A, A, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

Next substitute (A.3.23.) or (A.3.24.) into (A.3.7.) or (A.3.12.), respectively, yielding

$$(A.3.25.) \quad MC_E^* = MC_E^*(V^*, P, \widehat{E}(P), \widehat{T}, \pi, \sigma, Y_C, r_A, A, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

and

$$(A.3.26.) \quad MC_B^* = MC_B^*(V^*, P, \widehat{E}(P), \widehat{T}, \pi, \sigma, Y_C, r_A, A, i_{PV_b}, \\ i_{CF_b}, i_{PV_e}, i_{CF_e})$$

Finally, using (A.3.16.), substitute (A.3.25.) or (A.3.26.) and (2.3.19.) into (A.3.22.) to yield

$$(A.3.27.) \quad MR^{**}(V^{**}, p_r, \widehat{R}, c, h, \widehat{E}(h), i_I, i_U) \\ = MC_E^{**}(V^*, P, \widehat{E}(P), \widehat{T}, \pi, \sigma, Y_C, r_A, A, i_{PV_b}, \\ i_{CF_b}, i_{PV_e}, i_{CF_e})$$

or

$$(A.3.28.) \quad MR^{**}(V^{**}, p_r, \widehat{R}, c, h, \widehat{E}(h), i_I, i_U) \\ = MC_B^{**}(V^{**}, P, \widehat{E}(P), \widehat{T}, \pi, \sigma, Y_C, r_A, A, i_{PV_b}, \\ i_{CF_b}, i_{PV_e}, i_{CF_e})$$

We can now solve the above expressions for the equilibrium level of housing consumption V^{**} , which we shall also designate as VALUE:

$$(A.3.29.) \quad \text{VALUE} = V^{**} = V^{**}(p_r, \widehat{R}, c, h, \widehat{E}(h), P, \widehat{E}(P), \widehat{T}, \pi, \sigma, \\ Y_C, r_A, A, i_I, i_U, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

Substituting (A.3.29.) into (A.3.24.) and substituting the resulting expression into A.3.17.) yields an expression for the optimal down payment level (E^{**} or DOWN) at the equilibrium housing consumption level in terms

of our known characteristics of the household, the housing stock and neighborhood, the economy, and the mortgage:

$$(A.3.30.) \quad \text{DOWN} = E^{**} = E^{**}(p_r, \hat{R}, c, h, E(\hat{h}), P, E(\hat{P}), \hat{T}, \pi, \sigma, Y_c, r_A, A, i_I, i_U, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

Similarly, the use of mortgage credit (B^{**} or MORT) can be obtained through the expression $B^{**} = V^{**} - E^{**}$:

$$(A.3.31.) \quad \text{MORT} = B^{**} = B^{**}(p_r, \hat{R}, c, h, E(\hat{h}), P, E(\hat{P}), \hat{T}, \pi, \sigma, Y_c, r_A, A, i_I, i_U, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

Finally, we may obtain an expression for the decision to enter into homeownership (OWN), which we define as the discrete variable "1" for owning and "0" for renting. According to Figure II-7, and as discussed in Chapter II, OWN is determined by whether or not the marginal cost schedule is everywhere above the marginal return schedule in the positive quadrant. If it is there is no positive solution for V^{**} . Thus we have

$$(A.3.32.) \quad \text{OWN} = \begin{cases} 1 & \text{for } V^{**} > 0 \\ 0 & \text{for } V^{**} \leq 0 \text{ or no solution} \end{cases}$$

and therefore OWN is dependent on the same variables as V^{**}

$$(A.3.33.) \quad \text{OWN} = \text{OWN}(p_r, \hat{R}, c, h, E(\hat{h}), P, E(\hat{P}), \hat{T}, \pi, \sigma, Y_c, r_A, A, i_I, i_U, i_{PV_b}, i_{CF_b}, i_{PV_e}, i_{CF_e})$$

We have now formally completed development of expressions for the demand for housing consumption (A.3.29.), down payment financing (A.3.30.), mortgage financing (A.3.31.), and homeownership (A.3.33.) as functions of household, stock and neighborhood, economic, and mortgage instrument characteristics, including risk. These expressions are econometrically estimated in Chapters III-V using disaggregated cross-sectional data from the 1970 Survey of Consumer Finances.

APPENDIX IV

VARIABLE DERIVATION FROM COMPUTER

DATA TAPE

The dependent and independent variable observations used in estimation of our models were derived from cross-sectional household-level data contained in the 1970 Survey of Consumer Finances. Following is a brief description of the variables used in the model estimations and a summary of how they were obtained from the survey data:

Dependent Variables

Homeownership Decision (OWN)--Measured as a discrete 0-1 dummy variable, from variable 145 in the survey, asking whether the household rented or owned.

Housing Consumption (VALUE)--Variable 148 in the survey, which lists the present value of the house if it was moved into before 1968 and the cost of the house if it was moved into during 1969 or 1970.

Mortgage Credit Usage (MORT)--Derived from available survey data. From variable 145 we obtain a sample

of owners and from variable 151, a sample of those owners with one mortgage outstanding. Variable 152 is the interest rate (r) on the mortgage to the nearest one-tenth percent, and variable 144 is the year the household moved in, from which we obtain the period of time since the initiation of the mortgage (t). The unpaid balance on the mortgage (M_t) is given in variable 153. For a standard, fully amortized instrument, the remaining balance on a loan is given by the relation:

$$(A.4.1.) \quad M_t = \frac{L_0 [1 - (1+r)^{t-T}]}{1 - (1+r)^{-T}}$$

where L_0 is the original loan amount and T is the maturity of the loan.

We desire to estimate L_0 , but T is still unknown. Thus we need another independent relationship in L_0 and T . This is provided by variable 154, the total monthly payment Q , which is given by the following relation for a standard, fully amortized mortgage:

$$(A.4.2.) \quad Q = \frac{L_0 r}{1 - (1+r)^{-T}}$$

We now have two relations in two unknowns and may solve for T , the maturity, and L_0 , the original mortgage amount. L_0 is equivalent to MORT, the level of mortgage credit usage.

$$(A.4.3.) \quad T = \frac{\log \left[\frac{Q}{(Q - rM_t)} \right]}{\log (1+r)}$$

$$(A.4.4.) \quad L_0 = \text{MORT} = \frac{Q}{r} [1 - (1+r)^{-T}]$$

Down Payment Level (DOWN)--Estimated by subtracting the original loan balance (L_0) from the present home value (V). In the case of substantial appreciation or depreciation of homes bought several years in the past, such an estimate yields only a rough approximation of the true down payment and, since most real property has appreciated over the last several decades, tends to be upward biased. Therefore, in the estimation of the down payment equation, a variable for period of tenancy is added to attempt to partially control for this bias.

Nonmortgage-Related Independent Variables

Current Income (Y)--From variable 324 in the survey, total family income in 1969. We expect Y to positively influence both the level of homeownership, housing consumption, mortgage credit, and down payment financing.

Assets (A)--From variable 496 in the survey, total liquid assets, including U. S. Government Savings Bonds, savings accounts, certificates of deposit, and checking accounts. Assets, too, are expected to positively influence the levels of

homeownership, housing consumption, and down payment financing. Their effect on mortgage financing, however, is ambiguous and depends on the relative values of the asset elasticities for housing consumption and down payment financing.

