INFLATION-INDUCED DISTORTIONS OF THE REAL ECONOMY: AN ECONOMETRIC AND SIMULATION STUDY OF HOUSING AND MORTGAGE INNOVATION

by

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ABSTRACT

INFLATION-INDUCED DISTORTIONS OF THE REAL ECONOMY:

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HOUSING AND MORTGAGE INNOVATION

James Russell Kearl

Submitted to the Department of Economics on June 13, 1975 in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

This thesis examines the proposition that inflation, even when anticipated, can result in a distortion of relative prices and inefficient allocation of resources when capital market imperfections are present. In particular, it is suggested that the current instrument of housing finance, the long term, fully amortized, level payment mortgage may be particularly unsuitable for efficient allocation of capital to housing during periods of high or variable rates of inflation.

Chapter I develops this theme, examining some of the difficulties encountered in a system of residential finance that relies solely on such a mortgage instrument. A series of innovations in mortgage design is briefly introduced and summarized by a new characterization of the important elements of a mortgage instrument.

Chapter II investigates past research in housing for evidence of the postulated distortion. However, it is found that past efforts to model housing market behavior have, in general, not carefully delineated adjustment and equilibrium effects or the structural relationships involved in this market and the closely associated mortgage market.

Chapter III develops an explicit structural model of service and asset demand and housing investment. It is suggested that the asset price, determined by those holding the current housing stock, is a fundamental determinant of construction activity. Vacancies are then incorporated into the model and an effort made to examine the relationship between mortgage finance and housing. The chapter concludes by utilizing the model to examine issues of concern to investigators and policy makers in the housing area.

Chapter IV specifies the model in a structural form appropriate for econometric estimation. Estimation results are reported. Strong support is found for the postulated inflation-induced distortion. In addition, the chapter contains an empirical model of savings and loan mortgage lending behavior, focusing on the commitment process.

Chapter V returns to the mortgage innovations developed in Chapter I. The suggested innovations are made precise and developed in a manner that suggests macro economic impacts. A simulation scheme is outlined to examine the impacts of mortgage innovation and changing deposit-rate behavior on the various participants in the housing, mortgage and deposit sectors of the U.S. economy. Simulation results show that various mortgage innovations lead to changing relationships between deposit rates and thus shifts of deposits and of mortgage holdings. It is found that certain types of contracts hold considerable promise for the amelioration of inflation-induced distortions.

Thesis Supervisor: Franklin M. Fisher
Title: Professor of Economics

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The empiricist...thinks he believes only what he sees, but he is much better at believing than at seeing.

--Santayana

CHAPTER I

The traditional mortgage instrument is characterized by level nominal payments (implying changing proportions of interest payments and payments on principal) and full amortization or direct reduction. These characteristics pose a series of problems for both the borrower (the household) and the lender (the thrift institution) during periods of high and variable rates of inflation. Unfortunately, such problems

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Savings and loan associations (SLA) and mutual savings banks (MSB) are usually classified as thrift or savings institutions. However, savings are channeled to the mortgage market through a larger group of financial intermediaries including thrift institutions, commercial banks, life insurance corporations and certain Federally sponsored financial intermediaries.

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can interfere with efficient allocation of savings and accumulation of capital by creating distortions in markets that do not reflect economic scarcity and consequent changing relative prices. Further, even appropriately anticipated

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As Modigliani notes (91), assets that are issued by essentially default-free borrowers against physical capital they manage serve, in the absence of inflation, as fundamental in the process of efficient allocation of capital because they separate accumulation and holding of wealth from the management of assets. Anyone can avoid such risk of management as long as there are some members of an economy prepared to issue money fixed claims against themselves. This type of contract, with competitive financial markets, allows capital to be allocated so as to produce the highest return. With uncertainty about future price movements, no sure-outcome nontangible asset exists. If the risk of price fluctuations becomes too great individuals may move out of money assets into real assets, assuming the risk of management or they

may be unwilling to accept long term contracts, thus reducing the volume of long term loans and making capital formation dependent upon such loans more difficult.

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inflation may have allocational effects on capital accumulation unless rather dramatic changes occur in the traditions and structure of housing and housing finance markets. These structural changes may be no less dramatic than those that would have to take place to avoid capricious income redistribution, the usually noted effect of inflations. This is the central thesis of this research: inflation, even when perfectly anticipated, changes relative prices and interferes with efficient allocation of capital when combined with certain imperfections in capital markets.

This chapter introduces the reader to a series of difficulties likely to be encountered by the various participants in a financial system that relies on the traditional mortgage instrument for housing finance. Although this examination provides persuasive arguments that the difficulties encountered are serious and likely to induce distortions into the process of capital accumulation, their importance and magnitude are basically empirical questions. Chapters that follow examine the empirical support for the stated proposition. In addition, a model of housing demand, mortgage financing and housing investment is developed that embodies certain important structural relationships and provides the basis for examining a wide array of questions

concerning housing and the pronounced cyclical behavior of housing starts. Finally, I examine in some detail, several proposed remedies for the inflation-induced difficulties within the structure of the model developed. Specifically, I examine through simulation innovation of the mortgage contract.

The plan of this chapter is as follows. In Section I, I describe the traditional mode of housing finance and introduce specific distortions and proposed solutions to these distortions. The first of these distortions is discussed in Section II, where I examine the relationship between term structure intermediation and inflation. Variable-rate mortgages, proposed as remedies to this problem are introduced and briefly discussed. In Section III, I discuss the problem of inflation induced changes in the pattern of debt service on a level nominal payment mortgage. Indexing mortgages, as a possible solution to the changing real payment stream, is then discussed. In Section IV, I examine graduated payment mortgages as a possible remedy to a mismatch of debt service stream and life-cycle income. Finally, Section V summarizes the discussion, proposes a new way of characterizing a mortgage instrument and illustrates the various characteristics with examples.

I am very much indebted for the fundamental ideas of this chapter to Poole (108), Tucker (137), and Modigliani (91).

I. TRADITIONAL MORTGAGE INSTRUMENT

Research and analysis of housing problems have rarely been concerned with the nature of the mortgage instrument, except for the interest rate characteristics. This is probably due to the fact that the basic qualitative features of the mortgage have been virtually unchanged since the widescale use of the current mortgage instrument began in the 1930's and to the relatively low rate of inflation over that same period.

The pervasive use of the traditional mortgage instrument has its genesis in the Depression. (In 1971, of twenty nine plus million single unit properties, nineteen million were mortgaged. Of these, eighteen million required full amortization). The rather profound changes in the structure of mortgage lending have been long lived: the 1975 mortgage is essentially the same as a 1940-vintage instrument. Government policy instruments: insurance, mortgage support and regulation, also remain basically unchanged.

A household in the 1920's would most likely have purchased a home with a three to six year straight (interest only) mortgage, rolling over the principal less any accumulated equity. (Final payments substantially above the history of payments over the life of the mortgage are often referred to as "balloon payments". A roll over mortgage, not amortized is a polar case: interest payments over the period of the mortgage, the principal as the last payment. The traditional innovations that result in less than full amortization would, with fixed term, result in balloon payments.) Substantial equity was required to initiate the purchase of a home with these straight mortgages and a good deal of equity had to be accumulated. If such equity were not accumulated during the term of the loan, refinancing was required. Since the wealth necessary to purchase outright, even at the end of such a short term was not easily accumulated, households continued to turn over their debt. The general distress of the contraction during the 1930's affected the ability and willingness of mortgage lenders to refinance these short-term maturing mortgages. Foreclosures rose dramatically and millions of households found themselves in default. The Federal government

responded with a series of measures designed to assist households to meet their debt obligations.

An early exception to the short-term straight mortgages were amortized mortgages, thus longer term, offered by the savings and loan associations. In fact, the first major Federal legislation to affect housing following the Crash was directed not at the households with mortgages in default, but was in response to pressures that preceded the Crash to create an institution for SLA's similar to that created for the banking system with the establishment of the Federal Reserve. In 1932, Congress established a mini-FED, a system of regional institutions, Home Loan Banks, designed to provide support for and oversee the actions of savings and loan associations. The Federal Home Loan Bank Board, a regulatory body, was also created.

The problems brought on by the Depression required more drastic action and in 1933 the Home Owners' Loan Corporation (HOLC) was established. This organization was designed to assist in refinancing mortgages which were in default and did so, over the next three years, for more than one million homes whose mortgages had been held by private lenders. Mortgages assumed by HOLC were converted from straight (primarily three to six year) mortgages to fully amortized loans. (HOLC was one of those very rare species of government creation that did its job successfully and went out of business on schedule!)

The National Housing Act of 1934 created the Federal Housing Administration (FHA) and the Federal Savings and Loan Insurance Corporation. FHA began to offer mortgages with government insurance, mortgages that required full amortization and level payments, and tried to provide for the credibility of such mortgages in the portfolios of private lenders. Later Veterans' Administration (VA) mortgages, government guaranteed, were offered under essentially the same framework.

The Federal Housing Administration attempted to stimulate the establishment of private national mortgage associations, but private capital could not be attracted. Despite its failure in this area, FHA had an immense effect on the standardization of lending practices and the mortgage instrument. In January 1935 another effort was made to create a national mortgage corporation and market through the Reconstruction Finance Corporation. The RFC Mortgage Company was given power to purchase FHA mortgages and to finance certain commercial ventures, but was dissolved in 1937: a second failure in an effort to create a national mortgage association. Failing to stimulate private development, the Federal government in 1938 established its own national mortgage institution - Federal National Mortgage Association (FNMA) - to support the mortgage market. The third of the existing basic policy instruments of the Federal government was thus created.

The result of government intervention, competitive private response and the conditions of the times, led to abrupt changes

in mortgage contract terms by 1935:

1 full amortization became common which implied
2 extended contract length. (Formal maturity was much longer than five years under the old system, since renewal was generally anticipated - foreclosures resulted mainly from unanticipated termination of contracts by lenders.)
3 Loan-to-value ratios were dramatically increased. (Again, since junior mortgages were common in the 1920's, the actual loan-to-value ratios may have been quite high.)
4 Interest rates were lower.

(Analysis of cross section samples of mortgages differentiated by terms does indicate expected relationships between foreclosure rates and mortgage terms. (See Morton, (93), Chapter 5). However, as Saulnier ((93 Introduction) notes, it is not possible to attribute any significant proportion of these foreclosures to any particular contract term.)

In addition to these changes in the instrument and the development of the three government policy instruments there was a secular movement toward increased institutional lending in the mortgage market with the thrift institutions emerging post World War II, as the major participants. Despite these changes, the mortgage market became increasingly segmented. This occurred not just by type of loan (FHA, VA or conventional) but by the intermediary handling the particular type of mortgage, as there tended to be portfolio specialization by type of mortgage.

Savings and loan associations tended to compete rather than play an active role under FHA and VA programs. Since most of their mortgages were held by the initial lender, conventional mortgages tended not to be standardized nor discounted to other intermediaries.

The more standardized FHA and VA contracts led to the development of mortgage companies or mortgage bankers. These were essentially brokers who originated the mortgages for institutional lenders, usually life insurance companies. FNMA, originally created to provide a second market for FHA mortgages, has become a permanent holder of a sizable portfolio, so that mortgage companies originate and sell to FNMA in response to mortgage commitments much as they do with life insurance companies and mutual savings banks. These final holders, insurance companies, mutual savings banks, FNMA and other institutional lenders, make commitments for later purchase of mortgages. The brokers seek such commitments, secure interim bank financing, resale to the institutional lenders and then service the loans that they initiate. The vast majority of these loans have been government insured or guaranteed.

With the problems created by the credit "crunches" in the mid and late 1960's, savings and loan associations and the Federal Home Loan Bank Board have lobbied for and gained organizations (The Federal Home Loan Mortgage Corporation - FHLMC)

designed to fascilitate second market sales of conventional mortgages. The requirements of second market sales have begun to force some standardization on conventional contracts although all mortgage types, FHA, VA and conventional remain long term, fully amortized debt instruments. (The Federal government, to fascilitate subsidy programs, has established another mortgage intermediary, the Government National Mortgage Association - GNMA.)

While the qualitative characteristics of the mortgage instrument may have remained unchanged, it will be suggested in the remainder of this chapter that this constancy implies that the mortgage instrument becomes a quite different quantitative instrument with different rates of inflation. Mortgage lending also assumes a quite different pattern when high inflation rates or restrictive monetary policies are reflected in high short term interest rates (a descending yield curve) and/or high short rates relative to the past history of long term rates.

The nature of the difficulties resulting from the traditional, and often, legally imposed structure of housing finance can be roughly separated into three areas:

1 difficulties that inflation and the current structure of both instrument and sector impose on the thrift institution - primarily problems involving term structure intermediation, deposit ceilings and portfolio regulation

2 difficulties that various patterns of the debt payment stream pose for households - primarily problems involving level nominal payments, high rates of inflation

and imperfections in capital markets

3 the mismatch of the mortgage debt payment stream and a life cycle income profile - difficulties that younger households may encounter because of imperfections in capital markets.

While these problems are interrelated, the categorization is useful since one can roughly divide the variety of proposed instrument changes or innovations along similar lines, respectively:

1 variable rate mortgages

2 price level adjusted (indexed) mortgages and

3 graduated payment (low start or flexible payment) mortgages.

However, the categorization is not always distinct since a number of innovations attempt to solve more than one of the proposed problems with a single instrument format.

II. TERM STRUCTURE INTERMEDIATION AND INFLATION

A. The Problem

Deposit insurance, regulation and tradition confirmed the use of short term liabilities to finance the acquisition of long term assets by thrift institutions. Thrift institutions began the business of term structure (interest or maturity) intermediation, in addition to providing the usual intermediary function of bringing savers and borrowers together and providing default risk intermediation, by borrowing short and lending long.

The intermediary sells securities (deposits) with smaller default risk than the assets (mortgages) they purchase.

Consequently, the asset liability portfolios of thrift institutions, particularly savings and loan associations, are not maturity matched. Any portfolio of long term assets with fixed contract rates will suffer capital losses in periods of rising interest rates. Temporary, short term, losses are inherent in interest rate intermediation and are reversed over the life of the mortgage if the mortgage rate is the appropriate expectation of the series of short term rates over the life of the instrument. Permanent losses or gains result from poor predictions; one would expect poor predictions with increasing and/or variable rates of inflation.

Unless the institution holding the portfolio of mortgages that suffers capital losses from changing long term money interest rates is adequately capitalized the capital losses may impair the ability of such institutions to compete for funds with which to carry the assets or bid for new ones. However, for thrift institutions, market interest rate changes are reflected only in the newly issued mortgages, the marginal assets. But, with short term, mobile deposits, the current short rate must be offered on virtually the entire outstanding liabilities or else wealth holders go elsewhere with their savings ("disintermediation"), so that the marginal and average rates on time deposits concide.

The Federal government responded to a series of crises in the mid-1960's with new regulations to keep these institutions solvent: deposit ceiling regulation - Regulation Q and others. The government then engaged its other traditional policy tools by supporting the mortgage market with advances to cover deposit withdrawals and purchases of mortgages.

Recently, regulations on liabilities have been relaxed allowing thrift institutions to offer longer term liabilities.

When short interest rates rise, thrift institutions cannot compete and maintain their portfolio maturity position since the cash flow generated by the marginal assets cannot meet the required interest payments on the entire stock of short term liabilities. Wealth holders redirect savings to institutions with shorter asset portfolios who can respond better to fluctuating interest rates, or to the general capital markets. In addition to the cash flow difficulty, the market value of the asset portfolio falls and the institutions become technically, at least, insolvent. Ceilings on deposit rates may only contribute to disintermediation.

B. A Proposed Remedy: Variable Rate Mortgages

Variable rate mortgages (VRM's), where the mortgage rate on all mortgages of this type is some current market rate, have been proposed as a solution to the term structure intermediation problem. At the time the loan is made neither the lender nor the borrower knows with certainty the average rate which will be generated over the life of the instrument or even any period rate except the current one. The VRM proposals are essentially designed to create an asset that has some of the properties of

a short term instrument, thereby coordinating the maturities on the thrift institution's balance sheet structure.

Changing the characteristics of thrift institutions assets and/or liabilities is only one of several solutions or partial solutions to the cash flow difficulty. Another is to provide liquidity to the thrift through short term loans perhaps collateralized by its asset holdings, an option available through Federal Home Loan Bank Board advances. A third possibility is to provide liquidity to the mortgage instrument itself through an active second market. Efforts to create such a market for mortgages have been made by the Federal National Mortgage Association, Government National Mortgage Association and Federal Home Loan Mortgage Corporation.

There are two risks that unmatched maturity portfolios generate: withdrawal of deposits and prepayments of loans. Immunity from cash flow problems can, in general, be provided by matching maturities of assets and liabilities, either long or short. However, long matching presupposes that maturity is certain which implies no option to withdraw or prepay. Risk of prepayment would tend to inhibit long term liabilities, unless assumption of mortgages was common.

One might think it would be easy to match assets and liabilities given expected maturities, however, it is precisely when there are interest rate extremes that maturities of assets and liabilities would diverge, as borrowers want to borrow with provisions to prepay when the rate falls and depositors want long term assets (intermediary liabilities) to which the intermediary is bound.

In our society, with high mobility and household moves on the order of twenty percent per year (Census estimates), most

mortgages do not run to maturity and the risk of prepayment is an important one. Hence the attractiveness of an instrument which shortens the asset side of the portfolio. Also, with variable rate mortgages, the cash flow from the assets held by the thrift institutions would rise more quickly when tight money or inflationary expectations force market rates upward.

Proponents of this general class of instruments argue that such innovations would maintain the current structure of housing finance and household savings. Such mortgages would also presumably be more attractive to short term liability institutions and could result in increased funds channeled to housing finance. Widespread use could allow for the de-regulation of deposit interest rates. It is widely assumed, although nowhere demonstrated, that such positive effects would stabilize deposit inflows over the business cycle.

However, variable rate mortgages may or may not increase long term profitability of thrift institutions, since if long rates are reasonably correct anticipations of future short rates, they may only synchronize earnings and expenses.

Finally, such mortgages have been criticized as shifting unnecessary risks to the household: risks that should be borne by the thrift institutions. Serious investigation of these issues is not the task of this research. However, the many proposed variations of variable rate instruments are generally stimulated by the desire to ameliorate to some degree the perceived risk problems while maintaining the short term nature

of the contract.

A thorough analysis of these issues requires more than just an analysis of the risk for the borrower. Unanticipated inflation produces a decline in the real mortgage payments which is a windfall gain for the borrower and a loss for the lender. Ultimately, however, the loss falls, in part, on the depositor. To the degree that the adverse portfolio position generates rationing, there are also costs imposed on those rationed out of the mortgage market.

Precise specification of the mortgage innovations examined in this thesis will be made in Chapter V. I examine there only a small subset of the many proposals and do not examine micro-economic effects on representative households. An effort to examine these issues and make a more precise examination of a number of proposals can be found in a paper by Cohn and Fischer (17).

III. DEBT PAYMENT STREAMS AND INFLATION

A. The Problem

Distribution issues aside, it is generally assumed that high rates of inflation, per se, have no real effects in our economy. Therefore, it is alleged that pure inflation induced changes in nominal interest rates should have no effect on the demand for housing. This particular view was presented again in a recent article by Arcelus and Meltzer (3), "If market rates rise and are expected to remain permanently at their new level as a result of an increase in the anticipated rate of long-run inflation, there is no reason to believe that the demand for housing is permanently reduced... it is only at higher real rates (that) fewer houses are built."

However, with the current instrument of housing finance, there is good reason to believe that inflation-induced changes

in nominal rates of interest will have effects on housing demand. The conditions for neutrality or no effects seem too stringent.

The relationship between nominal rates and housing is quite simple: the ratio of monthly nominal mortgage payments (level under the current instrument) to monthly nominal income at the time the mortgage contract is secured is a key determinant of mortgage size. Suppose a household contemplated securing a thirty year, $30,000 mortgage. If there were no

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To some degree this is the result of the constraints currently imposed on the mortgage contract by law, tradition and market imperfections. However, the amount of monthly income allocated to housing is also constrained by household choice.

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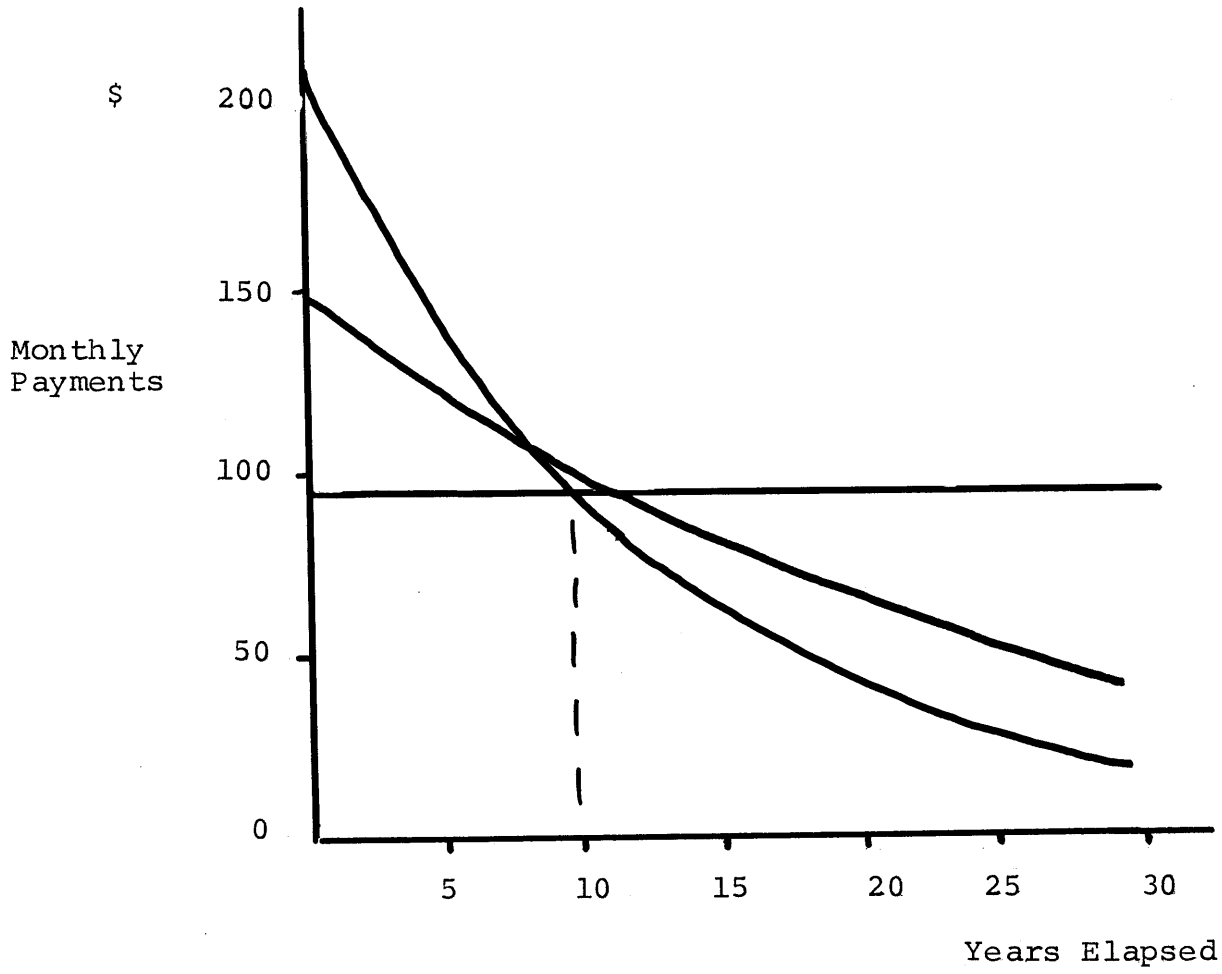
inflation and the real rate were 3 percent, annual payments necessary for full amortization would amount to $1517. If a 2 percent inflation were perfectly anticipated, the contract annual payment would jump to $1931, nearly a 25 percent increase. A 6 percent fully anticipated inflation with the same real rate would yield a 9 percent contract rate and per annum payments would rise to $2895, nearly double the non-inflation payment. The expectation of rising prices does not cause a household's real financial position to deteriorate. Yet it has increased the real initial burden of debt service and may force the purchase of a smaller dwelling unit by making it virtually impossible for the household to purchase as much house as in a non-inflationary era.

One can argue that households need only borrow the additional funds. However, serious capital market imperfections prevent such borrowing.

In both a world with inflation and one without, the present discounted value of the real payment stream must equal the amount of the loan or else lenders would not provide the capital. Inflation, with level nominal payments, implies a declining real stream of mortgage payments. Necessarily then, higher inflation implies higher nominal payments to maintain a given real present value at issuance of the instrument. Because the present discounted stream is the same but the real pattern declines, it must start at higher levels in both real and nominal terms (which, of course, are the same at the time the contract is made). It is precisely in this sense that higher nominal rates corresponding to higher inflation rates compensates for the gradual erosion of purchasing power of the nominal stream. The "tilting" debt payment stream is illustrated in Figure I.1.

Of course the inflationary world, combining a constant nominal payment with a continual rise in prices, eventually leads to real mortgage payments falling below the real value of payments in a non-inflationary world. This is precisely the point. Inflation imposes an uneven real cash flow on the borrower. The greater the rate of inflation, the more uneven is the stream; the greater the rate of inflation, the heavier, in real terms, is the cash flow burden in the early years of the level payment mortgage. However, it is only in the future that inflation may deliver

Figure I.1


$
200
150
100
50
0
Monthly
Payments
5
10
15
20
25
30
Years Elapsed

higher nominal incomes with which to make the inflation-induced high (relative to a non-inflation world) mortgage payments.

It may be a considerable period of time before the inflation tilted real stream and the level real stream of the non-inflationary world cross, consequently the heavier real burden imposed by inflation persists. For example, with a 6% perfectly anticipated inflation, a 3% real rate (9% contract rate), it takes more than twelve years for the real payment to fall below the non-inflation level payment. The average actual life of a mortgage in this country is something less than ten years. Therefore, for many households, the advantages of the small real payments at the end of the mortgage are never obtained, except for the larger equity accumulated, and result in an absolutely higher real burden over the effective life of the mortgage. This spread between the declining real payments

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Of course, the short average life of mortgages could in part be a result of households refinancing high interest mortgages when mortgage rates fall.

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in a world with inflation and the level real payments in a world with no inflation creates a gap ("financing gap") that persists as illustrated. If the household is to obtain the same mortgage in each world and allocate the same proportion of its budget to housing, it must finance this gap. Otherwise, it must either increase the proportion of income allocated to housing (if possible) or reduce the amount of housing purchased. In the

context of the example we have been using, if the household uses 15% of its income to purchase housing in a no inflation

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This phenomenon would obviously have no impact if the gap could be financed at the market mortgage rate. If it could be financed, by borrowing against future inflated income or against human wealth, the household could level the payment stream. Indeed, if such borrowing were available the household could create a payment stream that varied through time. The essence of the difficulty is that the gap cannot be financed or can only be financed with partial success and some difficulty.

If there were no such difficulty, the supply of funds would be sufficient only if lenders reinvested the difference between the real and nominal return. Otherwise the real value of capital is not maintained and the supply of funds will fall short of demand.

We would expect, if financing this gap is important, to see an increased demand for second mortgages during inflations. There are some indications that this is so, however, the data are so poor that no conclusive evidence has been found.

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world, the initial payment-income ratio jumps to over 19% with a 2% inflation and to nearly 30% with a 6% inflation. With 2% inflation, the payment-income ratio is above 15% for twelve years, though in the terminal year it will take only for 10.8%. The terminal payment with 6% inflation is 5% of income if income grows at the inflation rate.

Larger downpayments and/or longer amortization periods could be used to bring payments more in line with no inflation conditions. The flexibility allowed by varying either of these parameters is quite limited. One hundred percent downpayments and mortgage debts that have term longer than the expected life of the dwelling unit or occupant are obviously not satisfactory remedies. The practical limits for these parameters are much

less and consequently these are not particularly appealing methods of ameliorating the tilt. For example, to reduce payments on a 9% contract rate, 30 year mortgage to the level a 5% mortgage requires would force a reduction of the loan size by one third. Instead of a 10% downpayment, 40% would be required. The alternative is to scale back the size of dwelling unit by one third.

If the mortgage interest rate goes from 5% to 8%, the amortization period would have to extend from 22 to 45 years to keep payments the same. If the rate climbs to 8.25% with fixed payments, the mortgage is never paid off. Obviously,

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The decrease in initial payment is a function not only of extension of the amortization period but also of the contract rate. At higher rates extension of the amortization period becomes less and less effective. As an illustration consider,

interest rate	% reduction in initial payment (maximum)
3 %	24.7
6 %	15.0
9 %	8.7
12 %	4.9

---

there is little flexibility in these areas.

Finally, even though the amortization period may remain constant, inflation acts to shorten the maturity of the traditional instrument. The borrower is forced, as a corollary to the uneven real debt stream, to repay his real debt (accumulate equity) at a faster rate than he would with level real payments and the same initial size of mortgage. At an

interest rate of 12%, equity accumulation is increased 48% over the first five years relative to real payments with a 3% rate.

There are dynamic effects that result from moving from one steady state inflation to another. Households with old, low interest mortgages have a capital gain that is captured only by staying in the dwelling unit. Since assumption of contracts is not common in this country nor can the household carry the mortgage with him to a new unit - his existing dwelling unit serves as collateral - a capital loss is suffered when moving.

It should now be clear that there is good reason to suspect that the adjustments of nominal interest rates to reflect inflationary expectations will not be neutral in their impact on housing activity. Long term, level payment, fully amortized instruments may be appropriate in an environment of stable prices and stable long term incomes, however the more rapid the inflation the more defective the currently used mortgage instrument appears to be.

B. A Proposed Remedy: Price Level Adjusted Mortgages

Proposed mortgage instruments designed to eliminate these distortions generally involve a scheme to index the principal. The basic interest rate would be a real rate. This rate, combined with the other terms of the contract, determines the initial payment. Thus, regardless of expectations about inflation, a price level adjusted mortgage determines an initial payment independent of those expectations. If inflation does occur, the

the principal that remains at the end of the contractually determined adjustment period is increased by the ex-post inflation rate.

If the real payment stream is independent of inflation, equity accumulation is slower. Of course this is what is desired - both the traditional mortgage and variable rate mortgages force accumulation with a vengance under inflationary conditions.

Essentially the price level adjusted mortgage is a graduated payment mortgage (discussed in the next section) with an ex-post adjustable (by the inflation rate) graduation rate.

For the mortgage lender, the price level adjusted mortgage has the same qualities of a variable rate instrument only to the degree that interest rates and inflation move together.

The general class of variable payment mortgages is discussed in the penultimate section of this chapter. Specific instruments examined within a macro-economic framework are detailed in Chapter V.

IV. DEBT PAYMENT STREAMS AND LIFE CYCLE INCOME STREAMS

A. The Problem

Even in the absence of inflation, the greater the difference between a borrower's current and expected future real income, the more defective the current instrument appears. The traditional mortgage appears to be most appropriate when long-

term incomes are stable.

Home purchases made by younger households are often constrained or eliminated by current income or wealth. Established payment-to-income ratios and downpayment requirements may well limit the size of a home a younger household can purchase simply because such a household is at the low part of its income cycle. The resulting level payment stream of the traditional mortgage instrument is at variance with most life cycle income paths. The distortion persists unless the household is willing and able to engage in, perhaps, lengthy and costly "trading-up" transactions. Even in a world without inflation linking the amount of mortgage debt to the proportion of debt-service-to-current-income ignores general trends in productivity and the life cycle phenomena of rising incomes in general and incomes rising with age in particular. Capital market imperfections prevent two prospective borrowers with exactly the same present value of their respective income streams from securing the same mortgage loans if the profiles of those income streams differ. In particular, households with relatively low but rising incomes find it more difficult to mortgage the same amount as borrowers with relatively higher but stable incomes.

One should be careful, since this problem may be more perceived than real. Even though the percentage of real income allocated to service the debt instrument attached to housing falls through the life cycle this may or may not be viewed as

a burden by the household depending upon either claims upon income as the household ages, e. g. college education for children, purchase of consumer durables, etc.. Consequently, a falling housing debt service may be exactly what the household desires or may be easily tailored around in terms of its over all needs. But, there is no option presently available to structure a different stream of real payments relative to real income and the household must accumulate wealth in the form of housing equity over the early part of its income stream.

B. A Proposed Remedy: Graduated Payment Mortgages

A series of proposals to allow such flexibility on a limited scale have been made and are usually referred to as graduated payment or low-start mortgages. A graduated payment mortgage is a contract that allows for additional borrowing over the early life of the instrument. Such an instrument would be characterized by increasing real principal as early payments generally would not cover interest payment due on the original principal. The lender is essentially agreeing to make additional loans to cover the interest shortfall by enlarging the original principal. Rather flexible instruments could be created although their viability from the lenders view is an open question. Payments could rise at some fixed rate; rise rapidly but at a rate that declines over the life of the mortgage; rise for some period then be fixed; begin high and fall. All that is necessary is that the mortgage be amortized

over its life. Such mortgages are designed to provide a slower accumulation of equity than the traditional mortgage which may be attractive to the borrower but would be less attractive to a lender. Since the unpaid principal increases over the early life of the mortgage, the only equity accumulation is through capital gains on the dwelling unit (as long as the unpaid balance rose slower than the rate of appreciation of the asset).

In a world with inflation, a graduation scheme could be easily created where the unpaid balance increased in nominal terms, but always declined in real terms. That is, payments need only cover interest calculated at the real rate for equity to accumulate in real terms. Such instruments may have serious problems if rising monthly payments imply an increasing real burden on the household.

The risk that any flexible payment stream, generated by graduation, variable rates or indexation, will result in increasing real burdens is a serious one. However, it is one that also exists with the traditional mortgage instrument. In the latter, the risk is that real incomes may fall, while in the former it is this as well as a risk associated with real income streams not increasing as fast as the payment stream generated by a new instrument.

Inflation exacerbates the life cycle-productivity difficulties. Level payments simply impose hardships on borrowers often without being a protection for lenders. Tucker (137) notes that from 1965 to 1973 wage and salary income increased 57% (12% in real dollars) while initial monthly

payments, despite lengthening of the average amortization period, increased 85%. The fraction of income (assume the same percent downpayment) taken up by monthly payments would have been 16% higher if an average household made the purchase in 1973 than if it were made in 1965. This despite real incomes increasing by 12%. Households, with higher real incomes, could "afford" less housing. Over this period housing prices have not risen faster than income, thus changing costs do not reflect economic scarcity and changing relative prices but rather are due soley to the inflation-induced distortions from the traditional mortgage contract.

V. GENERAL CHARACTERISTICS OF A MORTGAGE INSTRUMENT

A useful summary of this material and introduction to that which follows can be made by characterizing precisely the mortgage instrument. We want to divorce the term of the instrument from its amortization period and the interest used to compute payments from the interest used to divide any such payments between payment on principal and interest due on principal.

A mortgage can then be characterized by:

a) amortization period

b) term

c) interest used to amortize and determine payment

d) interest actually charged on principal

e) rate of graduation

and f) principal

The original principal M(0) (par value at date of issue) of a mortgage with amortization period T, monthly payment MP(t) and interest rate R(t) is

$$\text{I.1} \qquad M(0) = \sum_{t=0}^{T} MP(t)/(1+R(t))^{t}$$

Where $M(0) \equiv LVR \cdot PH$, that is, the original loan principal is the purchase price (PH) less the downpayment (1-LVR). For a traditional mortgage the monthly payment is fixed and the interest rate on the mortgage is determined at the initiation of the contract and is consequently the rate on a mortgage with term T (= amortization period). Therefore,

$$\text{I.2} \qquad M(0) = \sum_{t=0}^{T} MP/(1+R(T))^{t}$$

$$= MP/R(T) \cdot (1-(1+R(T))^{-T})$$

Conversely, the monthly payment is that which will fully amortize a mortgage debt of M(0),

$$\text{I.3} \qquad MP = \frac{R(T) \cdot M(0)}{(1-(1+R(T))^{-T})}$$

If borrower and lender agreed on a contract with payments increasing at rate μ (the graduation rate) then

$$\text{I.4} \qquad M(0) = \sum_{t=0}^{T} MP(0)\ (1+\mu)^{t}/(1+R(T))^{t}$$

$$= \sum_{t=0}^{T} \left(\frac{1+\mu}{1+R}\right)^{t} MP(0)$$

would be the original principal (for original payment MP(0)) and

$$I.5 \qquad MP = \frac{(R-\mu)\ M(0)}{(1-(\frac{1+R}{1+\mu})^{-T})}$$

is the original payment for original principal M(0) .

The loan-to-value ratio and purchase price determine the original principal. Given that principal, the amortization period, interest rate and rate of graduation determine the original payment. The interest rate and rate of graduation determine subsequent payments.

At any moment, the interest collected by the lender is,

$$I.6 \qquad R^L(t) \cdot MP^T(t)$$

where $MP^T(t)$ is the remaining principal. If the rate used to compute such payments differs from the rate used to amortize the loan,

$$I.7 \qquad R^L(t) \neq R(t)$$

then the monthly payment may not cover the interest due. Clearly, d) and e) determine the proportion of payment credited as interest; the residual, which may be negative, is credited against the principal.

The term (b) is defined as that period of time over which the interest rate used to amortize the mortgage is contractually fixed. If the rate never varies then the term and amortization period coincide. But the term may be much less than the amortization period. For example, if the term is one month then the interest rate would vary monthly with other short rates even though the mortgage may be amortized over a thirty year period.

With a traditional instrument, the term and amortization periods coincide. The interest rates used to compute payments and divide payments between interest and principal also coincide. Thus, the instrument is long term, bears a market determined long rate, is amortized over that term and has no graduation. Interest is charged at the same rate on principal and so credited by the lender, with the residual reducing the principal by an amount necessary to amortize it over its life. This is but one of a number of possible combinations and encounters the difficulties already outlined. Consistency requires that

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In view of the wide variety of feasible designs it is perhaps a little strange that only one or two of these designs exist in this country.

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the term and the rate the thrift institution uses to credit the debtor's account (the thrift institution's perceived contract rate) be consistent and that the payments fully amortize the mortgage if balloon end payments are not desired.

The rate on the contract may be pegged to some rate not consistent with the term or market clearing, then, of course, the instrument would tend to be priced not at par but with a discount or premium.

Proposed innovations essentially try to combine these characteristics in such a way as to meet one or more of the perceived difficulties that the traditional combination

imposes. Clearly any such effort may create other difficulties and changes the basic risk characteristics of the mortgage as an asset.

Although a full development of the various alternatives examined in this study will be made in Chapter V, one can easily illustrate some particular cases as well as the flexibility that such a characterization of the mortgage instrument allows.

Consider a simple variable rate mortgage. One wants the average return on the lender's portfolio to move with current rates. A variable rate proposal simply separates the amortization period from the term. The contract is a series of (guaranteed renewable) short term instruments, with a long amortization period. It should bear the appropriate short term market rate. Then the mortgage itself, and consequently the portfolio of such mortgages, always pays the current market rate appropriate to the term of the instrument. If one wants to match the asset and liability sides of the thrift institution's portfolio as nearly as possible, this term should be "one" period - a month or quarter. Since this may imply a too volatile payment schedule, most proposals look for a clever method of smoothing the payments. That is, one wants the instrument to behave much like a long term instrument from the household's point of view and a short term instrument from the thrift institution's point of view. One compromise is to lengthen the term to several years. Then, to the degree that three to five year bond rates fluctuate less than short rates but more than long rates, one

gets some of the desired effects. Another variation suggested by France Modigliani which illustrates characteristics c) and d), would compute the payment the household makes based on a long rate. The thrift then splits that payment between interest and principal using a current short rate. It may be that the payment on principal is negative, i.e. the outstanding principal rises and/or the amortization period is extended.

This particular option and others will be developed later. It serves here as an illustration of what alternative mortgage types are designed to do about the particular difficulties encountered with the current instrument and the flexibility allowed by viewing the traditional instrument as merely one of many possible combinations of mortgage characteristics.

We return to mortgage innovation in the last chapter of the thesis. However, prior to examining the impacts of such innovation on housing and mortgage markets, it is necessary to develop a model of these markets that incorporates, in a structural way, the key parameters of the mortgage contract. The following chapter, Chapter II, examines the existing literature for evidence of the inflation-induced distortion. Much emphasis is also placed on the structures of various models. Chapter III develops a new, consistent model of housing; Chapter IV presents estimation results and evidence of the disruption caused by inflation and the resulting high and variable interest rates. Chapter V returns to the themes suggested in this chapter, with a simulation study of mortgage innovation and the deposit, mortgage and housing sectors of the economy.

CHAPTER II

The examples given in the first chapter provide rather persuasive arguments that the combination of inflation and the traditional mortgage instrument impose burdens on households and thrift institutions, burdens which are likely to have impacts in the housing market and ultimately on the construction of new dwelling units.

I now consider whether or not the existing literature, summarizing empirical research, can provide evidence of these impacts and an understanding of how changes in the mortgage instrument would affect the demand for housing and the demand for mortgage credit.

This chapter was written with Craig Swan and with the assistance of Kenneth Rosen. It will appear in a forthcoming Boston Federal Reserve Conference Volume reporting the work of the MIT Mortgage Study Project.

Unfortunately for such a survey, the mortgage instrument is multi-dimensional, with a variety of characteristics that influence housing finance. Among them are interest rate, amortization period, downpayment requirement, prepayment penalties and the resulting initial payment and time path of real and nominal payments. These terms of the mortgage contract, nominal rate excepted, have not been central to studies of housing and mortgage finance. However, there was some feeling in the post World War II period that the movement toward

fully amortized, long-term mortgages in the 1930's led to a substantial change in the housing stock since it represented such a dramatic change in the structure of housing finance. But Grebler et al (51) found that, at the end of the 1950's, there had been no substantial change in the growth of housing stock per capita since the turn of the century, despite these liberalized financing arrangements.

This survey of the literature is structured to evaluate the evidence about the impact of these parameters of the mortgage instrument on the demand for housing and mortgage credit during a period of more volatile interest rates. The discussion places heavy emphasis on econometric models of housing activity and the demand for mortgage credit of relatively recent vintage.

A number of older surveys exist which complement this study: de Leeuw (20), Grebler and Maisel (50), Fromm (44), Kalchbrenner (67).

The chapter is organized as follows. Section II of the paper presents a brief overview of the existing literature on the demand for housing and for mortgage credit. This discussion is designed to introduce the reader to the literature and place work in a historical context emphasizing major themes and conflicts. Section III attempts to develop a general framework for analyzing the research on housing and mortgage markets. This discussion is necessary since much of the existing literature

lacks a cohesive theoretical framework and does not deal directly with some of the proposed alterations of the existing mortgage instruments. Section IV presents a more detailed discussion of numerous models with an emphasis on the effects of changes in those parameters of the mortgage instrument which distinguish alternative possible instruments to finance housing, detailed in Chapters I and V.

An appendix, to be published separately as a technical paper by the MIT Mortgage Study Project, provides an annotated bibliography of the relevant literature.

I. SHORT-RUN VS. LONG-RUN BEHAVIOR

Most of the literature is relatively recent. Much of this literature is concerned with explaining post-war cycles as measured by quarterly data. There is, therefore, a heavy emphasis in the literature on explainging short-run behavior. Some work, but by no means all, places the explanation of this short-run behavior squarely in models with long-run stock equilibrium properties. Most studies, however, concentrate on short-run flows without explicit treatment of long-run equilibrium considerations. This emphasis on the short-run as opposed to the long-run has its advantages and disadvantages. A major advantage for our purposes is the general belief, supported by many of the studies surveyed, that financial variables and credit rationing have their major impact on short-run flows. This is consistent with a view of housing

that holds that the long-run stock demand for housing is primarily a function of income, relative prices, the rental rate of housing services, and the size and age-structure of the population with monetary policy and the parameters of the mortgage instrument having little, if any, impact on these basic demand factors. However, adjustment of the stock, that is, how quickly equilibrium is approached, does seem to be strongly influenced by monetary policy and the parameters of the mortgage instrument. It is also possible that the structure of housing finance implies different long-run equilibrium positions.

A major disadvantage of the emphasis on short-run flows is the consequent lack of attention paid to long-run implications. For example, increases in the loan-to-value ratio are usually expected to have a positive impact on the level of housing starts and the demand for mortgage credit. (see (56), (68)). What is ambiguous in most studies is how long such a positive effect is expected to persist. The higher flows will mean a larger stock of both houses and of total mortgage debt outstanding. Does the change in the loan-to-value ratio mean that there will be permanently larger stocks of houses and mortgages, or does it mean that the economy reaches an unchanged stock equilibrium sooner? Most short-run studies are not designed to answer this question; many lack any explicit long-run properties.

The distinction between short-run and long-run behavior is

an important one to keep in mind. Proposed policy changes may affect both sorts of behavior. Care must be taken not to draw inferences about long-run behavior from studies that are designed to capture mainly short-term effects since considerable confusion and much debate has been generated over monetary influences on housing for precisely this reason.