Demographic Characteristics (F)--Including variable 20, age of family head; variable 346, a dummy variable which distinguishes two-parent families; variable 26, number of children; variable 32, number of years education of head; variable 38, a dummy variable indicating white (1) or black (0); and variable 251, occupation, a dummy variable which distinguishes white collar (1) and blue collar (0) occupations.¹

Housing Stock (S) and Neighborhood (N) Characteristics--Measured by two dummy variables obtained from variable 11, which indicated whether the home was urban (central cities of SMSA's), suburban (suburban areas of SMSA's), or outlying (non-SMSA's). No detailed neighborhood characteristics are available from the survey. We do not include a structure-type variable since according to the 1970 Census of Housing 89.4 percent of all owner-occupied units are single-family and virtually all of the rest are three-family or two-family structures.²

Mortgage-Related Independent Variables

Initial Payment Level (P)--This variable is a measure of the initial mortgage payment level incurred by the household. For an FRM it is actually proportional to the partial payment factor since it is the annual payment in dollars per \$100 borrowed, or

$$\begin{aligned}
 \text{(A.4.5.) } P &= \frac{Q}{L_0} = \frac{1}{L_0} \left[\frac{L_0 r}{1 - \left(1 + \frac{r}{12}\right)^{-T}} \right] \times 100 \\
 &= \frac{100r}{1 - \left(1 + \frac{r}{12}\right)^{-T}} .
 \end{aligned}$$

Note that the initial payment is in a sense a generalized measure of initial cost of mortgage credit to the household; it increases with the rate of interest r and with a shortening of the maturity T . Note also that it converges to an approximation of the interest rate r for long-maturity instruments. (The contract interest rate r is often used as a measure of mortgage price in empirical studies.) We expect P to exert a negative influence on homeownership, housing consumption, and mortgage credit usage. Its expected effect on the level of equity financing is uncertain since a household would both lower its housing consumption and substitute down payment for mortgage financing upon an increase in P .

Trend in Payment Burden (π)--This variable is a measure of the expected trend in the payment-to-income ratio (Q/Y , also known as the payment burden) over time, based upon expectations of the payment level and the household's income over time. Virtually all of the mortgages in the survey sample are of the FRM type; thus the expected trend in the payment stream is level. All variations in π arises from income expectations, which are derivable from variables 140-143, in the survey, which measure the percent increase or decrease in annual income the household experienced from 1968 to 1969 and the percent increase or decrease they expected from 1969 to 1970.

For the derivation of the trend term, we assume incomes and prices are describable by continuous time stochastic processes and we apply the fundamental theorem of the stochastic calculus (Itô's Lemma) to obtain a continuous time stochastic process for the payment burden. (See Appendix I for a discussion of stochastic processes in continuous time and specifically of the derivation and application of Itô's Lemma.) The trend term is the expectation term of the continuous time stochastic process for the payment burden (Q/Y , or q/y in real terms). We shall now describe in detail the derivation of π .

We obtain from variables 140-143 an estimate of each household's percent increase or decrease in nominal income from 1968-69 (π_{y_0}) and expected percent increase or

decrease in nominal income from 1969-70 (π_{Y_1}).³ We also obtain from variables 49-52 an estimate of each household's perceived percent increase and decrease in prices from 1968-69 (π_{P_0}) and expected percent increase or decrease in prices from 1969-70 (π_{P_1}).⁴ We can derive from this information the percent change in real income in each period (π_{Y_0} , π_{Y_1}) which is given by the following expressions:

$$(A.4.6.) \quad \pi_{Y_0} = \frac{1 + \pi_{Y_0}}{1 + \pi_{P_0}} - 1$$

$$(A.4.7.) \quad \pi_{Y_1} = \frac{1 + \pi_{Y_1}}{1 + \pi_{P_1}} - 1$$

We assume further that real household income is describable by an Itô process, which is a continuous time stochastic process of the following form:

$$(A.4.8.) \quad \frac{dy}{y} = gdt + s_y dz_y$$

where g is the real income trend term and s_y is the stochastic term. This expression says that real income is expected to change at some constant rate g , with an uncertainty s_y which will increase linearly over time. For upwardly mobile households, g is strongly positive. For union households with wages tied to a cost-of-living index s_y is expected to be small. All household types can be described by a certain combination of g and s_y .

It is possible from our data to derive an estimate for each household of g and s_y . We assume g is the arithmetic average of last year's actual and next year's expected real income change:

$$(A.4.9.) \quad g = \frac{\pi_{Y_0} + \pi_{Y_1}}{2}$$

An estimate can be made of s_y by looking at the 1968-69 actual and the 1969-70 expected real income trends and calculating the standard deviation of the two estimates:

$$(A.4.10.) \quad s_y = \left[\frac{(\pi_{Y_0} - g)^2 + (\pi_{Y_1} - g)^2}{2} \right]^{\frac{1}{2}}$$

This estimate is not wholly satisfactory, since we would like an income stream estimate over a longer period of time; however, as discussed in Chapter III (Footnote 9), it is the best empirical estimate available from our data set, which is the only source which includes other financing information adequate for our purposes.

Since for a standard mortgage, the nominal payment is constant, in nominal terms the trend and stochastic terms of a stochastic process describing the nominal payment over time are zero. However, in real terms, this is not so. We assume the price index can be described by the following Itô process:

$$(A.4.11.) \quad dp/p = \pi_p dt + s_p dz_p$$

We can approximate π_p by the following relation, which is merely the arithmetic average of last year's perceived price increase and next year's expected price increase:

$$(A.4.12.) \quad \pi_p = \frac{\pi_{p_0} + \pi_{p_1}}{2}$$

s_p can be estimated by the following relation:

$$(A.4.13.) \quad s_p = \left[\frac{(\pi_{p_0} - \pi_p)^2 + (\pi_{p_1} - \pi_p)^2}{2} \right]^{\frac{1}{2}}$$

which is the standard deviation between our two price expectation observations, which were obtained from survey data.

According to Itô's Lemma, the real mortgage payment stream dq/q ($= d(Q/p) / (Q/p)$) is then describable by the following stochastic process:

$$(A.4.14.) \quad \frac{dq}{q} = [-\pi_p + s_p^2] dt + s_p dz_p$$

Note that since in general σ_p^2 is an order of magnitude smaller than π_p the real payment is expected to decline at a rate roughly equivalent to the rate of inflation.⁵

Again applying Itô's Lemma to expressions (A.4.8.) and (A.4.14.), we can obtain a stochastic expression for the real-payment to real-income ratio (payment burden):

$$\begin{aligned}
 \text{(A.4.15.)} \quad \frac{d(q/y)}{q/y} &= - (\pi_p + g - s_p^2 - s_y^2 \\
 &\quad - \rho_{py} s_p s_y) dt \\
 &\quad + (s_p^2 + 2 s_p s_y \rho_{py} + s_y^2)^{\frac{1}{2}} dz_{q/y}
 \end{aligned}$$

where ρ_{py} is the intercorrelation of prices and real incomes:

$$\begin{aligned}
 \text{(A.4.16.)} \quad \rho_{py} &= \frac{1}{s_y s_p} \left[\frac{(\pi_{y_0} - \pi_y)(\pi_{p_0} - \pi_p) + (\pi_{y_1} - \pi_y)(\pi_{p_1} - \pi_p)}{2} \right] \\
 &= \frac{s_{py}}{s_y s_p}
 \end{aligned}$$

Note that the trend term, the first term on the right in (A.4.15.), is roughly equivalent to the negative of the sum of the price trend and the trend in real incomes. The greater the rate of inflation, the greater the rate of drop in the real payment level and the greater the rate of decrease in the payment burden. Similarly, the greater the rate of increase in real income, the greater the rate of decrease of the real payment burden. The additional terms in the trend expression are ordinarily expected to be relatively small.

We have therefore derived the trend variable for the payment burden:

$$\text{(A.4.17.)} \quad \pi = - (\pi_p + g - s_p^2 - s_y^2 - \rho_{py} s_p s_y)$$

The stochastic term of this expression, the second term on the right in (A.4.15.), will be discussed in the next section.

We expect π to be negatively related to home-ownership and housing consumption, since a household with increasing income expectations, hence with a more negative π , would be expected to be more likely to own, ceteris paribus, and to consume more housing when it does own. However, its relation to mortgage and down payment financing is uncertain a priori. A household with expectations of a declining payment burden might feel more capable of financing a home out of future earnings; hence it would substitute mortgage for down payment financing. It might feel, on the other hand, its future income expectations require less of a hedge through its current assets; hence it would increase its down payment, thus lowering its monthly mortgage payment. With the resulting savings in future mortgage payments, it could gradually rebuild its assets. The relative strengths of these two effects would determine the signs of the mortgage and down payment financing coefficients.

Uncertainty Associated with Payment Burden (σ)--This variable is simply the stochastic term of the previously developed stochastic expression for the payment-to-income ratio (A.4.15.):

$$(A.4.18.) \quad \sigma = [s_p^2 + 2s_p s_y \rho_{PY} + s_y^2]^{\frac{1}{2}}$$

Note that σ varies directly with the uncertainties associated with the price level and the real income level. Thus in a highly volatile inflationary environment or for a household which is very uncertain about its future income prospects, σ is expected to be large.

Note also that the direction and strengths of inter-correlation between prices and real incomes is important; if they are strongly positively correlated--that is, if real income tends to increase when prices increase--the uncertainty in the payment burden is increased. This is because a price rise lowers the real payment level in the numerator while the real income increase raises the denominator, resulting in a much lower q/y ratio than before, and vice versa. Similarly, a strong negative correlation between the two variables reduces uncertainty. Uncertainty is expected to have a negative influence on all dependent variables.

Maturity and Uncertainty in Maturity (\hat{T})--An attempt was made to include consideration of the maturity in our estimates. Maturity should be included to provide a complete description of the mortgage payment stream. Otherwise, a household faced with two instruments with the same initial payment level and expected payment burden trend would

respond as if the instruments were identical even if one had twice the maturity of the other, hence a higher net present value. However, we were not successful in obtaining a consistent result, primarily due to multicollinearity problems, and therefore omitted the maturity variable.

This omission could be a problem if in each initial payment level (P) range there were a wide variation in maturities. This was not the case in general, however; shorter maturities were highly correlated with higher levels of initial payment in our data. Thus in our estimations, the initial payment effect was also picking up the maturity effect.

One possibility which would minimize the impact of the omission of the maturity in our estimations is if households are primarily interested in the consumption, and not the investment attributes of homeownership. In such a case they would be more concerned with the cash flow, and not the present value, aspects of mortgage credit. Their expected period of tenure, on the average only ten years, would be far short of the period required to pay off the mortgage, and the net proceeds from sale would be highly discounted. Even if the home is not resold, payments far in the future would be highly discounted. This scenario would imply the maturity variable would be relatively unimportant in housing consumption decisions unless there were wide variations in it.

One major assumption made in the simulations which lessens the problem of the omission of the maturity variable was that all alternative instruments, except the ILM, would be offered at the same maturity as the FRM had previously been offered. This is not necessarily warranted, as lenders would tend to adjust maturities to respond to default risk charges. However, it was necessary in view of the fact that our one-equation models cannot estimate maturity endogenously. One consequence of this assumption is that any pure maturity effect is controlled for across instrument types.

The ILM presents a special problem, since its maturity is variable, depending upon the income stream. However, as we explain in detail in Chapter III, the maturity effect can still be neglected in this case if we assume high turnover rates, small or second order differences in rates of equity accumulation, high discount rates by households, or a predominant consumption, not investment, objective associated with homeownership.

FOOTNOTES--APPENDIX IV

¹White-collar workers include professional, technical, and kindred workers; managers; officials, self-employed businessmen; artisans; and clerical and sales workers. Blue-collar workers include craftsmen, foremen, operatives, laborers, service workers, farmers and farm managers, and miscellaneous groups, including housewives, students, armed forces personnel and the permanently disabled.

²U. S. Census Bureau, Census of Housing, 1970, Housing Characteristics for States, Cities, and Counties: U. S. Summary, Washington, D. C.: U. S. Government Printing Office, Table I-16.

³Households consistently underestimate their actual income increases in survey data from 1965-1970. (Table 1-7, 1970 Survey of Consumer Finances (1971, p. 16.) However, it may be argued that in consumption analysis, it is the household's expectation and not the actual increase which is the relevant consideration. A household which experienced a 10-percent rise in nominal income over the last year but expects only a six-percent rise next year will behave in its consumption decisions

according to this six-percent expectation, regardless of whether next year he actually increases his income by ten percent.

⁴Households also tend consistently to over-estimate price increases in survey data of 1969-70 (Table II-18, 1970 Survey of Consumer Finance, [1971], p. 224.) Again, it may be argued in consumption analysis the expected as opposed to the actual rate of inflation is the relevant consideration.

⁵The term s_p^2 enters in the trend term because of the logarithmic rather than linear nature of the stochastic variable dq/q . In most cases, s_p^2 is expected to be small relative to π_p .

APPENDIX V

AUXILIARY REGRESSIONS: DETERMINANTS OF MORTGAGE-RELATED VARIABLES

Three additional regression equations were estimated to evaluate the relationship between our three mortgage-related variables (the initial payment level (P), the expected trend in payment burden (π), and the uncertainty in that expected trend (σ)) and household and locational characteristics and the remaining mortgage-related variables.

In each case several specifications were tested before settling upon a "best" specification with significant (at least to 95 percent) coefficients. The equation for P provides important supply information. The equations for π and σ provide important information about the determinants of income expectations and uncertainty.