II. AN OVERVIEW OF THE LITERATURE

A. Models of the Demand for Housing

A major part of the literature on housing reflects a long history of debate concerned not with cyclical fluctuations in housing, but with price and particularly income elasticities of the demand for housing services. The demand for housing services is usually translated into a derived demand for the stock of houses. Research was stimulated by the findings of Grebler et al, (51), of a remarkable decline in real capital investment in housing despite changing financial positions and increasing real income. Lee (74), Winger, Reid (110), Muth (107) and others, using both cross section and time series data, have reported widely differing income elasticities, ranging from .65 to 1.7. deLeeuw (20) has recently attempted a reconciliation of much of this literature by analyzing carefully the varying data used. He concludes the income elasticity of the demand for housing is most likely in the .8-1.0 range - higher for owner occupied than for rental housing.

However, Maisel et al (84) have claimed that grouping of data has led to an upward bias in the estimation of the income elasticity and conclude that the elasticity is in the .62-.70 range.

This research effort on income and rental rate elasticities has concentrated primarily on long-run equilibrium impacts, where income and rental rate changes lead to a new, long-run equilibrium in terms of the stock of houses. Financial variables have generally not been included in these studies, certainly not the variety of financial variables that have appeared in recent econometric models of short-run cycles in housing starts.

B. Models of Cycles in Housing Investment

Housing Starts, Credit Availability and Housing Cycles

Guttentag (53) and Alberts (1) were among the first researchers to emphasize the role of mortgage credit in the housing cycle. The arguments were relatively simple. Mortgages are residual investments for many financial institutions. During periods of tight credit conditions, there is less money for residual investments. Consequently, the flow of funds into the mortgage market falls off dramatically, leading to higher mortgage rates or rationing. Income effects on housing demand are dominated by the cost-of-credit effect. Thus the cycle in interest rates causes a cycle in mortgage lending and home building.

A factor contributing to the abrupt changes in funds available for mortgages could have been the fixed-interest ceilings on government insured (FHA) or guaranteed (VA) mortgage loans. A number of "fixed-rate theorists", Guttentag (53), Lewis, Smith (119), Schaef (113), and Grebler (48) advanced this argument. Alberts (1) argued that discounting was an effective way to get around ceilings. In recent years, the fixed rate theory has not enjoyed much popularity among researchers as a major explanation of cycles although some elements of the fixed rate view can be found in work by Brady (8) and Clauretie (16). This lack of popularity may be due, in part, to frequent ceiling changes in response to changing interest rates.

Maisel's studies for the Brookings model (82, 83) were some of the earliest efforts at explicit modeling and estimation of postwar cycles in home building. Maisel's work emphasized demographic factors, measured by household formation, as a basic determinant of demand. Short cycles were seen as coming from the supply side as the result of an inventory response by builders. The only financial variable appearing in Maisel's early empirical work was the treasury bill rate. Subsequent work in this tradition is represented by Sparks (123) and Huang (56, 59).

Further work by Maisel and much of the recent work on housing cycles have emphasized the availability of mortgage credit as well as its cost as an important determinant of home building in the short run. Implicit in much of this work is

the view that the mortgage rate is not a sufficient indicator of the state of mortgage markets. One may not be able to get a mortgage loan at existing mortgage rates implying that some form of credit rationing is an important element in housing markets in the short run.

In the early 1960's, in a review of the literature for the Commission on Money and Credit, Grebler and Maisel (50), concluded:

> While these analyses differ on matters of emphasis and detail they agree in the conclusion that short-run fluctuations in residential building have resulted mainly from changes in financial conditions labeled borrowing, availability of mortgage funds, supply of mortgage credit .....No matter how housing problems are defined, credit has almost invariably been singled out as the key to the solution.

A decade later, after considerable research, Friend wrote (43),

> The greater impact of monetary stringency on housing than on the rest of the economy apparently is due mainly to a capital rationing effect, resulting from deficiencies in current institutional arrangements for providing mortgage credit; and probably also to an interest rate effect, reflecting a greater interest elasticity of housing demand than of demand generally.

There are two major elements to the view that concentrates on the importance of mortgage credit. One element is the importance of mortgage credit to the purchase of housing units. The other element is the belief that mortgage markets are often in disequilibrium and that the mortgage rate is not a complete measure of the availability of mortgage credit.

In his 1968 paper, Maisel (80) speaks to the first point, the importance of mortgage credit:

> The reasons for expecting monetary shifts to influence housing starts are clear. By its nature, monetary policy should, in the first instance, affect those units whose spending is highly dependent on either the cost or the availability of credit. Among these groups, the degree of impact will vary. The variations will depend on the proportion of purchases made with credit, the amount of credit required per unit of expenditure, the ability or willingness to absorb higher interest rates, the institutional character of the market, and the degree to which traditional lenders are influenced by policy changes. Housing ranks high in sensitivity to monetary policy on all these counts.

An emphasis on the availability of mortgage credit appears in a number of studies in different forms. Brady (89) and Huang (56) have included measures of the loan-to-value ratio and amortization period in housing starts equations. A number of investigators have included some sort of quantity measure of mortgage supply or possible supply of savings. Maisel (80) includes a measure of the inflow of funds to financial institutions and a measure of FNMA purchases. Sparks (123) (after some substitution to eliminate a term for credit conditions), includes a quantity measure of mortgage acquisitions and commitments. Brady (9) has used mortgage commitments at life insurance companies as a determinant of FHA and VA financed starts. In later work, Brady (10) uses FHLB advances to help explain total starts. In Swan (127), the inflow of funds to savings institutions is the prime determinant of housing starts. The MPS (94) model includes a variable measuring the change in mortgage commitments.

As detailed below the mortgage market of the MPS model is estimated in a way that allows for possible disequilibrium and credit rationing.

The Bosworth-Duesenberry (7) model uses current and lagged net changes in the stock of mortgages. DRI (19) includes a measure of mortgage commitments as well as changes in the stock of mortgages.

All of the above studies have added measures of credit availability to essentially single equation explanations of housing starts. Other work has attempted to estimate both demand and supply curves for housing starts. In one of the earliest efforts, Huang (56) includes FNMA mortgage purchases as a determinant of the supply of VA financed starts. Savings flows at savings and loan associations and FHLB advances are seen as influencing the supply of conventionally financed starts. In more recent work, Kearl and Rosen (68) include the net change in total residential mortgages as a determinant of the supply of total housing starts.

In some interesting work, Fair (32) has developed a monthly model of housing starts that not only includes savings flows as a determinant of the supply of starts but also explicitly allows for market disequilibrium and the failure of the mortgage rate to always be a market clearing rate. Swan (127) has followed up on Fair's original work with a quarterly disequilibrium model with similar qualitative results.

A brief summary to much of this work is provided by Gramley (38) who, in summarizing a massive Federal Reserve Study of fluctuations in residential construction, notes:

> "....observed short-run swings in housing starts over the post-war period reflect principally the impact of

> changes in financial variables on residential home-building. This assertion has become an integral part of the traditional wisdom...."

The general conclusion of research conducted over more than two decades by a number of economists was that both the cost and availability of mortgage credit are important determinants of short-run fluctuations in housing activity.

Credit Availability and Housing Cycles: Nay

A vocal dissenter to much of the tradition represented by the preceding work is Meltzer (36). He argues that the emphasis on the availability of mortgage credit is simply wrong:

> Public policy toward housing is based on the conjecture that the "availability" of mortgage credit is an important--perhaps the most important--determinant of the demand for housing. Policy appears to be misconceived. We have found no evidence that the availability of the particular type of credit has any important or lasting effect on the type of assets individuals acquire. If the housing market is the market in which "availability matters" or matters most, there appears to be very little if any empirical basis for the conjecture or the public policies based on it.

A good deal of confusion surrounding Meltzer's position seems to arise from a failure to distinguish between short-run adjustment behavior and long-run equilibrium. Meltzer uses long time series of annual data whereas most of the analysts mentioned above use post-war quarterly data. It is likely that few, if any, of the researchers who found evidence of credit rationing

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See Swan (131) for a detailed critique of Meltzer's major empirical effort.

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would argue that the availability of mortgage credit would have

a substantial impact on the long-run equilibrium size of the housing stock. They are instead more concerned with cyclical fluctuations and feel that the availability of mortgage credit is an important short-run constraint.

C. Demand for Mortgage Credit

The apparent importance of mortgage availability has led a number of investigators to examine the mortgage market and the interrelationship of this market with the housing market. However, most early post-war studies of mortgage markets emphasized the supply of mortgage credit from financial institutions. For example, Klaman's monograph (72) gives extensive treatment of mortgage types, lenders and the structure of mortgage lending. But the discussion of demand takes less than one page and emphasizes the strong pent-up demand for housing after World War II.

Most formal modelling efforts of demand for and supply of mortgage credit date from the mid-Sixties. Almost all studies emphasize the demand for houses as the major factor affecting the demand for mortgage credit. This emphasis is surely not surprising given the traditional collateral requirements. However, focusing on mortgage demand as a derived demand from the demand for housing has ignored important questions of re-financing and household portfolio choice. Consequently, there are a wide variety of specifications.

The studies surveyed here differ as to whether they include a measure of the stock of houses or the flow of housing starts.

These studies also differ as to whether they include a direct measure of the stock or flow or whether they include variables, such as income and prices, to represent the demand for the stock or flow.

III. MODELLING HOUSING AND MORTGAGE MARKETS

A. Implicit or Explicit Measures of Housing Activity

The choice of an explicit or an implicit measure of housing activity has at least two implications. One implication involves the interpretation of coefficients on other variables in the equation for the demand for mortgage credit.

For example, consider the mortgage rate. A change in the mortgage rate will have a direct effect on the demand for mortgage credit as the change in the mortgage rate affects peoples' desired equity position in houses. Note that this effect will occur with an unchanged level of housing activity, measured on either a stock or flow basis. There will be a further indirect effect on the demand for mortgage credit to the extent that the change in the mortgage rate affects either the amount of homebuilding or the desired stock of houses. In models with an explicit measure of housing activity, the coefficient on the mortgage rate measures only the direct effect of mortgage rates on the demand for mortgages. (The indirect effect is already captured in the explicit measure of housing activity.) In models with only implicit measures - i.e. the basic determinants of housing activity--the coefficient on the mortgage rate captures both the direct and indirect effects of

the mortgage rate on the demand for mortgages.

There is a further implication of using an explicit or implicit measure of housing activity. Implicit measures have tended to be justified on the grounds that they measure the desired amount of housing. If credit rationing is an important phenomena there may well be times when the actual stock of houses or amount of homebuilding is less than desired. Thus, while people want more housing and hence would like more mortgage credit, they may be unable to get more housing and their effective demand for mortgages may well be reduced.

This possible distinction between desired and effective demands raises the further question of possible disequilibrium in mortgage markets and how one allows for any disequilibrium when estimating. Of the studies of the mortgage market surveyed, only Jaffee (61) directly incorporates possible disequilibrium into the specification of his model. Jaffee assumes that the mortgage market is always characterized by excess demand.

B. Models with Explicit Long-Run Properties

Only a few studies - Silber (115), Jaffee (61), and DRI (19) are formulated in a long-run framework with explicit long-run stock equilibrium implications. All of these studies include a measure of the lagged stock of mortgages in a partial adjustment framework. In the other studies surveyed, the implications of the cumulation of past flows does not play an explicit role in the estimated equations. These other studies do not include any measure of the lagged stock of mortgages.

Virtually all the studies surveyed use a measure of the flow of mortgages as the dependent variable. However, some studies use net flow data while other use gross flow data. Some studies use data on total mortgage flows while other studies disaggregate by either type of structure - single family or multi family - or by type of mortgage - FHA, VA or conventional.

Huang's (57) equations do include the lagged mortgage stock. However, it is difficult to interpret what are its effects since the lagged stock appears in ratio form divided by the total holdings of financial assets.

The three studies formulated with explicit long-run equilibrium properties include a measure of the stock of housing as the basic demand variable. They do not include other, implicit, determinants of the demand for the stock of housing.

C. Models without Explicit Long-Run Properties: Flow Models

The other studies surveyed, which do not have explicit long-run equilibrium properties, are more varied as to how they treat the demand for housing. In particular, some of these "flow" models of the demand for mortgage credit include measures of the flow of housing activity while other "flow" models of the demand for mortgage credit include variables that represent the demand for the stock of houses. The flow-flow models include Huang (56) who uses the value of housing starts; Sparks (123) who uses variables that determine housing starts in his model; and Kearl and Rosen (68) who use the number of housing starts. The flow-stock models include Huang (59) and Clauretie (16) who use variables that appear to represent the demand for the stock of houses in a strictly flow mortgage demand equation.

D. Interest Rates

Almost all studies have used the mortgage rate as the price variable that affects the demand for mortgages. For models with an explicit measure of housing activity, the coefficient of the mortgage rate measures the direct effect of mortgage rates on the demand for mortgage credit which is in addition to any effect the mortgage rate might have on housing activity. For models with an implicit measure of

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Huang (56) is the one exception. The mortgage rate enters only indirectly through its effects on housing starts.

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housing activity, the coefficient of the mortgage rate is meant to capture both effects. Only a few studies - Jaffee (61), Kearl and Rosen (68) and DRI (19) - include other interest rates. These three include some measure of the corporate bond rate although the DRI model also includes a measure of rates paid on deposits at savings institutions.

E. Other Mortgage Terms

For most studies, the mortgage rate is the only direct element of the mortgage instrument that is included. Jaffee (61) recognizes that other elements of the mortgage contract would be expected to influence the demand for mortgage credit, but he does not include them in his equation citing negative findings of earlier authors and possible bad data. It is interesting that Jaffee subsequently finds evidence of incomplete adjustment of mortgage rates resulting in short-run credit rationing. It is possible that some or all of this effect

might have been caught by the inclusion of non-rate terms. Silber (114) reports that he attempted to include both the loan-to-value ratio and the amortization period. However, in his preferred equation, estimated by first differences, neither term appears. Huang has experimented with both terms. His 1966 (57) and 1967 (58) studies use the change in the amortization period. This variable is found to have a strong positive impact in both studies.

Huang's 1969 study (56) uses a constructed variable called per annum payment which is the quotient of the loan-to-value ratio and the amortization period. The accompanying coefficient is negative in all equations. The interpretation of this coefficient is a bit difficult as one would expect that both terms in the ratio would have a positive impact on the demand for mortgages.

The Clauretie study includes all three parameters of the mortgage contract - the mortgage rate, the loan-to-value ratio and the amortization period. The coefficients on the mortgage terms always have their expected sign - the mortgage rate coefficient is negative and both the loan-to-value ratio and the amortization period coefficients are positive. The Clauretie study is potentially very valuable for examining the impact of changes in mortgage terms. However, as suggested, there appears to be a basic misspecification in the Clauretie study that raises some question about the interpretation of the effects of the mortgage contract terms. All of Clauretie's equations deal with the flow of mortgage credit. No measure of

the stock of mortgages appears in any equation, yet Clauretie's measures of housing demand - income, relative prices and a population variable - are clearly related to the demand for the stock of houses, not the flow of new houses. This misspecification is perhaps reflected in Clauretie's problems with these basic demand variables. Their coefficients are frequently of the wrong sign, statistically insignificant, or the variables have been dropped from an equation.

IV. THE INFLUENCE OF MORTGAGE INSTRUMENTS

The first chapter strongly suggested that the demand for houses may well be influenced by more than permanent income and/or net worth, relative prices and real interest rates. In particular, during inflationary periods nominal interest rates, through their effect on the stream of real payments over time, are very likely to have an effect on the ability of a segment of the population to buy a house.

While there is no clear cut way to model such factors, the earlier discussion does suggest that things like the initial payment-to-income ratio and the faster buildup of equity are important features and may well affect the ability of individuals to buy houses.

No study that I know of has reported attempts to measure the impact of such variables as the initial payment-to-income ratio or some measure of the tilt of the stream of real mortgage payments. Of course, these effects presumably correlate somewhat with movements in things such as nominal interest rates,

loan-to-value ratios, amortization periods and house prices. The following tables and discussion present in more detail implications from existing literature on the impact of some of these parameters of the mortgage instrument.

A. Interest Rates

There is virtually unanimous agreement that increases in mortgage rates reduce demand for mortgages and the number of housing starts. Table I shows mortgage interest rate elasticities of housing starts. However, simple correlation between housing starts and mortgage rates might be of ambiguous sign. On the one hand, higher mortgage rates lower demand. On the other hand, higher mortgage rates might increase the availability of mortgage credit and thus increase starts. For investigators who estimated demand and supply functions for starts, Table I reports only demand elasticities. Other investigators have estimated some sort of reduced form relationship Their interest coefficients, while still negative on balance, are some mixture of demand and supply effects. On balance, the single equation elasticities estimates appear to be substantially lower than the demand equation elasticities. It should also be

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Attempts to get elasticities for mortgage demand were less successful. Few authors reported elasticities; only Huang (57) published his data; measurement units were often ambiguous.

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noted that some elasticities deal with a subset of total starts.

There are several channels through which mortgage rates

might affect the demand for housing starts. One effect is through a change in the real mortgage rate, which would be expected to have a negative impact. Another effect is through the impact on monthly payments. Even if the real mortgage rate is unchanged, a higher nominal rate raises mortgage payments immediately and would be expected to reduce demand. A third effect might work through an expectations effect. When the mortgage interest rate rises, individuals might postpone purchasing a house in the expectation of lower mortgage rates. To adequately model this effect would require some expression for expected future mortgage interest rates.

Few studies we have surveyed have made a systematic effect to sort out these various effects. Almost all of the studies have used simple nominal interest rates. Swan (131) mentions an unsuccessful attempt to measure the real mortgage rate. He speculates that the failure of the real rate to work properly is related to the question of the financing gap, but does not pursue the point with any measure of the gap. No other empirical study reports on any measure of a financing gap.

It should be mentioned that the precise measurement of a financing gap would involve other variables besides the mortgage rate. The size of the financing gap would be related to the size of the loan, the maturity of the loan and the rate of inflation.

One must conclude that while the existing literature overwhelmingly suggests the negative impact of increases in nominal mortgage

THE EFFECT OF NOMINAL INTEREST RATES ON HOUSING STARTS

Investigator		Dependent Variable	Loan Parameter	Elasticity
MPS 1956:3 - 1972:2	Q	Value of single family starts	Mortgage rate	- .5[A] (Long Run) -1.00[A] (Short Run)
Brady 1960:3 - 197 :2	Q	Conventionally financed single family starts	Mortgage rate	-2.78[A]
Brady 1960:3 - 197 :2	Q	All starts	Mortgage rate	-2.02[A]
Arcelus-Meltzer 1915-40,48-28	A	All starts (demand)	Triple A corporate	-1.75[A]
		Single family starts (demand)	Triple A corporate	-1.36[A]
DRI (old) 1961:1 - 1973:2	Q	Starts	New corporate bond rate	- .3[G]
Fair 1959:6 - 1969:12	Q	Starts (demand)	Mortgage rate	- .59[G]
Huang 1963:2 - 1965:4	Q	Starts FHA (demand)	Mortgage rate	-2.36[E]
Rosen 1962:4 - 1972:4	Q	Single family starts (demand)	Mortgage rate	-1.33[A]
Kearl-Rosen 1962:4 - 1972:4	Q	All starts (demand)	Mortgage rate	-1.52[E]

Table II.1

Table II.1 (Cont.)

Investigator		Dependent Variable	Loan Parameter	Elasticity
Maisel 1952-1965	Q	Starts	Mortgage rate	-.56[A]
Swan 1958:1 - 1965:4	Q	Starts (demand)	Mortgage rate	-1.92[G]
Smith Canada		Single family starts	Mortgage rate	-1.56[A]
Bosworth-Duesenberry	SA	Value of residential construction ($1958)	Mortgage rate minus Triple A corporate	-1.86[E]
Wharton 1953:3 - 1970:1	Q	Non-farm residential construction	Triple A	- .67

A - reported by author

G - reported by W. Gibson in "Protecting Homebuilding from Restrictive Credit Conditions," BPEA, 1973:3.

E - Estimated

rates on the demand for starts, it is impossible to disentangle that effect into its several components.

B. Other Mortgage Terms

Other mortgage terms used in regression models are the loan-to-value ratio and the amortization period. The evidence of the impact of these terms is less extensive than that of interest rates. The absence of such terms from many models can be interpreted in several ways. Some investigators simply did not consider these variables either because of the lack of data, the belief they were correlated with other included variables, or the belief they were not important. Other investigators may have considered these variables during their preliminary work, did not get statistically significant results, and then eliminated the variables from their discussion. A small number of investigators report on "unsuccessful" attempts to include such variables.

By "unsuccessful" is meant a lack of statistical significance and/or an unexpected sign. This use of "unsuccessful" is a bit misleading. If a variable does not belong in an equation, the lack of statistical significance should not strictly be considered a failure.

Loan-to-Value Ratio

With respect to the loan-to-value ratio, the existing estimates, as shown in Table II, suggest a very strong response of housing starts to the loan-to-value ratio. When the number of starts is the dependent variable, elasticity estimates range

from 1.18 to 5.61. The Lee (76) study which uses the value

It should be noted that not all the elasticity estimates apply to total starts, some apply only to a subset.

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rather than the number of starts, finds a substantially lower elasticity. However, the Lee study is the only one that uses annual data. His data period runs from 1920-1941. All other studies use postwar quarterly data. If movements in the loan-to-value ratio are used to ration people out of the housing market in the short run, it would not be surprising to find a much larger response with quarterly data.

All the empirical estimates in Table II report a positive impact of the loan-to-value ratio on housing starts. Virtually all investigators have expected a positive impact although there are several possible ways that changes in the loan-to-value ratio could affect the demand for units. One can distinguish between a downpayment effect and a monthly payments effect. These two partial effects would be expected to work in opposite directions. The total impact of a change in loan-to-value ratios would thus be the sum of the two partial effects. The finding of a positive impact suggests the dominance of the down-payment effect.

Lower loan-to-value ratios mean higher downpayments and may thus eliminate families with little wealth from buying a house. Such an effect might mean no-house-purchase or the purchase of a smaller house. The latter impact would not mean a reduction

THE EFFECT OF OTHER LOAN PARAMETERS ON HOUSING STARTS

Investigator		Dependent Variable	Loan Parameter	Elasticity
Brady 1960:3 - 1970:2	Q	Conventionally financed single family starts	loan-to-value	2.54[A]
Brady 1960:3 - 1970:2	Q	All starts	loan-to-value	4.6[A]
Huang 1953:2 - 1965:4	Q	FHA starts (demand)	loan-to-value amortization	1.18[E] .22[E]
Kearl - Rosen 1962:4 - 1972:4	Q	All starts (demand)	loan-to-value	2.37[E]
Rosen 1962:4 - 1972:4	Q	Single family starts (demand)	loan-to-value	5.61[A]
Lee 1920 - 1941	A	Value of starts	loan-to-value	.865[A]
			mortgage rate times amortization period	- .277[A]

A = reported by author, E = estimated

Table II.2

in starts, only a reduction in the average size of units started. Undoubtedly some combination of effects on both the number and size of units takes place for those families who are down payment constrained. This discussion also suggests that a more appropriate way to measure the impact of loan-to-value ratios would include some measure of the wealth of potential home buyers and the price of houses.

The other way changes in the loan-to-value ratio could affect starts is through its effect on monthly payments. Other things equal, a higher loan-to-value ratio entails larger monthly payments. Larger monthly payments may eliminate some potential buyers. This monthly payment effect suggests that higher loan-to-value ratios would reduce the amount of homebuilding. There could be effects on either the number of units, the size of units, or both. Only one study, Huang (56) has suggested a negative impact of loan-to-value ratios on housing activity. All other studies we have surveyed, and Huang's equations for FHA and conventionally financed starts, report a positive impact of increases in loan-to-value ratios on housing activity. We thus conclude that the down payment effect exceeds the monthly payments effect.

Amortization Period

Evidence on the impact of amortization periods on housing starts is more sparse than that for the loan-to-value ratio. Huang (56) finds a small positive elasticity while Lee (76) finds a small negative elasticity. However, Lee enters the

amortization period multiplicatively with the mortgage rate, which makes the interpretation of his coefficient quite difficult. We conclude that in the existing literature there

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Unfortunately his specification does not include the mortgage rate as a separate variable if it had, interpretation of this variable would be possible.

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is some suggestion of a small positive impact on housing starts of lengthening the amortization period.

With regard to the demand for mortgage credit, there is more limited evidence of a positive impact of both the loan-to-value ratio and the amortization period. Clauretie (16) found large, positive and significant coefficients for both variables. Huang is the only other investigator to find any impacts of the non-rate terms on the demand for mortgage credit. His earlier work (57) finds a positive effect of changes in the amortization period. His later work (56) has the peculiar variable measuring per annum payments. Those results indicate that increases in the loan-to-value ratio decrease the demand for mortgage credit.

Huang's use of the per annum payment variable necessarily implies that the loan-to-value ratio and the amortization period will have effects of opposite sign.

In the interpretation of this evidence one should distinguish between the indirect effect of non-rate terms on mortgage demand

through their effect on starts and any additional direct effort on the demand for mortgage credit. In the Clauretie study, the non-rate terms have to be measuring both effects. However, other questions about the specification of his equation suggest caution in interpreting his results. In Huang's earlier study the change in the amortization period is also capturing both effects while in his later study the per annum payments variable is measuring only any additional effect. The equation already includes the value of new starts which in turn are influenced by both non-rate terms. We conclude that the existing literature offers only a limited suggestion of a direct effect of non-rate terms on the demand for mortgages. The largest effect would have to be derived from any impact on housing activity.

V. INTERPRET. . .WITH CAUTION

It seems that any interpretation of these results must be made with more than the usual caution, even for econometric evidence. The principal difficulty and one that is of major importance is the inadequate handling of short and long run effects. As noted above, most studies surveyed do not have explicit long-run equilibrium properties. For example, imagine that the interest rate falls. One would expect the demand for housing and home building to increase. The higher level of home building will increase the stock of houses above what it otherwise would have been. As the stock of houses approaches its new equilibrium one would expect the rate of home building

to decline. Any permanent effect of lower interest rates on home building would work through the stock (depreciation of a larger stock)--and through price effects--(new families may demand larger houses in response to lower interest rates). The mechanism described is the familiar stock adjustment mechanism where the initial response of the flow to a change is larger than its long run response. As mentioned before, the studies we have surveyed have concentrated on the flow of starts. Little attention has been given to long-run properties. Most studies have looked at the number of starts rather than the quantity of home building (size or quality times number). When considering starts one would imagine that the long run equilibrium number of units in the housing stock is dominated by demographic factors. The long-run influence of income, prices and interest rates on the number of units started would have to work through effects on either household formation or the demand for second units.

There is also a simultaneous effect of changes in the price of housing services on net household formation or, at least, households occupying separate units. An increase in rents can cause two or more generations of unrelated individuals to share housing, the "doubling" phenomenon, even though this possibility is usually not very attractive.

If a higher level of income leads to more mobility and hence a higher turnover in the housing stock, one might also observe a larger equilibrium level of vacant units and higher

stock of houses. Similarly, the use of housing units on a seasonal or occasional basis does not affect the number of households, but does affect the number of available vacancies and the stock.

Other appropriate changes in basic demand factors may lead to a higher level of replacement investment and thus a higher level of starts for any constant stock.

Another thing to keep in mind when looking at the elasticity estimates is the problem of possible disequilibrium in housing markets. If, as many observers believe, credit rationing is, at times, a real constraint on home building, then some observations would not be expected to lie on the demand curve. Inclusion of those points in estimation could bias estimates of the elasticity upwards. Only if one somehow adjusted these data points for the amount of rationing is the bias eliminated. Investigators have different views on the importance of rationing. Those who believe that rationing is important have included different variables in an attempt to measure credit rationing.

Two models with explicit allowance for rationing are Fair (31) and, following Fair, Swan (127). Fair reports an interest rate elasticity of the demand for starts of -.59 while Swan reports an interest rate elasticity of -1.92. The implications of possible disequilibrium in housing markets may not be as serious for interpreting coefficients on the loan-to-value ratio as it is for mortgage rate. Some investigators have argued that the loan-to-value ratio is, in fact, one measure of possible disequilibrium.

Finally, it is important what one's view of the structure of this sector happens to be. Several models have an explicit structure of demand and supply equations for starts. An alternative view presented in Chapter III conceives of a demand for capital (housing) because of the services provided, both old and new. Given the existing stock, a price is determined. The flow investment (starts) is then determined by the construction sector producing for profit. There is no separate demand for housing starts. Focus is on the processes of credit allocation, and response to prices and costs by those who construct homes.

This view of investment also implies that most studies of housing starts have been misspecified. To talk of the demand for starts is clearly inconsistent with this view. Particular starts equations might be better or worse approximations as they include good or bad proxies for this model. The MPS model is the only one surveyed that is specified in the spirit of the asset model, although it is estimated in a reduced form.

CHAPTER II: APPENDIX

The concern of this survey was not just with the results presented by any given piece of research but with the implications that a particular structure (or lack of one) had for the variety of results that anyone encounters when examining several pieces of econometric work: research that is nominally, at least, about the same business.

Hence, some time was spent analyzing the structures of various econometric models as estimated. This appendix provides schematic representations for overall comparison of model structures and included/excluded variables, something that is virtually impossible to do verbally. The models are reported as estimated. Those empirical studies examining the quantity of starts are outlined in Table II-A-1. Those examining the value of starts are in Table II-A-2. Research examining the mortgage demand functions, most normalized on the mortgage rate are in Table II-A-3.

II.A.1

	Dep. Variable	Income	P_{House}	P_{Other}	Rental	Costs	$r_{Mortgage}$	r_{Other}	Loan / Value	Amortization Period	Mortgage	Savings	Stock	Dep. Variable$_{-1}$	FHLB	FNMA	Demographic	Vacancy	Other
ARCELUS – MELTZER	C^H	Y_K^R		P	R														B/P S/P
	$^DH'$		PH		R			r_{AAA}			MS/P								$\hat{C}^H$ B/P S/P
	^SH		PH		R			r_{AAA}											L
DRI	H + MOB						$(r_m^c - P\dot{I}^c) \cdot POP1$				$\Delta OC/PI$	$\sum a_i \Delta MS/PI_{-i}$						$(\frac{1}{4}\sum VAC_{-i}) \cdot POP3$	
FAIR	^DH						r_{m-2} Δr_m						$\sum_{i=1}^{t} H_i$						T W DUM1
	^SH						r_{m-1} Δr_m					$\frac{1}{3}\sum SAV_{-i}$			$\frac{1}{4}\sum FHLB_{-i}$				T W DUM1
HUANG	$^DH^{FRM}$						r_m^{FRM}		ΔLVR^F $\Delta AMORT^F$					H_{-1}^F			ΔHHF_{-1}		
	$^DH^{VR}$		ΔPV						$\Delta (LVR/AMORT)^{VR}$					H_{-1}^{VR}			ΔHHF_{-1}		
	$^DH^C$	ΔY^D				C/			ΔLVR^C $\Delta AMORT^C$		$\Delta (MS/A)$			H_{-1}^C					
	$^SH^{FRM}$					C/PV	$(r_m^{FRM} - r_{AA})$	r_{CP-1}						H_{-1}^F H_{-2}^F					
	$^SH^{VR}$						$(r_m^{VR} - r_m)$	r_{CP-1}						H_{-1}^{VR} H_{-2}^{VR}		FNMA			
	$^SH^C$					C/PV		r_{CP-1}				SAV$_{-1}$		H_{-1}^C H_{-2}^C	FHLB				
KEARL-ROSEN	^DH	Y_C^P	$(PH/P)_{-2}$				r_m		LVR$_{-1}$								HHF		T SUB
	^SH					$(PH/C)_{-2}$		r_{CL}			M							VAC	
MAISEL	H				$(R/C)_{-1}$		$\frac{1}{3}\sum_{i}^{4} r_{TB-i}$							H_{-1} H_{-3}			ΔHHF	VAC	DEP
	H	Y_{-1}^D			$\frac{1}{3}\sum R/PH_{-i}$		$\frac{1}{3}\sum r_{m-i}$							H_{-1} H_{-3}		$\frac{1}{3}\sum FNMA_{-i}$		$\frac{1}{3}\sum VAC_{-i}$	
	H	Y_{-1}^P			$\frac{1}{3}\sum R/PH_{-i}$		$\frac{1}{3}\sum r_{m-i}$					$\frac{1}{3}\sum SAV_{-i}$		H_{-1} H_{-3}				VAC_{-2}	
SPARKS	ΔH	ΔY			$\Delta(R/C)_{-1}$						$\Delta(M+OC)$			$(H_{-1} - HHF_{-1})$		$\Delta FNMA$	ΔHHF		

II.A.1

DEP. VARIABLE	SUITS	SWAN		
ΔH		H		
		^{D}H		
		^{S}H		
$\Gamma_{MORTGAGE}$	$\Delta\{K(\Gamma_m^{D}+\Gamma_m^{S})-\Gamma_m\}$	Γ_{m-1}		
Γ_{OTHER}		Γ_{c-1}	$\Delta\Gamma_m$	
		Γ_{m-1}	$\Delta\Gamma_c$	
SAVINGS		SAV		
		SAV_{-1}		
DEP. VARIABLE$_{-1}$	H_{-1}	H_{-1}		
FHLB		FHLB		
		$FHLB_{-1}$		
VACANCY				T
OTHER				T
		VAC_{-1}		

II.A.2

	Dep. Variable	Income	P_{House}	P_{Other}	Rental	Costs	$r_{Mortgage}$	r_{Other}	Loan / Value	Amortization Period	Mortgage	Stock	Dep. Variable$_{-1}$	FHLB Advances	FNMA	Demographic	Vacancy	Other
Bosworth Duesenberry	HV						$\Delta(r_m^c - r_{BAA})_{-1}$				$\Delta(MS/PI)$ $\Delta(MS/PI)_{-1}$					ΔHHF		T DUM71
Brady	HV^c						r_m^c	$(r_m^c - r_{BAA})$		AMORT			HV^{VA} HV^{FHA}					STRG
	HV^{FHA}				R/P			$(r_m^{FHA} - r_{BAA})$	LVR		$OCLI_{-2}$		HV^c HV^{VA}		FNMA			
	HV^{VA}						r_m^{VA}	$(r_m^{VA} - r_{BAA})$			$OCLI_{-2}$		HV^c HV^{FHA}		FNMA			
	HV					C	r_m^c		LVR					FHLB				T
MPS	$\ln(HV1/POPS \cdot C)$	$\ln(Y_c^p/POP)$	$\sum_i b_i \ln(P/C \cdot RC1)_{-i}$ $RC1 = (1-TX)(.7\, r_m + .3\, r_{AAA} + .8\, TP) - 1.96$								$\sum_i c_i \ln\left(\frac{OCSL + FNMA}{OCSL_{-1} + FNMA_{-1}}\right)_{-i}$		$\ln(HS1/POP2)_{-1}$					cos T $\sum_i d_i \ln WL_i$
	$\ln(HVM/POP3 \cdot C)$	$\ln(Y_c^p/POP)$	$\sum_i b_i \ln(P/C)_{-i}$								$\sum_i c_i \ln\left(\frac{OCSB}{OCSB_{-1}}\right)_{-i} + d_1 \ln OCLI_1$		$\ln(HSM/POP3)_{-1}$					DUM66
Lee	$HV1/PH \cdot POPS$	$Y_p^p/POPS$				C	$(r_m \cdot AMORT)$		LVR			$(HS/POPS)_{-1}$						
Liu	HV1/P						$\frac{1}{3}\sum_i r_{AAA-i}$					$(HS/POP)_{-1}$ $(HVs/POP)_{-1}$, $(HVs/POP)_{-2}$						T $\frac{1}{3}\sum M2_{-i}$
Reid	HV/POP	Y_c^p/POP				$(C/P)_{-1}$												
Warrton	HV	Y^D	$\sum_i a_i (PI/R)_{-i}$				$\sum_i b_i (r_{AAA} - r_{CD})_{-i}$											
	HV	Y^D	$(PI/R)_{-3}$				$(r_{AAA} - r_{CP})_{-3}$											
Cassidy Valentini	^{D}HV1	$(a_0 \ln Y^D/HH - a_2 \ln POPS - a_3 \ln RC1_{-1})$										$HS1_{-1}$				DQ3 DQ1 DQ2		
	^{D}HVM	$(a_0 \ln POPS - a_2 \ln RCM_{-1} - a_3 \ln RCM_{-3})$										HSM_{-1}				DQ3 DQ1 DQ2		
	$\ln(PH/WPI)$											$\ln HV1$				DQ3	$\ln U$ $\ln W/WPI$	DQ1 DQ2

II.A.3

	DEP. VARIABLE	$r_{MORTGAGE}$	r_{OTHER}	DEPOSITS	MORTGAGE STOCK	HOUSING STOCK	HOUSING STARTS	LOAN / VALUE	AMORTIZATION PERIOD	INCOME	RENTAL $P_{HOUSING}$	VACANCY	DEMOGRAPHIC	COMMITMENTS
BOSWORTH-DUESENBERRY	Δr_m	r_{m-1}	$r_{US}^{3-5\,YR}$	$\%\Delta SAVW$	$\%\Delta MS$	$\%\Delta MS_{-1}$						VAC_{-1}		$SAVW = .75\,DSL + .25\,DSB + .03\,DCB + .05\,FRU$
CLAURETIE	M	$r_{\cdot}$						LVR	AMORT	Y^P	R/PH		DEM	
DRI	r_m		r_{N1} r_{N1-1} r_{ML_2}		$M/(HV+.1\alpha HS)$		$MS_{-1}/(HV+.1\alpha HS)_{-1}$							
HUANG	M				$\Delta MS/A$		H	LVR / AMORT						
JAFFEE (MPS)	r_m	r_{m-1}	r_{AAA}		$(\Delta MS+\lambda MS_{-1})/(HV+HS)$									$(OCSL_{-1}+OCSB_{-1}+OCLI_{-1})/(HV+HS)$
KEARL-ROSEN	M	$(r_m-r_{AAA})_{-1}$					H							
SILBER	ΔMS	Δr_m			ΔMS_{-1}					ΔY^P			ΔHHI	
CASSIDY-VALENTINE	r_m	$\%\Delta[\beta(r_m-r_{m-1})+(r_m-r_{m-1})]$			MS	HS_{-1}				Y^P				

Table III.A.4

GLOSSARY

A	Total financial assets
AMORT	Amortization period
C	Construction costs
D	Deposits in various thrift institutions
DUM	Dummy variables
FHLB	FHLB advances
FNMA	FNMA mortgage acquisitions
H	Housing starts
HHF	Household formation
HS	Stock of housing
LVR	Loan value ratio
M	Mortgage flows
P	Price of other goods
PH	Price of housing
PI	Price, Housing investment
PI^e	Expected inflation rate of housing prices
POP	Population variable
R	Rent index
r_{AAA}	AAA bond rate
r_{CP}	Commercial paper rate
r_M	Mortgage interest rate
r_{TB}	Treasury bill rate
SAV	Saving flows
STRG	Monetary stringency variable
SUB	Subsidized starts
S/P,B/P	Monetary base
T	Time
U	Unemployment
VAC	Vacancy rates
W	Wage
WL	Wealth
Y^D	Disposable income
Y^P	Permanent income

Superscripts:

D	Demand
S	Supply
VA,FHA,C	Mortgage types

Subscripts:

-i, ith	Lagged value
m, aaa, cp, etc.	Interest rate type

CHAPTER III

Households consume, among other goods in their market basket, housing services. Priced either implicitly or explicitly, such consumption is just one of a number of consumption decisions made by the household, and is assumed to be determined by utility maximization in the usual way. Like any other good consumed, the amount of housing services consumed is constrained by the budget of the household. Unlike many goods however, these housing services are provided by a durable which may depreciate through time, but which is not consumed in any single time period.

In fact, of course, housing services are provided by much more than just a structure. The type of neighborhood, the quality of schools and public services, taxes and many other contributors to the environment in which the household lives determine the service that a particular dwelling unit in a particular location provides. Many of these factor inputs that, combined, provide housing services are not easily augmentable or depletable. The costs of changing the services consumed may be very high. Consequently, the consumption decision for housing services may not have the same marginal relationships usually attributed to the rational household's consumption decisions at any given moment. However, over longer periods of time, households can adjust their position and the resulting consumption. It remains true that the consumption decision by the household for a flow

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Tiebout (136) suggested some time ago that households vote with their feet and change localities in response to these general services.

of services imparts value to the durable providing those services resulting in a derived demand, by wealth holders in the economy, for a stock of housing. This housing also serves as a store of wealth, an asset. This stock demand is based on the flow of income that the stock provides as an asset, income that represents expenditures for services. Those who demand housing services need not simultaneously have a demand for the stock providing those services. In the rental market, for example, the consumer of housing services and the holder of the durable dwelling unit, the apartment, are in fact distinct. The renter makes a consumption decision to purchase the services of a specified space in exchange for a payment, the monthly rent. The landlord supplies that service by owning an asset, the apartment. His decision to hold the apartment through time depends upon the income stream, the monthly rental, that the asset generates. (The actual stream of income is of course the rental adjusted for depreciation, maintenance, etc.)

If we ignore tax incentives for ownership for the moment, then it is conceptually useful to assume that all housing services are purchased in a rental market. That is, in the event that the consumer also owns the asset, he acted, when purchasing the home, as a rational wealth holder interested only in the stream of income (implicit) the asset provided. He would additionally be concerned with how well the asset served to store his wealth. Ownership of space is unimportant in the consumption decision; the consumption decision is unimportant in

the asset acquisition decision. There are, as a consequence, two demand relationships of importance: demand for housing services and, derived from the income stream the marketing of those services provides, a demand for the stock of housing.

There are some difficulties encountered when viewing the stock demand for housing as an asset demand. Asset demand theory views holders of wealth, a stock, as making decisions at a particular moment of time about the allocation of that stock among competing assets. The allocation decision is based on returns of competing assets, with portfolio diversification if the wealth holder is risk averse. The actual wealth held serves as a "budget" constraint on the portfolio size. A house is lumpy in the sense that the asset price is large relative to the wealth of the prospective "owner". In fact, of course, wealth holdings in the economy are skewed. Demand for owner occupied housing comes, at least in part, from the younger households in the economy, households that have not yet accumulated wealth. Wealth is held by the older households, often in the form of housing. Consequently, many of those who are active in the market for housing stock are not those with large accumulations of wealth, at least relative to the purchase price of housing.

But of course it is not true that the household acquires the asset at the time of purchase of the dwelling unit. Equity, actual ownership of the asset, is accumulated slowly through time. In fact, second mortgages, varying downpayments and varying

speeds of prepayment are indications of households' efforts to adjust their portfolios by adjusting how much wealth, that is equity, is held in the form of housing. The constrained nature of the ability to adjust portfolios is likely to become an important determinant of either short run housing stock demand or, perhaps, the adjustment toward long run positions.

This conceptualized dichotomy between service demand and stock demand could in fact exist for owner-occupied housing if there were housing trusts from which one rented housing owned by the trust and purchased ownership shares of the trust. Payments to the trust would then represent both rental for the service consumed which was provided by the housing capital and the decision by the household as a wealth holder to purchase housing capital. There is some experience in areas outside the United States with mortgage bonds, which despite legal and economic differences, in a crude way provide some of the services that such a trust might.

In a limited way this role is played by those financial intermediaries in the economy that offer mortgage funds. The household, via monthly payments, transfers to the mortgage holder a return on real capital, housing. Presumably this is the reason the mortgage was added to the portfolio of the holder. Simultaneously, the household is purchasing from the holder of the housing capital, the intermediary, a share of that capital. Constraints imposed by tradition, law and conditions in the rest of the economy limit the flexibility of both the household and

the intermediary in adjusting their positions. I have stretched the tale too far since the mortgage is, after all, a debt not an equity instrument. Moreover, under current law, the household holds title to the property and the mortgage provides capital to the household based on very special collateral, the housing unit. The mortgagee can only exercise its "ownership" of housing capital in the case of default on mortgage payments through lengthy and costly foreclosure procedure. Earlier in our history, the title remained with the mortgage holder until the debt had been repaid. Then it was transferred to the household. There are forms of contracts, contract for deed, where this is still the case. But, the difficulty of exercising the mortgagee's lien against the property through foreclosure often makes the household the de facto owner even though but little equity may have been accumulated. At the very least, such friction in the legal system allows the household, particularly one in economic distress, a good deal of flexibility in equity accumulation. Since the payment for services is lumped together with that for purchase of equity, the current contract yields for such a household a seemingly free "house" (if not a free lunch).

I. A MODEL OF THE HOUSING AND MORTGAGE DEMAND SECTOR

At any given moment of time, a stock of housing capital exists. Since someone must own that existing stock, the market price must be such that the stock is willingly held.