Initial Payment Level (P)--The preferred equation estimating the initial payment level (P) as a function of demographic and locational characteristics, a time trend term, and our risk variable σ is shown below. Standard errors are in parentheses:

$$\begin{aligned}
 \text{(A.5.1.) } P &= 9.563 + .0500 \text{ AGE} - .776 \text{ SUBURB} \\
 &\quad \quad \quad (.0216) \quad \quad \quad (.481) \\
 &\quad -1.065 \text{ URBAN} - .292 \text{ TENURE} + 9.086 \sigma \\
 &\quad \quad \quad (.555) \quad \quad \quad (.036) \quad \quad \quad (5.119) \\
 R^2 (\text{adj.}) &= .193 \quad N = 285 \quad \text{s.e.e.} = 3.544
 \end{aligned}$$

The strongest determinant is seen to be TENURE, the period of tenure, or equivalently the time the debt was incurred. The strong positive secular trend in mortgage interest rates over recent years (which has dominated increases in maturities during the same period, which would work upon P in the opposite direction) is reflected in the TENURE coefficient. This trend is estimated to be an increase in mortgage payment levels of 29 cents per year per \$100 borrowed. Evaluated at the mean, this is a relative increase of 3.0 percent per year.

The negative SUBURB and URBAN coefficients indicate quite possibly the effects of mortgage market competition and/or the extent of participation in mortgage subsidy programs. The positive coefficient on the age variable reflects either the necessity of shorter amortization periods, hence higher payment rates for older households with fewer income-producing years left to pay off their mortgage, or the fact that older households, because of desirable income and asset positions and expenditure patterns can afford a higher payment level.

Finally, the positive coefficient of σ indicates that lenders do indeed adjust the required payment level

to account for risk associated with future income fluctuations. The magnitude of the coefficient indicates that for every one percent increase in expected payment burden uncertainty, a household must pay roughly nine cents per \$100 borrowed per year or about a 0.9 percent higher payment rate evaluated at the mean.

Expected Payment Burden Trend (π)--The preferred equation estimating the determinants of the expected payment burden trend (π) is shown below:

$$\begin{aligned}
 \text{(A.5.2.) } \pi &= - .06353 - .00053 Y + .00052 A \\
 &\quad \quad \quad (.00022) \quad \quad \quad (.00021) \\
 &\quad + .00094 \text{ AGE} - .02038 \text{ OCCUP} \\
 &\quad \quad \quad (.00016) \quad \quad \quad (.00501) \\
 R^2(\text{adj.}) &= .106 \quad \text{s.e.e.} = .0639 \quad N = 781
 \end{aligned}$$

The payment burden trend for the standard instrument is entirely determined by income expectations since mortgage payments are fixed; thus the above equation is equivalently an estimate of determinants of income expectations. An increase in current income Y is seen, as expected, to decrease the expected burden. However, the level of assets seems to increase it. The reason for this is unclear, although it could represent a contingency hedging effect, in which those with lower income expectations save more now to avoid possible hardship later. It could also be picking up a part of the age effect. Older households

would be expected to have both higher assets and higher burden expectations. The age variable, as expected, increases burden expectations, since we expect older households to have lower income expectations. Finally, the negative coefficient on the occupation variable indicates that a white-collar household can in general expect a roughly two percent greater decline in its expected payment burden than a blue-collar household.

Uncertainty in Payment Burden (σ)--The preferred equation for the determinants of the uncertainty in the expected payment burden trend (σ) is shown below:

$$\begin{aligned}
 \text{(A.5.3.) } \sigma &= .03845 - .00043 \text{ AGE} + .00109 \text{ EDUC} \\
 &\quad \quad \quad (.00012) \quad \quad \quad (.00057) \\
 &\quad \quad \quad + .01062 \text{ RACE} - .00733 \text{ OCCUP} \\
 &\quad \quad \quad (.00506) \quad \quad \quad (.00393) \\
 R^2(\text{adj.}) &= .0404 \quad \text{s.e.e.} = .0436 \quad N = 666
 \end{aligned}$$

The AGE coefficient indicates that older households become significantly more certain of their future income level. In addition, the OCCUP coefficient indicates that a white-collar worker is significantly more certain of his future income. These results are as expected. However, the remaining results are anomolous. The coefficients for the education and race variables are both positive, indicating a more educated or white household would generally be expected to be more uncertain about its future income. These anomolies might possibly be due to the intervening

effects of the expected payment burden trend variable (π), which is more negative for white, white-collar households. While the ratio of the uncertainty (σ) to the trend (π) might be smaller for these households, in absolute terms σ might actually be larger, suggesting a possible problem in specification of σ alone as the proper measure of uncertainty.

APPENDIX VI

TABLES: AGGREGATE AND DISTRIBUTIONAL MORTGAGE-
RELATED VARIABLE VALUES AND SIMULATION
RESULTS

TABLE A6-1

MEAN VALUES OF INITIAL PAYMENT LEVEL
BY INCOME, AGE, AND RACE FOR ALL
INSTRUMENTS

	Initial Annual Payment Per \$100 Borrowed (P)					
	FRM	GPM	PLAM	VRMS	VRML	ILM
Total	9.92	7.76	8.05	9.58	9.58	11.38
<u>By Income Level</u>						
Under \$2000	9.13	7.02	7.00	8.80	8.80	4.24
\$2-3000	9.17	7.02	7.69	8.84	8.84	3.00
\$3-4000	14.99	13.08	12.75	14.65	14.65	8.88
\$4-5000	11.69	9.61	10.38	11.37	11.37	9.88
\$5-6000	11.80	9.65	9.74	11.47	11.47	17.00
\$6-7500	10.60	8.49	8.86	10.27	10.27	8.64
\$7500-10,000	9.91	7.74	7.96	9.57	9.57	9.40
\$10-15,000	9.69	7.53	7.75	9.36	9.36	10.60
\$15-25,000	9.66	7.50	7.91	9.33	9.33	11.50
\$25,000+	9.38	7.21	7.60	9.05	9.05	24.56
<u>By Age of Head</u>						
Under 25	13.71	11.67	10.71	13.38	13.38	10.42
25-35	10.65	8.49	8.34	10.32	10.32	11.30
35-45	9.64	7.49	7.86	9.31	9.31	11.07
45-55	9.04	6.87	7.50	8.71	8.71	11.67
55-65	9.98	7.87	8.44	9.65	9.65	12.41
65-75	9.45	7.30	7.76	9.11	9.11	9.04
<u>By Race</u>						
Black	9.36	7.20	7.57	9.03	9.03	10.25
White	9.90	7.75	8.05	9.57	9.57	11.47

TABLE A6-2

EXPECTED CHANGE IN FUTURE PAYMENT BURDEN
BY INCOME, AGE, AND RACE FOR ALL
INSTRUMENTS

	Expected Change in Future Payment Burden (π)					
	FRM	GPM	PLAM	VRMS	VRML	ILM
Total	-.0322	.0178	.0187	.0794	-.0240	0
<u>By Income Level</u>						
Under \$2000	-.0317	.0183	.0185	.2868	.0328	0
\$2-3000	-.0085	.0415	.0502	.0119	.0011	0
\$3-4000	.0056	.0556	.0580	.0038	.0019	0
\$4-5000	-.0128	.0372	.0312	.0931	.0756	0
\$5-6000	-.0185	.0315	.0255	.0647	.0423	0
\$6-7500	-.0264	.0236	.0240	.3120	.0302	0
\$7500-10,000	-.0258	.0242	.0216	.1425	-.0116	0
\$10-15,000	-.0423	.0077	.0103	.0364	-.0306	0
\$15-25,000	-.0516	-.0016	-.0018	-.0413	-.0560	0
\$25,000+	-.0603	-.0103	.0002	.2705	-.0180	0
<u>By Age of Head</u>						
Under 25	-.0776	-.0276	-.0304	2.2331	.1966	0
25-35	-.0420	.0080	.0063	.1847	-.0214	0
35-45	-.0381	.0119	.0120	.0569	-.0274	0
45-55	-.0314	.0186	.0240	-.0199	-.0347	0
55-65	-.0125	.0375	.0350	.3618	.0338	0
65-75	-.0044	.0456	.0491	-.3889	-.0430	0
<u>By Race</u>						
Black	-.0222	.0278	.0302	.7139	.0785	0
White	-.0333	.0167	.0171	.0454	-.0297	0