The household is assumed to own only the equity accumulated and the mortgagee owns the difference between that equity and the face value of the mortgage. Note that the household accumulates equity not just through purchase but through capital gains as well. Existing market arrangements allow only the household to capture any capital gain, since the household always "purchases" the dwelling unit from the mortgagee based on the face value of the mortgage not the present market value of the mortgage.

One can view several of the proposed mortgage innovations as forcing the household to purchase based on the current market value of the mortgage. (e.g. variable rate instruments) That is, instruments can be designed that allow for sharing the capital gain on the mortgage between the household and the thrift institution. It is possible, though highly unlikely, that instruments could be created that inherit the characteristics of equity instruments. In such a case, the thrift would share in the capital gain on the housing capital itself.

Housing services available for consumption at any given moment are determined by the stock of housing. They are functionally related to the stock. They are not related to the rate of change of the stock, housing investment, nor to housing starts. Indeed, in this view of the housing sector, focusing on the primary demand for services and the derived demand for a stock of housing, there is no direct demand for starts per se.

Since a number of housing studies postulate a demand for starts it is probably worth re-emphasizing why there is no such demand in this view of the housing sector. Households consume services. Services are provided by space. Space is determined

by the size of the stock. Except for depreciation, any unit in the stock, new or old provides the same consumption services from a given space. This is obviously a tremendous simplification since style, neighborhood and many other things determine the flow of services as perceived by the household. The market should and would price these heterogeneous goods differently. Only if one believes that "newness" however quantifiable completely over-rides all other considerations (including economic depreciation) will a separable demand exist. This would imply that there are two distinct goods, new homes and other homes, providing very different services.

A. Demand for Housing Services

It is usually assumed that the actual flow of services is proportional to the stock of housing. In equilibrium in the consumption market, demand for services (D^S), a function of the real rental (R/P), permanent income (Y^P) and perhaps financial wealth (W), is equal to the flow of services:

III.1 $\quad (R/P, Y^P, W, Dem) = \alpha HS.$

where R is the nominal rental and P is an appropriate consumption deflator. The flow of services provided by the housing stock (HS) over the relavent time period is a proportion (α) of that stock. The demand for services is of course dependent upon the number of households in the economy actively consuming those services and thus of the demographic (Dem) characteristics of the economy.

Since gross additions to the housing stock are below three percent of the stock on an annual basis, at any given time the stock can be considered fixed. The flow of services from that fixed stock is inelastically supplied. Therefore, the demand for services determines the implicit or explicit rental that clears the housing services market by rationing demand to the fixed

service flow. We can solve for the rental as a function of the fixed stock and permanent income, with account taken for demographic variables.

III.2 $R/P = \phi(Y^P, \alpha HS, Dem)$

It should be emphasized that this is not a demand for the housing stock, but a demand for services relationship. There are no direct effects of financial variables on the consumption decision.

Someone "rents" every unit - if the unit is not on the market nor occupied then an implicit rental is being paid, the foregone earnings on that unit. Flexible rentals necessary to clear the services market do not imply that every unit is occupied: the number of occupied units (households) may be a function of the rental.

The number of occupied units defines the number of households in the economy. Clearly, household formation, that is, people occupying separate dwelling units may be a function of the rental. Increasing rentals may force several generations to occupy the same dwelling unit. This "doubling" phenomenon was relatively common after World War II. Either increasing and/or high rentals may inhibit the movement of single young adults out of their parents' homes.

B. Demand for Housing Stock

The fixed housing stock is also an asset. Someone in the economy must hold that stock as an asset, the decision based on wealth and the return on housing capital relative to returns from assets competing for inclusion in the wealth holder's portfolio. Wealth holders in the economy are induced to hold

the stock of housing by changes in the asset price of housing (PH), changes that reconcile portfolio decisions with the fixed stock of housing. That someone must hold the stock implies price flexibility. The asset demand (D^h)-stock equilibrium is represented as

$$\text{III.3} \qquad HS = \psi(R, PH, \underline{r}, \underline{cr}, W)$$

where $\underline{r}$ is a vector of returns on competing assets and $\underline{cr}$ is a vector of credit terms, discussed in detail in the following chapter.

Some of the stock that is held is vacant and obviously not providing housing services to households. Strictly interpreted, the housing services are thus provided only by the actually occupied stock.

Vacancies occur for a variety of reasons: deterioration of the environment surrounding the unit, default and the frictions involved in foreclosure and resale, the normal frictions of the market place, speculation and inventory purposes. An important determinant of vacancies about which more will be said later, is mobility and migration. Unlike other stores of wealth the household may hold, housing units are identified by both lumpiness and stationarity. A house in Boston is not the same as a house in Logan, Utah if one must relocate.

This is simply to point out that, although presumably most of the stock is held because of the income stream provided by marketing the services, some of the stock is held by individuals for other reasons.

C. Relationship Between Service and Stock Markets

I assume that the flow of services is proportional to the housing stock, implying that the economic depreciation of the asset providing those services, the "amount" of the stock

consumed over any short interval would be

III.4 $\quad dHS/ds = -\delta HS(s).$

A unit asset purchased at time t depreciates to

III.5 $\quad \exp(-\delta(s-t))$

units at time s. This is the flow of services provided by the unit of housing over the interval. If the rental for those services at time s is R(s), then the earnings (implicit) of that unit asset at time s is

III.6 $\quad \exp(-\delta(s-t)) * R(s).$

Therefore, for a unit of capital acquired at t, the discounted value of the stream of services prices at the rental R (s) over the interval ds is

III.7 $\quad \exp(-r(s-t)) * R(s) * \exp(-\delta(s-t))\ ds.$

The asset is then priced at

III.8 $\quad PH(0) - \int_0^t \exp(-(\delta+r)s) * R(s)\ ds$

and III.9 $\quad PH = -R + (r+\delta) * \dot{PH}$

or III.10 $\quad R/PH = \delta+r-(\dot{PH}/PH)$

If there is no appreciation of the asset then the housing cost of capital (HCC) is defined to be

III.11 $\quad HCC \equiv r + \delta - R/PH$

If perfect capital markets existed and over extended periods of time, $\underline{r}$ would not be a vector but the relavent information would be summarized by the cost of capital adjusted for risk and liquidity. This housing cost of capital (HCC) serves to link the services and asset markets. With perfect capital markets and a long lived asset, the gross rate of return on housing capital, the rental rate relative to the asset price (R/PH), would equal the housing cost of capital. Given the rental, determined in the services market and the housing cost of capital which,

under competitive conditions would be viewed as exogeneous to the housing sector, the observed point on the asset demand function would always be determined as

III.12 $PH = R/HCC$

or that price that equated the gross return on housing with the return on capital in other sectors of the economy,

III.14 $R/PH = HCC.$

Competitive conditions would insure this condition would hold as arbitrage led to pressures on the asset price, PH. Such arbitrage may be extremely slow and long run since housing is purchased in discrete bundles and is not easily depleted or augmented. This arbitrage does not lead to immediate changes in the stock and thus services are but little affected immediately. However, price changes may lead to substantial changes in the additions to the stock, consequently the stock available in the future and, thus, the services such stock provides.

With less than perfect markets and over shorter periods of time, variations in the asset demand for housing lead to movements in the asset price as returns on various assets change and as the ability of households to move into and out of holdings of housing capital changes.

There is no clear meaning to "optimal capital stock" in this view of the housing markets. Indeed, the existing stock is always optimal in the sense that the price of the stock will adjust so that everyone is content to hold that portion which presently resides in his portfolio. Consequently, there is no stock adjustment mechanism that links the housing markets

with the investment in housing and ultimately with housing starts. Instead, we need to model the effects of changing asset prices, since that is what is moving, on housing investment and eventually starts.

D. Flow Supply of Housing Investment

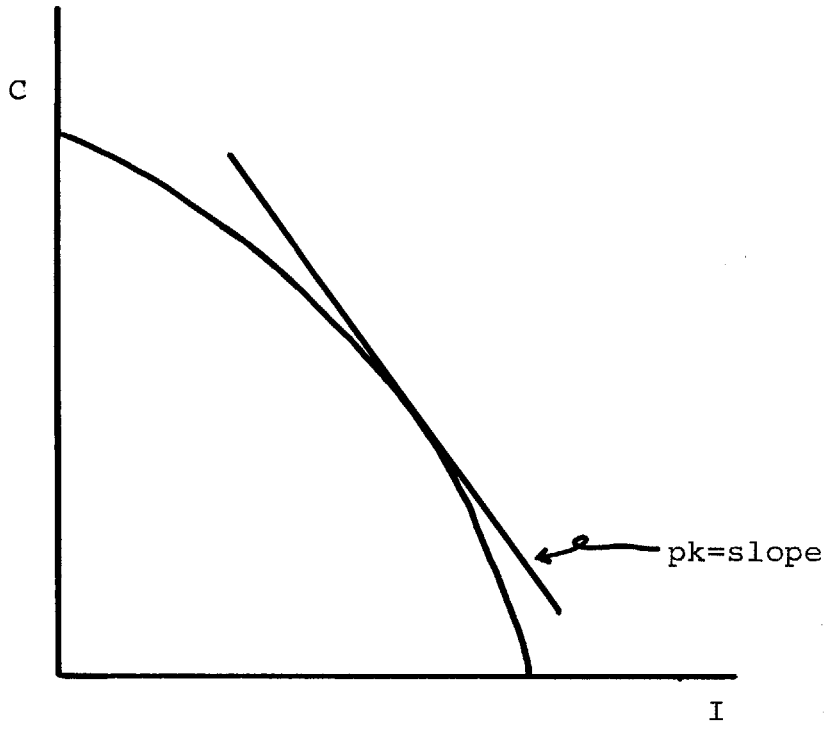
A caricature of the results that changing the asset price have for housing investment can be drawn by considering a simple two sector - two good economy with strictly concave production possibility frontier.

This simple model serves as the focal point for a series of articles and research by D. K. Foley and M. Sidrauski (39, 40) and Foley and R. Engle (25). It also reflects some of the ideas of Tobin (134) and Tobin and Brainard (11). A simple, early, but elegant outline of this view of investment was made by Witte, (143).

A diagram of such a frontier between investment goods and consumption goods is provided in Figure III.1. Given an asset price, relative to consumption, profit maximization will lead to production at the appropriate point of tangency on the frontier. Varying the price leads to varying outputs in the investment goods sector and consequent higher output and larger additions to the stock of capital.

Therefore, it is the price of capital that is the proximate cause of investment; it regulates the flow supply of capital. It also determines the gross rate of return, given equilibrium in the service market and the determination of the rental for those services. The higher the price, the lower the rate of

Figure III.1



return. The interest rate is a determinant of the asset price, but by no means the only one. With market imperfections, and varying risk and liquidity characteristics, the rates of return on a wide variety of substitutes for housing capital in households' portfolios would influence the asset demand for housing. It is possible, as suggested in the first chapter of this thesis, that movements in the nominal interest rate due to inflation may affect the effective demand for the stock and have rather pronounced impacts on the asset price and through this on the level of starts.

This view of the generation of the flow supply of capital goods focuses analysis on the capital goods production sector, in this case, the construction industry.

This focus is quite different than that generated by the optimal capital view of investment (Jorgensen, et al) which, for the most part, ignores the investment good production process. In models of this type it is implicitly assumed that supply is sufficient to meet demand at the going supply price. Investment is basically a demand phenomena.

Housing starts are provided by the construction industry. Both the value and the number of such starts depend, as described, on the asset price. Builders, in the single family market, are small low-capital firms. Production depends upon expected profitability and access to working capital. Given working capital, builders compare the asset price with their construction costs and respond with starts when profitable. However, since production is not instantaneous, but requires some period of time,

this period's starts are not marketable at the current asset price. Expectations about the path of the asset price are important determinants of actual starts. Therefore,

III.15 $\quad Hstart = \theta(PH, \underline{c}, PH^e)$.

The picture presented here is most appropriate to builders who produce units on speculation. The Census has recently begun to publish sketchy data on housing inventories. They provide data on sales by three classes: sales before start, sales during construction and sales after completion. The first would primarily be contract construction; the third primarily speculative building. If we consider the second class speculation also, then sixty to sixty-five percent of all single family starts are speculative. The great majority of multifamily are speculative since forward rental contracts for unfinished units are uncommon. Consequently, the percentage of speculative building is probably well above sixty-five percent.

Given the asset price of housing, the actual value of housing starts is determinate if the construction supply function is less than infinitely elastic. This will be so if capacity constraints increase costs as there are increases in the rate of construction.

As Witte notes (143), there are two equilibrium conditions: first, the asset price of housing must be such as to induce wealth holders to hold the stock; second, the rate of construction must be such as to equate this asset price and the marginal supply price. There is a third. The rental must be such as to equate the demand for housing services with the fixed supply of those services. Both the housing services market and the housing asset market can be in equilibrium, yet there can still be housing investment. There will continue to be such additions to

the stock of housing as long as the relationship between the asset price and construction costs creates profit possibilities for the construction industry. The size of the additions to the stock in any time period is determined by the construction industry. Builders determine how much they care to produce at the current market price, consideration made for the expected path of that price. The limitation is one of capacity and cost. The only variables that are unequivocally related to housing starts are price and price expectations. Other variables affect starts only because starts are not perfectly elastic with respect to the asset price.

The simple two sector model implies that as the price of capital changes, the economy remains on the production possibility frontier, thus insuring full and efficient employment of resources. This must imply rapid release or absorption of resources from the production of the various goods in such an economy. It is possible, however, that resources may simply become unemployed. Output continues to be determinate as long as the supply curve is still upward sloping, due to rising marginal costs to construction, only at a lower level of activity.

One can characterize the movement of resources implied in a way similar to that employed by Witte. If there is a schedule of prices at which individual construction firms will cease production because they cannot meet variable costs, then as the asset price of housing changes so will the number of firms engaged actively in construction. A rise in the price of housing

units will increase the number of firms in operation and thus employment, etc.. In this case the allocation of resources employed shifts but not the resources themselves.

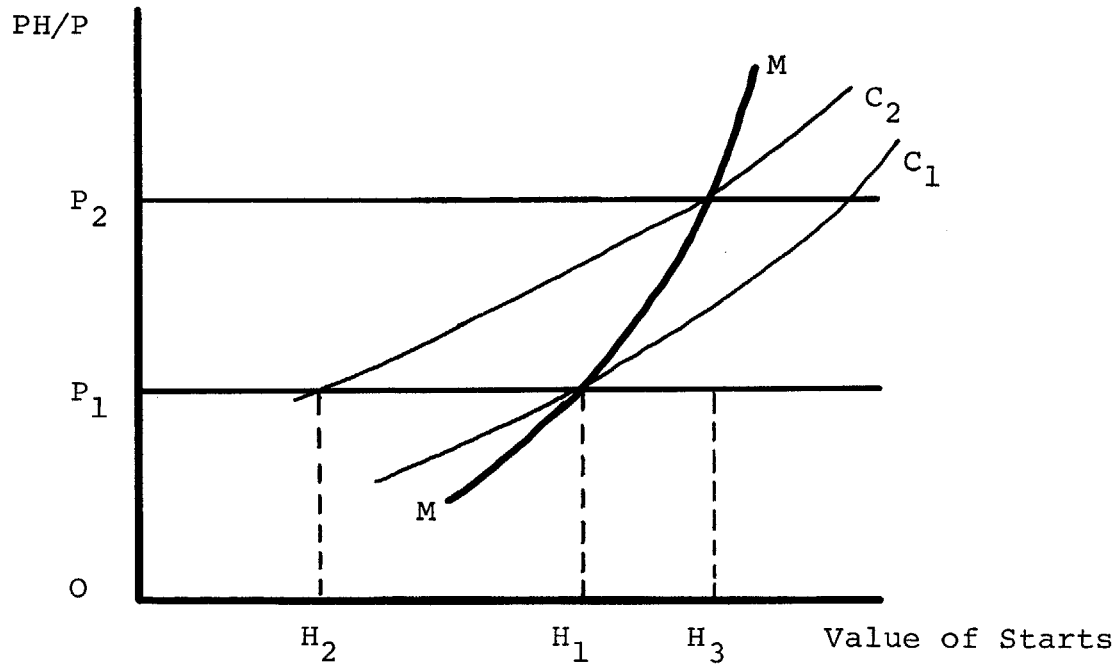
One must be careful about the precise meaning of costs in this model. Factors specific to the construction industry, even though priced as exogeneous to any given firm, are not exogeneously given to the industry and consequently are not unaffected by the aggregate demand of all such firms. Indeed, if all factors used by the construction industry are specific to that industry, then the costs of production are price determined rather than price determining. The price is determined in the asset market, builders simply expand construction until the marginal supply price of starts equals the asset price. The process of expansion drives up costs to the breakeven point for the marginal firm; it is the expansion that has led to higher construction costs. If costs did not rise as the price rose (and output), the supply would not be determinate.

Factors that are perfectly elastically supplied to both the firms and the industry, that is, where the industry appears as a competitive firm in these factor markets, shift the industry supply curve as the factor prices change.

With a dynamic industry, an identification problem arises, since shifts in the supply curves correspond to endogeneous expansions in output resulting from higher asset prices and the industry is viewed as moving along a supply relationship that has less elasticity than the ceteris paribus supply curve. Even though cost functions still underlie the supply curves, it is not possible to recover them from the estimated industry supply relationship.

For example, when the asset price is OP_1 in the following diagram, then C_1 is the industry supply curve. At OP_1 should costs increase the industry supply curve shifts up in the usual way to C_2 and construction activity falls from OH_1 to OH_2. (The supply curve slopes up because new firms coming into the industry are less efficient, etc..) However, suppose that the asset price moves from OP_1 to OP_2 in response to demand changes in the asset market, then the effort to expand by all the firms leads to higher factor costs and a shift in the supply curve to OC_2. However, in this case costs went up because prices went up and at equilibrium costs and prices should equal, differing only due to adjustment lags.

What the data reveal is the movement along M which display the combined effects of the intrepreneurs' selection of minimum cost combinations of inputs and the impacts on the firm of expansion by the industry. (See Stigler (125), Friedman (42), or Bishop (6)).



Finally, the simple model is completed by noting that the stock of housing (HS) is simply a sum of the past history of housing starts with adjustments made for alterations, depreciation, demolitions and other losses from the stock.

It is perhaps useful to summarize and illustrate the model. The demand for housing services, a consumption demand, determines the rental. Given the rental, the demand for housing stock, an asset demand, determines the asset price of housing. The wealth holder comparing the gross required rate of return on housing with the rates of return of other assets induces movement in this price. Given the asset price, starts are determined by builders. Thus,

III.2 $R/P = \phi(Y^P,$ a HS, Dem)

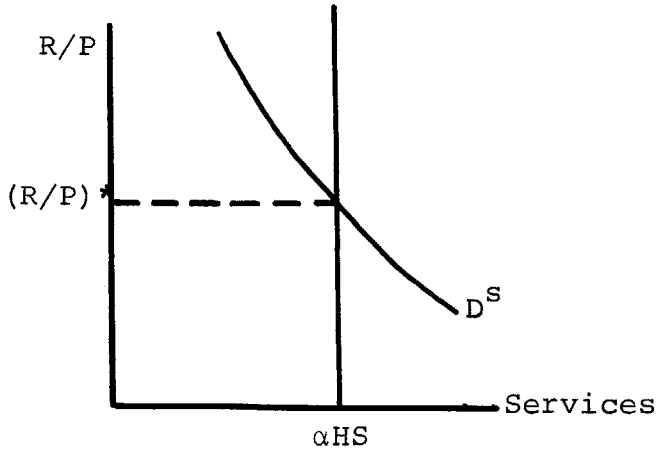
III.3 $PH/P = \Psi(R/P, \underline{r}, \underline{Cr}, W, HS)$

III.15 $H^S = \Theta(PH^*, PH^e, \underline{C})$

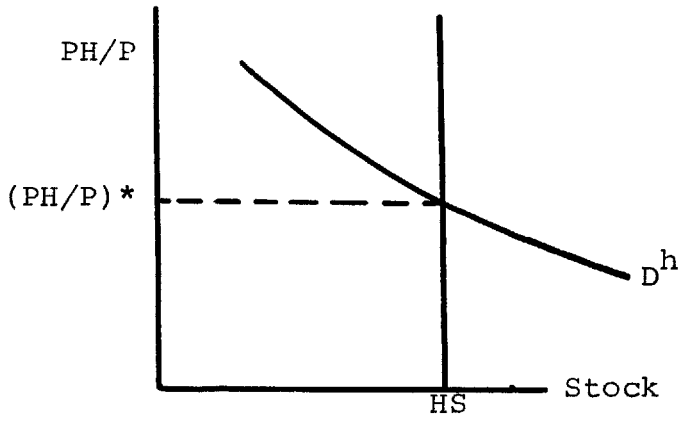
which are illustrated in Figure III.2.

In this model questions about "financial determinants of housing demand" are not well posed. The demand for housing services, a consumption flow demand is like the usual consumption demand function. No financial varaibles enter this demand function. Financial variables affect the, conceptually distinct, asset demand by altering the relationship between the various rates of return and credit conditions of a non-rate sort, thus changing the asset price and ultimately affecting housing starts. In addition, the housing starts relationship should properly account for financial costs of construction through a construction loan rate.

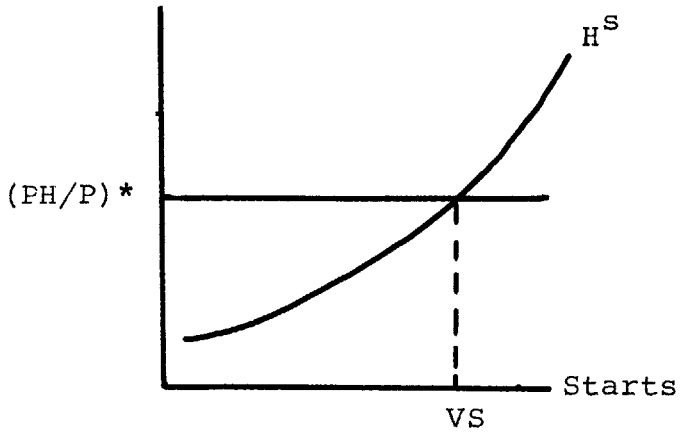
Figure III.2



Housing services market determines R*



Housing asset market given HCC, R* determines PH*



Construction given PH* determines starts

This simple model has an interesting dynamic which is illustrated by the following example. Assume that income rises in the economy. The demand for housing services shifts upward. Since the stock is fixed and thus the supply of services also,

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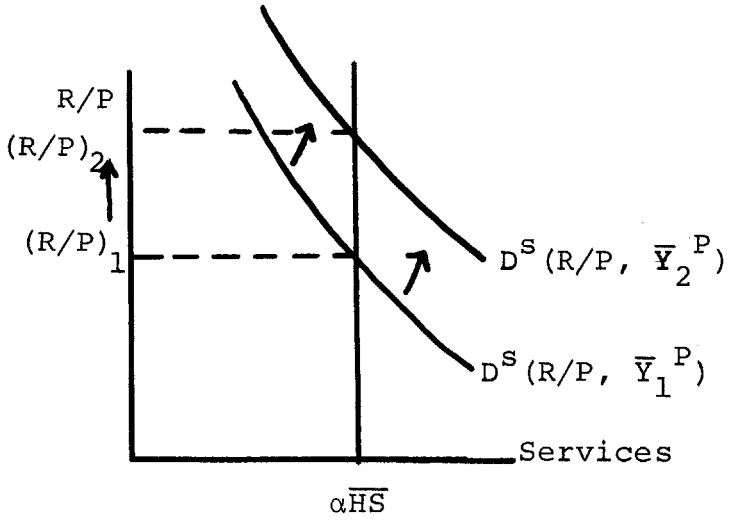
The size of the shift relative to the income change, the income elasticity of demand, is subject to considerable debate.

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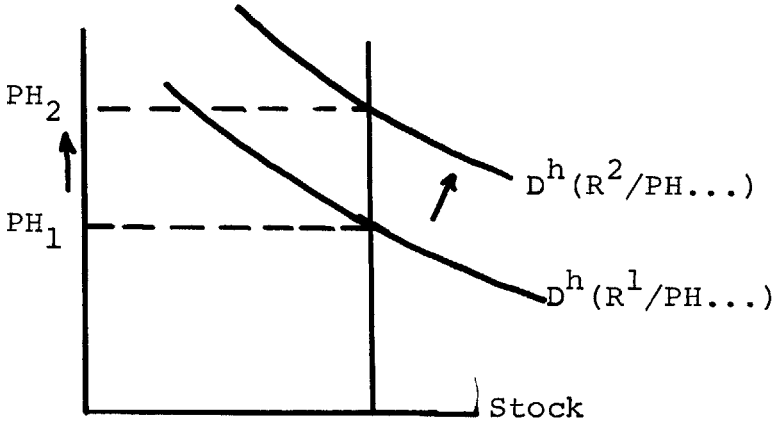
the demand shift leads to higher rentals for those services. Initially, asset holders find that the gross required rate of return on housing has increased, portfolio adjustments take place that shift demand for the stock. Again, with a fixed stock, this simply leads to higher asset prices. But those higher asset prices have a stimulative effect on the construction industry, as builders respond to a more favorable price-cost comparison by expanding construction. This addition to the stock eventually will lead to lower rents, lower asset prices, ceteris paribus, and consequently less construction. In the long run the flow supply of housing starts dominates, although short run parameter shifts are absorbed by rent and asset price changes. This argument is illustrated in Figure III.3.

Now let interest rates rise. Initially, with the asset price and rental at their old levels, the required gross rate of return on housing has fallen relative to alternative returns and the housing cost of capital. Portfolio readjustment leads to decreased asset demand. This can only be reconciled with the fixed stock of housing which must be held by someone in the

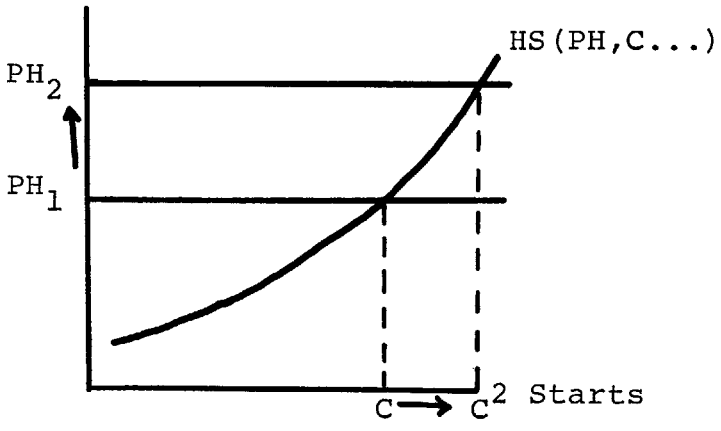
Figure III.3



Housing Services Market



Housing Asset Market

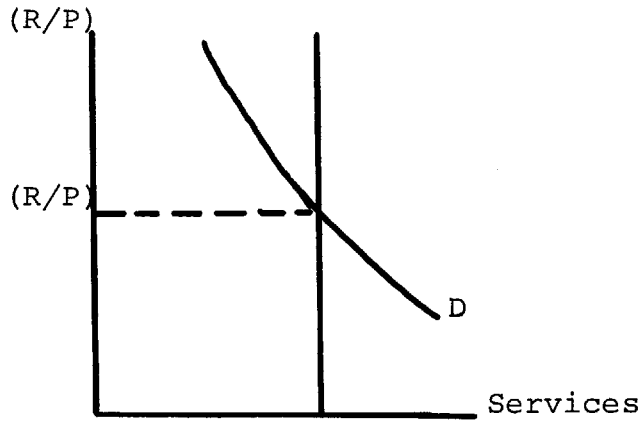


Construction

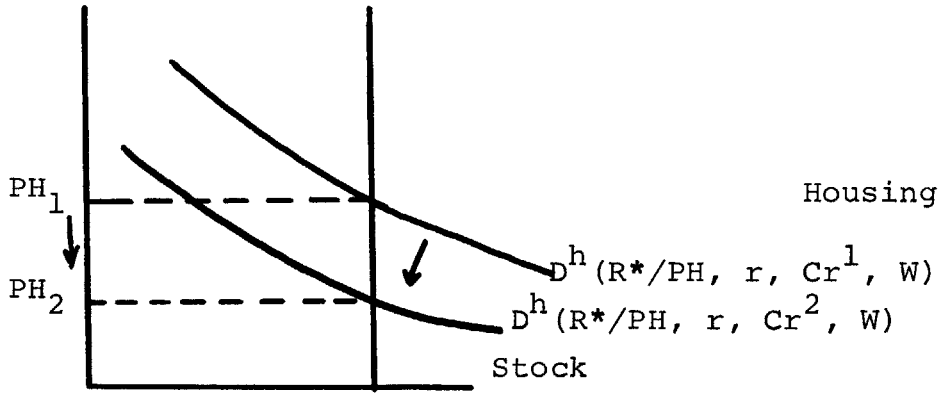
economy, by a fall in the asset price. This implies an increase in quantity demanded - a movement along the new asset demand curve. At the same time capital costs for the construction industry are rising and the supply curve shifts left. Starts fall. Note that the demand for housing services is unaffected and the implicit rental on the services from the stock does not change immediately. The interest rate change has not led to large changes in the consumption of housing services. Presumably, welfare has not been affected very much. Neither the stock nor the demand for services is directly affected by rising interest rates. Only via the mechanism of fewer additions to the stock are rents changed by financial variables, as we move up the demand for services function. The demand for services remains unaffected except through possible general equilibrium impacts on income and the price level or possibly through a Fisherian effect. Indeed, since changes in starts represent very small perturbations in the stock of housing, the flow of housing services to the households in the economy is hardly affected by changes in financial variables.

The principal impact of financial markets and mortgage markets on housing is through asset holders' valuations of housing capital and the resulting changes in the asset price - marginal supply price of starts comparison. Figure III.4 illustrates the changes that occur in the housing sector when changes in financial conditions cause a relative fall in the gross required rate of return on housing (R/PH). These initial

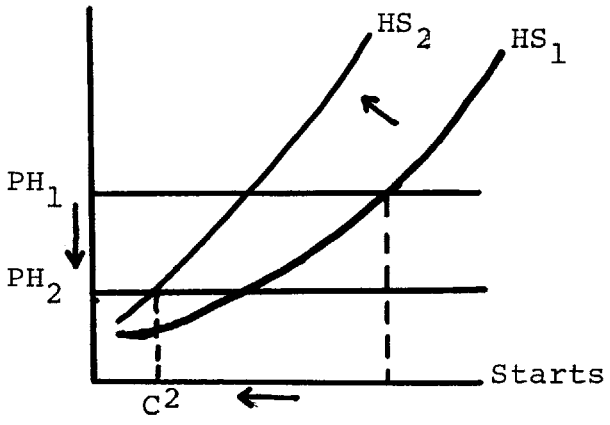
Figure III.4



Housing Services Market



Housing Asset Market



Construction

impacts are then followed by small changes in the stock and eventually a slight rise in the rental for housing services. However, large period to period changes in starts lead to relatively small changes in the stock.

In all of these examples, unless the sector is continually buffeted by shocks, the asset price will approach that price implied by the rental and cost of capital. The asset price so determined will be sufficient to coax from the construction sector a flow that just offsets the depreciation of the stock.

II. MORTGAGES AND HOUSING

Thus far, we have ignored the problem that housing, as an asset, is generally not easily depleted or augmented. It is a lumpy good, bought and sold in very discrete units. However, the physical capital may be upgraded or depleted through additions, alterations or depreciation. Moreover the amount of wealth actually held as housing, the accumulated equity, is easier to adjust and not as lumpy as the dwelling unit itself. A household can vary to some degree the amount of initial equity via the size of the downpayment. Later, the household can adjust the equity held in housing by issuing second mortgages against the dwelling unit. Traditional mortgages limit that flexibility to a considerable degree, by defining a rather lock-step forced equity accumulation (forced saving) via the amortization process.

At any moment, the household, as part of its portfolio decision makes choices about its holding of wealth in housing. It adjusts this holding by adjusting the share of housing it owns,

the share not mortgaged. This implies an optimum mortgage housing capital ratio (MS/KH)* which is assumed to be determined by the household's net worth and the returns on competing assets.

Portfolio allocation by rational households generally implies reallocations of wealth until the marginal utility of holding all assets will be equal. This need not hold precisely when borrowing is allowed since most borrowing requires specific collateral, in this case a mortgage requires the own dwelling unit. (This sort of collateral requirement encourages the purchase of those assets which serve to meet the collateral requirements.)

In the case of housing, the lumpy nature of the asset results in high initial price relative to income and perhaps wealth. Consequently, adjustments are likely to be slow. However, I believe one would expect adjustments. After all, the only way a household can capture the capital gains on the asset and still retain services is to offer a second mortgage, essentially against those capital gains. The shifting of wealth, that is the optimal MS/KH, may also be more subtle and more difficult to measure. Households can be quite active in this market, although goods are never traded explicitly by varying the speed of payments or prepayments of the mortgage. This view does not imply that all mortgage debt is used for housing: even though there are well defined collateral requirements, wealth is rather freely transferred into and out of housing.

Data on second mortgages are not available, however some data on first mortgages acquired after the purchase of the dwelling unit are available in the 1970 Census of Housing

For single unit (owner occupied) dwelling units

19,099,000 units were mortgaged (of 31,145,000 properties)

13,623,000 of these were placed at time of acquisition

2,599,000 were placed later (589,000 on property owned free and clear)

of these 2.5 million units

171,000 were used to renew loans

376,000 to obtain better terms

1,087,000 to finance additions and alterations

110,000 to acquire other real estate

113,000 to obtain funds for other investments

98,000 for funds to finance education.

The breakdowns are very similar in percentage terms for other classes of structures.

III. A CAVEAT

Whether or not such a model is a credible characterization of the economic relationships under study depends, to some degree, on the plausibility of certain assumptions. Price flexibility is a key determinant of the behavior of the model and is based on the assumption that individuals do not, over long periods of time, hold capital unwillingly. However, since a physical capital stock exists at any moment (and depreciates slowly), the existing stock has to be reconciled with peoples desires by changing in value. This obviously implies price

flexibility. There are two important issues associated with this implied flexibility: the role of vacancies and the importance of portfolio adjustment in this market.

A. Vacancies

Despite price movements, we do know that units are vacant and that vacancy rates move in a cyclical manner. Vacancies can be thought of, in this model, as demand determined; caused primarily by slower than instantaneous adjustment to new equilibria with demand shifts. The role that vacancies play

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The implication here is really for "excess" vacancies, that is, those above (or below) the level generated by the normal functioning of the market when prices are not moving.

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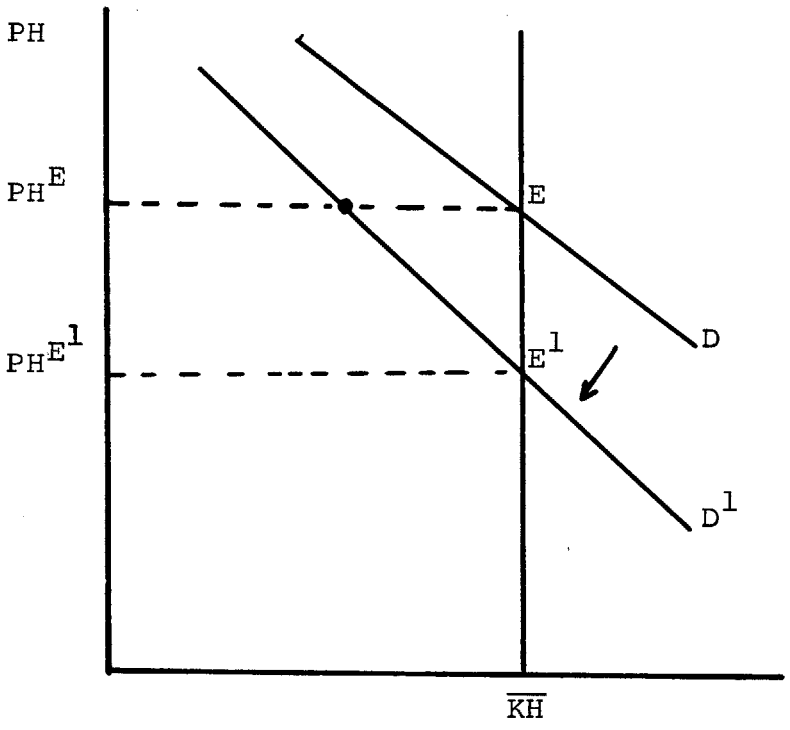
in this model has several further implications which can be easily illustrated.

Suppose there have been no exogenous demand shifts so that point E in diagram III.5 represents a long run equilibrium. Associated with E is a certain level of vacancies determined by the usual frictions involved in the turnover of the stock. Now suppose demand falls. E' is the new equilibrium price.

Such things as mobility, migration, household formation and institutional arrangements might be determinants of this equilibrium level of vacancies.

However, if there is less than instantaneous adjustment, the current price will lie somewhere between E and E'. It will of

Figure III.5



At PH^E and D^1, vacancies are high because PH^E is above PH^{E^1}, the new equilibrium prices.

course move toward E' as the slow arbitrage of the market takes place. With any price above E', the stock demand is less than the fixed supply and vacancies occur. Notice that vacancies are price determined, not price determining. (Although, they may, of course affect the rate at which the price changes.) Further, the model implies that vacancies and price move in the same direction. The causal relationship is, however, vacancies falling because the price is falling. At E', vacancies remain, but they should have fallen to the normal level associated with E, independent of the level of prices.

Unless, of course, other determinants of the vacancy rate associated with stock equilibrium changed during the course of price adjustment.

Even though the construction industry responds to the price in determining the level of its activity, clearly prices above E' associated with "high" vacancy rates do not convey the same signals as do equilibrium prices above E'. One would expect lower levels of activity at any given price when it is perceived that vacancies are "high" since completion lags imply that the actual selling price would be below the current asset price in these situations. These observations have implications for

---

If the level of vacancies also affects the length of time the unit is on the market after completion, then "high" vacancy rates imply higher expected carrying costs.

specification and estimation which are detailed in the following Chapter.

B. Price Flexibility and Portfolio Adjustment

An asset model of this sort implicitly assumes that all assets are traded or are potentially tradable at each moment. Then clearly, those who recognize or perceive arbitrage opportunities do so: those who liquidate their capital have a ready market; those not trading do so because they are content to hold their stock at the current price.

As discussed earlier, the mortgage may force restrictive capital accumulation but it does allow for more subtle trading as households continuously adjust their portfolios (often involuntarily due to transactions' costs) through amortization, capital gains, prepayments or second mortgages.

However, transactions costs and externalities (location, schools, friends, etc.) may imply that for any given household the implicit price is well above the trading price. Some of these externalities are capitalized while others are not (one obviously cannot buy into a set of relationships and friends, for example).

The implication is that for a large number of owners of the stock, price fluctuations well below their implicit price are quite irrelevant. The price is therefore determined by the trading of a much smaller quantity than the entire stock. For those trading, however, a joint decision is being made about the services desired and the amount of savings to be held in housing over a period of years.

C. Quantity versus Value

This model is not based on the discrete physical unit as the basic unit of the stock, nor is the number of units the primary measure of construction activity. After all, in our economy, virtually everyone has shelter of some form and the demand for housing services is much more than just demand for shelter. The size of the stock, as measured by value of stock and the value of additions to the stock are basic to this model.

Maisel (83) and those who concentrate on the number of starts, view cycles primarily as inventory cycles around a trend demand given by the rate of household formation. Long term trends are perceived as functions of determinants of household formation and occupancy rates.

While such demographic trends are important to housing, it would surely be unrealistic to believe that in a world with zero population growth but increasing income and wealth, construction activity would cease except for replacement construction. Nor does concentration on the number of units started necessarily reveal the events in the construction sector. It is conceivable that the number of starts could be relatively stable, yet there remain sizable cycles in the real value of construction.

IV. IMPLICATIONS

I believe this simple development provides some insights into a number of serious issues in housing and particularly, the issues addressed in Chapter I of this thesis. To the degree that this model captures the essence of the relationships between

housing and housing finance, it indicates, quite clearly, the role of the mortgage in the process of accumulation and holding wealth in the form of housing capital and, together with the arguments of Chapter I, is suggestive of some likely effects of inflation on the housing sector.

Inflation induced distortions generate costs of accumulation and holding wealth in housing that are not reflected solely by the real return to that capital. Therefore, inflation would lead to a shift of the demand curve for housing and a lower equilibrium asset price. The price of housing (PH) has fallen relative to other prices, but the change in relative price does not reflect scarcities. It is simply a distortion, and a little peculiar. The relative price of housing falls during (because) of a general inflation. Households are faced with lower house prices but higher monthly service on any mortgage and therefore a higher "effective price" in terms of demands upon current income. Of course, it is precisely because of this that the relative price falls. This implies that the introduction of new instruments that lower the "effective price" substantially for a sizable group of households would generate higher housing prices. It is likely to be a rather hefty inflation since the stock is essentially fixed. However, such an inflation is exactly what is required to bring on new production.

I believe the model also has some insights to provide to a long discussion in the literature and in policy areas about

housing and stabilization. In fact, a certain theme in much of the literature and discussion is based on a myopic view of this model.

There is a view (Harberger (36), Meltzer (88), Arcelus and Meltzer (3)) that housing serves as a sponge for the economy, releasing resources when squeezed and absorbing them when there is slack elsewhere. Since starts represent such a small proportion of the stock, rather large changes in starts have small impacts on the amount of housing services the economy uses, as illustrated in this Chapter. Thus, the welfare losses from using housing as a cyclical stabilizer and a chief source of monetary policy potency are small. The implication is that housing is a "best" stabilizer and should not be insulated from monetary policy.

I have no particularly strong feelings one way or the other about insulating housing, it seems to be basically a normative question, but one that needs some serious empirical support. However, such a view completely ignores the construction sector (the largest industry in our economy). For the welfare losses to be only those small ones from small stock changes, proponents of this view must also implicitly assume that factors are not specific to the construction industry. The assumption must be that these factors are not only not specialized, but that they are easily transferrable to other sectors. That is, resources released as a result of squeezing the sponge are readily absorbed into other productive sectors. When released, they must

then be readily reabsorbed into the construction industry. Otherwise, there are substantial welfare losses from resources that are simply released to be unemployed. (Perhaps there are losses from the forced non-specialization imposed by large cycles.)

Whether such factors are highly mobile is a question of some interest, but not the business of this thesis. The costs that arise from partial or no mobility also need to be estimated. It may still remain that housing is a "best" stabilizer, but such an argument certainly requires looking beyond the services market.

Finally, as Chapter II indicated, there is considerable confusion about stock-flow and short run - long run characteristics of various impacts on the housing sector. I believe this model to be helpful on both issues, the former discussed in detail during the development of this Chapter. Any parameters that affect the asset price have a short run impact on construction. Only those parameters that continue to hold the asset price above the price that induces investment to cover depreciation will have long run impacts. However, any price movement has long run implications in the sense that such movements lead to more or less investment and over periods of time, more or less housing stock, services etc. One really should ask whether parameter changes are expected to continually shift the asset demand function upward or whether a one-time shift is expected. Either way there are "long-run" implications.

There has been no discussion of the appropriateness of the view of investment presented here. The primary advantage of this theory is the separation of the decision to use, hold and reproduce housing capital. The determination of market value is separated from the construction of new units. This model is only appropriate if the assumption of perfect malleability of physical capital is appropriate. That is, the asset price and the equilibrium reproduction price must be meaningful concepts through time. If the world is characterized by ex-ante substitutability, ex-post fixed proportions (so called putty-clay) there is no reproduction cost of capital except in a steady state where no relative prices change. When no relative prices change, the ex-ante decision would be the same through time, as new capital looks like old capital and a reproduction cost has meaning. In a putty-clay world changing relative factor prices imply "different" capital goods (embodied capital-labor ratio) for each such change in relative prices. Reproduction costs are not meaningful.

Since housing capital requires minimal other production factors in the production of services, the reproduction cost of a dwelling unit that generates a given flow of services is consistent through time.

CHAPTER IV

The model developed in Chapter III has three equilibrium conditions corresponding to three markets: services, assets (stock) and flow. However, the nature of the model implies only three structural relationships. Two of these, service and stock demands were closely related by the asset pricing relationship, R/PH = HCC (at least in perfect markets). In addition, the intrinsically lumpy characteristic of housing units led to the development of an optimal mortgage housing stock ratio; the mortgage essentially allowing for the divisibility and thus acquisition or disposition of "pieces" of the asset by the household.

Since the household continues to control the entire dwelling unit, services from that unit are not disturbed. The mortgage merely serves to allow for adjustment of portfolio holdings except when the nature of the mortgage instrument places constraints on the initial acquisition of the unit, then services may be very much affected. The lumpy nature of the dwelling unit should not be over emphasized since additions, alterations or depreciation change the asset value (also, in general, the services provided).

A consistent model of housing is obtained by relating the value of residential investment (the flow market) through actual expenditures on housing to a stock identity: the stock determined by the past history of expenditures on housing and by depreciation.

In addition, investment in residential structures is a fundamental tie between the housing-mortgage sectors and the larger economy through the macro-economic impacts of aggregate net real investment.

Of course the model developed represents much too tight a characterization of the housing sector as it exists in the United States' economy. I have avoided until now important empirical constraints on the functioning of this sector and important data constraints on econometric modelling of that functioning. The heterogeneity of the stock has been ignored, particularly ownership characteristics. Not coincidentally, data limitations also emerge along ownership lines. For example, asset prices are now available for owner occupied units, but obviously, explicit rentals are not. Rentals are available for multi-family units but asset prices are not; virtually no data are available on mobile homes. Ownership is also important in determining tax treatment, credit availability and costs and consequently, the opportunity costs of holding such units as assets. Depreciation rates and completion lags also differ by type of unit.

A natural grouping of these characteristics leads to three categories: single family dwelling units, multi-family dwelling units and mobile homes. Structural models can be estimated for the first two categories. In this Chapter, I

There is some question about treatment of small (four or less) multi-family units. I assume buildings containing one to four dwelling units are owner occupied for cost of capital calculations and classify them with single family units; those with five or more dwelling units are considered rental only.

There is a reasonably serious data problem here. Since the late 1960's there has been a tremendous growth in condominiums: multi-family units that are owned and mortgaged like single family dwellings. The Census has only recently recognized the problem and has begun to collect separate data

on such structures. These data have not been published and were not accessible to me privately.

The assumption about 2 to 4 dwelling unit structures is fairly consistent with known statistics. The majority of single units are owner occupied. The 1970 Census of Housing provides the following breakdown of ownership of one to four unit structures in the rental market:

6,210,000	individually owned
218,000	owned by partnerships
179,000	owned by corporations
351,000	other

develop the specification for and present estimation of a quarterly model of the appropriate structural relationships.

An overview of the model and a view of the relationships between the housing, mortgage and deposit sectors is presented in Table IV.1. This schema attempts to present the fundamental ties between markets within a sector and between the sectors. Necessarily, the presentation of econometric results focuses on individual equations, so it is important to use this Table, together with Table IV.2 to tie the model together.

Following the tabular summary of the model in Table IV.2 (Table IV.3 presents a glossary of abbreviations), Section I discusses owner-occupied stock demand. Section II presents econometric results for multi-family service demand. Section III develops and presents results for both owner-occupied and multi-family investment functions. Section IV discusses econometric evidence concerning vacancy rates. In Section V, I specify econometric relationships for certain important variables impinging on housing and mortgage markets through mortgage demand and downpayment requirements. Section VI

discusses expenditures and stock identities. Section VII develops a supply model for savings and loan association commitments and mortgage flows.

Discussion of actual data and data sources is presented as an appendix to this chapter, where all definitions are made more precise with source documentation. A second appendix contains a derivation of costs of capital for owner-occupied and rental units with explicit treatment of taxation, depreciation and capital gains.

The basic model developed in the last chapter and estimated here is essentially recursive. However, it is unlikely that the errors are independent. Consequently, ordinary least squares estimates would be inconsistent and an instrumental variables technique is appropriate for estimation.

Free use has been made of two general type of distributed lag schemes: geometric (Koyck) and polynomial (Almon). The former introduces lagged endogenous variables on the right hand side. As is well known, if the untransformed function has zero-mean, constant variance uncorrelated errors, the Koyck transformation introduces a form of first order autocorrelation and the lagged endogenous variables should be treated as fully endogenous. In addition, serial correlated errors are to be expected in the type of time series estimation reported here. (In all cases I assume a first order autocorrelation scheme, $u_t = \rho u_{t-1} + e_t$, where u_t is the function error, correlated with its immediate past and e_t is an independent, zero-mean, error.) With autocorrelation and right hand side endogenous variables, and instrumental variables estimator suggested by Fair (33) is appropriate and is employed in all estimations reported.

Since the set of equations estimated here is a sector of a much large macro-model, many of the variables exogenous to this sector are endogenous to the larger model and are treated as endogenous.

As is well known, in such models the number of exogenous variables that could be used as instruments far exceeds the degrees of freedom of any particular function. Consequently, I use instrumental variables similar to those found by Mitchell and Fisher (89) and Mitchell (90) to be most appropriate for large model estimation. These include: Federal Reserve reserve

requirement, government expenditures (purchases), the discount rate of the Federal Reserve, the personal tax rate, exports, population, import prices and farm prices. In addition, for Fair's method, the appropriate lagged endogenous variables are added to the instrument list.

In all reported results, immediately under the coefficients are the asymptotic standard errors. The figures in the second set of parentheses are the ratios of the point estimates to their respective asymptotic standard errors. (Sometimes loosely referred to a t statistics or t ratios, although in this case the small sample properties of these statistics are unknown.) One can define quasi-significance as that level of significance for the coefficient if the coefficient - asymptotic standard error ratio were distributed as t. That is, if we treated the asymptotic standard error as a standard error. However, one does not know the small sample distribution of this statistic, so "significance" is necessarily used loosely. A rule of thumb often used suggests a ratio greater than 2 as significant (quasi).

In cases where there are lagged dependent variables, the D-W statistic is based toward two and not an entirely appropriate statistic. When an autoregressive estimation technique is used (Fair's method, first order) the reported D-W are calculated on the transformed residuals. This is a loose measure of higher order autocorrelation, However, the distribution of the statistic is unknown.

Ordinary least squares estimates for selected equations are reported in the Appendix of this Chapter.

Table IV.1

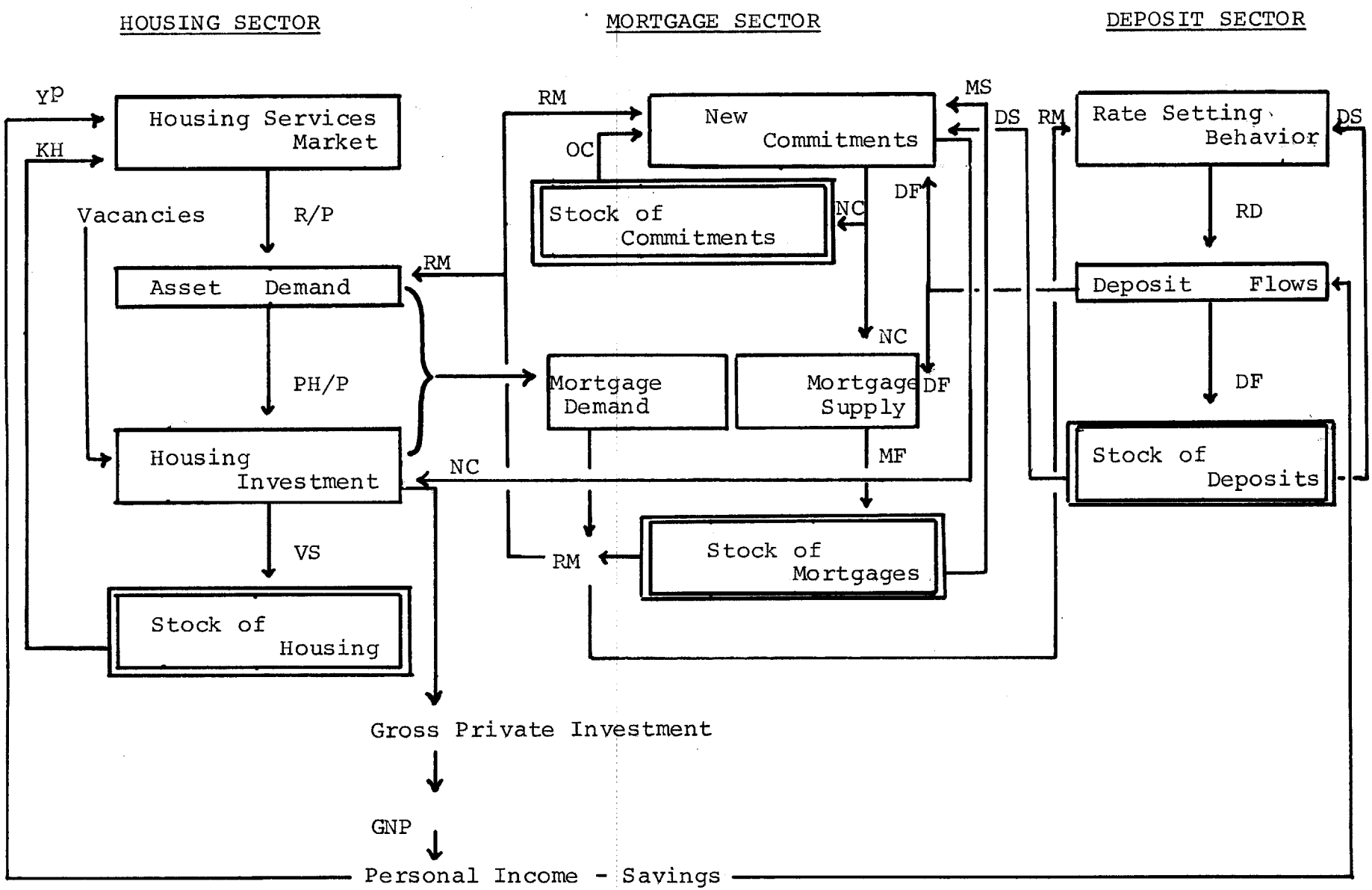

HOUSING SECTOR
MORTGAGE SECTOR
DEPOSIT SECTOR
YP
KH
Housing Services Market
Vacancies
R/P
Asset Demand
PH/P
Housing Investment
VS
Stock of Housing
RM
New Commitments
OC
Stock of Commitments
NC
DF
MS
DS
RM
Rate Setting Behavior
DS
RD
Deposit Flows
DF
Stock of Deposits
RM
Mortgage Demand
Mortgage Supply
DF
NC
MF
NC
RM
Stock of Mortgages
Gross Private Investment
GNP
Personal Income - Savings

Table IV.2

Owner-occupied:

$$PH/P = f(Qpay, \hat{T}, NW/(1-lvr), Y^P/HH, KH14/HH, Hcc14)$$

$$VS14 = g(PH/P, Rcl, Vac, Ncom)$$

$$Qpay \equiv Rmq/(1-(1+Rmq)^{-t})$$

$$T \equiv \sum^{T} t(1+Rmq)^{-t} / \sum^{T} (1+Rmq)^{-t}$$

$$Hcc14 \equiv (Rm+Ptax)*(1-ytax)+ \delta_{14} - \dot{PH}/PH$$

Multi-family:

$$R/P = f(Y^P/HH, KH5/HH, Dem)$$

$$VS5 = g((R/P)/Hcc5, Rcl, Vac, Ncom)$$

$$Hcc5 \equiv (Rm+Ptax)*(1-ytax)+\delta_5-\dot{R}/R-((1-ytax)*Rm+\delta_5-\dot{R}/R)*$$
$$\{0.6*ytax/40 * (1-e^{-40*(1-ytax)*Rm})/((1-ytax)*Rm)+$$
$$0.4*ytax/20 * ((1-e^{-20*(1-ytax)*Rm-1})/$$
$$((1-ytax)*Rm+1/20)+(e^{-20*(1-ytax)*Rm-1})/$$
$$((1-ytax)*Rm)-(e^{-40*(1-ytax)*Rm-1})/((1-ytax)*Rm))\}$$

Expenditures:

$$EH14\$ \equiv .4103 * VS14\$ + .493 * VS14\$(-1) + .1 * VS14\$(-2)$$

$$EH5\$ \equiv .1967 * VS5\$ + .3867 * VS5\$(-1) + .2466 * VS5\$(-2) +$$

$$EAA = h(KH, PH/P, (R/P)/Hcc5, Y^P, Rcl)$$

Stock:

$$KH14 \equiv (1-\delta_{14}) * KH14(-1) + EH14 + a1*(EAA-EREM) + a2*EHP$$

$$KH5 \equiv (1-\delta_5) * KH5(-1) + EH5 + a3*(EAA-EREM) + a4*EHP$$

$$a1 \equiv KH14/(KH14+KH5) \quad a3 \equiv KH5/(KH14+KH5)$$

$$a2 \equiv VS14/(VS14+VS5) \quad a4 \equiv VS5/(VS14+VS5)$$

Mortgage Demand:

$$Rm = j(MS/KH, MF/KH, Raa, FinW, Lvr)$$

Mortgage Supply:

$MF = g1(Ncom, \ldots)$

$Ncom = g2(Rm, MS, Ocom, DS, DF, Rep)$

$Ocom = g3(Ncom, Ocom_{-1})$

Misc. Stochastic Equations:

$LVR = f2(MS, Rm, DS)$

$VAC = f3(KH, HH, PH/P - \hat{PH}/P)$

Table IV.3

GLOSSARY

δ_{14}	Depreciation, 1-4 unit structures
δ_5	Depreciation, 5 or more unit structures
Dem	Misc. demographic variables
DF	Deposit Flows
DS	Deposits
EAA	Expenditures on additions and alterations
EH14	Expenditures on 1-4 unit housing
EH5	Expenditures on 5 or more unit housing
EHP	Expenditures on public housing
EREM	Removals
FinW	Financial wealth, real
Hcc14	Cost of Capital, 1-4 unit
Hcc5	Cost of capital, 5 or more unit
HH	Households
KH14	Realstock of housing, 1-4 dwelling unit structures
KH5	Real stock of housing, 5 or more dwelling unit structures
Lvr	Loan-to-Value ratio
MF	Total mortgage flow
MS	Total mortgage stock
Ncom	New mortgage commitments at savings and loan associations and life insurance companies
Ocom	Outstanding commitments, SLA and LIC
P	Consumer price index
PH	Sales price index, single family homes
Ptax	Property tax rate
Qpay	Quarterly payment
Rcl	Construction loan rate (proxy: commercial loan rate)
Rep	Repayments
Rm	Mortgage interest rate
Rmq	Mortgage interest rate, quarterly $Rmq=(1+Rm)^{1/4}-1$
$\tilde{T}$	Duration
T	Amortization period
Vac	Vacancy rate
VS14	Real value of 1-4 unit starts
VS5	Real value of 5 or more unit starts
Ytax	Income tax rate
Y^P	Permanent income

I. ASSET DEMAND - OWNER-OCCUPIED DWELLING UNITS

We begin with the services relationship, III.2, which is assumed to be of a constant elastic form,

IV.1 $R/P = \gamma_0 (Y^P/HH)^{\gamma_1} (KH/HH)^{-\gamma_2}$

where (R/P) is the real rental (unobserved), KH14 is the real value of owner-occupied housing stock, and Y^P is permanent income, The last two are measured per household (HH).

Since there are no data for explicit rentals on owner-occupied dwellings, I use the asset pricing relationship to eliminate the implicit real rental and corresponding to III.3 we have

IV.2 $PH/P = g(\gamma_0 (Y^P/HH)^{\gamma_1} (KH/HH)^{-\gamma_2}/HCC14)$

A. Specification of Initial Payment Constraints

The implication of Chapter I is that the housing cost of capital may not adequately measure the effective costs of home ownership when the household is forced to use a mortgage to acquire the asset. In fact, it was suggested that not only real returns matter, but because of distortions, nominal variables could be determinants of the household's position. Two effects, both ultimately reflections of the same underlying phenomenon, were suggested: higher initial payments in real terms caused by nominal interest changes, and, because the higher real payments persisted until eroded by inflationary effects, an effective shortening of the contract in the sense that equity is accumulated faster over the early part of the mortgage. Both, of course, are results of the inflation induced

tilt in the real payment stream that accompanies level payment mortgages. These effects were illustrated in Figure I.1, which is reproduced here as Figure IV.1.

If T is the amortization period (in quarters) then the initial quarterly payment, as derived in Chapter I is

$$\text{IV.3} \qquad PH \cdot LVR \cdot Rmq/(1-(1+Rmq)^{-T})$$

where PH · LVR is the per unit initial mortgage size. This

Rmq is the quarterly mortgage rate derived from the annual compounded rate Rm. That is,

$$(1+Rmq)^4 = (1+Rm)$$

therefore,

$$Rmq = (1+Rm)^{1/4}-1$$

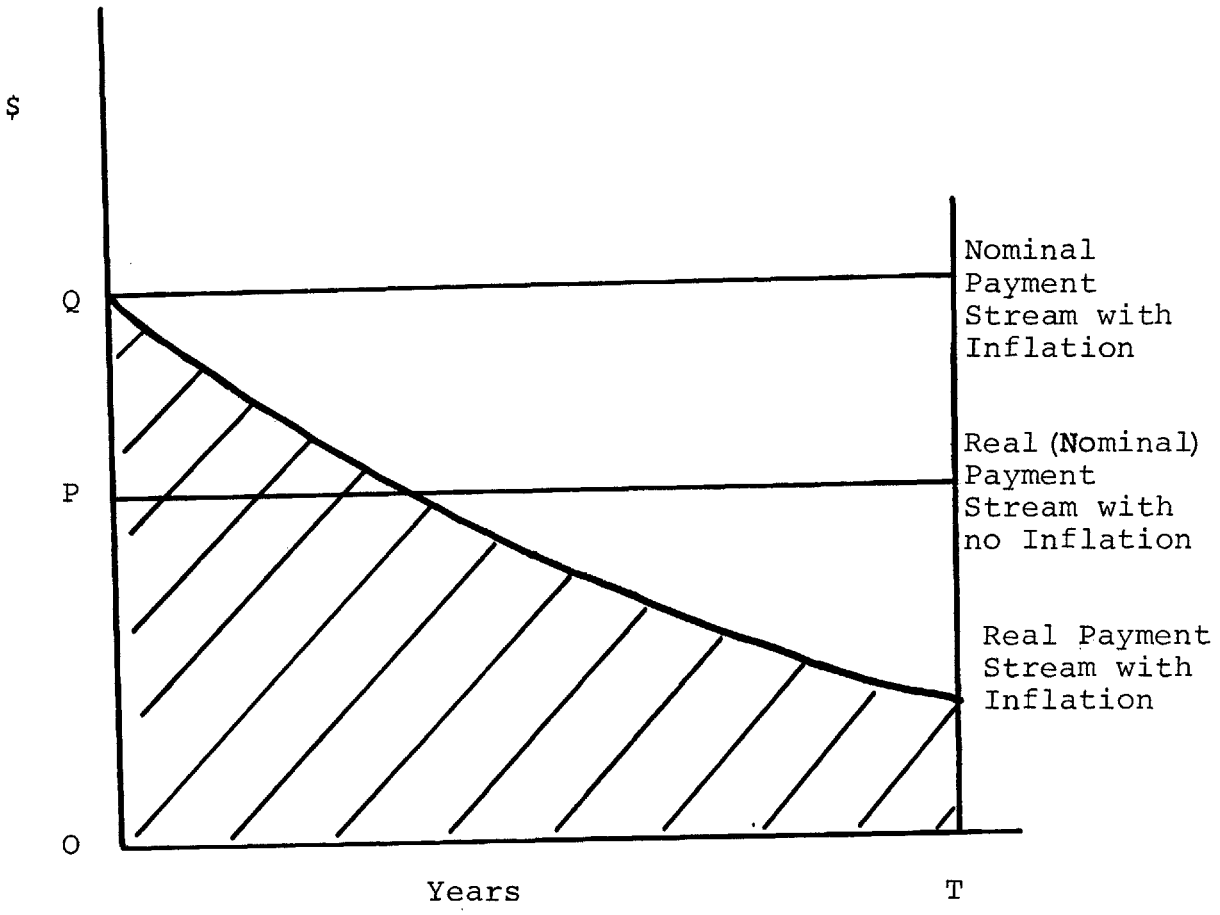
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measure corresponds to the vertical intercept in Figure IV.1 (OQ) and is dependent on the expected rate of inflation and the induced change in the nominal mortgage rate Rmq.

The effective shortening of the contract occurs since the real value of a mortgage in an inflationary situation (the lined area in Figure IV.1) is exactly equal to the real value of the mortgage in a no inflation situation (area OPST, Figure IV.1). Clearly, more of the mortgage is paid over the early years on the former situation.

These present discounted areas need only be equal if inflation is correctly anticipated and reflected in the nominal interest rate. If it is not correctly anticipated, windfall gains or losses occur. With low prepayment penalties (often zero) households can quickly cut their losses by refinancing. Financial intermediaries have no such option.

Figure IV.1


$
Q
P
O
Years
T
Nominal Payment Stream with Inflation
Real (Nominal) Payment Stream with no Inflation
Real Payment Stream with Inflation

There seems to be no unambiguous empirical measure of this tilt. A measure used here, first suggested by Macaulay (78), is the "duration" of the stream of nominal quarterly payments, (MP). Duration can be thought of as the elasticity of present value of a stream of payments with respect to the discount rate employed to calculate the present value.

However, unlike more common elasticities, duration is not a pure number, having instead a value in time units.

If MP is the quarterly payment due at date t = 1,2,3,...T where T is the amortization period ("nominal term of maturity") and d = 1/(1+Rmq) is the discount rate defined by the mortgage interest rate Rmq, then

$$\text{IV.4} \qquad M(MP) = \sum_{t}^{T} MP(t)\, d^{t}$$

is the present value of the stream of payments (the face value of the mortgage.) The elasticity of M(MP) with respect to d is

$$\text{IV.5} \qquad \mathbf{M}(MP) = \sum_{t}^{T} tMP(t)\, d^{t} \Big/ \sum_{t}^{T} MP(t)\, d^{t}$$

i.e., the weighted average date to maturity of the stream (MP).

This concept has been used several times to examine portfolio behavior. Both Hicks (55) and Samuelson (111) establish a Duration Theorem : "An increase (decrease) in interest rates will increase net worth if the weighted duration of the liability stream is greater than (less than) the weighted duration of the asset stream". Persons or intermediaries wishing to speculate on interest rate movements would adjust their portfolio of assets and liabilities so that they have different weighted durations. Matching the streams avoids such speculation. An interesting use of the measure to criticize usage of nominal term measures is found in (52).

Duration is used here as a proxy for the shortening of the contract the household offers since no explicit matching is involved.

I define

$$\text{IV.6} \qquad \hat{T} \equiv \sum_{t}^{T} t(1+Rmq)^{-t} / \sum_{t}^{T} (1+Rmq)^{-t}$$

Note that since the nominal quarterly payment is constant (with the current mortgage instrument) the duration of the mortgage is independent of the level of that payment, depending only upon the amortization period and the mortgage interest rate. (For some of the new instruments proposed, the quarterly mortgage rate would be a function of the index t as would the quarterly mortgage payment.) If the amortization period and the real rate remain relatively constant, then changes in the quarterly mortgage rate are induced by inflation. Inflation leads to a smaller $\hat{T}$, i.e., a shorter effective life or duration of the mortgage. Expectations about the path of inflation are embodied in the nominal rate, and to the degree that the rate is free to move with such inflationary expectations, reflect the perceived tilt in the payment stream.

A second measure of the tilt was used in some estimations. This measure attempts to make precise the expectations households may be expected to hold about price movements. For this measure, I calculate a geometric mean of "real" payments.

$$\text{IV.6.A} \qquad \tilde{T} \equiv \sum_{t}^{T} t^{*}(qpay/p^{exp})^{t} / \sum_{t=o}^{T} (qpay/p^{exp})$$

B. Initial Equity Requirements

The household is often required to purchase, outright at the initiation of the mortgage contract, substantial equity by placing a downpayment on the dwelling unit. At times this required investment can be quite large absolutely, and is generally relatively large compared to income. Unfortunately, such a lump sum reallocation of wealth held in housing is particularly illiquid. This is so since there has not yet been seasoning of the mortgage nor appreciation of the asset which allows wider flexibility through additional mortgages, mortgages which can be used to transfer wealth or convert it for consumption purposes, or varying prepayment. The loan-to-value ratio can then serve as a rationing device, placing constraints on smooth accumulation of equity, where the equity required per unit of asset is,

IV.7 $E = (1-LVR)*PH.$

A household, consequently, may encounter two constraints: initial payment relative to income and required initial equity relative to wealth. It is possible to show that either will be binding or both will not be binding. Consider the payment-income constraint. Suppose there was no problem for household in terms of required equity, then the household would simply increase its downpayment, thereby lowering the total amount mortgaged and the initial payment. It would continue until either the payment fell below any constraint level or until it no longer had wealth available for reducing such payments. If the initial downpayment were the constraint, but the payment-

income constraint was not binding, (the household had not exhausted its credit with the friendly mortgage lender) the household perhaps could increase its borrowing based on current income, lowering the equity required. However, if the intermediary uses the loan-to-value ratio as a rationing device (for whatever reason) then this latter possibility may not exist.

There is a presumption that it is more difficult to convert future income into current wealth than it is to convert current wealth into income. Such a presumption suggests that the downpayment constraint may be the more important empirical phenomenon.

This expectation is also consistent with the observed positive impact of an increase in the loan-to-value ratio on housing activity discussed in Chapter II.

C. Cost of Capital - Owner-Occupied Dwelling Units

One of the important determinants of the household's demand for housing as a store of wealth is the opportunity cost of holding wealth in this particular form, the housing cost of capital. The development of the owner-occupied and multi-family costs of capital is rather detailed and lengthy; derivations are found in an appendix to this chapter. For present purposes I simply note that the cost-of-capital is a function of the nominal interest rate, depreciation, property taxation, tax credits for income tax purposes and expected capital gains.

Using a measure of the cost of capital together with measures of nominal rate changes (initial quarterly payment and duration) brings together in a specification the nominal and real effects of interest rate changes.

D. Specification

The obvious normalization from the model developed in Chapter III is on the real asset price, PH/P. I assume a log linear specification with appropriate additive, zero-mean, constant variance error,

$$\log(PH/P) = C_o + C_1 \log(Qpay) + C_2 \log(\hat{T}) + C_3 \log(Finw/HH/(1-lvr)) + C_4 \log(KH14/HH) + C_5 \log(Y^P/HH) + C_6 \log(Hccl4) + e$$

$C_1<0$ $\quad$ $C_4<0$

$C_2<0$ $\quad$ $C_5>0$

$C_3>0$ $\quad$ $C_6<0$

Table IV.4 summarizes the regression results. All coefficients are statistically significant. The implied price elasticity of demand is -1.5; the implied income elasticity of demand is about .25. The latter is a little lower than those of other investigators, which suggest an income elasticity in the .5-.8 region.

The results do indicate strong influences of nominal interest rates on the relative price of housing. The relative price of housing is very responsive to both the initial payment and the duration or tilt of the payment stream. These results provide some support for the arguments provided in Chapter I that market

imperfections and the current mortgage instrument together with inflation can affect the relative price of housing. Other things constant, housing prices, as measured in real terms for this work, fall during periods of high inflation. The interpretation appears reasonably straightforward: inflation induced increases in the initial payment shift demand downward resulting in lower real housing prices, the lower prices necessary to reconcile the fixed stock with the demand to hold that stock. At the same time, however, inflation results in an effectively shorter mortgage contract (faster accumulation of equity). Given the inital payment, households prefer a shorter duration contract, thus the negative sign on the duration measure $\hat{T}$ implying an upward shift in demand with the shortened duration. If we assume the real rate to be reasonably constant, these results indicate that inflation as reflected in the nominal rate has two opposite effects: dampening demand through high initial payment constraints and stimulating demand through declining real payments. Interpretation may be fascilitated by deriving the interest elasticity. Remember that both the initial quarterly payment (Qpay) and the duration ($\hat{T}$) are functions (nonlinear) of the nominal mortgage interest rate and the amortization period. We can ignore the amortization period in the following discussion, since the relatively small movements in that data (23-25 years is the spread) do not matter much when discounted at any positive interest rate. A feel for interest rate effects on these terms may be developed

Table IV.4

$$\text{Log } (PH/P) = \underset{(3.606)}{12.2788} - \underset{(-2.97)}{3.5377} \log (Qpay) - \underset{(-2.92)}{\underset{(2.766)}{6.90}} \log (\hat{T})$$

$$\underset{(.0098)}{-.07682} \sum_{L=0}^{-3} bi \log (HCC14) - \underset{(.2874)}{.6589} \sum_{L=0}^{-3} Ci \log (KH14_{-1}/HH)$$

$$+ \underset{(1.90)}{\underset{(.081)}{.154}} \log (Y^P/HH)$$

		t			t
b_0	= .2	-7.97	c_0	= .2	-2.29
b_0	= .3	-7.97	c_{-1}	= .3	-2.29
b_1	= .3	-7.97	c_{-2}	= .3	-2.29
b_2	= .2	-7.97	c_{-3}	= .2	-2.29
b_3					

1961:1 - 1973:4

R^2 = .9557

SER = .4487E-02

SSR = .3296E-06

DW = 1.47

$\rho = \underset{(5.986)}{\underset{(.1085)}{.6499}}$

Mean LHS = -.03185

PH: Price Index, Housing

P: Price Index, Consumption

Qpay: Quarterly Payment

$\hat{T}$: Duration

HCC14: Cost of Capital

KH14: Stock, 1-4 Units

HH: Households

Y^P: Permanent Income

by examining Table IV.5. Column 3 gives the elasticity of the initial payment with respect to the nominal interest rate; column 4 presents the analogous duration elasticity. Note that the initial payment is more elastic relative to interest changes the higher the interest rate and that the relationship is highly nonlinear.

This nonlinear effect of interest rate on both duration and quarterly payments elasticities is illustrated in the bottom part of Figure IV.1. The mortgage rate, ranging for illustrative purposes from 2% to 10%, is on the vertical axis. The elasticity of quarterly payments with respect to the interest rate is the set of points to the right. The negative of the elasticity of duration with respect to the interest rate is the set of points to the left. The lines illustrate the concavity of the functions.

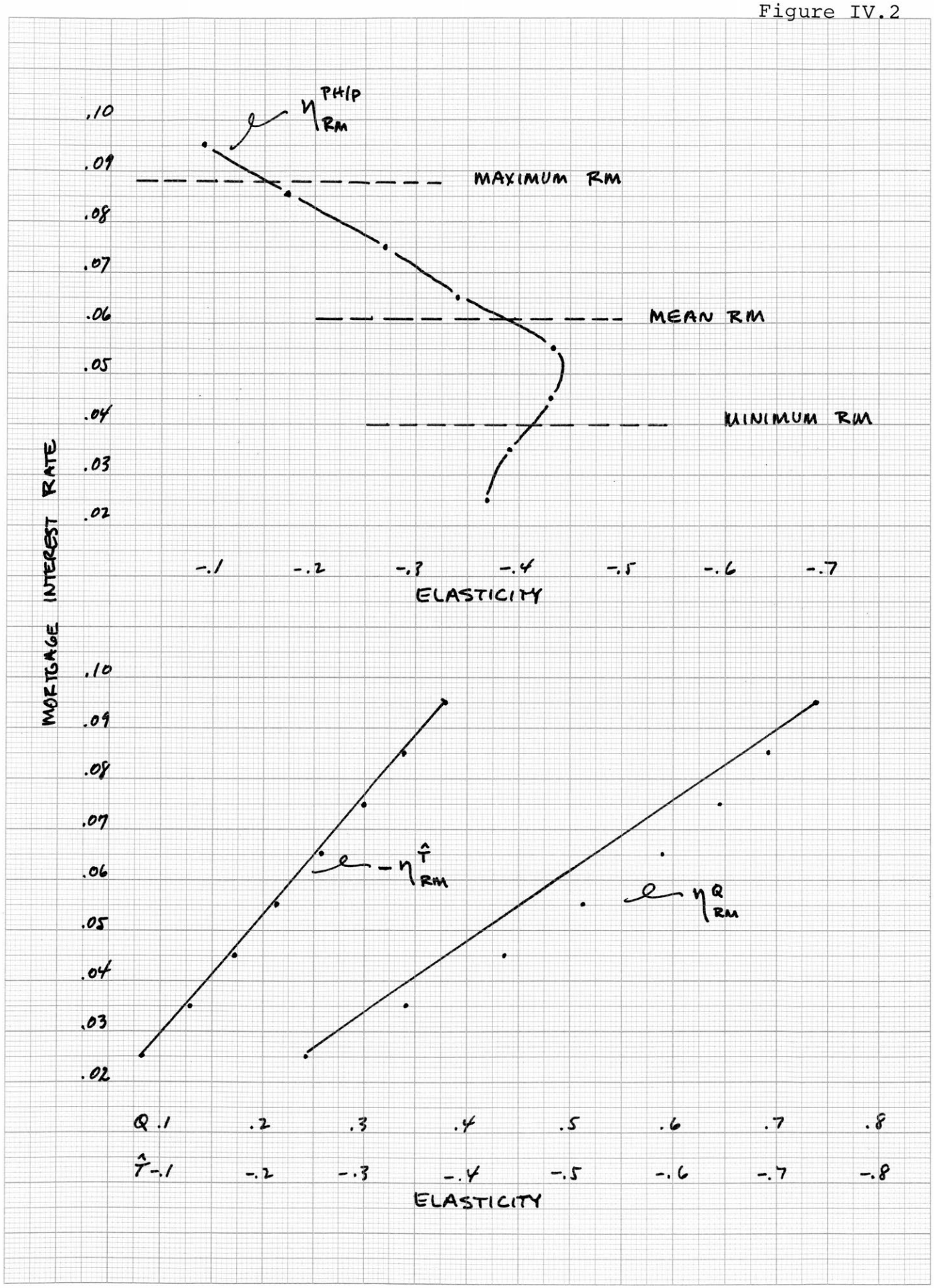
The elasticity of duration, also nonlinear but less so than the initial payment elasticity, has a steeper slope though smaller elasticity in absolute terms.

These two nonlinear effects result in a variable elasticity of price with respect to nominal interest rates. Furthermore, the combination of steeper slope and higher coefficient (-6.90) for duration ($\hat{T}$) result in a variable interest elasticity that is itself nonlinear. Eventually the duration effect begins to weigh more heavily and the elasticity falls as nominal rates rise. This is illustrated in the top graph of Figure IV.5. (Again, the interest rate is on the vertical axis.) The price

Table IV.5

RM	Q	$\hat{T}$	η^{Q}_{RM}	$\eta^{\hat{T}}_{RM}$	$\eta^{PH/P}_{RM}$
.02	.05122	11.97			
			.24	-.08	-.39
.03	.05743	11.48			
			.34	-.13	-.39
.04	.0640	10.99			
			.43	-.17	-.43
.05	.07095	10.52			
			.51	-.21	-.433
.06	.07823	10.07			
			.58	-.26	-.34
.07	.08581	9.64			
			.64	-.3	-.273
.08	.09368	9.23			
			.74	-.38	-.09
.09	.10181	8.83			
.10	.11017	8.46			

Figure IV.2


MORTGAGE INTEREST RATE
.10
.09
.08
.07
.06
.05
.04
.03
.02
$\eta^{PH/P}_{RM}$
MAXIMUM RM
MEAN RM
MINIMUM RM
-.1
-.2
-.3
-.4
-.5
-.6
-.7
ELASTICITY
$-\eta^{\hat{T}}_{RM}$
η^{Q}_{RM}
Q .1
.2
.3
.4
.5
.6
.7
.8
$\hat{T}$ -.1
-.2
-.3
-.4
-.5
-.6
-.7
-.8
ELASTICITY

elasticity with respect to the nominal interest rate - including effects on quarterly payments, duration and the cost of capital - is on the horizontal axis. The maximum (max RM) and minimum (min RM) mortgage rate of the sample are noted as is the mean ($\overline{RM}$=.062).

Although the interest elasticity falls (algebraically) with nominal rates it is negative throughout. The elasticities range from -.43 to -.1. At the point of mean, the interest elasticity is -.39.

The elasticities reported are for price. The (more common) demand elasticities are obtained by solving for the quantity. The range of demand elasticities with respect to interest changes is -.65 to -.15. At the mean interest rate, the elasticity of demand is -.6.

Since this model is structural, these results are not directly comparable to previous research, however we can derive the implied reduced form (constrained) elasticity of value of starts with respect to interest rate changes. Anticipating results reported below, it is found that the elasticity of housing investment with respect to the asset price is about 1.6. Therefore, the implied effect of interest rates on housing investment, at the mean interest rate, is approximately -.96.

These results are, in general, a little unexpected. Although they clearly demonstrate (as best as econometric evidence can) the impact of the current mortgage instrument

on housing demand through inflation induced effects on initial payments the duration effect is much stronger than anticipated.

Since small perturbations in the amortization period have little effect on either initial payment or duration, the large elasticity on duration implies that very large changes in the amortization period would be required to offset the "shortening" caused by the higher nominal rates. This, in turn implies, as was suggested in Chapter I, that changing the amortization period of the mortgage is not a particularly viable method of offsetting high initial payments.

One can only speculate about whether the falling elasticity is reasonable. The following observations are offered in that spirit. Inflation may have three different effects. First, as illustrated in the cost of capital appendix to this chapter, since nominal rates are tax deductible, higher rates of inflation result in a lower real cost of capital even if the "real" rate of interest remains constant. This effect results in increased demand during inflations. Second, because of strong moderating pressures on mortgage rates during periods of generally rising rates (the pressures result mainly from government intervention and regulation), a person securing a mortgage over the past ten years or so, has virtually always received a windfall gain. To the degree that this is generally expected and the windfall moves with the nominal rate, those households that can skirt the cash flow problems find mortgages attractive and thus their collateral: dwelling units. With increasing liberalization of prepayment penalties, the costs of error in this area are minimal. That is, should a household

find itself holding a high interest mortgage with inflation less than expected, it is reasonably painless to re-negotiate the mortgage. This downward variable rate feature of the current mortgage instrument virtually insures any speculation.

Finally, with inflation, there may be a movement into tangible assets of which housing is a primary asset in many portfolios.

It should be made very clear that this particular relationship is not robust to specification. The initial payment, duration and cost of capital terms continue to be important and of appropriate signs in a variety of specifications. (Although the coefficient values change with different specifications, the relative weights remain the same.) However, the income effects are rather elusive and very much depend upon the specification.

In addition, the results are quite sensitive to the lag structure in the following sense: if one imposes a Koyck lag then the income and stock terms become insignificant, often of the wrong sign and the lagged dependent variable carries most of the weight in the regression (even with correction for serial correlation). However, it may be that the data are in fact revealing something interesting. Using a simple Koyck lag imposes the same lag <u>shape</u> and <u>parameter</u> on all of the right hand variables. One might expect the nominal terms, initial payment and duration, to have strong impact effects, but not long lags due to the reasonably rapid changes in capital

markets. However, the implicit rentals (income and stock as proxies) discounted by the real capital costs give the long run equilibrium. Arbitrage might be expected to be slow. These two different effects would be confounded by the imposition of a single lag structure. If we hypothesize impact effects for the nominal variables but a distributed lag effect for discounted rentals, the specification would be,

$$PH/P = f(Qpay, \hat{T}, L(G(Y^P/HH, KH14/HH)/Hcc14))$$

where L is a lag operator and $G(Y^P/HH, KH14/HH)$ the implicit real rental. Estimating the lag structure then requires certain nonlinear constraints on the estimation procedure. If one ignores these constraints and simply imposes the same polynomial degree and lag on the three variables under the lag operator, the lag shapes are virtually identical. With a second degree polynomial, constrained at both ends, the coefficients are: (Long run effects have been factored out, leaving only the relative weights.)

	Hcc14	Y^P/HH	KH14/HH
t_0	.2	.199	.19
t_{-1}	.3	.309	.29
t_{-2}	.3	.309	.29
t_{-3}	.2	.199	.19

It is interesting that they have the same shape without any constraints. However, there is not enough information in the data (multicollinearity) to support the free estimation of all these lags. The reported results give lags only for Hcc14 and

KH14/HH, with Y^P/HH being constrained to its long run impact. The lag shapes in this case are still the same independent of constraint.

I did not find evidence to support strong downpayment effects on the stock demand. This is a little surprising given the evidence accumulated by other researchers. However, there is a strong indirect effect: as will be shown below, the loan-to-value ratio has a strong effect on mortgage demand and thus on interest rates. The implication of the structure of the model as estimated is that initial homeowners' equity is a portfolio allocation decision. The division between debt and equity has no direct effect on the stock demand. Indirect effects occur through changes in mortgage interest rates resulting from changes in mortgage demand as households decide to finance more or less of the purchase cost of a home through mortgage debt.

Credit rationing in this market was not found to be important. This finding is at variance with the findings of most researchers in this area but supportive of the work of Meltzer. However, as indicated below, strong quantity effects are found in the flow market. Since most of the work in this area has been of a reduced form variety, both careless use of terminology and unwarranted conclusions may be the sources of differences. Most of the literature deals with housing starts (either quantity of or value of). Somehow demand for housing gets mixed in with the quantity of new homes purchased

in discussions of research. The inference is then made that the findings have something to do with the demand for the stock. I would suggest that unwarranted conclusions about credit rationing in the stock market have been drawn from the relationships between capital flows and the construction industry's activity. Of course, without a structural model it is not possible to disentangle the effects.

Finally, we return to the principal finding of this section: nominal and real interest rates matter for housing demand. Thus, inflation, even if anticipated, is not neutral but rather leads to changing relative prices. Since these changes do not reflect scarcity but are inflation-induced distortions in prices, inflation has introduced inefficiency into the process of capital accumulation.

II. HOUSING SERVICES MARKET - MULTI-FAMILY DWELLING UNITS

One can estimate directly a demand for rental services function; data are collected and available on rentals. Since asset prices are not available for multi-family units, I then use the equilibrium relationship between the gross return (R/PH) and the cost of capital (Hcc) as a proxy for the implied asset price in the multi-family investment function.

This is a better or worse proxy depending upon the degree to which factors other than rental and capital costs have transitory or lasting effects on the asset price.

Since rents are often fixed over lease periods and there

are a variety of strong downward pressures (e.g. rent control) on rents, one would expect slow adjustment and relatively long lags in an aggregate rent function. One can easily provide for this by estimating IV.1 with a Koyck lag or a lag structure designed to account for periodic renegotiation of rent contracts. However, the straight forward estimation of this function in real terms yields very poor results. Although stock and income have the correct sign, neither are significant and the Koyck coefficients are very near or above one. The implication of the former is a very slow adjustment. The latter is, of course, a nonsense result. Since all efforts at straight forward estimation on real rents resulted in Koyck coefficients that were not statistically significantly different from one, the results seem to indicate that the data do not support real rental adjustment.

The data themselves are a little peculiar. Using the CPI rent index and any consumption deflator, one finds a secular decline in the "real" rent index of about 11% over the 1965-74 period. Although there is considerable variation around the trend, the data appear a little suspect, even though there are considerable distortions in rental markets over that period of time (rent control, rent subsidy programs, etc.)

A number of researchers in this area (see, for example, (126, (139)) suggest that adjustments occur in nominal rentals. Assume that

$$R/R_{-1} = (R^*/R_{-1})^{\lambda_0}$$

where R* is the nominal level corresponding to the real relationship,

$$R^*/P = \alpha_0 (Y^P/HH)^{\alpha_1} (KH^5/HH)^{-\alpha_2}$$

Eliminating the unobserved equilibrium nominal rental (R*), we have

$$\log(R/R_{-1}) = C_0 + C_1 \log (Y^P/HH) - C_2 \log (KH5/HH) + C_3 \log (P/R_{-1}) + e$$

where

$$C_1 = \lambda_0 \alpha_1$$

$$C_2 = \lambda_0 \alpha_2$$

$$C_3 = \lambda_0$$

The relationship in real terms is

$$\log (R/P) = C_0 + C_1 \log (Y^P/HH) - C_2 \log (KH5/HH) + (1-C_3) \log (R_{-1}/P)$$

which implies an adjustment in last period's nominal rental in current dollars rather than in last period's dollars. While it is true that rent contracts are written in nominal terms and that readjustment of such contracts may be subject to a variety of pressures that do not allow for a smooth adjustment, I view this specification as being less than satisfactory. However, it is virtually impossible to get sensible results with a different specification.

It is not clear whether the data are trying to reveal something interesting that has simply been missed or whether the econometric results indicate serious problems with current methods of reporting and aggregating the data.

It is probably important to account for the strong economic (and social) pressures toward home-ownership. I have included in the specification the implied long run rental for owner-occupied units,

Hccl4 * PH/P

as the implicit price of a substitute good (housing services provided by owner-occupied dwellings). However, to the degree that urban areas do not provide the substitutability between home ownership and renting, the degree of urbanization (urban) should positively affect rentals.

Table IV.6 provides estimation results. Permanent income is excluded from the reported estimation. The coefficient was small and was not found to be significantly different from zero. Often, however, the coefficient was less than zero. Excluding or including income made little difference to the other coefficients. Although, a priori, I would believe rental housing to be an inferior good (especially since all indications are that owner-occupied housing has an income elasticity of demand well below one), the negative coefficients are a little disconcerting in macro work. Examination of the data indicate what is happening to a degree (but obviously not what is happening in the economy to generate such data): real permanent income has a strong upward trend over the sample; real rentals, as discussed earlier, have a secular downward movement.