TABLE A6-3

UNCERTAINTY IN FUTURE PAYMENT BURDEN BY
INCOME, AGE, AND RACE FOR ALL
INSTRUMENTS

Uncertainty in Future Payment Burden Trend (σ)						
	FRM	GPM	PLAM	VRMS	VRML	ILM
Total	.0330	.0330	.0407	.1335	.0581	0
<u>By Income Level</u>						
Under \$2000	.0355	.0355	.0431	.0904	.0325	0
\$2-3000	.0256	.0256	.0391	.1170	.0428	0
\$3-4000	.0362	.0362	.0480	.1702	.0650	0
\$4-5000	.0327	.0327	.0414	.1763	.1341	0
\$5-6000	.0416	.0416	.0516	.1710	.1140	0
\$6-7500	.0258	.0258	.0371	.1206	.0477	0
\$7500-10,000	.0327	.0327	.0411	.1362	.0616	0
\$10-15,000	.0324	.0324	.0373	.1339	.0566	0
\$15,25,000	.0342	.0342	.0402	.1302	.0566	0
\$25,000+	.0406	.0406	.0435	.1372	.0554	0
<u>By Age of Head</u>						
Under 25	.0529	.0529	.0579	.1336	.0507	0
25-35	.0388	.0388	.0469	.1334	.0573	0
35-45	.0315	.0315	.0362	.1269	.0535	0
45-55	.0296	.0296	.0358	.1382	.0589	0
55-65	.0276	.0276	.0365	.1341	.0639	0
65-75	.0297	.0297	.0451	.1463	.0778	0
<u>By Race</u>						
Black	.0239	.0239	.0310	.1292	.0548	0
White	.0339	.339	.0417	.1334	.0580	0

TABLE A6-4

SIMULATION RESULTS--PREDICTED HOMEOWNERSHIP
LEVELS BY INCOME, AGE, AND RACE FOR
ALL INSTRUMENTS

Simulation Results--Predicted Home- ownership Levels (Percent of Households)						
	FRM	GPM	PLAM	VRMS	VRML	ILM
Total	67.8	69.9	69.2	61.9	66.6	68.4
<u>By Income Level</u>						
Under \$2000	44.3	46.4	46.0	41.3	44.8	51.3
\$2-3000	59.7	61.9	60.4	54.5	59.0	67.4
\$3-4000	49.4	51.3	50.9	41.5	48.0	57.6
\$4-5000	54.2	56.2	54.9	45.7	48.3	58.0
\$5-6000	62.0	64.1	63.4	54.4	57.9	59.4
\$6-7500	62.1	64.2	63.1	56.6	61.1	65.6
\$7500-10,000	64.8	66.9	66.2	58.7	63.3	67.3
\$10-15,000	70.5	72.8	72.3	64.8	69.5	71.8
\$15-25,000	79.1	81.5	86.7	73.8	78.3	79.6
\$25,000+	91.4	93.6	92.5	85.9	90.9	78.9
<u>By Age of Head</u>						
Under 25	24.1	26.2	26.8	19.5	24.6	30.7
25-35	50.5	53.6	53.3	41.3	51.1	53.2
35-45	68.8	71.0	70.3	63.3	67.8	69.4
45-55	80.4	82.6	81.6	74.1	78.9	79.6
55-65	77.0	79.1	77.9	70.7	75.1	76.3
65-75	81.8	83.9	82.5	75.0	79.2	84.0
<u>By Race</u>						
Black	53.2	55.4	54.6	47.1	51.7	53.8
White	70.3	72.5	71.7	64.5	69.2	70.9

TABLE A6-5

SIMULATION RESULTS--PREDICTED PER HOUSEHOLD
HOUSING CONSUMPTION BY HOMEOWNERS
BY INCOME, AGE, AND RACE FOR
ALL INSTRUMENTS

Simulation Results--Predicted Housing Consumption (\$1000)						
	FRM	GPM	PLAM	VRMS	VRML	ILM
Total	22.804	24.040	23.856	23.000	23.000	21.972
<u>By Income Level</u>						
Under \$2000	9.879	11.085	11.097	10.068	10.068	12.671
\$2-3000	8.177	9.404	9.022	8.364	8.364	11.702
\$3-4000	13.322	14.411	14.597	13.513	13.513	16.814
\$4-5000	16.689	17.877	17.440	16.875	16.875	17.731
\$5-6000	15.278	16.511	16.454	15.470	15.470	12.307
\$6-7500	17.167	18.374	18.158	17.354	17.354	18.281
\$7500-10,000	16.885	18.124	17.998	17.077	17.077	17.185
\$10-15,000	21.694	22.931	22.805	21.883	21.883	21.171
\$15-25,000	27.340	28.575	28.339	27.531	27.531	26.257
\$25,000+	37.290	38.530	38.310	37.480	37.480	28.617
<u>By Age of Head</u>						
Under 25	19.749	20.917	21.464	19.936	19.936	21.632
25-35	20.659	21.897	21.984	20.849	20.849	20.291
35-45	23.307	24.541	24.328	23.497	23.497	20.494
45-55	25.445	26.685	26.322	25.636	25.636	23.944
55-65	19.654	20.859	20.534	19.842	19.842	18.267
65-75	20.179	21.408	21.141	20.369	20.369	20.413
<u>By Race</u>						
Black	18.490	19.728	19.517	18.680	18.680	17.985
White	23.333	24.563	24.393	23.523	23.523	22.440

TABLE A6-6

SIMULATION RESULTS--PREDICTED PER HOUSEHOLD
MORTGAGE CREDIT USAGE BY HOMEOWNERS
BY INCOME, AGE, AND RACE FOR ALL
INSTRUMENTS

	Simulation Results--Predicted Mortgage Credit Usage (\$1000)					
	FRM	GPM	PLAM	VRMS	VRML	ILM
Total	15.645	16.404	16.227	14.748	15.762	14.489
<u>By Income Level</u>						
Under \$2000	9.172	9.900	9.910	6.239	8.730	11.681
\$2-3000	7.811	8.560	8.089	7.800	7.906	11.288
\$3-4000	8.876	9.486	9.650	9.087	9.106	12.458
\$4-5000	12.038	12.747	12.364	11.186	11.358	12.964
\$5-6000	10.708	11.463	11.465	10.087	10.307	7.527
\$6-7500	12.406	13.135	12.914	9.276	12.041	13.273
\$7500-10,000	12.284	13.045	12.944	10.827	12.339	12.334
\$10-15,000	15.576	16.335	16.182	14.995	15.652	14.633
\$15-25,000	18.422	19.178	18.942	18.514	18.658	16.822
\$25,000+	22.168	22.930	22.605	19.116	21.946	12.818
<u>By Age of Head</u>						
Under 25	16.164	16.854	17.433	-6.312	13.664	17.305
25-35	15.633	16.392	16.497	13.601	15.623	14.849
35-45	16.094	16.849	16.634	15.354	16.180	14.899
45-55	16.830	17.592	17.172	16.910	17.056	15.006
55-65	13.499	14.225	13.921	10.017	13.234	11.975
65-75	10.763	11.513	11.209	14.726	11.333	10.955
<u>By Race</u>						
Black	13.956	14.715	14.478	6.927	13.160	13.227
White	15.950	16.702	16.525	15.369	16.106	14.721