The interpretation of the coefficient on the lagged coefficient is different than in the case of the usual Koyck lag. For example, suppose we had partial adjustment in real

Table IV.6

$$\text{Log}\ (R/R_{-1}) = \underset{\substack{(.0885)\\(2.126)}}{.18816} + \underset{\substack{(.0943)\\(2.099)}}{.19797}\ \log(\text{Urban}) - \underset{\substack{(.00016)\\(-1.53)}}{.00147}\ \log(\text{Hccl4}\cdot PH/P)$$

$$\underset{\substack{(.00699)\\(-2.1783)}}{-.01523}\ \log(KH5_{-1}/HH) + \underset{\substack{(.01856)\\(5.052)}}{.0937}\ \log(P/R_{-1})$$

1961:1 - 1973:4

$R^2 = .94$

SSR = 3.968 E- 05

SER = 9.497 E - 04

DW = 1.93

$\rho = .3216$
(.1353)
(2.3778)

Mean LHS = .00606

R: Rent

Urban: % urban population

HH: Households

KH5: Real housing stock, 5 or more

PH: Asset price, 1-4 unit

Hccl4: Cost of capital, 1-4 unit

terms and the real rental was, for the purposes of this example, determined by the per capita stock, kh,

$$\log(R/P)^* = \alpha_0 + \alpha_1 \log(kh)$$

Imposing

$$(R/P)/(R/P)_{-1} = ((R/P^*/(R/P)_{-1})^{\lambda_0}$$

as the adjustment mechanism yields the usual Koyck representation in log terms,

$$\log(R/P) = a_0 + a_1 \log(kh) + (1-\lambda_0)\log(R/P)_{-1}$$

$$a_0 = \alpha_0 \lambda_0$$

$$a_1 = \alpha_1 \lambda_1$$

If the adjustment is in nominal terms,

$$R/R_{-1} = (R^*/R_{-1})^{\lambda_0}$$

then

$$\log(R^*) = \alpha_0 + \alpha_1 \log(kh) + \log(P^*)$$

and

$$\log(R/P_{-1}) = a_0 + a_1 \log(kh) + \lambda_0 \log(P/R_{-1})$$

$$a_0 = \alpha_0 \lambda_0$$

$$a_1 = \alpha_1 \lambda_1$$

In both cases the long run elasticities are,

$$\alpha_0 = a_0/\lambda_0$$

$$\alpha_1 = a_1/\lambda_0$$

The equation, corresponding to that in Table IV.6 in real terms, is

$$\log(R/P) = .188 + .20 \log(\text{Urban}) - .00147 \log(\text{Hcc14}^*R/P)$$
$$-.01523 \log(KH5_{-1}/HH) + .9060 \log(R_{-1}/P)$$

The adjustment is, as expected, slow having a mean lag of nine

quarters. The implied long run real rent elasticity of demand is about 6.6. The cross elasticity with respect to the implied owner occupied rental is -.10. Rents are highly elastic with respect to the degree of urbanization: this is not unexpected since the stock really is fixed even over longer periods of time within urban areas.

The high own rental elasticity implies that sizable additions would be absorbed into the rental stock without dramatic effects on the level of rents.

III. HOUSING INVESTMENT

A. Owner-Occupied Dwelling Units

We begin with the simple supply function (investment in housing) of Chapter III,

VII.15 $$H^s = \theta(PH, C, PH^e).$$

As emphasized in the development, an attraction of this model is the focus on the construction sector's role in the investment process: conditions in the asset market convey information to builders (primarily through price) but their response is determined by conditions within the investment sector.

Single-family dwelling unit construction is mainly undertaken by small, low-capital firms. In fact, I assume that a reasonable proxy for the capital stock of this group is the financial capital used as construction loans. These loans are not generally unsecured. Either the builder (on speculation) or the household (contract construction) secures from a mortgage lender

a commitment for mortgage financing upon completion of the dwelling unit. This commitment is subsequently used as security for a construction loan (working capital) for financing construction expenses, both labor and materials. Upon completion, the commitment is either taken down or allowed to expire. The commitment would usually be taken down if the specified terms were better than those available elsewhere.

The working capital, a construction loan, is generally not made by the mortgage lender but, more often, at commercial banks. During periods of tightness in money markets, it is not uncommon for suppliers, e.g. lumber dealers, to provide such capital. The important parameters for the construction industry are the availability of such loans, dependent upon the commitment process and the costs, determined by other short term borrowing costs.

Builders who speculate, essentially offer a joint product: a dwelling unit with mortgage financing. This mortgage financing can, at times, be attractive and important.

Costs include labor and materials plus capital costs. Construction cost indices are heavily weighted by measures of the former two items. Unfortunately, there are no data on separate measures of labor and materials costs. Materials are supplied with some elasticity and consequently, as suggested in Chapter III, such costs move with the asset price and construction activity; information about them is embodied in the asset price. Indeed, in the results reported in this section, one can replace

the asset price with any of several published cost indices and obtain basically the same econometric relationships.

The specification of the supply function is thus very simple,

$$VS14 = h(PH, Rcl, VAC)$$

where Rcl is a construction loan rate. I again assume a log linear specification,

$$\log(VS14) = C_0 + C_1 \log(PH/P) + C_2 \log(Rcl) + C_3 \log(VAC) + e$$

$$C_1 > 0$$

$$C_2 < 0$$

$$C_3 < 0$$

Under varying circumstances, the asset price (PH/P) conveys different information to the construction sector. The expected price at completion and/or the expected marketing time after completion are likely to condition firms' responses. Within the framework of this model, discussion in Chapter III also indicated that the combination of price and associated vacancy rate would be expected to convey such information. Therefore, the vacancy rate is included in the investment function.

The simple investment function (Table IV.7) does reasonably well. All the coefficients have the expected sign and are significant. The estimation provides some confirmation of the importance of the asset price as a determinant of investment and of the expected relationship between asset price, vacancy rate and investment in single family structures. However, if there is substantial rationing of credit in this market specification error results in an asset price coefficient that

Table IV.7

$$\begin{array}{lcccc} \text{Log(VS14)} = & 8.29 & + 4.06\ \text{log(PH/P)} & - .4785\ \text{log(Rcl)} & - .373\ \text{log(VAC)} \\ & (0.464) & (1.4995) & (.1368) & (.1783) \\ & (17.86) & (7.712) & (-3.497) & (-2.095) \end{array}$$

1961:1 - 1973:4

$R^2 = .64$

SSR = .209

DW = 1.71

SER = .066

$\rho = .8133$

VS14: Real value of 1-4 unit starts

PH: Price of housing

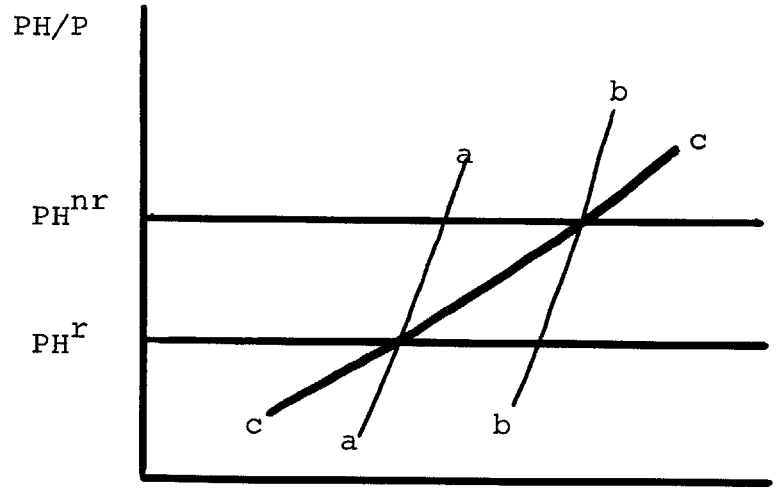
P: Price of consumption

Rcl: Commercial loan rate

VAC: Vacancy rate

is biased upward, and the resulting estimate would be too high.

One would expect the elasticity to be biased upward. Consider the following diagram:



aa represents a supply relationship during periods of rationing and bb, during non-rationing periods. Since rationing occurs during periods of high nominal rates, the asset price is lower, PH^r; the no rationing price corresponds to PH^{nr}. Observations drawn from such a market would tend to be along line cc. Estimation, ignoring such shifts, would tend to indicate a supply relationship with greater elasticity than would actually exist.

In addition, the large first order serial correlation coefficient also indicates some misspecification. A plot of the residuals indicates that the function always underestimates the troughs of the cycle. Chapter I indicated that a serious problem confronting thrift institutions was their inability to compete when the term structure sloped downward for any length of time.

It is thought (and widely accepted as true) that during such periods credit rationing becomes important. Not just the cost of short term construction capital (Rcl) but the availability of collateral (commitments) is likely to affect starts.

Note, the assumption that rationing of mortgage money is the only rationing of importance for construction implicitly assumes that once the commitment is acquired, construction loans are rationed by price, Rcl.

To the degree that such rationing is important, the mortgage sector has an important effect on housing quite independent of the demand effects estimated in the last section. The marketing of the joint product which the builder sells, during periods of tight money markets, makes obtaining commitments very lucrative and important.

It might seem natural then to consider the investment function as determined in such periods solely by the flow of new commitments, so that

IV.15 $$VS = \min(Com, h(PH, Rcl)).$$

One can then use one of several methods that have been developed (e.g. Fair and Jaffee(35)) for the estimation of markets in disequilibrium. The problem here is a little different, since most of the literature is concerned with supply constrained or demand constrained disequilibria. Here, we are concerned with the shape of the supply function alone during periods of disequilibria (rationing) and with the possible biases caused by misspecification.

Estimation requires dividing the sample points into constrained and unconstrained samples. Once appropriate samples are selected we can test the formulation by estimating the investment function over the unconstrained sample. Using the resulting function, we can extrapolate over the constrained periods. We should find a consistent over estimation of the constrained sample points if rationing was indeed important during those periods. In comparing the predicted values, I suggest a double criteria: both predicted and actual values must indicate the appropriate regime. That is, suppose we have a point in the constrained sample. If the predicted value from the unconstrained regression results in less than both the predicted and actual constrained sample values, that point should not be in the constrained sample. The point should be in the constrained sample if the unconstrained predicted value is greater than the constrained predicted value, I only require the second requirement if the predicted value fails this test.

Despite the appeal of such a procedure, no sample of likely "rationed" observations could be constructed which could be explained by non-price variables alone. It remained an empirical fact that price and capital costs were important determinants of supply even during periods of rationing.

The price elasticity did, however, fall over periods where these points were excluded. However, nearly the same effect was captured by including commitments in the investment function directly. Table IV.7.B reports the results.

The price elasticity has fallen considerably; the construction capital cost elasticity less. The real commitment variable enters with the appropriate sign; the best fit was obtained with a one quarter lag, although that was not critical.

A variety of lag structures were estimated, however there was no econometric evidence of any lags of appreciable length. With the simplest lag, a Koyck lag, the lagged dependent

Table IV.7.B

$$\begin{aligned}\log(VS14) = {} & 7.319 + 1.59012\ \log(PH/P) - .4416\ \log(Rcl) \\ & (.22066)\ (.71094) \qquad\qquad (.1045) \\ & (33.168)\ (2.237) \qquad\qquad (-4.224) \\ & + .30406\ \log((NCOMSL + NCOMLI)/PH) \\ & \quad (.04112) \\ & \quad (7.395) \\ & - .2373\ \log(VAC) \\ & \quad (.1238) \\ & \quad (1192)\end{aligned}$$

1961:1 - 1973:4

$R^2 = .911$

SSR = .12496

DW = 2.02

SER = .05329

ρ.= .3347
(.1346)
(2.4859)

Mean LHS: 8.3067

VS14: Real value of 1-4 unit starts

PH: Price index, housing

P: Price index, consumption

Rcl: Commercial loan rate

NCOMSL: New mortgage commitments, SLA

NCOMLI: New mortgage commitments, LIC

VAC: Vacancy rate

variable had a coefficient of .01 with a standard error of .071. Introducing the lagged dependent variable had no appreciable effect on either fit (actually, it was a little worse) or on coefficient values.

Whatever the precise characteristics of the firms and resources in this sector, the data imply a rapid response to price, cost and credit-availability measures.

The econometric evidence indicates an elasticity with respect to asset price of approximately +1.6 and a rather heavy dependence of value of starts on availability and cost of construction capital, yet continues to provide strong evidence of the importance of the asset price.

The finding of dependence on commitments provides some support for the development of intermediaries, such as the Federal National Mortgage Association, that play an active role in making commitments during those periods when disintermediation takes place (commitments that are supported by borrowing in the general capital market). Such borrowing, reintroduces, at some costs of intermediation, capital that has moved out of the mortgage markets due to the inability of thrift institutions to compete.

The significant, positive coefficient on price, simplicity of the functional form and lag structure give strong support to the model of investment developed in the last chapter. The size of the coefficient implies that should policy changes

eliminate to a degree the periodic difficulties with rationing, the construction sector would provide a reasonably stable flow of investment. Rather large price changes would be necessary to generate the kind of cycles that we have seen in the past.

The model of the construction sector has taken no account of possible expansion of capacity, except as reflected in the elasticity of response with respect to price and construction capital.

I examined three proxies for capacity change. The first was a simple time trend with freely estimated coefficient. A second was a trend with coefficient fixed to indicate various possible growth rates per annum, 2, 2½ and 3 percent. A third was a measure of potential GNP. The desire was to allow for the possibility of a larger response by the construction industry to price and costs as the economy grows. There was no econometric evidence to support such arguments.

B. Multi-Family Dwelling Units

A fundamental determinant of investment flows is, as outlined, the asset price. However, as discussed, over periods of time that allow for adjustments, owners would arbitrage deviations of the gross return (R/PH^m) from the multi-family cost of capital, so that

$$PH^m = R/Hcc5$$

would hold. (PH^m is the unobserved multi-family asset price).

The results for the asset demand function gave strong indications that imperfections in capital markets resulted in deviations of the asset price from the discounted rentals. To the degree that these same imperfections affect multi-family financing, the discounted rentals may not be a very good proxy

for price movements. And of course, if Hcc5 reflects the true cost of capital for those building and investing in new rental units, this measure would be a better proxy of asset price movements. It is difficult to know, a priori, whether the proxy is a good or bad one.

The specification of the multi-family investment function is the same as that for owner-occupied dwellings. Results are presented in Table IV.8.

The long run relationship implied by the regression in Table IV.8 is

$$\log(VS5) = -1.59 + 1.29 \log((R/P)/Hcc5) - 1.25 \log(VCR) + .53 \log(Ncom/PH)$$

The mean lag is a little less than one quarter.

The lag structures here and in the owner-occupied investment function are very short. Whether or not they are reasonable is difficult to know. However, some confusion may arise in comparisons of these lags to lags estimated to hold in investment studies in other areas. The dependent variable is value of starts. The interpretation then is speed of adjustment of the starts by the construction industry to various economic stimuli. All lags inherent in the actual construction process are lags on these starts. While the actual construction put in place may be (and is) a long distributed lag of starts, starts respond fairly quickly to appropriate economic stimuli.

The dependent variable in most investment studies corresponds more closely to construction put in place than to the value of starts (which would be roughly analogous to orders).

The long run price elasticity above one and near 1.5 is interesting since it corresponds to roughly the same magnitude elasticity in the owner-occupied investment function. However,

Table IV.8

$$\begin{aligned}\text{Log(VS5)} = &- .7375 + .6037\ \log((R/P)/Hcc5) - .58637\ \log(VAC) \\ &(.5802)\quad (.19997)\qquad\qquad\qquad (-.1155) \\ &(-1.27)\quad (3.019)\qquad\qquad\qquad (-5.076) \\ &+ .24816\ \log((NCOMSL + NCOMLI)/PH) \\ &\quad (.10136) \\ &\quad (2.448) \\ &+ .53194\ \log(VS5(-1)) \\ &\quad (.09787) \\ &\quad (5.4349)\end{aligned}$$

1961:1 - 1973:4

$R^2 = .97$

SSR = .24594

SER = .07476

DW = 1.91

$\rho = .01428$
(.1428)
(.098)

Mean LHS = 7.298

VS5: Real value of 5 or more unit starts

R: Rent

P: Price index, consumption

Hcc5: Cost of capital, 5 or more units

VAC: Vacancy rate

NCOMSL: New mortgage commitments, SLA

NCOMLI: New mortgage commitments, LIC

construction in this area appears much more responsive to the availability of long term financing and expectations of demand (vacancy rate). This is not surprising given the larger scale of construction and longer construction horizon. That is, one can imagine speculative builders, building single family units without a mortgage commitment, using other collateral (or perhaps internal funds) for working capital. However, larger scale projects would generally require firm commitments for long term financing before working capital was made available.

The primary difference between the two investment functions is the different response to vacancies: multi-family construction is much more responsive to the vacancy rate than smaller scale construction (given any level of asset price).

IV. VACANCY RATES

Vacancies appear as an important determinant of both owner-occupied and multi-family housing investment. Chapter III indicated that such unoccupied units could be accounted for in an asset model if prices moved less than instantaneously toward their new equilibria with demand shifts. It was suggested that in this respect vacancies were price determined rather than price determining. A further implication of the model is that the level of vacancies should be independent of the price when the market is in equilibrium. That is, a frictional level of vacancies, determined by turnover, population growth etc., would

exist at any equilibrium. Unless these factors are affected by the equilibrium price, the level of vacancies at any equilibrium is independent of that equilibrium price. This suggests a functional form for vacancy determination where vacancies depend upon the spread between the actual price and the equilibrium price implied by the stock demand and the current stock. In addition, ceteris paribus, if households increase there is pressure on the existing stock and vacancies would fall. At the same time, the asset price would increase. Starts would be stimulated both by the higher asset price and the lower level of vacancies. I allow for this direct effect of demographic changes (in addition to the indirect effect through the asset price) since the increase in households implies a concurrent increase in occupied housing units. The increased demand pressure is then translated into more and higher quality starts through the price effects.

Under some conditions there may be a simultaneous depressing effect of increasing prices and/or rents on household formation.

The general specification is

IV.16 $$Vacr = A_0 + A_1\, HH + A_2(PH/P - \hat{PH}/P) + \lambda_0\, Vacr_{-1}$$

$$A_1 < 0$$

$$A_2 > 0$$

$$0 < \lambda_0 < 1$$

Table IV.9 presents regression results.

Table IV.9

$$VAC = \underset{(2.387)}{.0528} - \underset{(-2.315)}{.609}\ HH + \underset{(2.346)}{.1361}\ (PH/P - \hat{PH}/P) + \underset{(7.906)}{.7541}\ VAC_{-1}$$
$$\qquad\qquad\qquad

The econometric evidence provides confirmation of the role of price adjustments in generating movements of vacancies.

Note that the use of $P\hat{H}/P$, the implied long run equilibrium price from the asset demand function, implies cross equation constraints. Efficient estimation would require joint estimation with the constraints imposed. However, the constraints in this case are non-trivial as the price is that long price implied by an estimated lag distribution. I ignored these constraints in the estimations reported here.

The dynamics of the equation imply a mean lag of about three quarters.

The reasonableness of such a specification depends upon the long run properties imbedded in the estimation. Assuming full adjustment of both price and vacancies, the level of vacancies at equilibrium is,

$$VAC^* = .212 - 2.406\ HH$$

At the mean level of households, the equilibrium vacancy rate is 6.24 percent. The mean level of actual vacancy rates over the 1961-1974 period is about 6.89 percent. Clearly the equation's long properties are credible. The results do indicate that over this period we have experienced on average, some unemployed resources but of such a small magnitude as to imply, over the fourteen year period virtual "full employment" of housing resources. This is surely not surprising given the demographic pressures from the post-War "baby boom" cohorts.

V. THE DEMAND FOR MORTGAGE CREDIT

A. Mortgage Demand Function

I have suggested throughout the development of this model that mortgages are demanded as part of a portfolio decision by the household. Quite independent of the high initial mortgage-asset value ratio necessary for many households to purchase a dwelling unit, this portfolio decision depends upon the implicit and explicit costs and returns from holding wealth in the form of housing capital. Depending upon these costs and returns the household is assumed to have an optimal debt-equity ratio. However, the movement toward any optimal position is certain to be extremely slow. Not only are there the usual recognition lags, but the market does not fascilitate rapid adjustment since any adjustment must take place through the mechanisms of second mortgages, prepayment or the amortization procedure (given the housing stock). In fact, of course, there is continuous adjustment in this market through the amortization process. Conscious adjustment only takes place when households attempt to monetize their capital gains or run down their mortgages at a faster rate than the amortization process. Another form of adjustment over periods of changing spreads between mortgage rates and other rates in the economy is refinancing. In sum, the mortgage stock-housing capital stock ratio can be expected to vary with costs and returns although strong behavioral inferences cannot generally be made.

Essentially the assumption is simply that the mortgage stock is dependent upon the housing stock (surely not surprising given collateral requirements) with variation allowed as people adjust their desired debt-equity ratio.

If we assume the usual stock adjustment framework,

IV.17 $$\Delta(MS/KH) = \gamma((MS/KH)^* - (MS/KH)_{-1})$$

but impose the further strong assumption that households view the stock as fixed and adjust the mortgage stock, then

IV.18 $$\Delta MS/KH = \gamma((MS/KH)^* - (MS/KH)_{-1}),$$

where I assume

IV.19 $$(MS/KH)^* = c_o - c_1 \, Rm + c_2 \, Raa + c_3 \, Finw/HH.$$

The opportunity costs are assumed proportional to the new issue bond rate, Raa. The last term allows for per household financial wealth to affect the mortgage-housing ratio.

This assumption introduces some serious problems with the simulation scheme presented in the next chapter. A discussion of the problems is included there. It is sufficient here to note that an assumption on the spread, say -cl(Rm - Raa), could not be supported by the data.

Therefore,

IV.20 $$MS/KH = \gamma c_0 - \gamma c_1 \, Rm + \gamma c_2 \, Raa + \gamma c_3 \, Finw/HH - (MS/KH)_{-1}$$

Normalizing on the mortgage rate,

IV.21 $$Rm = c_0/c_1 - 1/(\gamma \cdot c_1) \, MF/KH + c_2/c_1 \, Raa + c_3/c_1 \, Finw/HH + 1/c_1 (MS/KH)_{-1}$$

In addition, I allow for a distributed lag effect by net financial wealth on the mortgage rate. Since the loan-to-value

ratio very much affects flexibility, I have allowed for a variable lag depending upon the loan-to-value ratio.

$$\text{IV.22} \qquad Rm = a_0 - a_1\, MF/KH + a_2\, Raa + a_3\, L(1/(1-lvr)*\ Finw/HH) - a4(MS/KH)_{-1}$$

Table IV.10 presents the regression results.

Free estimation of this function yields implicit estimates of 1.47 for c_1 and .68 for c_2. Clearly, a model based on the interest rate spreads (α(RM-Raa)) would be rejected as the implied coefficients are very different from each other and from one. This finding is of some importance to our simulation design and I return to this issue in the appendix of the next chapter.

The adjustment factor is, as expected, very slow: the parameter estimates indicate an adjustment of about .14 per quarter. In addition, the mean lag on the wealth variable is nearly 3 quarters.

One can test explicitly for credit rationing on the supply side (see Fair and Jaffee (35)), by including in addition to the other regressors, the lagged endogenous variable. Introducing this variable was not successful. While the slow adjustment and long and variable lag on per capita may indicate a form of rationing, the evidence is really not very clear.

B. Loan-to-Value Ratio

Mortgage lenders and borrowers make a multivariate decision when determining the terms of the mortgage for any prospective housing purchase. The cost, the mortgage interest rate, alone

Table IV.10

$$RM = \underset{(5.23)}{.061443} + \underset{(6.25)}{.465032}\ Raa - \underset{(-2.666)}{\underset{(2.15)}{5.7422}}\ MF/(KH_{-1}\cdot PH)$$

$$- \underset{(-2.665)}{\underset{(.2554)}{.6808}}\ MS_{-1}/(KH_{-2}\cdot PH_{-1}) + \underset{(1.06)}{.2128} \sum_{t=0}^{-4} b_i\,(Finw/HH)/(1-LVR)$$

		t
b_0	= .14284	3.53
b_{-1}	= .2285	3.53
b_{-2}	= .2570	3.53
b_{-3}	= .2285	3.53
b_{-4}	= .14284	3.53

1961:1 - 1973:4

R^2 = .9858

SSR = .7098 E-04

SER = .127 E-02

DW = 1.64

ρ = .62
(.11)
(5.55)

Mean LHS = .0681

RM: Mortgage interest rate

Raa: AAA bond rate, new issue

MF: Mortgage flow - sum of flows at
SLA
MSB
CB
LIC
FNMA

KH·PH: Total housing stock, current $

MS: Mortgage stock - sum of stocks at
SLA
MSB
CB
LIC
FNMA

W: Net financial wealth

HH: Household

LVR: Loan - value - ratio

may not ration the market. Unfortunately, economic theory gives little information or guidance about the structure of non-price elements of contracts nor about the role they play in interaction with price elements. However, in the mortgage market there are joint decisions made about the rate and the percentage of the dwelling unit price that will be mortgaged. In addition, the term or amortization period is also part of this decision process.

It is often suggested (see discussion in Chapter II) that thrift institutions, faced with deposit outflows, ration their available mortgage credit through equity investment requirements: downpayments. To the degree that the ability to purchase a larger part of the house at the initiation of the mortgage contract provides information about default risk when such a mortgage is issued at relatively high nominal rates, the loan-to-value ratio becomes a rather selective rationing device. It eliminates those with small accumulations of wealth (or an inability to finance the downpayment with a non-mortgage loan) and perhaps as a consequence, those perceived as having a higher probability of default.

Whether or not in fact default is correlated with down-payment, the mortgage lending industry certainly believes it is. Loan-to-value ratios on government insured mortgages have been consistently and appreciably higher than those on conventional loans. The former have had loan-to-value ratios near 95% (there are some 100% VA mortgages now being offered), while the average loan-to-value ratio for conventional mortgages (mostly uninsured) has been around 74% over the past fourteen years.

Private mortgage insurance rates increase with loan-to-value ratios and often, so does the contract mortgage rate.

Several studies (see(140), (141)) have examined the relationship between mortgage terms and deliquency or foreclosure rates. Although the evidence is quite weak, the best empirical estimates indicate that higher initial loan-to-value ratios correspond with higher deliquency rates in an increasing fashion.

The specification is necessarily ad hoc and should be considered a reduced form of some demand-supply schedule over loan-to-value ratios given the asset price and interest rates. I postulate that,

$$\text{IV.23} \qquad LVR = d_0 + d_1\, DS + d_2\, Rm + LVR_{-1}$$

Table IV.11 presents the regression. The stock of deposits (DS) includes Federal Home Loan Bank Board Advances and represents the available money (gross) for mortgage lending. Although one might want to examine differential effects of deposits and advances, collinearity precluded such estimation. I also examined the impact of mortgage repayments and found that they contributed little independent information to the regression (sign was wrong but insignificant).

Viewing this from the supply side, one might expect the stock of mortgages held by an intermediary to affect mortgage lending and thus the terms of the contract. Except for the usual quantity-price relationship (examined below) there was no evidence of existing stock effects on LVR (the coefficient was not significant).

Table IV.11

$$LVR = \underset{(4.758)}{.3152} + \underset{(4.0306)}{.1476}\ DS - \underset{(-3.884)}{.9394}\ RM + \underset{(6.819)}{.5949}\ LVR_{-1}$$
$$\qquad\qquad\quad (.0663) \qquad (.0366) \qquad\quad (.2418) \qquad\quad (.0873)$$

1961:1 - 1973:4

$R^2 = .909$

SSR = .002

SER = .00646

DW = 1.86

Mean LHS = .7367

LVR: Loan-to-value ratio

DS: Deposits at SLA, MSB, CB and FHLB advances (trillions, current $)

RM: Mortgage rate

This is not at all surprising for savings and loan associations where regulatory constraints on portfolios insure that deposits and mortgage stock are very highly correlated. I did think however, that I might get some independent movement for those intermediaries with less constrained balance sheets.

The econometric evidence indicates a lagged adjustment with a mean lag of nearly three quraters with elasticities (at the point of means) of .27 and -.31 for deposits and mortgage rate respectively.

VI. EXPENDITURES AND STOCK

A. Expenditures

The value of residential investment clearly depends upon the value of units started. It also depends upon those expenditures that are used to upgrade the existing stock, such as additions and alterations of previously built units. Aggregate data are supplied by the Bureau of Census based on multi-family expenditures, single family expenditures, expenditures on additions and alterations and certain miscellaneous expenditures. The single - multi split is at five

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There are some serious problems with data in this area which are covered in some detail in the appendix to this Chapter.

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dwelling unit structures. For these two expenditure series, expenditures on one to four units and expenditures on five or more units, the Census uses fixed lag identities on value of

starts. Expenditures on additions and alterations are estimated by survey. The aggregate of these various components is published in the National Income Accounts as a single series, investment in residential structures. Instead of estimating regressions based on this data, most of which derive from identities, I simply use the appropriate identities,

IV.24 $EH14\$ \equiv .4103\ VS14\$ + .498\ VS14\$(-1) + .096\ VS14(-2)$

IV.25 $EH15\$ \equiv .1967\ VS5\$ + .3867\ VS5\$(-1) + .2466\ VS5\$(-2) + .11\ VS5(-3) + .06\ VS5(-4)$

The mean lags for EH14 and EH5 are .5 and 1.5 respectively.

Total expenditures equals the sum of these plus additions and alterations and certain miscellaneous expenditures (see Appendix for details).

Actually, the Census uses monthly distributions of nominal value of starts. The identities presented here are the quarterly equivalents.

The miscellaneous expenditures are taken to be exogenous. To link this sector to a larger macro model and to generate stocks, we need only explain expenditures on additions and alterations. This is treated essentially in the manner common to studies of consumer durables,

$$EAA = j(Y^P, KH, \bar{r}).$$

Again, assuming a linear relationship, the results are reported in Table IV.12.

The results are most disappointing. No specification or grouping of variables can explain more than 12 percent of the variance. The series appears to be essentially random. Particularly disappointing is no demonstrable relationship between additions and alterations and the total stock of housing in the economy (or any of its constituent parts). Surely, there must be some relationship (positive) between the size of the stock and the amount of expenditures necessary to maintain it. It is also reasonably common for homes to be purchased with parts unfinished, to be completed as the family grows. One suspects that there are very serious errors in the method of data collection and analysis for this series, something the Census needs to make some effort to investigate. I am forced to treat this component of expenditures as exogenous for simulation purposes.

Table IV.12

$$\log(EAA) = \underset{(.58)}{\underset{(1.69)}{.98}} - \underset{(-.09)}{\underset{(.271)}{.0246}}\ (KH14 + KH5)_{-1} - \underset{(-.02)}{\underset{(.0028)}{.0007}}\ CON + \underset{(.84)}{\underset{(.00559)}{.0047}}\ PH/P -$$

$$\underset{(-.45)}{\underset{(.0248)}{.0112}}\ Rcl$$

1960:2 - 1972:4

$R^2 = .12$

SSR = .759

SER = .128

DW = 2.39

$$\log(EAA) = \underset{(-1.52)}{\underset{(.629)}{-.957}} + \underset{(1.80)}{\underset{(.29)}{.546}}\ (KH14 + KH5)$$

1960:2 - 1972:4

$R^2 = .06$

SSR = .825

SER = .1072

DW = 2.24

EAA: Real expenditures on additions and alterations

KH14 + KH5: Total real stock of housing

CON: Consumption, real

PH: Price index, housing

Rcl: Commercial loan rate

B. Stock of Housing

The separation of expenditures and starts conveniently provides for an accurate measure of the respective stocks. Beginning of period stock equals end of period stock less removals and depreciation plus the period's expenditures on new housing and expenditures on additions and alterations. The government, usually at a local level, has provided public housing (not to be confused with subsidized private housing starts). Such additions to the stock of housing are treated as exogenous but are not ignored since they provide a substitute for certain groups to private housing. Such substitution will have price effects which are handled by adding such construction to the stock of housing. The larger stock, generated from this source, has a depressing effect on prices during those periods when such public expenditures are important, and consequently, lowers private starts. Thus a form of crowding-out is allowed for. However, the respective elasticites in the asset demand and investment functions imply a net elasticity slightly less than one. That is, given the substitution effects, there is a net addition from public starts nearly equal to the value of those starts.

The specifics of other miscellaneous additions and removals from the stock are discussed in some detail in the appendix. Using depreciation rates of 2 percent for owner-occupied dwellings and 2.4 percent for rental units, the stock identities become

IV.23 $KH14 \equiv .995 * KH14(-1) + EH14 + a_1 EAA +$ miscellaneous items

$KH5 \equiv .994 * KH5(-1) + EH5 + a_3 EAA +$ miscellaneous items

VII. MORTGAGE SUPPLY

The MPS model has a well developed mortgage loan sector, disaggregated by intermediary type: savings and loan associations mutual savings banks, life insurance companies and commercial banks.

The sector was developed by D. Jaffee (61).
A serious problem, but one very difficult to rectify, is the treatment of the Federal mortgage intermediaries as exogenous to the mortgage market. However, research in this area is topic for further work.

The spirit of the estimated relationships is correct, unfortunately data limitations forced specification constraints that masked much of the original model. The principal difficulty was the lack of data on new commitments, commitments expirations and/or commitment takedowns (conversion to mortgages). The only new commitment data available to Jaffee were for life insurance companies. I was able to obtain, in addition, new commitment data for the largest single mortgage intermediary-savings and loan associations.

Both sets of data were used elsewhere in the housing model. Since it was necessary to model the new SLA commitments, I

essentially adopted Jaffee's development of mortgage supply, estimating the relationships in their appropriate specifications.

Following Jaffee, let the intermediary's desired level of mortgages (MS*) be proportional to its stock of deposits, DS.

For SLA's a minimum proportional relationship is enforced by regulation (FHLB), as such institutions must hold at least a minimum proportion (approximately 80%) of their portfolios in mortgages.

This development ignores liquidity requirements, a possible tool of FHLB policy.

Since there are no long term competing assets for SLA's,

LV.25 $$MS^* = (a_0 + a_1 Rm)\ DS$$

is assumed to be the optimal relationship and a change in the stock follows the usual adjustment assumption,

IV.26 $$\Delta MS = \lambda_0 (MS^* - MS_{-1})$$

In addition, I allow for an impact effect of deposit changes,

IV.27 $$\Delta MS = \lambda_0 (MS^* - MS_{-1}) + \lambda_1 \Delta DS$$

However, since the process of mortgage lending involves a commitment step, this should be viewed as intended changes in mortgage holding rather than the actual change. The basic innovation of the Jaffee approach is to allow for quite different behavior of commitments made and mortgages acquired. (To the degree that the current flow of mortgages is determined by commitments of the past, the current additions to mortgage holdings may not be what the intermediary would acquire based on current information. In fact, the intermediary may have

to meet commitments with some difficulty if deposit flows have fallen off rapidly, hence a role for FHLB advances.)

I assume that the amount of mortgages expected to be derived from new and outstanding commitments should equal the desired change in the mortgage stock.

If we define the planning period as that time necessary for full adjustment to take place, then

IV.28 $$\hat{\Delta MS} = MS^* - MS_{-1} + g_1 \Delta DS + Rep$$

where Rep repayments, converts this to a gross flow relationship.

Three things can happen to the intermediary, however the intermediary can currently control only two:

1 It can make direct mortgage loans (MF_d).

2 It can make new commitments anticipating the mortgage flows that will result.

3 It has outstanding commitments that are maturing and either being taken down or allowed to expire, at the option of the holder of the commitment not the intermediary.

Therefore,

IV.29 $$\hat{\Delta MS} = MF_d + \alpha_0 Ncom + \alpha_1 Ocom_{-1}$$

α_0 and α_1 are less than one and reflect expiration of commitments. Lack of data force the assumption that the actual mortgages acquired by the intermediary from new and outstanding commitments are proportional to their respective magnitudes, although rapid and precipitous changes in interest rates may well result in cyclical behavior of takedowns. In fact, one would expect this

to be important if commitment contracts extended over lengthy time periods.

Since cyclical takedowns increase the risk of error in the target portfolio, one would expect that over periods of large variations in interest rates, commitment contracts would shorten and the ratio of commitments to direct mortgage lending would fall.

There is, however, no way of distinguishing in the data mortgage flows that result from direct acquisitions as opposed to those from commitment takedowns.

The sketchy data available on commitment lengths, indicate that for one intermediary FNMA, the period has shortened. It is difficult to know, however, how much of this resulted from the risk problem and how much from standardization of lending practices as FNMA adjusted to its new role as a private firm after 1968.

There is, at the same time, a cyclical constraint on intermediary behavior. For example, as deposits fall, the overhang of past commitments forces the intermediary to make fewer direct loans so as to be able to meet past obligations that come due.

All of this implies that the assumption of proportionality is not innocuous.

Solving for new commitments (Ncom) we have,

$$\text{IV.30} \qquad Ncom = 1/\alpha_0 \, (\hat{\Delta MS} - MF_d) - \alpha_1/\alpha_0 \, Ocom_{-1}$$

I assume that

$$\text{IV.31} \qquad MF_d = \alpha_3 \, \Delta MS,$$

which implies that the actual flows from all three sources are a constant proportion of the target accumulation, $\hat{\Delta MS}$. Once the desired accumulation is determined, the intermediary knows from its past history of similar experiences that there are reasonably stable relationships between commitments and takedowns. We now have,

$$\text{IV.32} \qquad Ncom = (1-\alpha_3)/\alpha_0 \qquad \hat{\Delta MS} - \alpha_1/\alpha_0 \quad Ocom_{-1}$$

Given the expression for MS and using the above relationship we derive,

IV.33 $$Ncom = (1-\alpha_3)/\alpha_0 (MS^* - MS_{-1} + g_1 \Delta DS + Rep) - \alpha_1/\alpha_0 Ocom_{-1}$$

and

IV.34 $$Ncom = (1-\alpha_3)/\alpha_0 ((a_0+a_1 Rm)DS - MS_{-1} + g_1 \Delta DS + Rep) - \alpha_1/\alpha_0 Ocom_{-1}$$

which can be estimated directly.

In this model mortgage flows are a distributed lag on past commitments. However, to allow for some flexibility due to the difficulties raised in the last footnote, allowance is made for current market conditions to affect this relationship. During the current period, the intermediary may make fewer or more direct mortgage loans depending upon actual deposit flows, the hangover of outstanding commitments, and its ability or desire to make new commitments during the current period.

To close the supply side of a model of intermediary mortgage behavior, we need simply keep track of the stock of outstanding commitments, the stock of mortgages and repayments. The stock of commitments (Ocom) is the sum of last periods stock less takedowns less expirations plus new commitments (Ncom). However, since all of the necessary data are not available a simple identity will not suffice, therefore

IV.35 $$Ocom = Ncom + Ocom_{-1} - \alpha_1 Ocom_{-1} - \alpha_2 Ocom_{-1}$$

and

IV.36 $$Ocom = Ncom + d_1 Ocom_{-1}.$$

The penultimate term in the first expression maintains the assumption of proportionate takedowns and the last term represents an implicit assumption that expirations are a proportion of the stock.

The current mortgage stock is a simple accumulation identity

IV.37 $\quad MS \equiv MS_{-1} + MF - Rep.$

Finally, repayments (Rep) are assumed proportional to the stock, with allowances made for portfolio adjustment because of interest rate changes. For example, a recent history of higher interest rates may slow down the repayments on past mortgages. In addition, allowance is also made for the separate effect of last period's flows. We then have,

IV.38 $\quad Rep = i_0 MS_{-1} - i_1(\overline{Rm} * MS_{-1}) + i_2 MF_{-1}$

For any intermediary, the supply side of the mortgage market is modeled by,

IV.39 $\quad Ncom = \hat{\gamma}_0 + \hat{\gamma}_1 Rm*DS + \hat{\gamma}_2 \ \Delta DS + \hat{\gamma}_3 Rep + \hat{\gamma}_4 Ocom_{-1}$

IV.40 $\quad Ocom = \hat{\alpha}_0 + \hat{\alpha}_1 Ocom_{-1} + Ncom$

IV.41 $\quad MF = \hat{\eta}_0 + \hat{\eta}_1 \Sigma b_i \ Ncom_{-1}$

IV.42 $\quad MS = MS_{-1} + MF - Rep$

IV.43 $\quad Rep = \rho_1 + \rho_1 MS_{-1} - \rho_2 (\overline{Rm}*MS_{-1}) + \rho_2 MF_{-1}$

Tables IV.13, IV.14, and IV.15 report the respective results.

Since the purpose of this section was to link my new data with the current mortgage supply model in the MPS model for simulation purposes, I have estimated these functions only for my new data on savings and loan associations.

However, even though this model seems plausible and an attractive view of the commitment-mortgage process, the estimated model in the MPS macro model is quite different due to data limitations. For commercial banks only a net mortgage acquisition function is estimated. Not enough data are available on new commitments for mutual savings banks to estimate the model directly, instead Jaffee was forced to examine net acquisitions of commitments and to adjust the mortgage flow specification appropriately. The same procedure for savings and loan associations will be replaced for simulation purposes by the work reported here. The model was estimated, as specified, for life insurance companies by Jaffee.

The estimation results are straight forward and quite good in the sense of appropriate signs and significance levels. Repayments, which appear in both the mortgage flow equation and the new commitment equation, imply a cross equation constraint. This restriction arises because in long-run equilibrium, with new mortgage flows zero, gross mortgage flows must equal repayments. Therefore, the total equilibrium effects of repayments, both directly on mortgage flows and indirectly through new commitments must equal one. Since the direct effect is .61, the indirect effect must be .39. The long run effect of commitments on mortgage flows is .95. Thus, the equilibrium effect of repayments on commitments must be .4. This parameter was constrained in the estimation of the new commitments' equation.

Joint estimation of the two equations with a cross equation constraint would be the efficient estimator. However, the constraint is nonlinear and involves the sum of simultaneously estimated lags. Consequently, the equations were estimated separately.

Table IV.13

$$MCNSL = \underset{(-1.27)}{\underset{(.85)}{-1.076}} + \underset{(2.96)}{\underset{(.07)}{.221}}\ DS + \underset{(3.67)}{\underset{(.086)}{.3166}}\ DF + \underset{(1.61)}{\underset{(.2)}{.35}}\ RM \cdot DS$$

$$+ \underset{\text{(Constrained)}}{.4 \cdot (1-.547)}\ Rep - \underset{(-2.88)}{\underset{(.081)}{.232}}\ MS_{-1} - \underset{(-2.081)}{\underset{(.124)}{.2582}}\ Ocom_{-1} + \underset{(4.927)}{\underset{(.111)}{.547}}\ MCNSL_{-1}$$

1961:2 - 1973:4

$R^2 = .932$

SSR = 13.28

SER = .5485

DW = 1.82

$\rho = .4084$

LHS mean = 4.935

MCNSL: New commitments, SLA

DS: Deposits

DF: Deposit flows

Rep: Repayments

MS_{-1}: Mortgage stock, SLA

$OCOM_{-1}$: Outstanding commitments, SLA

Table IV.14

$$OC_{SL} = \underset{(-2.559)}{-1.047} + \underset{(3.195)}{.2125}\ PC_{SL-1} + \underset{(.409)\ \ (.0665)}{NCOM_{SL}}$$

1961:2 - 1973:4

$R^2 = .9469$

SSR = 18.403

SER = .6128

DW = 1.63

$\rho = .6812$

Mean LHS = 4.7924

OC_{SL}: Outstanding commitments, SLA

$NCOM_{SL}$: New commitments, SLA

Table IV.15

$$MF_{SL} = \underset{(3.73)}{1.582} + \underset{(.05337)\ (3.43)}{.18318\ DS_{SL}} + \underset{(.07155)\ (4.26)}{.3047\ FHLBA} + \underset{(.1340)\ (4.51)}{.6071\ Rep_{SL}}$$

$$- \underset{(-3.92)}{.2154\ MS_{SL-1}} + \underset{(.0734)}{.9524} \sum_{i=0}^{-4} b_i\ NCOM_{SL-i}$$

		t
b_0	= .4782	(9.60)
b_{-1}	= .2956	(12.91)
b_{-2}	= .1565	(8.55)
b_{-3}	= .0609	(2.87)
b_{-4}	= .0087	(.54)

1961:2 - 1973:4

R^2 = .9897

SSR = 4.49

SER = .3269

DW = 2.01

ρ = 0

Mean LHS = 7.025

MF_{SL}: Gross mortgage flows, SLA's

$\Delta(\overline{DS}_{SL})$: Change in 4 quarter average deposits

DS_{SL}: Deposits, SLA's

FHLBA: Advances, FHLB system

MS_{SL-1}: Mortgage stock, SLA, lagged once

NCOM: New mortgage commitments, SLA's

The empirical results provide an interesting insight into savings and loan lending behavior. The mean lag on the commitments variable in the mortgage equation is approximately one quarter, which fits nicely with the data since most commitments are for less than six months. Commitments themselves are heavily dependent upon the current asset-liability condition of the SLA's as evidenced by the strong impact of the stock of deposits and deposit flows. Mortgage flows are less dependent upon current deposit conditions (the elasticity, at the means, of the weighted flow is only .12) but are determined by the past history of commitments and "uncommitted" liquid funds: repayments and the advances provided by the Federal Home Loan Bank System. (Elasticities, at means, are .41 and .24 respectively.)

The role that the FHLB advances play in this market is interesting and subject to considerable disagreement among policy markets. I tried estimating the commitments equation with this variable included but found no effect. However, it is clearly a determinant of mortgage flows. The data thus tend to indicate that SLA's use the FHLB as a "lender of last resort" to meet past commitments and perhaps increase their liquidity position. The econometric evidence is that they do not make long term decisions based on this kind of borrowing at least reflected by their willingness to make commitments to deliver mortgage funds at some future date. This seems reasonable, since during periods of disintermediation the major

source of liquid funds to meet liabilities has to come from the general capital markets through the advances provided by the Federal Home Loan Bank System. However, it is not clear why SLA's do not behave the same in response to all short term liabilities (advances and deposits). Why is their behavior different with respect to advances than with deposits? I have no answer, but this may be an area of fruitful future research.

One way of getting a feel for the sensibility of this model, is to examine the long run properties embedded in the estimation results for consistency with the characteristics of the particular intermediary. Since, in equilibrium (long run),

IV.44 $$Ncom = (1 - \alpha_3)/\alpha_0 \ Rep - \alpha_1 /\alpha_0 Ocom_{-1}$$

this implies that

IV.45 $$(1 - \alpha_3)/\alpha_0 ((a_0+a_1 Rm)DS - MS_{-1} + g_1 \Delta DS) = 0.$$

Since in an equilibrium with no growth, ΔDS would equal zero, we have

IV.46 $$MS = constant + (a_0 + a_1 Rm)DS$$

as the long run equilibrium mortgage stock-deposit stock relationship. Using the commitments equation, setting appropriate terms to zero and dividing by the estimated coefficient of MS_{-1} we have,

$$MS = constant + .95DS + .01\ RM * DS.$$

For savings and loan associations, this implies that about 95 percent of their deposits are invested in mortgages with an additional effect coming from interest rate sources. This

provides a surprisingly good confirmation of the properties of the model, as SLA's are constrained by regulation to hold at least 80 percent (the actual percentage varies from time to time with FHLB regulation) in mortgages. Since they have no other long term asset choices, the long run portfolio should consist essentially of mortgages. A small holding of liquid reserves seems plausible.

CHAPTER IV: APPENDIX A

I. COST OF CAPITAL: DERIVATIONS

A. Owner Occupied Dwelling Units

We derived earlier (Chapter III) a general expression for the housing cost of capital. However, there was no treatment of taxation. Not all housing units receive the same tax treatment and the differing treatment of rental and owner-occupied housing under current tax laws undoubtedly affects the observed mix in our economy. For single unit, owner-occupied housing, the government shares a portion of household interest costs by allowing deduction of interest charges on debt from taxable income. Implicit rental earnings are not taxed and no tax allowances are made for depreciation. Capital gains on housing are taxable only if the household "realizes" those gains by selling the housing unit and purchasing another at a lower price, by not purchasing another unit at a higher price within one year, or by not building a new unit within eighteen months. Should the household acquire another housing unit at a price above the disposition price of the old unit no tax liability arises. I assume that capital gains are never "realized" for tax purposes and thus never taxed.

Let tax be the proportional tax rate, then we get the simple Jorgensen formulation,

$$PH(0) = \int_0^T e^{-(1-ytax)\cdot\rho s} * R(s) * e^{-dep\cdot s} ds$$

and

$$R/PH = (1-ytax)*\rho + dep - \dot{PH}/PH.$$

For owner-occupied units the appropriate return is a little different due to property taxes, which are deductible from taxable income.

With an ad valorem property tax rate, ptax,

$$ptax * PH(s)*e^{-dep(s-t)}$$

is the tax due per unit of asset of time s and,

$$PH = \int_{e}^{-((1-ytax)*\rho + dep)s} *(R(s)-(1-ytax)*ptax*PH(s))ds$$

therefore,

$$R/PH = (1-ytax)*\rho tax + (1-ytax)*\rho + dep - \dot{PH}/PH$$

where it is assumed that property is appraised a full value for tax purposes.

Since I use an effective tax rate, this assumption is the same as assuming partial appraisal and statutory tax rate.

This form of the housing cost of capital is used in the single family asset demand function.

B. Multi-Family Dwelling Units

The cost of capital for multi-family units is considerably more complex due to tax allowances for depreciation. Taubman and Rasche (132) found that the current tax depreciation allowances confer a subsidy, often substantial, on the owner of the multi-family asset, since economic depreciation was found to be significantly less than depreciation allowed for tax purposes. (The findings are not unambiguous, however, since economic depreciation depends upon tax treatment.)

With allowances for tax depreciation,

$$PH = \int_0^T e^{-((1-ytax)\cdot\rho + dep)\cdot s} (R(s)*(1-ytax) - (1-ytax)* ptax*PH(s))\,ds + \int_0^T ytax*PH(0)\cdot D(s)\cdot e^{-(1-ytax)*\rho*s}\,ds$$

where the second integral gives the discounted value of allowable tax depreciation on an asset purchase at time 0. The first integral is similar to that of the owner-occupied cost of capital, however, rental income is taxed.

Following the procedure used by Jorgenson (64), let

$$Z = \int_0^T D(s)\cdot e^{-(1-ytax)*\rho*s}\,ds$$

then

$$(1-ytax*z)*PH = \int e^{-((1-ytax)\rho+dep)\cdot s} (R(s)\cdot(1-ytax) - (1-ytax)*ptax*PH)\,ds$$

$$\dot{PH}\cdot(1-ytax*z) = -R\cdot(1-ytax) + (1-ytax)\cdot Ptax\cdot PH + ((1-ytax)\cdot\rho + dep)\cdot\int e^{-((1-ytax)\cdot\rho+dep)\cdot s} (R(s)\cdot(1-ytax) - (1-ytax)\cdot ptax\cdot PH)\,ds$$

and $$R/PH\cdot(1-ytax) = (1-ytax)\cdot ptax + ((1-ytax)\cdot\rho+dep)(1-ytax\cdot z) - \dot{PH}/PH(1-ytax\cdot z)$$

If the tax is borne by capital and economic depreciation equals tax depreciation, one gets the familiar neutrality condition (see Jorgenson (64)).

The multi-family stock is held by both corporations and unincorporated owners, about 1/3 being owned by corporations. For these owners the market rate is net of taxes and the appropriate tax is the corporate tax rate. It is assumed that the unincorporated owners are the marginal investors and subject to the personal income tax. For these owners, the appropriate

market rate is gross of taxes. Therefore, for both owner-occupied and multi-family housing

$$\rho = RM$$

Van de Water (139), in an excellent development of the tax treatment of multi-family units, noted that there was an additional subsidy until 1969, prior to which parts of ordinary income was converted to capital gains and taxes at a lower rate. The loophole was closed in part in 1964 after which depreciation above the straight-line rate was recaptured at a rate decreasing from the 20th to the 120th month of ownership. The Tax Reform Act of 1969 reduced the permissible depreciation rate on used apartments and postponed the phaseout of recapture to the 100th through 200th month of ownership. Because of this, Van de Water using data from Taubman and Rasche, estimates the subsidy to be approximately six percent prior to 1969:3 and adjusts the multifamily cost of capital by .94 prior to that time.

The life of multi-family structures for tax purposes is 40 years. It is assumed that 60 percent of the structures are depreciated using a straight-line formulation and 40% using double declining balance. (This is not entirely correct, since second owners of multi-family units can only use 125 percent declining balance, but can depreciate the full purchase price.) Despite tax advantages, Van de Water reports that only 37% of the assets of financial and real estate corporations and partnerships who acquired property between 1954 and 1959 used accelerated methods. Evidence indicates this has not changed

much (see Hall and Jorgenson (54)). Nearly all of this depreciation claimed for tax purposes was taken using the declining balance method, even though the sum-of-the-years-digits methods is more profitable.

Again, following Jorgenson, for the 60 percent using the straight line method,

$D(t) = 1/T \quad t \text{ less than } T, \; T = 40$

therefore,

$$z = (1-e^{-40*(1-ytax)*\rho})/((1-ytax)*\rho*40).$$

For the 40 percent using double declining balance, assuming rational switching to straight line when profitable

$$D(t) = 1/20 \; *e^{-1/20 \; t}$$

$$\text{or}=1/20 \; e$$

and

$$z = 1/20*((1-e^{-20\cdot(1-ytax)\cdot\rho-1})/((1-ytax)\cdot\rho+1/20) + (e^{-20\cdot(1-ytax)\rho}-e^{-40\cdot(1-ytax)\cdot\rho})/(e\cdot(1-ytax)\cdot\rho))$$

Finally,

$$HCCM = R\cdot(1-ytax)/PH$$

$$= (1-ytax)\cdot ptax + (1-ytax)\cdot\rho + dep - \dot{PH}/PH$$

$$-((1-ytax)\cdot\rho + dep - \dot{PH}/PH)\cdot\{\cdot\frac{6\cdot ytax\cdot(1-e^{-40(1-ytax)\cdot\rho})}{40\cdot(1-ytax)\cdot\rho}$$

$$+ \cdot\frac{4\cdot ytax}{20}(\frac{1-e^{-20\cdot(1-ytax)\cdot\rho-1}}{(1-ytax)\cdot\rho+1/20}$$

$$+ \frac{e^{-20\cdot(1-ytax)\cdot\rho-1}}{(1-ytax)\cdot\rho}$$

$$- \frac{e^{-40\cdot(1-ytax)\cdot\rho-1}}{(1-ytax)\cdot\rho})\}$$

II. COST OF CAPITAL AND SUBSIDIES

Although these opportunity cost measures are aggregate approximations, they suffer some serious defects. In particular, for single family units, the government's growing involvement in housing markets significantly changes the costs for selected households. This intervention may take many forms, among them

1: lowering the market rate on mortgages relative to other rates by making the mortgage less risky (through insurance or guarantee) or more liquid (being the second market)

2: direct ownership - public housing

3: tax subsidies

4: lowering the effective rate on mortgages relative to the market rate through interest subsidies.

In general, the government's role in the housing market has been limited to the first three. Since the mid-1960's however, the government, through interest or rent subsidies has significantly lowered the cost of capital for numerous households. The following table indicates the pattern:

Year	Subsidized Units	As % of Total Private Starts
1961	36,162	2.8
1962	38,815	2.7
1963	47,829	3.0
1964	55,117	3.6
1965	63,630	4.3
1966	71,632	6.1
1967	91,433	7.1
1968	166,969	11.1
1969	200,001	13.6
1970	433,259	30.2
1971	429,558*	13.9

At least in the case of HUD subsidized single family homes (so called "235 houses") and Farmers Home Administration homes, the program is similar to a combined graduated payment - variable rate scheme. The subsidy depends upon the income of the household and varies upon periodic evaluation of the household's income position.

Clearly such programs alter the cost of capital, but they do so in a way that cannot be measured directly given the data available. (Data are only available on the number of starts, not on the effective rates the household's pay.)

Simply examining the number of units produced with subsidies is inappropriate - even if the programs had not existed, people would have been housed. Such programs do not give homes to those who otherwise would not have had them, rather they lower the capital costs for certain groups, allowing them to compete more effectively, even though the net result is higher asset prices.

The precise path through which such programs affect the market is difficult to discern. They may encourage household formation, increase removals of old units, or redistribute expenditures away from lower priced substitutes - mobile homes. It is clear, however, that to affect construction, such programs must increase demand, increase the asset price and then housing starts.

III. COST OF CAPITAL AND INFLATION

Since the tax treatment of interest allows for deductions

of nominal rather than real interest paid, inflation induced changes in the nominal rate change the cost of capital. This change persists and can be easily demonstrated. Assume the real rate, RR, does not change with inflation, that inflation is perfectly anticipated and, for the moment, that there is no appreciation of the asset except the movement with the general price level. Then without inflation

$$\begin{aligned} Hcc1 &= (1\text{-}ytax)*RM + dep + ptax \\ &= (1\text{-}ytax)*RR + dep + ptax \end{aligned}$$

In a situation with perfectly anticipated inflation,

$$\begin{aligned} \overline{Hcc1} &= (1\text{-}ytax)*RM + dep + ptax - \dot{P}/P \\ &= (1\text{-}ytax)*(RR + P/P) + dep + ptax - \dot{P}/P \end{aligned}$$

The difference

$$\overline{Hcc1} - Hcc1 = -ytax\ \dot{P}/P$$

is an inflation induced change in the real cost of holding housing capital that would exist even with perfect markets or alternative mortgage instruments. It is simply a function of the tax system.

IV. COST OF CAPITAL AND PRICE EXPECTATIONS

The cost of capital measures require price expectations. Simple six and twelve quarter weighted average of past price changes were tried for single family dwellings. No price was available for multi-family, so I used rent changes with identical weighting schemes. The weights imply a slow adjustment of expectations to changes in inflation rates, a view consistent with numerous term structure studies. (See Modigliani and Shiller (92) or Eckstein (27)). Ideally, one would like to

estimate the weights and lag as part of the equation estimation. The available data will not support such estimations. Only the coarsest of information can be gleaned from the data, by altering the weights or lag lengths.

Some work was done with variable weight expectations schemes. For example, a scheme was used that weights the current price changes of the variance of actual price changes over some recent period of time. If there is a strong trend in inflation rates, the weighting scheme gives more weight to more recent history. Although this work proved interesting, it was not central to this thesis and was not pursued.

DATA: SOURCE DOCUMENTATION AND DESCRIPTION

This appendix presents data by mneumonic, sources and annotations where necessary. Part of the data was obtained from the MIT-PENN-SSRC data bank and is indicated by an appropriate flag. All real variables are in 1958 dollars.

CON Real Consumption (MPS) 1958 $

Creation for the MPS model; 1958 $ consumption from National Income Accounts (NIA) less consumer durable expenditures (NIA) plus imputed consumption of consumer durable services.

EH14 Real expenditures on one to four unit structures

EH5 Real expenditures on five or more structures

EAA Real expenditures for additions and alterations

EPUB Real expenditures on public housing

EREM Real net purchases by the government of private housing stock

ECOM Real expenditures on commissions and fees

ENON Real expenditures on non-housekeeping units

Expenditures on private structures are derived from the fixed lag, fixed coefficient identities of value-of-starts for one to four and five or more units.

Expenditures on additions and alterations, public housing and nonhousekeeping units are published by the Census in Construction Reports C-30 and are seasonally adjusted using X-11.

Brokers' commissions and net purchases by the government are quarterly interpolations of annual NIA data. The latter is mostly negative and represents government purchases for a variety of purposes: urban renewal, highways, etc.

Non-housekeeping units and commissions are not used in the creation of my stock series. However, the NIA Investment in Residential Structures data are supposed to be the sum of these seven items, most provided by the Census. A problem: the Census has at various times judged its multifamily series in gross error and revised its method of valuing the starts and converting them to expenditures. (Prior to 1963, the current single family expenditure identity was used for all starts. In 1968, new methods were used to compute non-housekeeping and multifamily units. There are no data published for additions and alterations during 1964.) I have used the current method the Census uses over the entire time period; however, the NIA series, conceptually the same, only reflects these revisions recently. Therefore, a small residual exists, which along with the last four items (EPUB, EREM, ECOM, ENON) is considered exogenous for simulation purposes.

HH Households, millions

HM Proportion of households expected to live in multi-family dwellings.

The Census provides (Current Population Reports, P-20) annual data on households. Monthly data on marriages is also available (Vital Statistics of the US: Marriage and Divorce). The annual data are interpolated for quarterly purposes using the marriage data. This ignores household dissolutions except for the annual benchmarks.

The Census also provides (P-20) annual data on the number of households with heads in various age categories. I assume those less than 30 and 65 or over are more likely to live in multi-family dwellings. Quarterly interpolations are made from trends between benchmarks.

KH14 Real value of one to four unit structure capital stock, millions $

KH5 Real value of five or more unit structure capital stock, millions $

KMOB Real value of mobile home capital stock, millions $

All stocks are end of quarter, derived by perpetual inventory methods using identities explained in the text. Account is take of public housing, upgrading the stock and removals for urban renewal and highways. Commissions and fees on sales are omitted, an implicit assumption that they are not capitalized in the unit. Land costs are excluded from the stock as are non-housekeeping units. A depreciation rate of 2 percent per year was applied to one to four unit structures, 2.4 percent per year for those with five or more units. (The same rates were used

in an excellent paper by Young, Musgrave and Harkins (142).) Benchmarks for 1959:4 were derived from Young et al. Non-housekeeping and mobile homes were excluded from their series but commissions were included. No breakdown was given by class of structure for public housing. I summed Federal and State and Local housing and simply assumed a 50 percent break, and further, assumed all farm housing was in the one to four unit class. The resulting benchmarks in millions of 1958 dollars are

1-4 unit $373,350

5 or more $ 27,350

The depreciation rate on mobile homes is subject to much debate and therefore considerable variance. I use the assumption of Young, et al that the economic life is sixteen years, and used 9 percent as the depreciation rate. A simple perpetual inventory

$KMOB = (1-d)*KMOB_{-1} + EHM$ is used, where EHM is the real expenditures on mobile homes available from the Mobile Home Manufactures' Association and the Commerce Department (MPS). Current dollar figures are deflated by a mobile home cost index provided by the Commerce Department (unpublished).

The 1959:4 benchmark was $1800 million.

LVR Loan-to-value ratio

Ratio on conventional mortgages from Federal Home Loan Bank Board Journal

MCNLI New, real dollar, mortgage commitments of life-insurance corporations (MPS)

MCNSL New, real dollar, mortgage commitments of savings and loan associations

Stocks of mortgage commitments are available for savings and loan associations (Federal Home Loan Bank Board Journal), mutual savings banks (Federal Reserve Bulletin) and life insurance corporations (Federal Reserve Board, capital markets section (MPS)).

New commitment data are readily available only for life insurance corporations (Federal Reserve Board, capital markets section (MPS)). I was able to obtain a series for new commitments for savings and loan associations from the government provided it would not be published nor documented. Data on new commitments are available for the major lenders through HUD, but the series have been extended back to 1971 only. (in Housing and Urban Development Trends)

MS Real mortgage stock

MF Real mortgage flows

In all cases I have used the sum of holdings or flows by the major intermediaries: savings and loan associations, mutual savings banks, life insurance corporations and commercial banks. In addition, stocks held by Federal National Mortgage Association are used. All stocks are Federal Reserve Board Flow of Funds data (MPS).

Mortgage flows are available only for savings and loan associations, mutual savings banks, and life insurance corporations. The latter from FRB Flow of Funds, the former from the Federal Home Loan Bank Board Journal. For mutual savings banks, repayments are available from National Fact Book of Mutual Savings Banks and flows are created from stock changes and repayments (MPS).

PCON Implicit price deflator for consumption (MPS).

PH Asset price of housing

Data are housing prices used for the home purchase component of the CPI (1958=100) and are unpublished, used with special permission.

PTAX Effective property tax rate

The annual average real estate tax payment on existing homes insured by FHA ("section 203") divided by the estimated average value of such homes. Annual data are from US Federal Housing Administration, Series Data Handbook. Quarterly interpolations are based on total state and local property tax collections as reported by the Census, Quarterly Summary of State and Local Tax Revenues.

R Rent index (1958=100)

NIA series, adjusted by 1.36% each year to account for decline in gross operating income as an apartment building declines with age (see Taubman (133) and Van de Water (139).

RAA AAA Utility bond interest rate, new issue, Federal Reserve Bulletin (MPS)

RCL Construction Loan Rate

Construction loan rate data are available (unpublished), however to avoid expanding other sectors, I use a commercial loan rate, Federal Reserve Bulletin. (MPS)

RM Mortgage interest rate

Effective rate on FHA mortgages for new and existing homes, using weights of 1/3 and 2/3 respectively. Data are from Federal Reserve Bulletin (MPS).

Actually, it would be preferrable to use conventional rates, since they are not subject to FHA-VA ceilings. However, these data (Federal Home Loan Bank Board Journal) are only available since the mid-Sixties.

It is important to use effective rates, since ceilings on FHA-VA mortgages or state or local usury ceilings create discounting or "points".

SUB

SUB14

SUB5

The total number of starts is published in Census Construction Reports, C-20 where the number of subsidized starts is published by program ("235, 236, 221d") Division by type is made according to program, e.g. program 235 is primarily single family, program 236 is for rental and thus primarily multi family. Program 221d3 multifamily starts are available from HUD Annual Report.

VS14 Real value of starts, one to four unit structures

VS5 Real value of starts, five or more unit structures

1: The Census publishes (Construction Reports, C-20) monthly data on the number of 1, 2, 3-4 and 5 or more unit starts. These data were seasonally adjusted using X-11, then compacted to quarterly totals. Prior to 1963:4, there was no division between 3-4 and 5 or more unit starts. I assumed that prior to then the proportion was the same as the average proportion for 1964-65. The 3 or more series was then split back to 1959:1 by

3-4 = .12(3 or more)

5 or more = .88(3 or more)

2: Using Census Construction Reports C-40 one can get data on the total valuation of all building permits issues in a large ($\doteq$ 13,000) sample. Also available are the number of units authorized. The quotient yields the average permit valuation per unit in permit areas.

Using Census Construction Reports C-20, one can find a division of the number of starts in permit areas and non-permit areas. These data are available for 1, 2, 3-4 and 5 or more unit structures. The Census has a series of blow-up factors to account for undervaluation. The product of these factors and the average permit value yields the average value per start in permit areas. The blow-up factors are:

Unit	Factor
1	1.179
2	1.34
3-4	1.34
5 or more	1.5

For single family dwellings, the average value per start in non-permit areas is determined by a Census regression line, $6010 + .34 (average value per start, permit areas). I assume that for 2, 3-4 and 5 or more units non-permit area values are 85 percent of thoes in permit areas. (Not a serious assumption, since most starts with 2 or more dwellings per unit are in urban or suburban areas and therefore in the permit sample.)

Finally, using the division of starts between permit and non-permit areas, the permit and non-permit valuations are weighted and summed quarterly to yield the average value per start for the respective dwelling unit classes in current dollars. (The number of units in permit and non-permit areas is not available for 2, 3-4 and 5 or more units prior to 1963:4. I assume the same ratio to have existed as the average ratio for 1964.)

3: The number of starts and the average value per start then yield, obviously, the total value of starts per unit classes.

4: Real values are computed using the Census index of new one-family construction costs (a hedonic index). Since

this series is only available back to 1963, it is linked at that time to the FHA-OBE index (a survey index).

VAC Vacancy rate

Several vacancy rates are available from HUD. I used the respective single family and rental rates, for preliminary estimation but use the rental rate for simulation.

YTAX Effective rate on personal income tax (MPS)

(personal + fiduciary tax)/(personal + fiduciary taxable income)

YP Real Permanent Income

Friedman in a classical work (41) shows that permanent income is an adaptive function of current disposable income (YD) and past permanent income,

$$Y^P = B*Y^d + (1-B+A)*Y^P_{-1}$$

where B is the adjustment coefficient and A is the trend growth in real income. Darby (18) suggests that this is not the correct discrete form of Friedman's continuous time formulation, but instead

$$Y^P = B*Y^d + (1-B)*(1+A)*Y^P_{-1}$$

Depending upon the exact data, time period and method of estimation there are various estimated for A and B in the literature. I constructed various time series using both Friedman's and Darby's methods and their weights plus the weights published by Wright (145).

All reported results use Wright's weights. There was no

substantive difference in the results from other weights however. These were chosen on the purely subjective basis that they gave more weight to current disposable income. This was appealing since mortgage lending very much depends upon rough measures of current "permanent" income.

CHAPTER IV: APPENDIX C

The following tables present ordinary least squares estimates for selected functions. Table numbers correspond to those in the text of the chapter.

Table IV.A.3

$$\text{Log } (PH/P) = \underset{(4.5)}{\underset{(3.35)}{15.1}} - \underset{(-4.00)}{\underset{(.85)}{3.394}} \log (Qpay) - \underset{(-3.96)}{\underset{(1.44)}{5.71}} \log (\hat{T})$$

$$\underset{(.009)}{-.068} \sum_{L=0}^{-3} b_i \log (HCC14) - \underset{(.223)}{.704} \sum_{L=0}^{-3} Ci \log (KH14\text{-}1/HH)$$

$$\underset{(2.33)}{\underset{(.077)}{+.179}} \log (Y^P/HH)$$

		t			t
b_0	= .2	-7.65	c_0	= .19	-3.15
b_{-1}	= .3	-7.65	c_{-1}	= .29	-3.15
b_{-2}	= .3	-7.65	c_{-2}	= .29	-3.15
b_{-3}	= .2	-7.65	c_{-3}	= .19	-3.15
	2^m Both			2^m Both	

1961: 1- 1973:4

R^2 = .92

SER = 4.48 E-03

SSR = 9.24 E-04

DW = 1.47

ρ = .6587

Mean LHS = -.03185

PH: Price Index, Housing

P: Price Index, Consumption

Qpay: Quarterly Payment

$\hat{T}$: Duration

HCC14: Cost of Capital

KH14: Stock, 1-4 Units

HH: Households

Y^P: Permanent Income

Table IV.A.6

$$\text{Log}\ (R/R_{-1}) = \underset{(2.46)}{\underset{(.0675)}{.166}} + \underset{(2.42)}{\underset{(.0745)}{.18}} \log(\text{Urban}) - \underset{(-1.62)}{\underset{(.00092)}{.00148}} \log(\text{Hccl4}\cdot PH/P)$$

$$- \underset{(-2.54)}{\underset{(.0052)}{.01316}} \log(KH5_{-1}/hh) + \underset{(5.61)}{\underset{(.0167)}{.09344}} \log(P/R_{-1})$$

1961:1 - 1973:4

$R^2 = .93$

SSR = .00004039

SER = .000979

DW = 1.93

$\rho = .3361$

Mean LHS = .00606

R: Rent

Urban: % urban population

HH: Households

KH5: Real housing stock, 5 or more

PH: Asset price, 1-4 unit

Hccl4: Cost of capital, 1-4 unit

Table IV.A.7

$$\begin{aligned}\text{Log(VS14)} = {} & 7.1697 + 1.0718\ \log(PH/P) - .53819\ \log(Rcl) \\ & (0.1396)\quad (0.48856)\qquad\qquad (.07132) \\ & (51.35)\quad\ (2.19379)\qquad\qquad (-7.546) \\ & + .32158\ \log((NCOMSL_{-1} + NCOMLI_{-1})/PH_{-1}) \\ & \quad (.02824) \\ & \quad (11.386) \\ & - .32613\ \log(VAC) \\ & \quad (.08119) \\ & \quad (-4.017)\end{aligned}$$

1961:1 - 1973:4

$R^2 = .93$

SSR = .109

DW = 1.96

SER = .0482

$\rho = .1587$

VS14: Real value of 1-4 unit starts

PH: Price index, housing

P: Price index, consumption

Rcl: Commercial loan rate

NCOMSL: New mortgage commitments, SLA

NCOMLI: New mortgage commitments, LIC

VAC: Vacancy rate

Table IV.A.8

$$\begin{aligned}\log(VS5) = &- .344 + .4445 \log(R/P/Hcc5) - .6214 \log(VAC) \\ &(.50615)(.1634) \qquad\qquad (.1038) \\ &(-.679)\ (2.72) \qquad\qquad (-5.989) \\ &+ .3457 \log((NCOMSL_{-1} + NCOMLI_{-1})/PH_{-1}) \\ &(.07069) \\ &(4.8829) \\ &+.4704 \log(VS5_{-1}) \\ &(.073) \\ &(6.43)\end{aligned}$$

1961:1 - 1973:4

$R^2 = .97$

SSR = .264

SER = .075

DW = 1.97

$\rho = .1075$

Mean LHS = 7.298

VS5: Real value of 5 or more unit starts

R: Rent

P: Price index, consumption

Hcc5: Cost of capital, 5 or more units

VAC: Vacancy rate

NCOMSL: New mortgage commitments, SLA

NCOMLI: New mortgage commitments, LIC

Table IV.A.10

$$RM = \underset{(12.074)}{.0593} + \underset{(12.35)}{.4496}\ Raa - \underset{(-4.125)}{4.284}\ MF/(KH_{-1}\cdot PH) - \underset{(-4.4159)}{.5388}\ MS_{-1}/(KH_{-2}\cdot PH_{-1}) + \underset{(.033)}{.2}\ \sum_{t=0}^{-4} b_i\,(W/HH/L1\text{-}LVR)$$

b_0	= -.047	(0.3)	
b_{-1}	= .1607	(3.62)	
b_{-2}	= .2692	(3.94)	2^{nd} degree, tail
b_{-3}	= .2782	(3.01)	
b_{-4}	= .1882	(2.67)	

1961:1 - 1972:4

R^2 = .987

SSR = .000044

SER = .00102

DW = 1.97

ρ = .5062

Mean LHS = .0681

RM: Mortgage interest rate

Raa: AAA bond rate, new issue

MF: Mortgage flow - sum of flows at
- SLA
- MSB
- CB
- LIC
- FNMA

KH·PH: Total housing stock, current $

MS: Mortgage stock - sum of stocks at
- SLA
- MSB
- CB
- LIC
- FNMA

W: Net financial wealth

HH: Household

LVR: Loan - value - ratio

Table IV.A.15

$$MF_{SL} = \underset{(2.115)}{.7266} + \underset{(1.85)}{\underset{(.3435)}{.2639}}\ (\overline{DS})_{SL} + \underset{(1.94)}{\underset{(.069)}{.1336}}\ DS_{SL} + \underset{(3.0754)}{\underset{(.0833)}{.2561}}\ FHLBA$$

$$+ \underset{(7.570)}{\underset{(.1053)}{.7973}}\ Rep_{SL} - \underset{(-2.16)}{\underset{(.072)}{.1561}}\ MS_{SL-1} + \underset{(.106)}{.677} \sum_{i=0}^{-5} b_i\ NCOM_{SL-i}$$

		t
b_0 =	.4181	(5.3)
b_{-1} =	.2806	(6.45)
b_{-2} =	.1736	(5.72)
b_{-3} =	.092	(2.86)
b_{-4} =	.0359	(1.14)
b_{-5} =	.0052	(.24)

2^{nd} Degree, tail

1961:2 - 1973:4

R^2 = .9852

SSR = 3.876

SER = .3002

DW = 1.82

ρ = .312

Mean LHS = 7.025

MF_{SL}: Gross mortgage flows, SLA's

$\Delta(\overline{DS}_{SL})$: Change in 4 quarter average deposits

DS_{SL}: Deposits, SLA's

FHLBA: Advances, FHLB system

MS_{SL-1}: Mortgage stock, SLA, lagged once

NCOM: New mortgage commitments, SLA's

CHAPTER V

A central theme of this thesis has been that price instability combined with the traditional structure and milieu of housing finance is likely to result in serious problems for the housing market. The evidence for this is strong (albeit certainly not conclusive). Mortgage innovation, however, generates its own concerns and difficulties. A number of these concerns involve the microeconomic impacts of changing debt payment streams on individual households, whose income streams are subject to variation and uncertainty. As genuine and important as these issues are, they are not addressed in a formal way in this thesis. Instead, the focus of this chapter is on the general macroeconomic impacts likely to result from mortgage innovation.

There are three general areas of macro-economic concern:

1 The ability of proposed innovations to ameliorate the cyclical behavior of housing investment.

2 The effects of such innovations on the current structure of housing finance, that is, on the thrift institutions (particularly savings and loan associations - which have been the most constrained).

3 The implications that insulating housing and thrift institutions somewhat from interest rate fluctuations has for the stability of the rest of the economy and for monetary policy.

Many particulars of these issues are of sufficient complexity

that they are not easily resolved analytically nor by econometric data analysis, but they do lend themselves to analysis through simulation. To address particular issues of interest however, requires, at the minimum, an extensive model of housing, mortgage lending and deposit behavior. Questions under the general area of item three above would require a much larger macro-model of the U.S. economy. The research reported here is limited to interesting questions under the first two areas, the third is left as a topic for future research.

For these purposes, the model of housing developed and estimated for this thesis is embedded in a larger econometric model of the U.S. economy, the MIT-Penn-Social Sciences Research Council (MPS) model.

This model was chosen because of its extensive detail in the mortgage and deposit sectors. (The mortgage sector was modified with the new savings and loan associations model presented in Chapter IV. The deposit sector was used in its present MPS form.) The depth of detail allows the various effects of alternative mortgage instruments to be distinguished.

In principal, the simulation design developed in this chapter could be adapted to any model with appropriate mortgage and deposit sectors. However, the results presented here are quite independent of the properties of the larger MPS model and do not rest on characteristics of any sector of that model except the deposit and mortgage sectors.

However, the results presented here must be interpreted with

a good deal of caution. The purpose of the simulations is not to provide quantitative measures but rather a qualitative feel for the effects and interactions of thrift institutions, mortgage lending and housing construction with various mortgage types. This caution is stressed for several reasons. First, the basic sectors were developed with specification and estimation methods that are subject to error, while the results are presented as simple point estimates. Second, the simulation design is quite different from the usual simulation game where policy variables or parameters are changed. Here, the experiments are different: we impose a structure on the model that did not exist over the history of estimation nor historical simulation. The technique for implementing this new structure involves changing certain structural features of the econometric relationships in the actual model which no doubt introduces additional uncertainty into the results. Third, often the introduction of new instruments implied structural changes elsewhere that were not unambiguous. To proceed, ad hoc assumptions were made. Where possible alternative assumptions were made to test for sensitivity. I have tried to make very clear in the body of the chapter where such assumptions were made. Finally, the results are "partial equilibrium" simulations of the direct effects of mortgage innovations. The results do not allow for the full general equilibrium feedback from the rest of the economy. However, as suggested, this does have the advantage of making the results model independent in the sense discussed above.

In this chapter, I outline a series of simulation experiments that examine alternative mortgage designs. Concurrent with the outline of various simulation strategies is an outline of the main features of a variety of mortgage innovations. Three basic types of instruments are distinguished: graduated payment, variable rate and price-level adjusted. For each type, there are alternative variants. In each case, a brief scenario of the basic macroeconomic effects of the instrument is provided.

The order in which the alternative instruments are tested represents an attempt to develop in a logical manner the key features of these instruments. (It does not represent a view as to their relative desirability.)

This chapter is organized as follows. In Section II a general framework for illustrating the workings of the model is presented. This includes:

i) an outline of the relevant equations in the MPS model

ii) discussion of the manner in which specific equations, variables, and parameters will have to be changed for the various instruments,

iii) discussion of some general points on the simulation strategy.

In Section III, the specification in the model of alternative mortgage instruments is discussed in detail. Specific details on programming of the instruments are included in an appendix. Section IV presents results.

The general simulation design and much of the writing of all but Sections IV and V of this chapter were done jointly with Dwight Jaffee as part of similar simulations using the current MPS housing sector. This work, representing joint research in the best sense, is reported in the Federal Reserve Bank of Boston's Conference Report of the MIT Mortgage Study. Jaffee's help in getting the simulations working and making sense was invaluable.

II. GENERAL FRAMEWORK FOR THE SIMULATIONS

A. The Deposit, Mortgage and Housing Sectors

In order to develop a rough feeling for the interaction of the deposit, mortgage and housing sectors used in this simulation, a simplified schema of these sectors is presented.

Complete and technical descriptions of the mortgage supply and savings deposit sectors of the MPS model are available in Gramlich and Jaffee (45). The new housing sector has been discussed at length in this thesis.

Fortunately, for present purposes, the equations of basic interest for the simulations can be usefully presented without the details of dynamic lags, proxy variables and empirical approximations and the like. The relevant equations, making a closed system, are:

II.1 $PH/P = PH(Qpay, \hat{T}, Hccl4, KH)$

II.2 $VS = VS(PH/P)$

II.3 $MD = MD(RM, RO, KH, LVR, W)$

II.4 $MS = MS(RM, RO, DS, Rep, \ldots)$

II.5 $MD = MS$

II.6 $RD = RD(RM, RO, \ldots)$

II.7 $D = D(RD, RO, \ldots)$

II.8 $RES = RES(INT, RD, D, \ldots)$

II.9 $Qpay$ = function of mortgage instrument

II.10 $\hat{T}$ = function of mortgage instrument

II.11 PAY = function of mortgage instrument

II.12 INT = function of mortgage instrument

II.13 REP = function of mortgage instrument

Symbols in these equations and others which enter later in the discussion are defined in Table V.1.

Table V.1

c	constant spread between RD and RMS reflecting the costs of intermediation
CB	commercial banks
DS	supplied stock of time deposits
GMF	gross mortgage flow during period
GP	graduated payment mortgage
IN	price-level indexed mortgage
INT	interest income received by savings and loan associations
KH	real value of housing stock
LIC	life insurance companies
LVR	maximum available loan-to-value ratio
MD	demand for stock of mortgages
MS	supply of stock of mortgages
MSB	mutual savings banks
Qpay	initial payment on relevant mortgage contract
P	consumption price index
PAY	aggregate mortgage payments in period (includes payment of interest and payment on principal)
PH	price of standard house
PLAM	price-level adjusted mortgage
RCB	long term bond rate
RCP	commercial paper rate
RD	time deposit interest rate
REP	repayments of principal on mortgage contracts
RES	transfers to reserve accounts of savings and loan associations
RM	long-term conventional mortgage interest rate
rm	real rate of interest on mortgage
RMS	short-term mortgage interest rate
RMS_o	initial short-term mortgage interest rate
RO^o	"other" rates, typically the long term corporate bond rate
RP	current rate of inflation
RP	expected rate of inflation over the duration of the contract
RP_o	initial rate of inflation
$(RMS-RM)_o$	difference between short-term and long-term mortgage rates at initial date of contract
SLA	savings and loan associations
T	amortization period of mortgage
T	measure of tilt
μ	degree of graduation, i.e., annual rate of increase in total payment
μ_o	initial graduation rate
VRM	variable rate mortgage
VS	value of housing starts

The housing model has been discussed at length in Chapters III, IV, the SLA mortgage model in Chapter IV. Mortgage demand is also discussed in Chapter IV. However, the above equations that are part of the MPS model are briefly described as follows.

V.4 Mortgage Supply. The supply of mortgages is derived basically from the available sources of funds. For savings and loan associations (SLAs), mutual savings banks (MSBs), and commercial banks (CBs), the funds are mainly time deposits, while for life insurance companies (LICs) the driving variable is reserves. In addition, except for SLAs, there are important portfolio allocations whereby mortgage supply rises with the mortgage rate (RM) and declines with other rates (RO). There are also complicated dynamic structures in the model to take into account the commitments process of mortgage lending. These remain in the simulated system in their original form, but they do not interact in important ways with the changes in the mortgage instruments introduced here.

V.5 Mortgage Market Equilibrium. The mortgage sector allows for disequilibrium in the mortgage market with distributed lag effects and this is also retained in the simulated system. Conceptually, however, this affects only the short-run dynamics of the model, and thus it is convenient for expository purposes to assume a full equilibrium model for the discussion that follows.

V.6 Deposit-rate Setting. Deposit-rate setting by SLAs, MSBs, and CBs is based on a model of modified profit

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

V.7 Household Supply of Time Deposits. The MPS model deposit equations follow a mechanism through which household net worth and current savings are balanced first between time

deposits and other financial and real assets, and second, between the various depository institutions. The spreads between deposit interest rates and other interest rates determine the allocations and balance at both levels.

V.8 Reserve Transfers of SLAs. There is now available for the MPS model a series of equations that determine the reserve transfers of SLAs. The two main variables are the mortgage interest income and deposit interest costs for SLAs, but, in addition, taxes and other income and costs are accounted for. A description of these equations is provided in the appendix and their use in simulating the effects of removing Regulation Q ceilings is available in Jaffee.

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

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

II.11 Mortgage Repayments. The MPS econometric model

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

B. General Points on Simulation Strategy

(1) Initial Conditions and Phasing-in of New Instruments. The simulations are run from a point early in the 1960's, 1962:1, through a recent date in the 1970's, 1973:4. The initial conditions for such simulations must necessarily be those of a conventional mortgage environment. Consequently, the simulations show the dynamic effects of introducing the new instruments to portfolios initially based on conventional mortgages. By the end of the simulation period, however, lenders hold almost entirely new instruments since the stock of initial conventional mortgages is almost fully repaid. This would appear a highly advantageous situation since one observes both the dynamics of transition in the early years and then the new instrument equilibrium in the later years.

(2) One Instrument at a Time. We have simulated the

effect of each new instrument by allowing it alone in the market during the simulation period. An alternative procedure would be to allow two or more instruments to exist together in the market, with borrowers having a choice at the existing interest rate prices. As a matter of policy conventional mortgages should probably co-exist with the new mortgage instrument(s). But, at this point, both in terms of gaining experience with simulating new instruments and in terms of interpreting the results, a regime of one contract at a time was followed.

(3) No Innovation in Time Deposit Markets. It is assumed that there are no fundamental changes in the nature of the time deposit contract. (The model was estimated over a period characterized by short term, fixed interest passbook accounts.) For example, although as a matter of policy one might be inclined to consider seriously the possibility of indexing time deposits, this was not considered in these simulations. However, changes in these determinants of rate setting behavior that result from the market response to new mortgage instruments are allowed to fully work through the sector.

(4) Regulation Q Ceilings. The introduction of new mortgage instruments could perhaps allow for the disbanding of the regime of regulation Q ceilings. In other words, a major objective is to evaluate the resulting conditions in housing and mortgage sectors if, when the new instruments are introduced regulation Q is revoked. Consequently, most simulations are

carried out without Regulation Q constraints on deposit-rate setting. A dilemma will arise, however, if the combination of removing the Regulation Q ceilings and adding the new mortgage contract does not simulate an improvement in the status of SLAs. The dilemma is that the model continues to function normally in such a situation, whereas, in reality, the mortgage and housing industries would be seriously disrupted were the SLAs to go out of business. Fortunately, the model generates values for reserve transfers, and therefore for each simulation comparisons are made between the reserve transfer being generated by the system with the reserve transfer observed with Regulation Q. Assuming the Regulation Q reserve transfers were near the minimum amount acceptable (without disrupting the industry), a condition for a feasible instrument innovation is that the simulated amounts exceed the observed minimums. In essentially all cases, one finds an improvement in reserve transfer, and thus this magnitude is important only in comparing simulations.

Since implementation of policy changes in our economy tends to be done in a piecemeal way, I do examine, for two representative instruments, the introduction of new mortgages under the current deposit ceiling regime.

(5) Treatment of Individual Lenders. The current MPS mortgage sector structurally distinguishes four private mortgage lenders - SLAs, MSBs, CBs, and LICs - and also includes government supplied mortgages (FNMA et al) in the total mortgage

supply. This separation will be continued in the simulations. The following points should be noted:

--Government supplied mortgages are treated as exogenously determined at their historical levels. Within the model, it is straightforward to consider changes in these policy variables, but these are not central to this research and are topics for future work.

--It is assumed that all intermediaries (including the government agencies) issue the innovated mortgage instrument, given that only one mortgage contract will be allowed in the market in each simulation. In reality, of course, we anticipate a multi-contract regime will evolve and that certain lenders may prefer certain contracts (in particular, insurance companies may continue to prefer fixed interest-rate, long term contracts). Again, however, simulations of multi-contract regimes must be on the agenda for further work.

--The variables REP (repayments) and INT (interest payments) cannot be calculated for all the intermediaries. REP is not included in the model for CBs since data on commercial bank repayments are available for only the most recent periods. This should not have an important bearing on the results. INT is explicitly calculated in the model for only SLAs. Since there is no causal feedback from INT to the rest of the model, the simulation results are not affected by this. INT however, is a

variable of interest by itself, and the case of SLAs should serve as a good indicator of the status of the other intermediaries.

III. DESIGN OF THE EXPERIMENTS

A. Graduated Payment (GP) Mortgages

GP mortgages are the first class of instrument innovations to be considered. The important property of GP mortgages is that they reduce the initial payment below the level of an equivalent conventional (fixed-payment) mortgage. The payment in each period then grows at a contractually determined rate. Thus, if the first payment were, say $100 and the graduation rate 5%, then the second would be $105. The initial payment and rate of graduation must be such as to amortize the mortgage over its life since in all other respects, fixed interest, fixed maturity and fixed amortization period it is the same as the traditional mortgage. In addition, as with the traditional mortgage, the accounting procedure subtracts interest due from the payment, the residual (negative over the early life of mortgage) is subtracted from the outstanding principal.