TABLE A6-7

SIMULATION RESULTS--PREDICTED PER HOUSEHOLD
DOWN PAYMENTS BY HOMEOWNERS BY INCOME,
AGE, AND RACE FOR ALL INSTRUMENTS

	Simulation Results--Predicted Down Payment Level (\$1000)					
	FRM	GPM	PLAM	VRMS	VRML	ILM
Total	7.446	8.139	8.152	8.994	7.559	7.892
<u>By Income Level</u>						
Under \$2000	1.703	2.397	2.400	6.123	2.599	2.143
\$2-3000	2.606	3.300	3.420	2.889	2.739	2.724
\$3-4000	3.839	4.533	4.566	3.814	3.788	3.761
\$4-5000	5.154	5.848	5.765	6.624	6.381	5.332
\$5-6000	4.008	4.701	4.618	5.162	4.851	4.264
\$6-7500	5.087	5.781	5.787	9.783	5.873	5.454
\$7500-10,000	5.340	6.034	5.998	7.676	5.537	5.698
\$10-15,000	6.573	7.267	7.303	7.665	6.735	7.160
\$15-25,000	9.922	10.616	10.613	10.065	9.861	10.638
\$25,000+	16.144	16.838	16.984	20.735	16.731	16.981
<u>By Age of Head</u>						
Under 25	2.990	3.684	3.645	35.056	6.795	4.067
25-35	4.951	5.644	5.621	8.096	5.236	5.533
35-45	6.708	7.402	7.404	8.027	6.857	7.237
45-55	7.366	8.059	8.134	7.526	7.320	7.801
55-65	7.929	8.623	8.588	13.123	8.571	8.102
65-75	7.071	7.765	7.813	1.735	6.535	7.132
<u>By Race</u>						
Black	.248	.942	.976	10.463	1.646	.556
White	7.404	8.098	8.103	8.496	7.454	7.866

TABLE A6-8

SIMULATION RESULTS--PREDICTED DEBT-EQUITY
RATIOS BY INCOME, AGE, AND RACE FOR
ALL INSTRUMENTS

Simulation Results--Predicted Debt- Equity Ratio						
	FRM	GPM	PLAM	VRMS	VRML	ILM
Total	2.10	2.02	1.99	1.64	2.09	1.84
<u>By Income Level</u>						
Under \$2000	5.39	4.13	4.13	1.02	3.36	5.45
\$2-3000	3.00	2.59	2.37	2.70	2.89	4.14
\$3-4000	2.31	2.09	1.99	2.38	2.40	3.31
\$4-5000	2.34	2.18	2.14	1.69	1.78	2.43
\$5-6000	2.67	2.44	2.48	1.95	2.12	1.77
\$6-7500	2.44	2.27	2.23	0.95	2.05	2.43
\$7500-10,000	2.30	2.16	2.16	1.41	2.23	2.16
\$10-15,000	2.37	2.25	2.22	1.96	2.32	2.04
\$15-25,000	1.86	1.81	1.78	1.84	1.89	1.58
\$25,000+	1.37	1.36	1.33	0.92	1.31	0.75
<u>By Age of Head</u>						
Under 25	5.41	4.57	4.78	-0.18	2.01	4.25
25-35	3.16	2.90	2.93	1.68	2.98	2.68
35-45	2.40	2.28	2.25	1.91	2.36	2.06
45-55	2.28	2.18	2.11	2.25	2.33	1.92
55-65	1.70	1.65	1.62	0.76	1.54	1.48
65-75	1.52	1.48	1.43	8.49	1.73	1.54
<u>By Race</u>						
Black	56.27	15.62	14.83	.66	8.00	23.79
White	2.15	2.06	2.04	1.81	2.16	1.87

BIBLIOGRAPHY

- Anderson, Paul S. and Eisenmenger, Robert W. "Impact of the Proposed New Financial Structure on Mortgage Markets," in Policies for a More Competitive Financial System (Conf. Series 8), Federal Reserve Bank of Boston, June, 1972, pp. 149-178.
- _____. "Structural Reform with the Variable Rate Mortgage," in Housing and Monetary Policy (Conf. Series 4), Federal Reserve Bank of Boston, October, 1970, pp. 121-139.
- Anderson, Paul S. and Hinson, J. P. "Variable Rates on Mortgages: Their Impact and Use," New England Economic Review, March-April 1970, pp. 3-20.
- Board of Governors of the Federal Reserve System. Ways to Moderate Fluctuations in Housing Construction. Federal Reserve Staff Study, December, 1972.
- Brady, E. A. "A Sectoral Econometric Study of the Post-War Residential-Housing Market," Journal of Political Economy, 1967, pp. 147-158.
- Candilis, Wray O. "Variable Rate Mortgage Plans," Research Paper No. 7, Washington, D.C.: The American Bankers Association, 1971.
- Cassidy, H. J. and McElhone, J. M. "A Call for New Mortgage Instruments," Federal Home Loan Bank Board, Working Paper #46, Washington: Office of Economic Research, 1974.
- Clauretje, R. M. "Interest Rates the Business Demand for Funds, and the Residential Mortgage Market: A Sectoral Econometric Study," Journal of Finance, December, 1973, pp. 1313-1326.
- Cohn, Richard A. and Fischer, Stanley. "An Analysis of Alternative Non-Standard Mortgages." Sloan School Mortgage Study Report No. 5, Massachusetts Institute of Technology, December, 1974.
- Cox, D. and Miller, H. The Theory of Stochastic Processes, New York: John Wiley and Sons, 1968.

- Daly, George. "The Impact of Monetary Policy and the Maturity of Savings and Loan Association Assets: A Critique of Reform Proposals," Journal of Money, Credit, and Banking. 27:441-4, May, 1972.
- Doling, F. "A Two Stage Model of Tenure Choice in the Housing Market." Urban Studies, Vol. 10, 1973, pp. 199-211.
- Duss, Lee. "Survey on Status of Mortgage Loan Interest Adjustment Clauses at Savings and Loan Associations," (Study prepared for the United States Savings and Loan League, September, 1971).
- Eckstein, Otto. "A Survey of the Theory of Public Expenditure Criteria," in National Bureau of Economic Research, Public Finances: Needs, Sources, and Utilization. James Buchanan, ed., Princeton: Princeton University Press, 1961.
- Epley, Donald R. "Can Variable-Rate and Fixed-Rate Mortgages Coexist?" Real Estate Review, Vol. 5, No. 4, Winter, 1976, pp. 119-121.
- Fair, R. C. "Disequilibrium in Housing Models," Journal of Finance. 1972, pp. 207-221.
- Field, Al. and Cassidy, Henry J. "Economic Framework for Analysis of Alternative Mortgage Instruments." Presented to the Fifth Annual Meeting of the American Real Estate and Urban Economics Association, Washington, D.C., May 23, 1977.
- Fischer, Stanley. "The Demand for Index Bonds." Journal of Political Economy. May-June 1975.
- Fisher, Robert M. "Variable Rate Mortgages," Board of Governors, Federal Reserve System, Staff Economic Studies No. 30. March 1967.
- Follain, James, and Struyk, Raymond. "Homeownership Effects of Alternative Mortgage Instruments," Journal of the American Real Estate and Urban Economics Association. Vol. 5, No. 1, Spring, 1977, pp. 1-43.
- Freeman, A. Myrick, III. "The Distribution of Environmental Quality," in Allen V. Kneese and Blair T. Bower (eds.), Environmental Quality Analysis. Baltimore: Johns Hopkins Press, 1972, pp. 243-278.

- Friend, I. (ed.) Study of Savings and Loan Industry. Federal Home Loan Bank Board. Washington, D.C.: 1969, (4 volumes).
- Gelfand, Jack. "Mortgage Credit and Lower-Middle Income Housing Demand," Land Economics. May 1970, pp. 163-170.
- Goldberger, A. S. "Best Linear Unbiased Prediction in the Generalized Linear Regression Model," Journal of the American Statistical Association, Vol. 57, 1962, pp. 369-375.
- Gramley, Lyle E. "Short-Term Cycles in Housing Production: An Overview of the Problem and Possible Solution," in Board of Governors, Federal Reserve System, Ways to Moderate Fluctuations in Housing Construction. December 1972, pp. 1-67.
- Guttentag, Jack. "Credit Availability, Interest Rates, and Monetary Policy," Southern Economic Journal, January 1960, pp. 219-228.
- Harberger, A. "A Structural Approach to the Problem of Import Demand," American Economic Review, Vol. 43, May, 1953, pp. 148-159.
- Holland, Daniel M. "Tax Aspects of Alternative Mortgage Instruments." MIT Mortgage Study Reports, No. 4, December, 1974.
- Huang, D. S. "Effects of Different Credit Policies on Housing Demand," Study of the Savings and Loan Industry, Vol. III, I. Friend, ed., Washington: Federal Home Loan Bank Board, 1969.
- _____. "The Short-Run Flows of Non-Farm Residential Mortgage Credit," Econometrica, Vol. 34, April, 1966, pp. 433-459.
- "In Simulation and Real Life, Variable Rates Really Work," Savings and Loan News, pp. 21-26, January, 1971.
- Jaffee, D. M. "An Econometric Model of the Mortgage Market: Estimation and Simulation," Chapter 5, in Savings Deposits, Mortgages and Residential Construction, Gramlich and Jaffee (eds.), Lexington: Lexington Books, 1972.

- Johnston, J. Econometric Methods, 2nd ed. New York: McGraw-Hill, 1972.
- Kain, J. F., and Quigley, J. M. "Housing Discrimination, Homeownership, and Savings Behavior," American Economic Review. June, 1972, pp. 263-277.
- Katona, George; Mandell, Lewis; Schmiedeskamp, Jay. 1970 Survey of Consumer Finances. Survey Research Center, The University of Michigan: Ann Arbor, 1971.
- Kaufman, G. G. "The Questionable Benefit of Variable-Rate Mortgages," Quarterly Review of Economics and Business, 13:43-52, Autumn, 1973.
- Kearl, J. D., Inflation-Induced Distortions of the Real Economy: An Econometric and Simulation Study of Housing and Mortgage Innovation. Ph.D. Dissertation, M.I.T. Department of Economics, September, 1975.
- Kearl, J., Rosen, K., and Swan, C. "Relationships Between the Mortgage Instrument, the Demand for Housing and Mortgage Credit: A Review of Empirical Studies," Sloan School Mortgage Study Report No. 3, Massachusetts Institute of Technology, December, 1974.
- Krupnik, A. J. "Variable-Rate Mortgage: Boon or Bane?" Federal Reserve Bank Business Review, Philadelphia, September, 1972, pp. 16-23.
- Lee, T. H. "Demand for Housing: A Cross-Section Analysis." Review of Economics and Statistics, 1963.
- _____. "Housing and Permanent Income: Tests Based on a Three-Year Reinterview Survey," Review of Economics and Statistics, 1968.
- deLeeuw, Frank. "The Demand for Housing: A Review of Cross-Section Evidence." Review of Economics and Statistics, Vol. 53, No. 1, February, 1971, pp. 1-10.
- Li, Mingche M. "A Logit Model of Homeownership: The Case of Multi-Dimensional Interactions." Working Paper, Graduate School of Design, Harvard University, August, 1975.

- Maisel, Sherman J. "A Theory of Fluctuations in Residential Construction Starts." American Economic Review, 1963, pp. 359-383.
- Maisel, S. "Rates of Ownership, Mobility and Purchase," in Essays in Urban Land Economics. Los Angeles: Real Estate Research Program, 1966.
- Maisel, S. J., Burnham, J. B., and Austin, J. S. "The Demand for Housing: Comment." Review of Economics and Statistics, 1971.
- Maisel, Sherman J. and Roulac, Stephen E. Real Estate Investment and Finance. New York: McGraw-Hill, 1976.
- Malone, J. R. "The Capital Expenditure for Owner-Occupied Housing: A Study of Determinants." Journal of Business, 1966.
- Marcis, Richard G. "Variable Rate Mortgages: Their Use and Impact in the Mortgage and Capital Markets." Presented at the Annual Meeting of the American Real Estate and Urban Economics Association, New York City, December 30, 1973.
- Markowitz, H. "Portfolio Selection." Journal of Finance, March 1952, pp. 77-91.
- Mayer, Thomas. "Variable Interest Rate Mortgages and Household Risk." Working Paper Series No. 21, Dept. of Economics, University of California, Davis: November, 1972.
- Merton, R. C. "An Intertemporal Capital Asset Pricing Model." Econometrica, Vol. 41, No. 5., Sept. 1973, pp. 867-87.
- _____. "Lifetime Portfolio Selection Under Uncertainty: the Continuous Time Case." Review of Economics and Statistics, Vol. 51, No. 3, August, 1969.
- _____. "Optimum Consumption and Portfolio Rules in a Continuous-Time Model." Journal of Economic Theory, Vol. 3, No. 4., Dec. 1971, pp. 373-413.
- Modigliani, F. M. "Some Economic Implications of the Indexing of Financial Assets with Special Reference to Mortgages." Sloan School Working Paper #736-74, M.I.T., September, 1974.