The main advantage of a graduated payment mortgage is that the initial payment is below that of a traditional instrument with the same mortgage terms. This reduction should stimulate housing. However, at the same time, the mortgage has a longer duration which offsets some of this stimulus in the way described in Chapter IV. On the other hand, one would expect

no more than secondary effects from GP mortgages on SLA's. There are no direct effects on SLA's in that the mortgage contract continues with a fixed rate feature. The secondary effects occur through a mechanism whereby increased housing demand generates increased mortgage demand, and therefore there should be upward pressure on the mortgage rate with a positive impact on SLA reserve transfers. Also it can be anticipated that repayments of mortgages will decline, at least in the early years of the simulation, since the reduction in the payment rate will be reflected in a reduction in the repayment rate (interest is always subtracted from the payment first). Finally, it could be expected that the cyclical variation of housing investment (as distinct from the level) is unlikely to be significantly affected. In particular, GP mortgages would offer no real solution to the SLA problem of disintermediation which may have been an important factor determining the housing downturns in, for example, 1966, 1969-70, and 1973-74.

To understand the simulation design for graduated payment mortgages, it is useful to refer to the model of Section II.A. It can be seen that the initial payment (Qpay), duration ($\hat{T}$), and therefore mortgage payment, repayments and interest payments - PAY, REP, INT (V.11, V.12, and V.13) must be specified to reflect the properties of a GP mortgage.

The specifics of the equations for each of the instruments to be simulated are given in the appendix. It is useful at this point, however, to spell out the timing assumptions that are maintained throughout for all instruments. To start, we assume that all new mortgages, that is gross mortgage flows (GMF), occur at the very end of each quarter. Then during the first period of the mortgage, the total payment and its two parts - interest and repayments - are calculated. These magnitudes are calculated as a function of the amount outstanding at the end of the previous period. Finally, as the last step in the current quarter, the outstanding stock is updated by the addition of any new gross mortgage flows and the deduction of any repayments. An alternative procedure could assume that the mortgages are made at the beginning of the period, with payments and interest paid at the end of the same period. This would appear to have no behavioral advantage and would (mildly) complicate the computer coding.

The remainder of the model, however, is adequate in its present form, in the sense that no functions will be shifted by the introduction of GP mortgages. For example, the demand (PH/P) equation (V.1) will vary with initial payment (Qpay) and duration ($\hat{T}$) and any induced changes in the mortgage rate (RM), but the equation will not shift due to GP mortgages. Also, the mortgage demand (MD) will respond to the induced changes in its arguments, but again it will not shift. Similarly, the supply of mortgages will endogenously adjust, but there will be no exogenous shifts due to the introduction of the GP mortgages. This ease of implementation is due to the fact that GP mortgages are the same as conventional mortgages in all respects except for the graduation.

We distinguish two alternative forms for GP mortgages: fixed graduation, and new issue graduation. Fixed graduation means that the amount of graduation is fixed once and for all

at some initial value. The graduation is thus constant over the life of each mortgage contract as well as over time as new mortgages are issued. New issue graduation retains the feature that the graduation is constant over the life of each mortgage contract, but allows the degree of graduation associated with each "vintage" of newly issued mortgages to vary. There is also a third possibility for graduation, namely that the graduation is allowed to vary even over the life of each mortgage contract. This outstanding stock graduation is closely related to price-level adjusted mortgages and is simulated as part of the "Tucker Plan" in IN.1 below.

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

The amount of payments in any period, PAY, are derived as the sum of two components. The first component is based on gross mortgage flows of the previous period, to which is applied the payment rate of the previous period. The second component is based on payments on previously outstanding mortgages, which are graduated at the rate $(1+\mu)$ in accordance with the GP plan.

Interest (INT) is calculated as on conventional mortgages. REP (repayments) is then simply the difference between PAY and INT. Two additional points with REP should be noted. First, there will be two types of mortgages in the system: maturing conventional mortgages that were part of the initial conditions; and the GP mortgages issued during the simulation period. We will, therefore, have to calculate the repayments for each stock of mortgages separately, and then add the two components together to determine the total value of REP as it feeds into the rest of the system. Second, it should be noted that the formula for REP is not a steady-state representation of the GP mortgage, since in the steady-state the repayments on GP mortgages would equal the repayments on an equivalent stock of conventional mortgages. The steady-state does not appear relevant to our simulations, however, both because the system is growing and because over the ten year period of the simulations no GP mortgages will be fully repaid.

The following indicates how the system should evolve under the fixed GP simulations:

--Initial reduction in Qpay stimulates housing demand, with immediate effects on mortgage demand and thereby an increase in mortgage rate (RM),

--Increase in RM will stabilize both housing and mortgage markets as demand for housing and mortgages are reduced while supply of mortgages is increased,

--Increase in RM will also cause the deposit rate (RD) to rise, thus stimulating an inflow of deposits,

--Repayments will decline somewhat due to lower repayment rate, although this will be offset by higher outstanding stock of mortgages from the initial impact of Qpay,

--Net effects, therefore, will be more housing, more mortgages, more time deposits, higher mortgage and deposit interest rates,

--There will also be macroeconomic effects: first, the increase in housing investment will give standard GNP multiplier and inflationary impacts; second, interest rates will rise generally in the economy, although this rise will be dampened by the shift from demand deposits to time deposits caused by the increase in RD.

--One effect on SLA's reserve transfers will be positive since the higher demand for mortgages and the resulting higher RM must necessarily improve their position. However, there is nothing in the GP plan that solves the term structure problem in their portfolio, and without

Regulation Q ceilings, the situation could even deteriorate. Thus, in this case especially, we must check carefully whether the innovation is even feasible in terms of reserve transfers.

--The cyclical variation in housing investment (as distinct from the level) is unlikely to be significantly affected The main point is that SLA's will suffer in 1966 and 1969-70 as just indicated.

Anticipating the results of Section IV, we find most of these effects are demonstrated in the simulations. However, the GP effects of SLA reserves are found to be complex and are discussed at length in Section IV.

(2) New Issue Graduation (GP.2). As already indicated, the main factor in new issue graduation is that the degree of graduation, μ, is to vary for each vintage of newly issued mortgages. Specifically, for each vintage of mortgages we set the graduation rate equal to the average inflation rate observed over the previous four quarters. As indicated above, once the graduation rate is set for a vintage, the rate is then retained for the rest of the life of the mortgage.

The payments equations must also be modified for new issue graduation from the form used in (GP.1) to take into account that successive vintages are being graduated at different rates. This requires keeping track of each vintage, and specifically its graduation rate, separately. Then, the

payment PAY(v), interest INT(v), and repayments REP(v) are determined for each vintage v. Finally, the aggregate values for PAY, INT and REP are determined by summing over all current v.

It should also be noted that a further divison of INT and REP into lender categories is necessary for two reasons. First, for INT, we require the specific amount of interest received by savings and loan associations, and thus we calculate INT's by attributing to SLA's their share of INT on the basis of their share of total mortgages; this involves a slight approximation to the extent that the time phasing of gross mortgage flows differs among the intermediaries. Second, for REP, SLA's, MSB's, and LIC's, we need a breakdown so that the appropriate repayments flow back to the respective intermediaries (and then out again, with some lags, as gross mortgage flows). This separation is again based on the outstanding mortgage stock, and involves the same minor approximation.

The basic pattern of response of the model to new issue GP mortgages will be the same as just described above fixed GP mortgages. The important difference, however, will be that the new issue GP should significantly help in stabilizing the mortgage and housing markets. The correlation between variations in the mortgage rate, RM, and the inflation rate, RP, which can be expected given stability of the real mortgage interest rate, is the basis for the stabilization. That is, when mortgage interest rates rise, or when availability of funds is limited, thus depressing housing, we should find the degree of graduation being increased as a major offset. The same mechanism, of course, will work in the opposite direction when housing is stimulated by low mortgage rates.

B. Variable Rate (VR) Mortgages

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

A variety of techniques have been suggested as the means for finding a compromise that allows the lender the advantages of a fluctuating yield while protecting the borrower from the mort extreme possibilities. One set of techniques limit the frequency and/or absolute amount by which the yield is allowed

to fluctuate. In these simulations such "dampers" are not used, but it is possible that future simulations could experiment with such possibilities.

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

These difficulties may be particularly acute if the mortgage is pegged to an instrument with a term that does not correspond to the term of the mortgage. For example, the Federal Home Loan Bank Board has proposed a variable rate mortgage with the rate tied to a 3-5 year Treasury bill. However, the rate on the mortgage is to be changed every quarter. Consequently, the mortgage is short-term with a rate tied to a moderate term instrument. Such an "inconsistency" would lead to an initial discount (or premium). Ex ante it would be difficult to know at what rate the market would price the mortgage.

To avoid prepayment problems and the pricing of this call option, it is probably sensible to have VRM's such that everyone pays the same rate.

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

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

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

(iii) A further implication of (i) is that the rate of VR mortgages is necessarily that of a short-term security with maturity equal to the frequency with which the rate is varied. This is true because the yield on an existing VR mortgage is set to the newly determined new issue rate each decision period. This is advan-

tageous to the borrower, as discussed above.

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

It should be made clear, however, that a possible disadvantage of this plan is that the period by period cost to the borrower will fluctuate in the manner of a short-term rate. Thus, it would be desirable, at least for purposes of comparison, also to simulate VR mortgages that try to correct for this.

There are, in fact, several alternatives. One, sometimes termed a "dual-rate" VRM, was discussed in Chapter I. The basic idea is that while the interest payments are allowed to fluctuate each period with the short-term rate, the total payments are stabilized by being pegged to a longer-term rate. This, of course, necessarily implies that the principal repayment acts as the residual from period to period. A potential problem with such a plan, consequently, is that a series of low repayments will accumulate such that "balloon" payments will be required toward the end.

A second alternative to correct for the variations in the interest rate on the variable rate mortgage is to peg

the interest rate to a longer maturity instrument.

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

(1) VR Mortgages Which Are Not Smoothed. A basic point with the VR mortgage is that the rate determined in the mortgage market must necessarily be a short-term interest rate for all outstanding VR mortgages. This follows because the VR instrument which is not smoothed is short-term in the sense that fluctuations in the interest rates do not change the pattern of amortization of principal and thus are reflected in fluctuations in the current payment. We denote this short rate as RMS, and since the model is quarterly it can be interpreted as the one-quarter mortgage rate. The problem is to generate this value within the model. In principle, of course, the rate would be determined through a mechanism of demand and supply in the mortgage market, and at least to a first approximation this is what has been done.

Even though we have generated the short-term rate RMS, there remain important questions as to where this rate will apply in the model. Specifically, the interest elasticities estimated in the housing and mortgage equations of the model correspond to long-term interest rates. Consequently, if no

adjustments were made, and given that the short-term rates fluctuate over wider bounds, there would result unrealistic fluctuations in housing and mortgages. Therefore, RMS is taken as the relevant rate in determining the size of the initial payment (Qpay), in determining the amount of interest payments to SLA's (INT) and as the base rate for the deposit-rate setting of SLA's and the other thrift institutions. Similarly, RMS is the relevant rate in determining the demand and supply of mortgages (MD and MS). Thus, in terms of the model presented in Section II.A, the functions just noted will all depend on RMS for the VR.1 simulations.

Given that this substitution has been made, the demand, supply, and equilibrium mortgage market equations (V.2, V.3, and V.4) can be used in their current form. The market would determine a short-term rate RMS as is appropriate under our VR scheme. This rate, under the VR scheme without smoothing, would thus be the determinant of the initial payment (Qpay) on mortgage contracts. A complication arises here, however, in that while all contracts pay the same rate RMS, and thus would determined the same Qpay, they have differing terms to maturity. Thus it is necessary to distinguish vintages of mortgages, and in particular the remaining maturity of each vintage, so as to properly calculate the payments of each vintage. Mortgage interest, on the other hand, has the very simple form (independent of vintage) as:

$$\text{(VR.1.1)} \qquad INT = (RMS)_{-1}\, M_{-1}$$

And, of course, repayments of principal are then:

(VR.1.2) REP = PAY - INT

At one point in the model however, the demand for housing, a long-term mortgage rate concept is more valid. This arises because housing is a durable asset, and thus an investor would be concerned with the long-term cost of capital, not the current one period mortgage rate (RMS). In order to determine such a rate, one must specify how an investor would translate the observed short-term rate RMS into a long-term equivalent. We denote this long-term equivalent as RM, which is the interest rate on conventional mortgages, since our conversion technique amounts to making the long-term equivalent the same as the conventional mortgage rate. Specifically, our conversion has the form: RM = RMS + (RCB-RCP). RCB is the long-term corporate bond rate, and RCP is the 4-6 month commercial paper rate, so the formula indicates that investors would translate the short-term RMS into the long-term equivalent RM using the same term-structure relationship that holds for comparable securities in the corporate securities market.

The formal details of this adjustment, and the other specifications for VR.1 are given in the appendix.

Unlike the housing investment sector in the deposit-rate setting equation (V.6), the short-term rate (RMS) should be used as the determinant of the deposit rate (RD). This follows because the deposit rate is indeed a short-term rate and RMS

is the corresponding short-term rate on mortgage assets. This mechanism, in fact, is a critical one for the benefits of any VR plan. What it shows is that the SLAs will be able to vary their time-deposit rates in the appropriate short-term fashion under a VR plan. In addition, this is also the mechanism through which SLAs can explain variations in the mortgage rates in terms of variations in deposit rates.

There are also two other possibilities for changing the actual structure of the deposit rate setting equation (V.6). One factor is that the equation currently allows rather long lags in the response of deposit rates to mortgage rates. It would appear consistent with VR mortgages, and the balancing of short-term asset and short-term liabilities, however, that these lags be eliminated from the equation. In our simulations we will at least experiment with this possibility, although the results of Fair and Jaffee (34) indicate it may not matter much.

The other possibility for restructuring the deposit rate equation is to force an even tighter relationship between the deposit rate and the mortgage rate. As indicated above, the current MPS deposit rate equations are based on profit maximization. Consequently, the mortgage and deposit rates do move together, but shifts in the deposit equation (V.6) can cause the spread to vary somewhat. An alternative possibility is to have the deposit rate set in the form:

$$RD = RMS - c \qquad \text{(VR.1.4)}$$

where c is the constant spread between RD, the deposit rate, and RMS, the short mortgage rate, reflecting the costs of

intermediation. Equation (VR.1.4) would then replace equation (V.6) in the model. The main advantage of (VR.1.4) is that it is consistent with a plan under which the mortgage and deposit rates are fully tied.

Finally, in terms of structural shifts in the model, one difficult problem should be noted. VR mortgages intrinsically must create risk for the borrower in terms of uncertainty over the future course of short-term interest rates. Our assumption that housing investors use for their decisions the long term equivalent (RM) of the market quoted short-term rate (RMS) is fully correct for risk neutral individuals. But for risk averse individuals there would be additional effects. In particular, for household sector borrowers, there could be a reduction in housing demand and possibly even a greater reduction in the mortgage financing of housing. Unfortunately, however, we have no means by which to estimate empirically the amount of this effect.

One could simulate alternative downward shifts in the housing and mortgage markets in order to illustrate the dimensions of the problem. For these purposes one could calibrate the downward shift in terms of interest rate points: that is, for example, the shift might be such that to maintain housing investment at a given level, borrowers are willing to pay only, say, a one percent lower (RM, not RMS) interest rate.

It is well to indicate also a possible offset to this risk aversion on housing demand. Consider a situation in which

no inflation is anticipated and in which the term structure (both nominal and real) is flat. Then, over time, these expectations continue to be maintained, but from time to time there are one-shot periods of inflation which are reflected in the current short-term rate (RMS). In these periods we would have RMS - RM = RP where RP is the current inflation rate. It would be wrong in such a situation to consider the fluctuations in RMS as detrimental to housing; rather, the amount to which RMS rises relative to RM will be exactly offset by the capital gain experienced by housing owners. The only problem then is one of cash flow in that the interest based on RMS must be paid currently, while the capital gain will generally not be realized. The cash flow effect, moreover, can be handled in a variety of ways as indicated below.

Now consider a second case in which the real term structure is still flat, but in which inflation is expected at varying rates in the future and this is reflected in the nominal term structure. In other words, it is expected ex ante that RMS will fluctuate relative to RM due to the expected timing of inflation. Here again, the fluctuations in RMS create no real fluctuations - each rise in RMS is due to inflation and is therefore offset by a capital gain on the house. To the contrary, a holder of a conventional mortgage will be receiving unmatched capital gains and losses over time, and if he is risk averse this could reduce housing demand. Furthermore, unanticipated inflation will have no effect on the RMS contract (cash flow

effects aside) while unanticipated inflation would create gains (if inflation is higher than expected) or losses (otherwise) on a RM contract.

These arguments do however assume that the short rate changes only because of inflation. Changes from other sources would not be offset by changing asset values. In addition, with both VRM's and conventional contracts, capitalizing these capital gains may be very difficult.

Thus, contrary to popular notions, the preceeding two cases indicate a short-term contract may actually be preferred by an individual who is risk averse in terms of real quantities and who has no cash flow problems. There is one correct point to the popular notion, however, and that is the results of potential fluctuations in real rates of interest. Assuming, to simplify, no anticipated and no ex-post inflation, it is clear that a conventional mortgage guarantees a fixed real rate. On a variable rate mortgage, in contrast, variations in the short-term real rate would be felt by the borrower, and this would be a cost if he is risk averse. The key point is that the fluctuations in RMS that can be attributed to real factors are probably small relative to the contribution of inflation. The upshot is that the risk aversion affect, cash flow problems aside, is probably much exaggerated with respect to short-term variable rate mortgages.

The following indicates how the system evolves under a VR.1 plan:

--In the early part of the 1960's, the term structure was relatively flat and thus the model would determine RM and RMS at approximately equal values. Consequently, there would be no important changes in the model's solution.

--Beginning with 1966, however, we have gone through periods in which short-term interest rates have risen considerably relative to long-term rates, and this would be reflected in the simulations in terms of a high RMS relative to RM. A high RMS would have several impacts on the model:

  --housing demand would decline perhaps quite significantly due to the Qpay effect,

  --SLA mortgage interest income would rise,

  --SLA deposit rates would rise, thereby stimulating the supply of deposits, and in turn offsetting the initial decline in housing,

  --the net effect of mortgages and housing, therefore, is not fully clear a priori, but we would not be surprised if they both suffered due to the initial payment effect. Taking into account significant borrower risk aversion, housing would surely suffer,

  --the position of SLAs, on the other hand, would clearly improve since they would have the interest income with which to pay competitive deposit rates.

Simulation, however, demonstrates that the VR impacts are much more complex and ambiguous than anticipated. The results often do not indicate rising SLA deposits, and this surprising finding has serious ramifications for the entire housing-mortgage-deposit relationship. These findings are discussed at length in Section IV.

(2) Dual Rate VR:2. The distinguishing feature of dual rate VR is the manner in which payments (PAY) and repayments (REP) are determined; INT (interest payments) under dual rate VR is unchanged from VR.1. The spirit of the plan, however, is that each period PAY is determined as a function of some long-run rate that fluctuates less than the RMS used in VR.1 above. To keep things simple, we shall let RM (the mortgage rate) (see VR.1.3) be the determinant of payments such that,

(VR.2.1) $\quad Qpay = Qpay\ (RM,o)$

and payments are then calculated as a function of Qpay using (VR.1.2). As just noted, INT then is still given by (VR.1.1) and REP can be calculated as a residual from (VR.1.2).

The effect of this modification is that if RMS (the short rate) should rise relative to RM, then the payments will rise by the smaller amount associated with RM, rather than the larger amount associated with RMS. Since interest payments are still based on RMS, however, this necessarily implies that REP will be smaller. Consequently, in the following periods the base to which the initial payment rate is applied will be larger, and in this way eventually, that is by the end of the

contract, repayments should catch up. In general it is hoped that this modification will provide a better cash flow (from the standpoint of the borrower), and yet repay the contract over the life. There is the possibility that if RMS consistently rises relative to RM over the sample (i.e. the short rate is always above the long rate), then a "balloon" payment or payments may be required toward the end of the contract. In general, one would expect that the plus and minus deviations in RMS would tend to average out, so nothing unusual would occur toward the end of the contract.

It is perhaps useful at this point to note a major difference between GP and VR plans as illustrated in the scenarios for GP.1 and VR.1. GP mortgages tend to stimulated housing demand directly due to the effects of the graduation on initial payments. GP mortgages help the SLA's however, only in the indirect way that the increased mortgage demand will result in higher mortgage interest rates and thereby improve portfolio earnings. VR mortgages, in contrast, directly improve the SLA earnings position, by allowing them to earn the rate RMS on their mortgage portfolio which, in turn, allows competitive levels for deposit rates. VR mortgages, on the other hand, are likely to reduce housing investment both because of the initial payment effects and because of the risk aversion toward fluctuating mortgage rates. Consequently, it is an appealing notion that some combination of GP and VR mortgages will have the joint virtues of stimulating housing investment (the GP payment) and helping

the SLAs (the VR effect). Two instruments that operate in this way are simulated here: the Tucker Plan mortgage, and the price-level-adjusted mortgage (PLAM).

The Tucker plan is particularly instructive in that it is explicitly constructed as a combination of GP and VR features. We will thus consider it first. Full price-level indexing, in contrast, is formally developed by setting a real rate of interest on the mortgage contract, and then period by period adjusting the outstanding principal by an appropriate price index. In fact, however, in many cases, Tucker plan and price-level indexed mortgages are almost equivalent. The discussion below will illustrate this point. (This does deny, however, that the two plans may differ in their taxation features - but taxes are not explicitly considered in the simulations.)

(C) The Tucker Plan. Donald Tucker (of the Federal Reserve System) has suggested one mortgage instrument that directly combines GP and VR features (see (137)). The VR features of our Tucker Plan mortgage have essentially the same form we used in the VR simulations above. Specifically, this means that mortgage supply and demand equations (II.3, II.4, II.5) will be used to determined the short-term mortgage rate (RMS), and that the term structure relationship (VR.1.3) will then be used to determine RM. Similarly (VR.1.1) is used to determine the interest payments credited to the SLA's. Unlike VR.1, however, the initial payment (Qpay) and the repayments (REP) must reflect the graduation features of the Tucker Plan.

The equation for Qpay has the same form used for GP.1 above, in that it includes the graduation rate μ, but it is based on the market short rate RMS, not the long-term equivalent

RM. A critical features of the Tucker Plan is the manner in which μ is determined. We begin initially with the graduation rate μ_o set at some appropriate rate, which could be, as given, the initial inflation RP_o. Then, period by period, the graduation rate μ is adjusted to correspond to the realized increments in RMS. It can be noted, in particular, that Qpay depends over time only on $RMS_o - \mu_o$ and not, in fact, on the current values of RMS and μ. This is the feature of the Tucker Plan whereby housing demand is shielded from short-run variations in the Qpay initial payment amount.

Payments are calculated in a manner similar to that used for the graduated payment schemes, except that the situation is easier because, in effect, each period all mortgages start out fresh. Repayments can be calculated directly as the difference between PAY and INT.

Since the Tucker Plan is fully a variable rate mortgage in terms of intermediary interest income, it is also essential that the deposit rate setting reflects this. The adjustments to the deposit-rate setting equation (V .5) are exactly the same as discussed under VR.1 above.

Finally, the Tucker Plan is subject to the same question of risk aversion on the part of borrowers as was raised under VR.1. That is, the Tucker Plan through its Qpay adjustments does take care of cash flow constraints, but it does not remove the feature of variable rate mortgages that the interest RMS will vary significantly over time. Moreover, it should be noted

that logically there is no way to avoid the risk aversion problems of variable rate mortgages. That is, if SLA's are to count RMS as the relevant interest rate on their income, then it must be paid by someone, presumably the borrower.

It would be possible for government agencies to pay the difference between RM and RMS to SLA's. One could consider this, however, an SLA subsidy scheme, rather than a variable rate mortgage.

Over time, the Tucker Plan would develop as follows:

--The initial impact on housing demand would depend critically on the relationship between $(RMS-RM)_o$ (the initial short - long spread) on the one hand, and μ_o (the initial graduation rate) on the other hand. If they are equal, then there is no impact on housing demand, while the greater μ_o relative to (RMS_o-RM_o) the more stimulated is housing. Since μ_o is a policy parameter, it follows that the initial stimulation to housing will depend in the real case on a policy decision, and in our case on the simulation decision. More concretely, if we use RP_o (the initial inflation rate) for the initial setting of μ_o, there is then the question whether the spread $(RMS-RM)_o$ equals RP_o. The answer depends critically on the term structure of <u>real</u> interest rates. If the term structure of <u>real</u> interest rates is flat, then $(RMS-RM)_o$ measures the <u>difference</u> between

the short-term and long-term expectations for inflation. Since RP_o is a measure of expected inflation rate <u>levels</u>, it must necessarily exceed the difference. This, therefore, leads to the presumption that the RP_o initialization of μ_o would stimulate housing. On the other hand, it is possible to simulate the model with $\mu_o = (RMS-RM)_o$; in this case, essentially by definition, we would have eliminated any initial stimulus to housing.

--As the model moves through the early 1960s, RMS and RM should move closely together, as already indicated for VR.1, so the variable rate features of the Tucker Plan would not be important. We would, however, continue to accumulate the effects of the initial graduation as discussed just above.

--Then, as we move into the tight money periods beginning in 1966, the variable rate feature of the Tucker Plan would protect the SLA's mortgage interest income. At the same time, the graduated payment features of the plan would maintain Qpay at its initial level, thus avoiding a reduction in housing demand from this source.

--Of course, throughout the simulation housing demand will have been reduced by the amount specified by the risk aversion shift. Thus, on net, SLA's will definitely experience a more favorable income flow, of exactly the type developed under any VR plan. The outcome for housing, on the other hand, is difficult to determine

a priori. It will be the net effect of three basic factors:

(i) the gain to housing through the initial graduation

(ii) the gain to housing due to the ability of SLA's to continue to bid for funds beginning in 1966

(iii) the reduction in housing due to the risk aversion.

The ability to form an estimate of this net effect is clearly a major objective of the simulation experiments.

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

In fact, simulation shows the Tucker proposal to have the expected characteristics. Housing is stimulated considerably where the short rate aspects of the plan are demonstrated and do benefit SLA's. However, the Tucker Plan does encounter some

of the same (unexpected) difficulties as a straight variable rate instrument. These difficulties and specific characteristics are discussed below.

The plan just described deviates from Tucker's original proposal in that the VR portion is pegged to a short-term rate rather than a long-term rate. This, as discussed in the beginning of the variable rate section is an advantage to the lender, but a disadvantage for the borrower.

In addition, for reasons discussed elsewhere, a long-rate variable interest mortgage encounters serious problems and does not provide a competitive short return to the lender.

(D) Price-level Adjusted Mortgages. The starting point for a price-level indexed mortgage is the real rate of interest, which is denoted as rm (rather than RM for the nominal rate). The real rate (rm) will be determined in the mortgage market in the same format that the short-term nominal rate (RMS) is determined under a variable rate mortgage scheme. The equation for converting rm to RM is simply:

$$(IN.2.1) \qquad RM = rm + \hat{RP}$$

where $\hat{RP}$ is the expected rate of inflation over the duration of the contract. (This is different from the current rate of inflation RP.)

In terms of the model of Section II.A, this means that the real mortgage rate will be determined by the demand, supply, and equilibrium equations (V.3), (V.4) and (V.5), but with RCB (the long term bond rate) transformed to a real rate (rcb) by:

$$(IN.2.1) \qquad rcb = RCB - \hat{RP}$$

The next step, then, is to consider how indexing affects other equations of the model, and in particular how rm enters these equations. The initial payment (Qpay) is now given by:

(IN.2.2) Qpay = Qpay (rm,o)

It can be seen immediately that the initial payment will stimulate housing relative to the standard mortgage in inflationary periods, since the rm used for indexed mortgages will be lower than the RM used for conventional mortgages.

It can also be seen, by comparison that Qpay under Tucker Plan mortgages and Qpay under price-level indexed mortgages will be the same when

$$(RMS - \mu)_{Tucker} = (rm)_{indexed}$$

Basically, three sufficient conditions are required for this equality to be met. First, the graduation of the Tucker scheme (μ) must equal the expected rate of inflation; in this case ($RMS-\mu$) can be interpreted as (rms), that is the real short term mortgage rate. Second, actual inflation must equal expected inflation, since the price-level indexed mortgage responds to the actual rate while the Tucker Plan will respond to the expected rate as reflected in the short-term interest rate. And third, the real term structure must be flat. The first of these sufficient conditions, the equality of μ and RP, is a policy decision and can be enforced in the simulation as described above for IN.1. The second and third conditions, the accurate expectations and a flat real term structure need not hold. In particular, in periods in which rms exceeds rm, Qpay will be larger under the Tucker scheme and thus housing depressed more. Alternatively, this effect can be interpreted as the result of the fact that the Tucker Plan incorporates a variable real rate which depends on cyclical phenomena as well as errors in expectations (i.e. rms), while price-level indexing assumes a long-term real rate (i.e. rm). Of course, in periods in which rms is less than rm, the Tucker Plan will stimulate housing more than conventional mortgages. Thus, two conclusions can be drawn: housing demand will be more cyclical under the Tucker Plan given that rms varies more than rm; and for risk averse individuals (in terms of real rates), the risk shift in the demand for housing will occur only under the Tucker Plan (since on each contract under indexing rm is set for the life of the contract). In fact, it

is possible for indexed mortgages relative to conventional mortgages, that the housing equation should shift positively to reflect reduced certainty with respect to the real value of the contract.

The specification of the various payment, interest payment and prepayment (PAY, INT, and REP) magnitudes under and indexed mortgage require some care due to the accounting procedures for the indexed component. The basic payment equation is structured in the same form as a conventional, that is fixed payment, mortgage but with two distinctions. First, the interest rate is the real rate rm. Second, the outstanding magnitude is updated at the end of each period by the amount of inflation; consequently, the payment is calculated anew each time (but on the presumption of fixed payments) to adjust for the new outstanding magnitude. An alternative interpretation of this procedure is that the borrower must pay the rate (rm + RP) each period against the outstanding magnitude, but then the lender issues a secondary mortgage (at the real rate of that vintage rm) to cover the inflation premium; and this secondary amount is amortized over the remaining maturity of the initial contract.

In the same spirit, the interest credited to the borrowers account would be calculated as the rate rm times the current outstanding balance. And repayments are then simply the difference between PAY and INT. For the purposes of the SLA accounting, however, it is important to note that the SLA receives each period, in addition to interest, a capital gain

in the amount of the inflation rate (RP) times the outstanding mortgage stock. This gain has no offsetting liability cost, and thus would show up, in one way or another, as part of mortgage income, and thus we combine it with the price-level interest in calculating the income of SLA's. In other words, in our SLA calculations, interest income is calculated as the rate (rm + RP) times the outstanding stock.

Whether this capital gain is treated as such or as interest income may have important tax implications depending upon future courts' interpretations of indexed contracts.

Finally, we come to the deposit-rate equation (V.6). It would be natural under an indexed mortgage scheme to consider the possibility of intermediaries issuing index-linked time deposits. In fact, this probably should be considered seriously as part of a policy proposal, however no attempt has been made in these simulations to examine this issue. Given, therefore, that deposit contracts retain their current form, it is assumed that the deposit rate (RD) will be determined, following (V.6), as a function of the current yield on mortgage assets. As just indicated, this yield would be (rm + RP), the first term representing interest income on the principal and the second term being the capital gain due to the revaluation. It can be seen that this equals the yield under conventional mortgages (RM) available on newly issued mortgages. The advantage of indexing, therefore, is not the marginal yield (on newly issued mortgages),

but that the inflation premium is received on all outstanding mortgages, which will be reflected in the SLA profit and loss statement.

Compared to conventional mortgages, price-level indexed mortgages would develop in the simulations in the following way:

--The simulations would start off very close in the early 1960's since inflation was relatively low. Increasingly, however, inflation rates rise, leading to a divergence between rm and RM. Since rm affects Qpay, we would thus receive a stimulus to housing investment from that source. This would be similar to the effect under the Tucker Plan since the graduation rate would rise in a similar way under that scheme. Differential effects between the two would depend on differential movements of rms and rm. Also, the Tucker Plan would suffer on account of risk aversion, but would benefit from any graduation introduced at the initialization of the scheme.

--The SLA's would also benefit as inflation rose, since profits would rise both because interest is calculated against a nominally higher stock and because of capital gains due to the revaluation of the stock. This improvement would be at least roughly comparable to the SLA gain under the Tucker Plan due to high values for RMS. Again, the best plan in this respect would depend on the relative movements in the real rates rms and rm.

Simulation substantiates these expectations. The PLAM is found to provide a sizable stimulus to housing over our recent history of inflation and at the same time to substantially benefit SLA reserves and depositors.

We now move on to the simulation results. Prior to doing so, however, it is probably useful to summarize the key provisions of the various alternatives already discussed at length. For simulation purposes, the important parameters are the interest rate used to calculate the initial payment (Qpay) and future payments (PAY) and the rate used to calculate the interest income (INT) actually charged against the mortgage and thus accruing to the mortgage lender. Table V.2 provides such a summary.

Table V.2

	Interest Rate	
Mortgage Type	Qpay and PAY	INT
Conventional	long	long
VR.1: single rate	short	short
VR.2: dual rate	long	short
GP.1: fixed	long-graduation	long
GP.2: new issue	long-graduation	long
IN.1: Tucker	short-graduation	short
IN.2: PLAM	real	real

IV. SIMULATION RESULTS

A. Control Simulations

We begin by examining how well the model does over long periods with dynamic simulation (using the endogenous variables predicted by the simulation). Figure V.1 presents a time series view of several key variables. (In this, and all cases, values are in billions of dollars. Arrows indicate the left or right margin for appropriate scale.) For the value of starts (VS14), the mortgage rate (RM) and a deposit rate (RD) both historical and simulated historical values are presented. A comparison indicates how well the model is fitting. For the most part for these (and for other variables not shown) the model does a creditable job. In particular, the starts function catches the turning points and does remarkably well, as does the asset price function (not shown) and the mortgage demand function (RM). Virtually all functions of central concern have root mean squared errors for the dynamic simulation of 5 percent or less.

For example;

Function	Mean	Root Mean Sq. Error	Mean Error
VS14	4.11	.258	- .03
PH	118.2	1.495	.44
RM	7.0	.227	.014
KH14	465.1	2.285	-2.076
RD SLA	5.05	.156	- .0245*
DS SLA	132.6	7.69	3.876*
MS SLA	132.7	7.58	3.767
MF SLA	7.027	1.047	- .018

* MPS equations

There are however, some deviations of note. Starting in 1969, deposit levels for SLA's grow at a slower rate than actual history. This has an unfortunate feedback effect through mortgage commitments to mortgage flows. Consequently, the stock of SLA mortgages grows at a slower rate than the historical stock does. These effects are offset to some degree, since over the same period stocks of MSB and life insurance company (LIC) mortgages increase slightly faster than history. Commercial banks (CB) mortgage holdings follow history quite closely. In addition, some of the flow variables are subject to occasional large percentage errors. For example, value-of-starts (VS14) under-predicted in 1966:4 and over-predicted in 1970:1.

Also included in Figure V.1 are plots of the model generated real and short mortgage rates. Although they play no role in the control simulations, it is interesting to note the dramatic movements in the short rate, something we will return to elsewhere in this discussion. The time series plot indicates a falling real rate over periods of relatively high expected inflation, as the nominal mortgage rate fails to move completely with expectations of inflation - at least as embodied in my expectations scheme.

I set up three control simulations:

1 historical, with regulation Q ceilings imposed on deposit rates

2 without regulation Q ceilings

and 3 competitive, i.e., after 1966:4, I assume that CB's, LIC's, MSB's and SLA's all pay the same (SLA) deposit rate. These control simulations correspond to alternative deposit regimes postulated to co-exist with the new mortgage instrument regimens. Figures V.2, V.4, V.7, V.10, and V.11 present comparative results for housing, interest rates, mortgage stocks, deposit stocks and SLA reserves respectively.

Other researchers have examined the results of removing Regulation Q ceilings within a variety of models (e.g. (62)) so I do not pursue this simulation in detail here. Note, however, that removing ceilings (first binding in 1966) has no substantitive effect until 1969. Beginning in 1969, however, the model simulates deposit rates (Figure V.4) above the ceiling levels. The maximum spread of .57 occurs in 1971:2. Deposits (Figure V.10) are up from 1969 to 1972 then they fall below those observed over the Regulation Q history. Over the first set of years, SLA's raise their deposit rates rather strongly with the removal of ceiling constraints while the commercial banks respond more slowly. Thus SLA's and MSB's are able to attract more deposits from the capital markets and to more than hold their own in competition with commercial banks. Over the last couple of years, in contrast, commercial banks and mutual savings banks raise their deposit rates considerably more than SLA's with the result that the SLA's lose deposits compared to the baseline Reg Q simulation. In fact, the loss of deposits for SLA's would have been considerably worse were it not for the

average level of deposits being higher without ceilings, as deposit institutions as a group attract flows from the general capital markets.

Unfortunately, the imposition of Regulation Q ceilings on deposits very much masks the relationship between the various deposit rates set by the different deposit institutions. This creates considerable difficulties for our simulation design. Since over most of the post-ceiling period the constraints have been binding, the only free market information we have on deposit rate behavior is prior to 1968. At that time there was a positive spread between rates, with SLA's paying the highest deposit rates followed by MSB's and CB's. (This spread was institutionalized with deposit ceiling spreads of the same general pattern). Simply removing the ceiling carries the implicit assumption that the intermediaries continue to compete as they did over the sample period, 1954-1967. It is possible, however, that if the ceilings were removed today commercial and mutual savings banks might compete more strongly. How intense this competition might be is merely speculation. I make, for a series of experiments, the strong assumption that both commercial and mutual savings banks compete actively by matching the deposit rates offered by savings and loan associations. The reader is thus provided with two polar cases: deposit rates set based on behavioral relationships holding historically (at least until 1968) and deposit rates set by the SLA's and then matched by the other depository institutions.

The relationship between the deposit rate and the mortgage rate under new mortgage regimes is also an open question and will be discussed briefly later in this Section.

The effect of increasing CB rate competition noted with the no Reg Q simulation is substantiated when one imposes a competitive assumption. The deposit rate is considerably higher, as evidenced in Figure V.4 and approximately follows the mortgage rate with a spread.

Deposits (Figure V.10) of SLA's are well down while MSB's deposits are nearly even with the base simulation. Again, commercial banks increase their holdings substantially and the total deposits are up as savings are attracted away from the general capital markets.

In response to these changing deposit patterns, mortgage stocks also change. Without Regulation Q, SLA's hold fewer mortgages but the losses here are essentially covered by increased MSB holdings as they respond to higher mortgage rates and deposit flows. With a competitive regime, however, where large deposit flows move to commercial banks, mortgage stocks fall considerably. As savings move out of the thrift institutions, their mortgage holdings decrease, sometimes dramatically (in the case of SLA's), while commercial banks increase their holdings only marginally as they diversify the increased deposits among competing assets.

SLA reserves respond as expected to the deposit outflows and changing deposit rates - down in both the no Reg Q and

competitive control simulations although removing Reg Q affects the reserve position less than competition. For the comparison, see Figure V.12.

Finally, consider the effects on housing from removing Regulation Q ceilings in Figure V.2. For the stock, the final effects are negligible. Deposit rate ceilings have essentially no effect over the 1966-74 time period. However, the flow, VS14, indicates that gains over the 1968-70 period were essentially lost with fewer starts over the 1970-73 time period. Note that these periods correspond to the trough and peak of the most recent housing cycle. Thus it would appear that cyclically, the ceilings were actually slightly destabilizing in their effects on housing. Essentially the same pattern holds for rental starts, VS5.

It is interesting that, although competition causes a marked downward shift in the supply schedules, that it too is more "stable" than the Regulation Q simulation.

A good deal has been said about deposit ceilings and the protection or lack of protection they provide for mortgage lenders and therefore for housing. I do not pursue the issue here except to note that, over the last housing cycle in this model, they have contributed to the instability, with a zero net effect on housing. These simulations provide no support for the contention that regulation protects housing although they do, of course, protect the reserve position of savings and loan associations.

B. Graduated Payment Mortgages

I now consider mortgage innovation within the structure of this model. Initially, all comparisons are made to the control simulation without Regulation Q ceilings. I return to the Reg Q and competitive control simulations later. Although this discussion is generally developed sequentially for each instrument, I have presented the results in the various diagrams comparing, for each variable, the impacts of the various options. Thus, the reader can easily do a "cross section" comparison, to which we shall return formally toward the end of this section.

Consider first the simple graduated payment options. Both provide essentially the same results. As can be surmised, fixed graduation GP.1 is more stimulating over the early years and less over the latter since the graduation rate is the average inflation over the 1962-74 time period. GP.2, with graduation based on relatively current inflation rates, is less stimulating over the early years, more over the latter period. Given these observations, I present results only for GP.2. The principle effect of graduation is on the initial payment, although these effects are partially offset because the contract now has a longer duration than the usual mortgage at comparable rates. The net effect for housing is positive, as can be seen in Figure V.3. By the end of the period, the single family capital stock is up around $56 billion over the control (no Reg Q) simulation. However, an interesting phenomenon is evident: the

increased single family stock is partially offset by the substitution away from rental starts, which are down over the entire period during which single family starts have increased. The over-all net effect for housing remains strongly positive. However, at least part of the gross effect is a change in the character of the stock. This substitution effect is important for all the cases in which the single family starts are substantially stimulated.

The increased flow of starts and increased housing stock lead to a greater mortgage demand and consequently higher mortgage rates. This occurs since there is nothing about graduated payments mortgages that directly affects the ability of mortgage lenders to increase their lending. Notice that the spread between the control and GP.2 interest rates increases over the 1966-69 period and from 1971-74. This occurs because the graduation rate on newly issued mortgages under GP.2 is increased during periods of high inflation, which stimulates housing and increases the demand for mortgage credit. With GP.1 this effect was not pronounced, as is to be expected since the graduation rate is fixed.

The stock of mortgages is higher (Figures V.8 and V.9) in aggregate. Stock holdings change slightly as SLA and MSB (V.8) increase their holdings, the latter by a sizable percentage, although both increases are around $10 billion by 1973:4. Commercial banks (CB's) also increase their holdings, but by a smaller amount ($4 billion in 1973:4) while life insurance

company (LIC's) holdings remain essentially unchanged.

The viability of this instrument with regards to the SLA's is an open question. Figure V.13 illustrated that by the simulations period's end reserves are down an additional $2 billion from the no deposit constraint simulation, which was, in turn, down nearly $2 billion from the historical simulation. This represents a 20 percent drop in SLA reserves, which would undoubtedly have serious effects on their ability to adequately perform in the capital market. These results may seem a little peculiar since it was noted in Section III that the secondary effects on SLA's should be small and positive. In fact, the secondary effects do work as postulated: the increase in housing demand stimulates mortgage demand with the result that the mortgage rate is higher than the control, and mortgage holdings have increased. What has happened to the SLA reserve position is that the graduated payments have lengthened the average mortgage age in the SLA portfolio. In a stationary economy this effect would disappear but in a growing economy more and more mortgages are issued at low initial payment values and the SLA's never catch up although each vintage of mortgages is graduated. This affects reserve transfers since over the simulation period interest rates are generally rising and there is a shift to older mortgages which is also a shift toward lower yield mortgages. A similar effect is expected to show up over the first few quarters of the introduction of these instruments even in a stationary economy. That is, until the

rate of graduation increases the payments on the first generation of such mortgages above the payment that would have been received in a no graduation world the SLA stands to suffer some cash flow problems. This is partly offset by the higher nominal rate from the increased demand but there would always be a transition problem. The surprising result of this simulation is that the transition problems persist in a growing economy.

Of course, had our simulation been over a history of generally declining rates, the implication for GP mortgages would have been just the opposite and the SLA's would have benefitted from the aging higher yield portfolio unless there were large scale prepayments resulting from the falling rates.

A final point. It has been suggested that the lower amortization rate of GP mortgages may increase default risk. This is based on the contention that there is a critical period for default which occurs when but little equity has been accumulated, i.e. over the early years of the mortgage. This accumulation is, of course, slowed by graduation. However, if GP mortgages were used primarily in periods of inflation to offset the inflation distortion, the collateral value of the dwelling unit will generally be rising and therefore, it is possible to design graduation schemes that insure such a rising value of collateral. That is, even with graduation, equity can accumulate through the rising value of the dwelling unit. If indeed the graduation rate is set equal to the inflation rate

of the asset, the effective mortgage-dwelling unit value ratio on the GP mortgage will have the same path as a conventional contract would with no inflation. This ratio would, of course, be higher than that implied by a conventional contract with inflation - but that is the purpose of the graduation. In the simple examples examined here this larger stimulative effect was found to hold for GP.2 and GP.1 during the inflation of the past several years, although more pronounced for GP.2.

C. Variable Rate Mortgages

Simulation indicates that the variable rate mortgage is a good deal more complex in its impacts on housing and thrift institutions than anticipated and consequently, not nearly the panacea for SLA woes that its proponents claim.