- Modigliani, F. M. and Lessard, D.R. (eds.) New Mortgage Designs for Stable Housing in an Inflationary Environment. Boston: Federal Reserve Bank of Boston, Conference Series No. 14, January, 1975.
- Morgan, James N. (ed.) Five Thousand American Families: Patterns of Economic Progress, Vol. 2. Ann Arbor: Survey Research Center, 1974.
- Morgan, J. N. "Housing and Ability to Pay." Econometrica, 1965.
- Muth, Richard. "Interest Rates, Contract Terms, and the Allocation of Mortgage Funds." Journal of Finance. March, 1962, pp. 63-80.
- _____. "The Demand for Non-Farm Housing," in The Demand for Durable Goods. A. C. Harberger, ed. Chicago: The University of Chicago Press, 1960.
- Nadler, Paul S. "Spotlighting the Variable Interest Rate Mortgage." Bankers Magazine. Winter, 1973, pp. 34-42.
- Olson, Edgar. "A Competitive Theory of the Housing Market." American Economic Review. September, 1969, pp. 612-622.
- Poole, W. "Housing Finance Under Inflationary Conditions," in Ways to Moderate Fluctuations in Housing Construction. Washington, D. C., Board of Governors of the Federal Reserve System, 1972.
- Prell, Michael J. "Index Linked Loans--Part I," Federal Reserve Bank of Kansas City Monthly Review, September-October, 1971.
- Projector, D. S. and Weiss, G. S. Survey of Financial Characteristics of Consumers. Board of Governors of the Federal Reserve System. Washington, D.C.: 1966.
- Pyle, David H. "On the Theory of Financial Intermediation." Journal of Finance, Vol. 26, June, 1971, pp. 737-47.
- Reid, M. G. "Capital Formation in Residential Real Estate." Journal of Political Economy, 1958, pp. 131-153.

Reid, Margaret. Housing and Income. Chicago: University of Chicago Press, 1962.

Report of the President's Commission on Financial Structure and Regulation. (Hunt Commission Report), December 1971.

Roistacher, Elizabeth. "Housing and Homeownership," in Five Thousand American Families: Patterns of Economic Progress, Vol. II, James N. Morgan, ed., Survey Research Center, University of Michigan: Ann Arbor, 1974, pp. 1-40.

Rosen, Kenneth. Fluctuations in Residential Construction. Unpublished Ph.D. thesis, M.I.T., Department of Economics, 1974.

Rosen, Kenneth, and Kearl, James. "A Model of Housing Starts, Mortgage Flows, and the Behavior of the Federal Home Loan Bank Board and the Federal National Mortgage Association," Joint Center for Urban Studies of M.I.T. and Harvard Working Paper No. 27, May, 1974.

Silber, W. L. "An Econometric Model of the Mortgage Market," in Cyclical and Growth Problems Facing the Savings and Loan Industry. A. W. Sametz (ed.) Bulletin No. 46-47, Institute of Finance, N.Y.U., 1968.

Smith, L. B. "A Model of the Canadian Housing and Mortgage Markets," Journal of Political Economy. 1969, pp. 795-816.

Sparks, G. R. "A Model of the Mortgage Market and Residential Construction Activity." American Statistical Association Proceedings, 1967.

Stansell, Stanley R. and Millar, James A. "How Variable Rate Mortgages Would Affect Lenders." Vol. 5, No. 4, Winter 1976, pp. 116-118.

Struyk, Raymond J., assisted by Marshall, Sue. "The Determinants of Household Home Ownership." Urban Studies. Vol. 11, 1974, pp. 289-299.

Struyk, Raymond J. and Marshall, Sue. "Income and Urban Homeownership." Review of Economics and Statistics. Vol. 57, No. 1, February 1974, pp. 19-25.

- Swan, Craig. "A Quarterly Model of Housing Starts: A Disequilibrium Approach." Working Paper No. 39, Federal Home Loan Bank Board, 1972.
- Theil, Henri. Principles of Econometrics. New York: Wiley, 1971.
- Thygeson, Kenneth J. and Thompson, Joe R. "Implementation of the Variable-Rate Mortgage: Some Considerations." U. S. Savings and Loan League Working Paper #7, October 21, 1971.
- Tobin, James. "Liquidity Preference as Behavior Toward Risk," Review of Economic Studies. February 1958, pp. 65-86.
- Tucker, D. P. "The Variable-Rate Graduated-Payment Mortgage." Unpublished paper, Board of Governors of the Federal Reserve System, January, 1974.
- U. S. Bureau of Census, Census of Housing: 1970 Vol. V, Residential Finance, Washington, D. C., 1973.
- U. S. Congress, House of Representatives. "Variable Rate Mortgage Proposal and Regulation Q." Hearings before the Subcommittee on Financial Institutions Supervision, Regulation and Insurance of the Committee on Banking, Currency and Housing, 94th Congress, 1st Session, April 8-10, 1975.
- U. S. Congress, House of Representatives. ". . . Variable Rate Mortgages. . .," Congressional Record --House, May 8, 1975, pp. H 3826-H 3846.
- U. S. Congress, Senate. "Variable Rate Mortgages," Hearings before the Committee on Banking, Housing, and Urban Affairs, 94th Congress, 1st Session, April 14-17, 1975.
- U. S. Congress, Senate. "Variable Rate Mortgages," Congressional Record--Senate, June 16, 1975, pp. S 10689-S 10691.
- United States League of Savings Associations. "Variable Rate Mortgages: Issues and Prospects." Chicago, 1974.

vonFurstenberg, George M. "The Economics of Mortgages with Variable Interest Rates." FHLMC Monograph No. 2, Federal Home Loan Mortgage Corporation, Washington, D. C., February 1973.

_____. "The Equilibrium Spread Between Variable Rates and Fixed Rates on Long-Term Financing Instruments," Journal of Financial and Quantitative Analysis, 8:807-19.

Winger, A. R. "Housing and Income." Western Economic Journal. June 1968, pp. 226-232.

BIOGRAPHICAL NOTE

Kerry Dean Vandell was born in Biloxi, Mississippi, January 8, 1947. He grew up in Cheyenne, Wyoming, and Amarillo, Texas, graduating from high school in Amarillo in 1965. He entered Rice University in the fall of 1965 and graduated cum laude with a B.A. and Masters degree in Mechanical Engineering in 1970. While there, he was elected to Tau Beta Pi and was named Outstanding Senior Engineering Student.

After working for a year for Exxon as a petroleum engineer, he was awarded a National Science Foundation Graduate Fellowship and entered the City Planning program at the Harvard Graduate School of Design in the fall of 1971. While at Harvard, he was a research assistant for the Ralph Nader Task Force on Congress, the Environmental Systems Program, and the Southeast Sector Urbanization Study.

In the fall of 1973, he entered the Ph.D. program in Urban Studies and Planning at M.I.T. While at M.I.T., he acted as a research assistant on the Arts Policy Project and consulted. In 1975 he was the recipient of a grant from the Bemis Foundation for continuing research on racial transition.

In the spring of 1975 he was awarded a Charles Abrams Fellowship through the Joint Center for Urban Studies of M.I.T. and Harvard to fund his dissertation research. He began teaching at Southern Methodist University, Dallas, Texas, in the fall of 1976 as an Assistant Professor of Real Estate and Regional Science.

He is co-author, with Bennett Harrison of "Racial Transition in Neighborhoods: A Simulation Model Incorporating Institutional Constraints," in the Journal of Urban Economics (forthcoming) and Joint Center Working Paper No. 39. He has presented papers at meetings of the American Institute of Planners, the Regional Science Association, and the American Real Estate and Urban Economics Association.