To understand this instrument, it is important to trace the history of a "short" mortgage rate. This is pictured for the control simulation in Figure V.1 or for the variable rate instrument, VR.1 in Figure V.5. Remember that this rate is a created variable based on the assumption that the term structure in the mortgage market would be similar to the term structure observed in the general capital market. This rate is, as pictured, very volatile. Starting below the long rate in 1962 it rises above the same in 1966 and again in 1968-69. It plummets to its 1962 level in 1971:3 and then climbs sharply to a high in 1973:3. For most of the period the rate is, as expected, below the long rate.

One gets the impression from some of the discussion of variable rate instruments of a naive expectation that the variable mortgage rate will fluctuate around the historic long rate. It does indeed, but the swings are relatively large and for much of the period the rate is well below the corresponding long rate. For the most part, when the thrift institutions no longer assume the risk of interest rate fluctuations they no longer get "paid" for that service through higher returns. And, of course, as they no longer take capital losses with rising long rates they no longer get capital gains either as for example after 1970:1 when the long rate fell from 8.75 to 7.70 in 1973:1.

Two conflicting pressures result from these short rate movements. First, when the rate is below (above) the long rate, there is a stimulus (depressant) on demand because of the resulting lower (higher) initial mortgage payment. This is, of course, partly offset by the corresponding change in duration. The short rate below the long rate leads to a stimulus of mortgage demand and a higher long rate (remember, however, that all new contracts bear the current short rate - the long rate simply indicates the demand pressure). On the other hand, deposit rates are also a function of the short mortgage rate and the generally lower values for the short rate (RMS) translate into smaller flows of savings to lenders. This, in turn, reduces the holdings of mortgages by these intermediaries and creates an additional upward pressure on the mortgage rate.

These effects are illustrated in the accompanying figures. In Figure V.5, for example, one clearly sees the higher long rate corresponding to the lower short and deposit rates. When the short mortgage rate is high, the long rate is close to the control, e.g. 1967 and 1969, but the deposit rate is above the control. These relationships are particularly pronounced over the last three years of the simulation, where the dramatic decline in the short rate results in a higher long rate and a substantially lower deposit rate. The net effects are decidedly unfavorable for housing. Mortgage holdings by SLA and MSB's are well down by the end of the sample, however these declines are offset somewhat by the increased holdings of mortgages by CB's and LIC's.

The results of falling mortgage availability but stimulated demand for housing is also generally negative. By 1973:4 the single family stock is down nearly $6 billion. Starts are down over the early period (1962-65) when the deposit effects swamp the payment effect. They are up in 1967 and finish well down as the high short rates in 1973 curtail demand. Starts fall precipitously to $2.5 billion from a high of $5.4 billion six quarters earlier. In addition, lower deposits affect, through mortgage flows, multi-family starts, which also fall. In this case, the deposit effects more than offset the price substitution effects observed earlier for the GP mortgage.

The primary expectation for the VR mortgage is the increased financial strength of the SLA's, as measured here by

their reserve position. Here the results are unambiguous. Figure V.13 indicates that by the end of the simulation the reserves are about $.35 billion higher than the Reg Q control. Moreover, this simulation no longer allows for Regulation Q ceilings, which themselves accounted for a $1.95 billion in reserves. The VR contract therefore contributes a gross gain to reserves of some $2.3 billion. The time path itself is interesting: the low short rate of 1971-72, translated through low deposit rates, very much depressed SLA reserve accumulations which essentially leveled off as a result of small transfers. They pick up again in 1973 with the sharp increase in the short rate. It thus appears, that even here, the results are a bit mixed: VR mortgages may not provide much help when the yield curve is sharply ascending.

The strong downward pressure of the short rate (RMS) on deposit rates during periods of a sharply ascending yield curve is interesting. SLA's have historically borrowed short and made long term loans. Now, to the extent that they can intermediate in this way successfully they provide a valuable service for which they receive higher net returns on their portfolios than they would if they were perfectly hedged. While this may be a difficult task in periods of inflation and uncertainty, over other periods the higher returns allows them to pay higher deposit rates than competitors who are not in the business of term structure intermediation. Consequently, they attract considerable deposits. Variable rate instruments destroy this

function. SLA's, as a result, while viable in the reserve sense do less lending and play a smaller role in the mortgage market. Other lenders do not completely assume the lost SLA share and the result is fewer mortgage stocks being held in the economy, higher rates and a lower housing stock. The simulation indicates that SLA's simply carry out less intermediation in a world in which the amount of term-structure intermediation is reduced.

As indicated in Chapter I and Section III of this chapter, attempts have been made to design payment smoothing mechanisms to avoid the large short rate swings. One of these, the dual-rate proposal of Modigliani (VR.2) was found to be unsatisfactory in simulation despite its intuitive appeal. On the deposit-mortgage side, the results were, as expected, essentially like those of the simple variable rate instrument (VR.1) and are not reproduced in the accompanying figures. However, on the demand side the effects are not encouraging but are, in retrospect, expected within the simulation framework. The results for housing are presented in Figure V.18 for VR.1 and VR.2.

First note that in any event the differences between VR.1 and VR.2 are not large. Second, VR.2 smoothes in the sense that the peaks are less (e.g. 1972:2, the VR.2 simulates $.37 billion less starts) and the troughs are marginally higher (e.g. 1966:4, $.03 billion). Since the thrift institution receives the short rate there are no additional supply side effects beyond those of VR.1 where it was found that the generally

lower short rates (than the historic long mortgage rate) resulted in smaller deposits and smaller mortgage stocks. On the demand side, the VR.2 looks like a long term conventional instrument, at least with regards to the initial payment. But, this, of course, means that over similar periods of generally lower short rates, (ascending yield curve), the household finds the initial payment above that of the simple variable rate instrument. Hence, the smoothing mechanism results in additional depressing effects on starts and a generally lower level of starts over such periods.

If people are risk averse in the sense that they desire not to absorb payment fluctuations that would occur on their seasoned mortgages from periods like 1966:3, 1969:1 - 1970:2 or 1973:2 - 1973:4, then they may prefer a smoothed contract. But the cost is an appreciably higher initial payment. However, the simulations have no way of capturing the effects of fluctuating future payments on demand. Indeed, it is difficult to know what the duration of the VR contract is when there is uncertainty about the future path of short rates. In addition, the high elasticity on the duration term implies considerable sensitivity to the assumed future path. This is not a problem, incidentally, with the other contracts where the contract rate is either fixed at issuance or moves in a contractually determined way.

It seems unlikely to me that the risk effects would be so dominant as to reverse the general conclusion that the dual-rate variable rate instrument smooths, but by the nature of the contract, it does so around a lower path for starts.

On the upside, the elasticities are such that the lower initial payment is nearly offset by the higher deposit and mortgage flows. During periods of stable rates, the resulting starts are lower because of the combined initial payment and lower deposit-mortgage effects.

In sum, the assumed benefits that the VR instruments provide for lenders appear smaller than expected by many proponents. VR mortgages are basically short-term instruments and, in general, the yield-curve in the U.S. economy has produced short rates below long rates. Lenders lose on this account. However, this is more than offset by increasing levels of rates over the simulation period, and the VR provisions which allow the entire portfolio of variable rate mortgages to keep pace with this movement. One must note, however, that a history of generally declining rates would result in lower profit positions for these intermediaries. (Presumably, there would then be a clamor for the return of fixed rate instruments.)

The surprising results from the simulation occur on the demand side: the lower rates stimulate demand, in general, but the substantially lower deposit and mortgage flows result in fewer mortgages being available. The net effect is essentially zero. What the implications of risk are for these conclusions I do not know.

D. Graduated Payment-Variable Rate Instruments: The Tucker Proposal (IN.1)

On the intermediary side the qualitative results from the Tucker proposal are essentially the same as those for VR.1 and VR.2. The simulations confirm that the contract retains the variable rate provisions in this sense. These results are indicated in Figure V.5 for mortgage and deposit rates, Figures V.8 and V.9 for mortgage stocks, Figure V.11 for deposits, and

V.13 for reserves.

The stimulation on the borrower side, discussed in more detail below, results in marginally higher mortgage and deposit rates. (The short rate for IN.1 would be above the VR.1 short rate path by the same amount that the IN.1 long rate is above the VR.1 long rate and is not separately shown.) These higher rates result in larger deposit flows relative to the simple variable rate option with resulting higher relative mortgage holdings by all intermediaries. The graduation effect on reserves, discussed above in Section IV.B, virtually offsets any increases in reserves from the deposit rate-mortgage side and consequently, the reserves are essentially the same as those generated by the variable rate options.

On the demand side, we find a large positive stimulus to housing over the 1962-1970:2 time period. In 1970:3, the stock of single family units (KH14) is up some $24 billion over the control and some $26 billion over the VR.1 history. However, the supply side problems encountered with the simple variable rate instruments over the 1971-74 period also affect this mortgage proposal. Starts, (VS14), while still up are up proportionally less and fall dramatically nearly to the control level by 1973:4. They are, however, still well above the VR.1 history. As a result, the stock spread (over control) increases only slightly by 1973:4, although the spread between VR.1 and IN.1 stocks is larger in 1973:4 than in 1970:2. The path is

slightly more stable than both the control and the VR.1 path in terms of peak to trough changes.

The effects on rental-family units (VS5) are rather strong. Here we get the adverse effects of both price-substitution toward single family units and the depressing supply effects from the mortgage lending side. The resulting decreases in starts are non-trivial and consequently, the net effect on housing is considerably less for IN.1 than the single family effects alone would indicate. In fact, in 1973:4 total starts, single family and rental are down more than $1.6 billion from the control. They are up relative to the variable rate options however. Consequently, as with the graduated payment options, we have a smaller net effect than the gross effect for single family would indicate. Again, mortgage innovation directed primarily at those who own their own homes results in a changing mix of the stock, certainly not an unexpected result, but one that the simulations not only capture but indicate in several cases to be relatively large.

E. Price-Level Adjusted Mortgages (IN.2)

The final mortgage innovation examined by simulation was one that indexed the principal, the mortgage being contracted in real terms. Again, a feel for what evolved through the simulations is gained by examining a time series plot of the "real" mortgage rate in Figures V.1 and V.6. This series is created, as discussed, by using a simple Koyck expectations mechanism and subtracting those inflation expectations generated

from the nominal mortgage rate. Specific details are found in Section II and the appendix accompanying this chapter. The "real" rate is generally between 3.5 and 4.5 percent, except over the last two quarters. These results seem in the "ballpark" although one obviously does not know exactly what the rates would be since they are not observed directly in any market. The path shows a secular decline through 1970 as nominal rates lagged inflation expectations, then increase only to fall sharply over the last two quarters of 1973.

The results are straight forward and the borrower-demand side, intermediary-supply side effects are, in general, those to be expected from the model.

Starts are stimulated over the entire period, more so in periods of high rates of inflation. The stock (KH14) is up to some $10 billion by 1973:4 over the control history. Since the model does not produce the large substitution effects vis-a-vis rental starts, the net effect is closer to that of GP.1, GP.2 and IN.1 than the single family stock picture alone conveys. (By 1973:4, the total single family plus rental housing stock was, in billions, $658.8, $650.2 and $673.9 for IN.1, IN.2 and GP.2 respectively.) In addition, the price-level adjusted mortgage scheme is the least susceptible to the sizable decline in housing over the last three quarters of the sample, since it does not get caught by the extremely high short rate over that period.

Figure V.6 indicates that the mortgage (RM) and deposit

rates (RD) essentially follow the control history, slightly higher due to demand pressures. Whether or not this is reasonable is a topic to which we return later in this section. Because of the small changes in these rates, the mortgage and deposit stocks also follow the control, except at higher levels (in response to the slightly higher rates and necessary to support the higher stock of housing).

The main difference between the price level adjusted instrument and the other instruments is in the reserve position of SLA's and presumably the profit position of the other intermediaries. The reserves are up dramatically. Beginning with the inflation in 1966, reserves climb to a level of some $30+ billion, nearly double the control reserve level (Figure V.13) and over $13 billion above the levels that existed in the historic simulation. Over this period inflation, for the most part, was increasing. The large reserve build-up results from a consistent underestimation of the rate of inflation. That is, the SLA's, in the face of rising and uncertain movements in inflation rates, consistently offer deposit rates below those they could have offered had they known, ex ante, the ex-post rate of inflation. Since the outstanding stock of mortgages is, period by period, revalued by the actual rate observed over the last quarter, this underestimation results in unexpected reserve accumulation. They do, however, begin to build their expectations of inflation into lending and deposit rate behavior. Note, for example, quarter 1971:4 (Figure V.13).

Reserves decline $.2 billion, as the ex-post inflation rate fell sharply. Consider the following selected, quarter by quarter, annual inflation rates:

1971:1	3.249
1971:2	4.588
1971:3	3.345
1971:4	1.472
1972:1	3.524
1973:1	5.933
1973:2	8.018
1973:3	7.590
1973:4	9.248

During periods of relatively constant rates of inflation, the rate of reserve buildup is consistent with that observed under the historical regime. For example, from 1970:1 to 1972:4 reserves increase by $4 billion under conventional mortgages (the historical simulation). It is during periods of increasing (decreasing) rates that the underestimation (overestimation) leads to reserve accumulation (depletion). This seems entirely consistent with what one might expect behavior to be in a world characterized by such conditions.

While this inflation effect seems reasonable the continued large accumulation of reserves does not. (In fact, under a number of regimes reserves accumulate to levels above those observed historically.) Most savings and loan associations are mutuals and would be expected to pay out "excess" reserves

to share holders in the form of higher deposit rates. Since these "excesses" were not something encountered by SLA's over the history of estimation, the model has no provisions for such behavior. We must return again to deposit rate setting behavior.

F. The Competitive Assumption

All of the results reported thus far are based on the assumption that the rates of the various intermediaries are set, free of ceiling constraint, by the institutions acting vis-a-vis each other as they did in the early and mid-1960's. As noted above, a simple assumption might be that the commercial banks would behave today in the absence of ceilings, more aggressively in soliciting time deposits. It is interesting to examine the effects of the strong assumption that all intermediaries pay the same deposit rate, an assumption I have labelled "competitive." Figures V.14 through V.17 illustrate the effects. Since the same general relationships hold between deposits, mortgages and housing for most of the instruments as were evidenced in the simulations already discussed, I summarize this set of experiments in a little different manner to provide a different view of these relationships.

Figure V.17 illustrates the time path of SLA reserve accumulation since 1967. We are interested here, in whether the SLA's could, with mortgage innovation maintain their integrity as mortgage lenders and remain viable financial institutions under strong competitive pressures. The answer is clearly yes if they had issued price level adjusted mortgages

over a history such as existed in the U.S. economy over the past six years. Reserves are again well above the levels observed historically. The gains are more impressive when one notes that competition under a regime characterized by conventional contracts would lead to a net loss of $6.3 billion in reserves, more than 30 percent of the historical accumulation. The gross gain under IN.2 is nearly $14 billion by 1973:4. Both variable rate and Tucker plans encounter difficulties with the sharply fluctuating rates over the last two years of the sample, but both provide reserve accumulations well above those that occurred in the control simulation with conventional contracts and competition. However, the reserves are down some $2.5 billion from the historical simulation with conventional contracts and Regulation Q.

These results tend to confirm those reported earlier that Regulation Q is not the only source of protection for SLA's, if policy makers continue to insist on their existence in essentially the same character they now possess.

A comparison of Figure V.17 with Figure V.14 indicates, as stated earlier, that qualitatively the results are very much the same under the competitive assumption as they were with no ceiling regulation.

Competition does lead to generally higher deposit rates with deposit shifts toward commercial banks. Even though total savings has increased because of savings flows from the general capital markets responding to the higher deposit rates in the

thrift sector, the shift in composition often leads to less mortgage lending. A picture of the control results can be obtained by examining Figure V.4, V.7 and V.10 for rates, mortgages and deposits respectively.

Figures V.14 and V.15 then indicate "cross-section" views of results for VR.1, the simple variable rate instrument and IN.2 the price level adjusted instrument. Since the results are very much the same as those discussed in detail above, I simply note some interesting points.

With VR.1, the deposit rate (RD) shows a sharp cycle corresponding to the movement in the short mortgage rate (RMS) and thus to the short rates elsewhere in the economy. The shift in deposit holdings results in changing composition of mortgage holdings (MS), with as noted above, a decrease in mortgages despite increased deposit flows. This seems to me to be an interesting insight worth emphasizing. Commercial banks and life insurance companies increase their holdings but not by enough to offset the decrease in SLA and MSB holdings from the control simulation (which also produced holdings lower than historical holdings, Figure V.7). Housing is again affected and the stock falls (KH14) $6 billion by 1973:4. The gross loss from the historical simulation is nearly $12 billion.

The results for IN.2 (Figure V.12) are quite different. The stock of housing (KH14) is up $10+ billion, relative to the control, by 1973:4, to a level some $5 billion above that of the historical simulation. There is not the shift of deposit

holdings exhibited in the VR.1 simulation. Deposit rates (RD) are higher than historically observed, but the indexed contract allows the thrift institutions to hold their own in competition with the commercial banks.

I think the simulations reveal something quite interesting in these two cases: shifting deposits, for whatever reason, toward commercial banks and away from thrift institutions leads, at least in simulation, to decreased mortgage flows, higher rates and less housing. Further, these results generally occur when one tries to hedge SLA portfolios, i.e. when savings and loan associations lose their term-structure intermediation role. Finally, the simulation results indicate that there are instruments, here specifically the price level adjusted mortgage, that can provide support to housing and SLA's (if that is what is desired socially) in the face of competitive returns paid elsewhere. In fact, we can do better, as a series of experiments reported below indicates.

I confess to be surprised and somewhat chagrined at these findings. As the first chapter of this thesis often implies, I have not been a strong supporter of the current structure of housing finance and view specially protected deposit institutions as an anachronism. But these simulations do indicate quite strongly, that destroying the basic character of these institutions (their term structure intermediation role) results in a smaller housing stock through the mechanism described in the text above. The seriousness of this loss is, of course, an issue of social policy.

Finally, I summarize the effects of the various instruments

(under the competitive assumption) for housing in Figure V.16. The results are very much the same as those discussed earlier but more pronounced. VR.2 (not shown) again smooths very little, essentially by cutting off the peaks in 1968:1 and 1972:2. IN.1, VR.1 and VR.2 all encounter the same problems with the volatile short rates of the last few years. IN.2 is less affected.

G. IN.2 and SLA Reserves

A problem, alluded to several times above, with this type of simulation is the assumptions one ought or needs to make about deposit rate behavior. The preceeding set of experiments examined as assumption termed competitive. These, plus the first set of simulations, made assumptions about the relationship between deposit rates set by the various intermediaries. Even more difficult, and an added complexity to this issue, is the relationship between the deposit rate any one intermediary sets and the mortgage rate generated by a new instrument. In Section II of this Chapter I indicated that one might postulate a fixed spread between the rates for variable rate instruments or perhaps indexing deposits for price-level adjusted mortgages. These are not pursued in this thesis but remain areas for further research.

However, the results reported for IN.2 are still not fully satisfactory. Examination of Figure V.17 indicates that, even with a competitive regime, indexing the mortgage stock results in substantial reserve accumulation. As indicated above, it is

unrealistic to believe that the mutual-type savings and loan associations would not pay these "excess" reserves to their share holders. Consequently, I examine a simple hypothesis that the SLA's are forced to pay out the excess. I assume that those reserves historically observed were the minimum necessary to keep the SLA's viable, any excess generated by IN.2 is "paid out". That is, I essentially force a deposit rate such that the reserve position approximately tracks the historically observed accumulation.

Whether or not the observed accumulation is the minimum necessary for viability is an open question. The only evidence is pretty loose. That is, the assumption is based on the observation that if SLA's were, over the sample, in continuous serious trouble, Regulation Q would have been changed. If they had excess, there would have been pressures to relax deposit ceiling regulation so that savings and loan associations could have been more competitive, paying out excess accumulations as higher deposit rates to attract more deposits.

We are now faced again with the question of other deposit institution behavior. A naive assumption, that only SLA's adjust their rates yields perverse results, since the reserve position leads to much higher rates for SLA's and virtually all savings being channelled to them. I pursue two assumptions analogous to the two sets of experiments already reported. First, it is assumed that other institutions match the increment to the SLA rate from the reserve pay out. Second, it is assumed that the other institutions compete and match the rate actually paid by the savings and loan associations. Figures

V.19 and V.20 illustrate the simulation results. However, in an effort to present still another view of the simulation process, these results are plotted against the historical simulation rather than either of the two control simulations. (The reader is reminded that this historical control simulation maintained ceilings on deposit rates for the various intermediaries.) In Figure V.19 the mortgage (RM) and interest (RD) rate behavior for both experiments were very close, consequently only one plot appears. Otherwise the interpretation is straight forward given the preceding discussion of other simulation results.

I begin with the deposit rate (RDSL). Reference to the path for the short rate (Figure V.1 or V.5) indicates that the deposit rate path follows, to a large extent, movements in that rate. The reader is reminded, however, that the corresponding mortgage rate for a price level adjusted mortgage is a long real rate. Whence the deposit rate behavior? At any moment, the holder of a PLA mortgage receives the real long rate and, in addition, essentially the actual rate of inflation. If the real rate is more or less constant, then

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"Essentially" since the stock is adjusted by the rate of inflation and then amortized to determine the new nominal payments. This tends to smooth the inflation effects.

---

this return moves like a short money rate, as is evidenced by the deposit rate movements in response to forced pay out of the

mortgage lenders' inflation gain. In a loose sense, the model "indexes" deposits, although not explicitly forced to do so. The results of these highly competitive deposit rates are evident: large increases in mortgage holdings corresponding to sizable increases in deposit flows (not shown). Two effects are evident, both stimulating to housing: first, the now familiar demand effect from indexed elimination of the inflation distortion; second, the supply side effect - larger mortgage flows which dominate the increased demand resulting in lower nominal mortgages rates, as illustrated (Figure V.19). The effects for housing are dramatic indeed. The price level adjusted simulation run under the first hypothesis (IN.2, no Reg Q) results in a remarkably high and stable flow of housing (KH14). Note, that the levels are not unreasonably high, i.e. "history" produced larger flows from 1972:1 to 1972:3. The flow is very stable. For example, the 1970-1972 trough to peak is $.8 billion, from $4.8 to $5.6 billion. By comparison, the same movements in the historical simulation was $2.4 billion, from $2.45 to $5.72 billion. The end of period results are also very different: IN.2 turning up slightly while history showed a sizable decline. The end of period stock (KH14) is up $27 billion, around 6%.

The comparisons made here differ from those of earlier sections, where comparisons were made to a control simulation. Such comparisons can be easily made by comparing IN.2 (no Reg Q), Figure V.19 with Figure V.2 and IN.2 (competition), Figure V.19 with Figure V.16.

Introducing competition results in a lower level of final stock relative to the non-competitive regime. Again, the shifting pattern of deposit flows (relatively more to commercial banks) results in lowered (relatively) mortgage holdings.

Figure V.20 provides time series views of mortgage holdings (MD) and reserve positions. The results must introduce a good deal of caution into the interpretations of the pay-out schemes. The pay-out scheme makes the SLA's and MSB's extremely competitive. (Note the tremendous increase in MSB mortgage holdings resulting from the increased deposit flows.) They maintain this position in the face of competition from commercial banks (IN.2, competition). However, in these cases there certainly would be general equilibrium feedback effects from the rest of the economy in response to the extraordinarily large movements of savings to the deposit sector.

The interesting observation here is the PLA mortgages can provide for extremely competitive thrift institutions. Housing benefits, SLA's can maintain their viability, and small savers obtain competitive, and in a sense indexed, returns on their deposits. Holders of old mortgages, of course, forfeit their capital gains from the lower interest mortgages obtained during the period of generally rising rates. The model is, in essence, providing a sizable redistribution away from mortgage borrowers to depositors, with benefits for those who desire to obtain mortgages over the latter periods of the secular increase in nominal rates. What the impacts of the lost

capital gains on mortgages would be for those holding such mortgages and therefore for housing, I do not know. To the degree that there is a sizable amount of speculation on inflation the impacts may be rather sizable. That is, if it were the case that households, over the last ten years, had obtained larger mortgages and dwelling units because of the expected decline in real mortgage payments (and, of course, the redistribution from small savers to home owners due to the capital losses on mortgages held by thrift institutions), then, faced with constant real payments, they may have purchased differently.

H. Regulation Q, Variable Rate and Price-Level Adjusted Mortgages

Many of the characteristics of the proposed mortgage innovations are designed to provide for viable savings and loan associations when deposit ceilings are de-regulated. Much of the academic discussion of these proposals assumes that such would be the case upon the introduction of new instruments. However, it is likely, should mortgage innovation ever be allowed on a large scale, that implementation would be piece-meal. New instruments may be introduced and ceilings maintained. While this seems to be inconsistent policy making, one might note that in the recent Federal Home Loan Bank Board proposal for a form of a variable rate mortgage absolutely no mention was made of even the possibility of removing ceilings. Consequently, it seems worthwhile to briefly examine the effects

of mortgage innovation assuming the current deposit rate structure to hold.

Figure V.21 summarizes selected results for two innovations, variable rate (VR.1) and price-level adjusted mortgages (IN.1). The historical simulation with conventional mortgages and ceilings regulation is plotted as a baseline.

Certain results are very much to be expected. Both IN.1 and VR.1 increase SLA reserves considerably. The variable rate contract continues to introduce wider fluctuations into housing starts than those observed historically and consequently, results in a smaller end-of-period housing stock (down $7 billion). The results are, in general, more unfavorable for variable rate contracts with regulation than for variable rate contracts without deposit ceilings. The reasons are, by now, familiar. During periods of low short rates, lower deposit rates are paid than historically occurred, less deposits are attracted and fewer mortgages are made. Now, in addition, when short rates shoot up, SLA's cannot pay the corresponding deposit rate above the ceiling and deposits are down even further relative to the VR.1 with no constraint. (Comparisons for this purpose should be made with Figure V.3). Since periods of high short rates are of relatively short duration these last effects are not large in this simulation but, I believe, are an important insight.

The price-level adjusted mortgage results are straight forward. Housing is stimulated somewhat. Virtually all of this

stimulus must come from the demand side (the index elimination of the inflation caused initial payment distortion) since the deposit ceilings do not allow active competition for deposits by increasing the deposit rate. Using this as a rough measure of the demand effects, one can easily compare other IN.1 simulations to get a feel for the net supply effects of indexing. Such an exercise is left to the interested reader.

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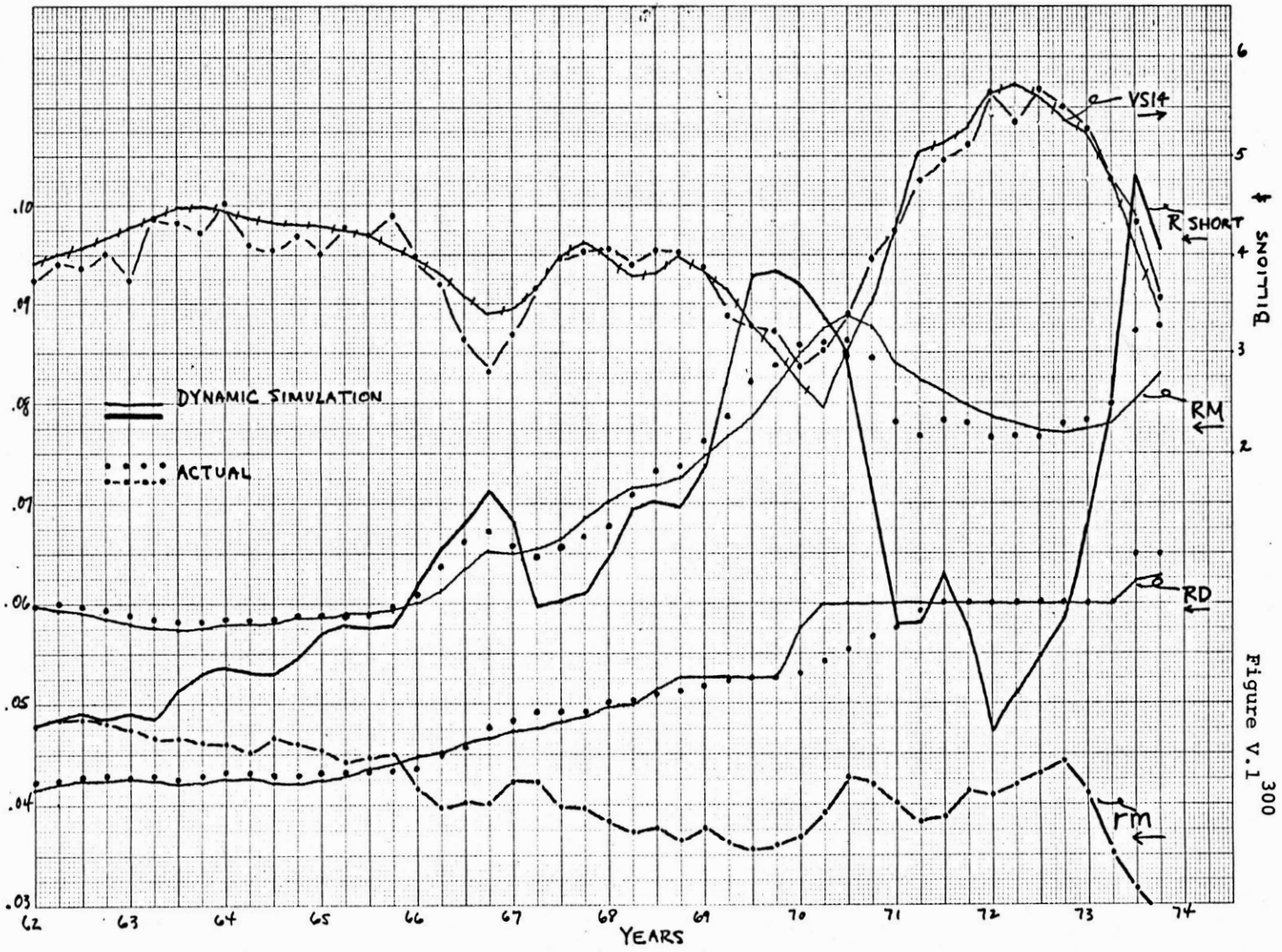


Figure V.1

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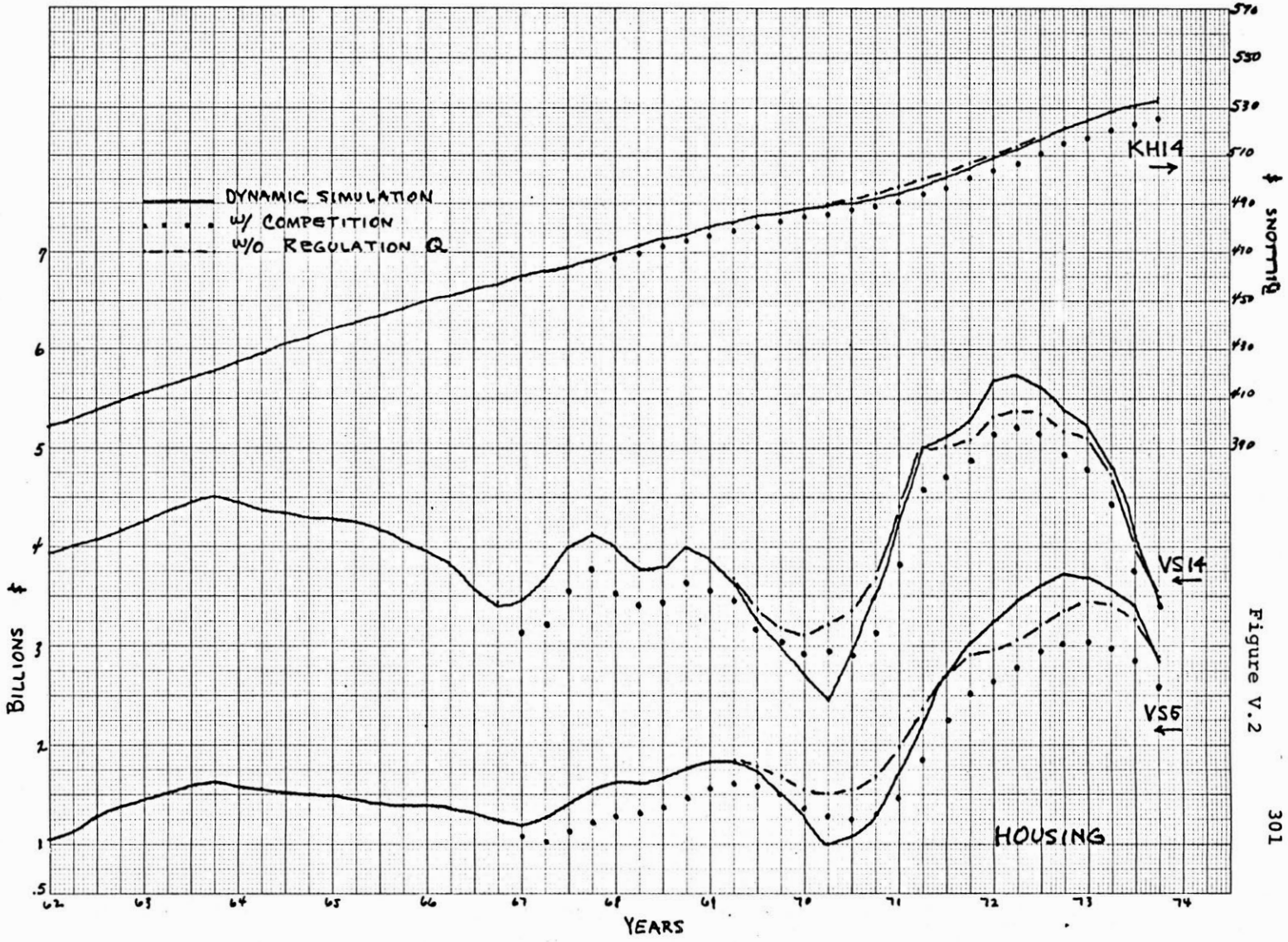


Figure V.2

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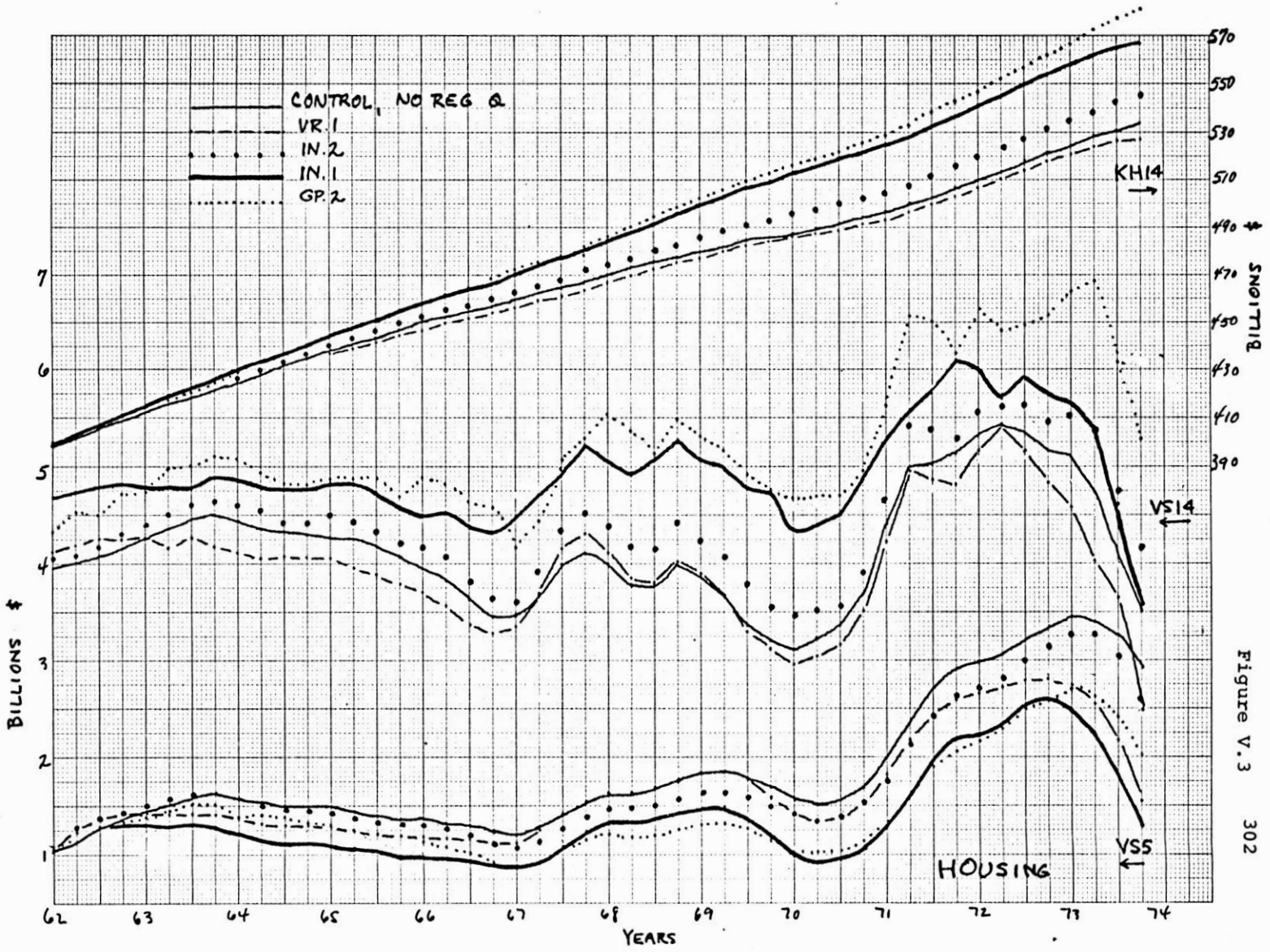


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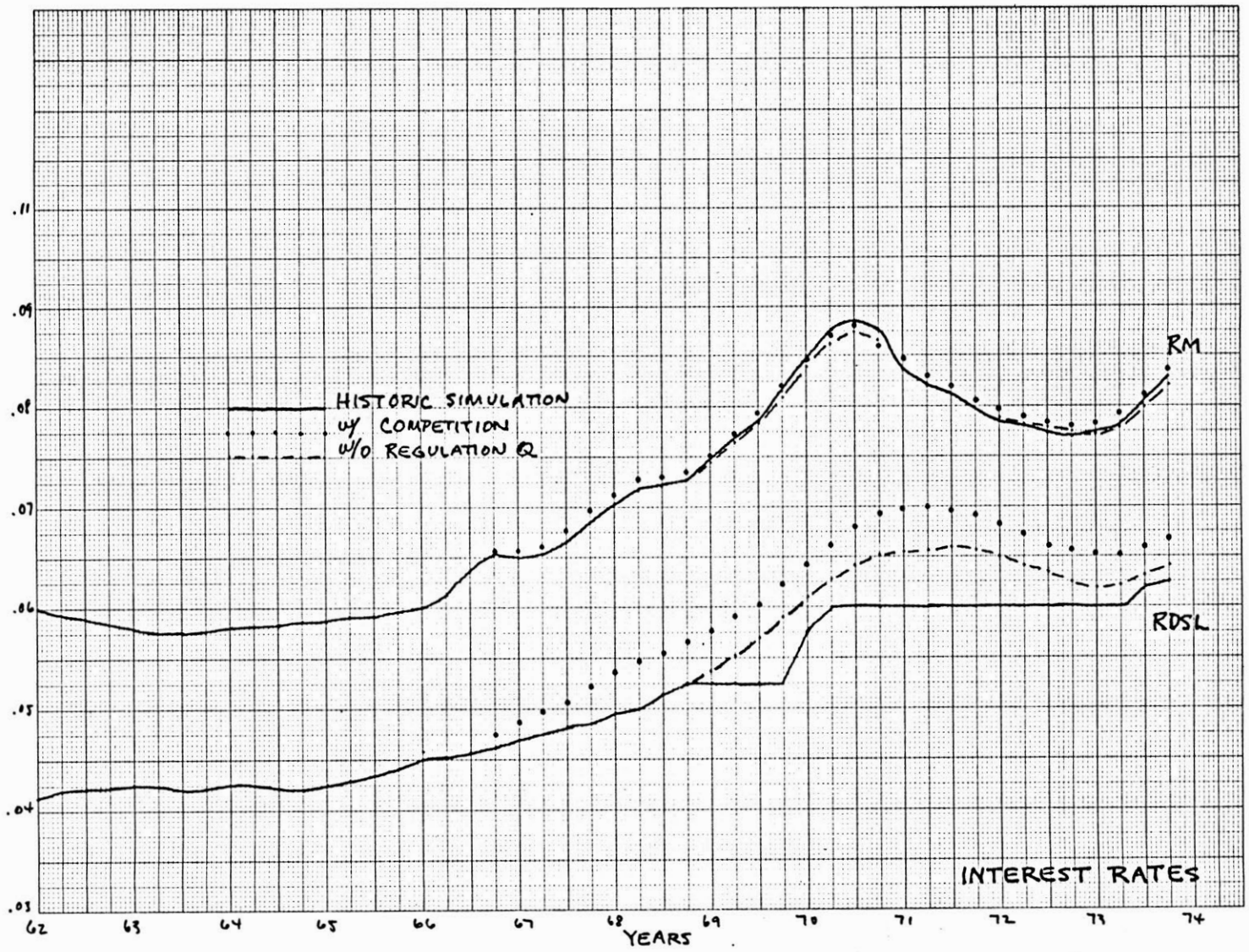


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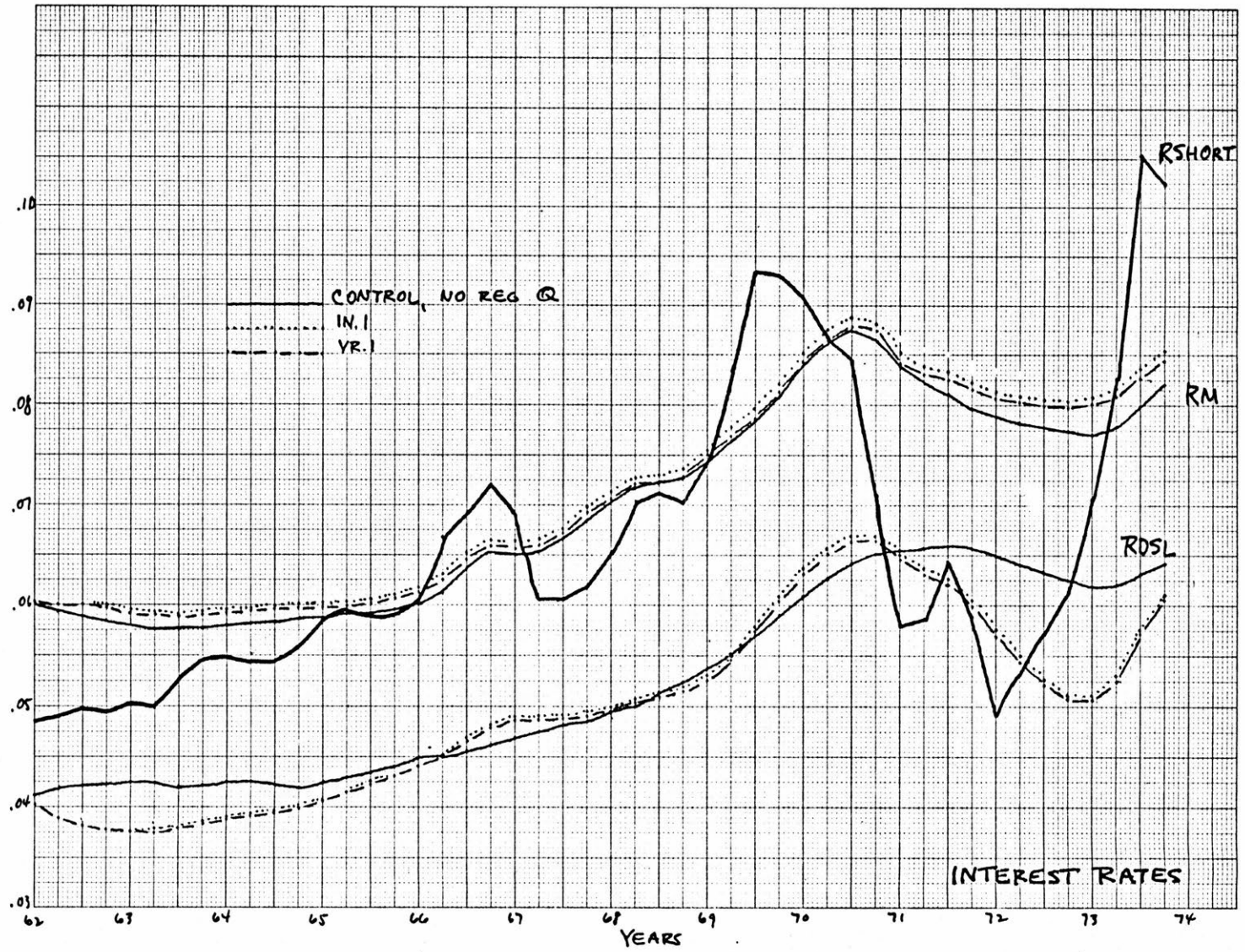


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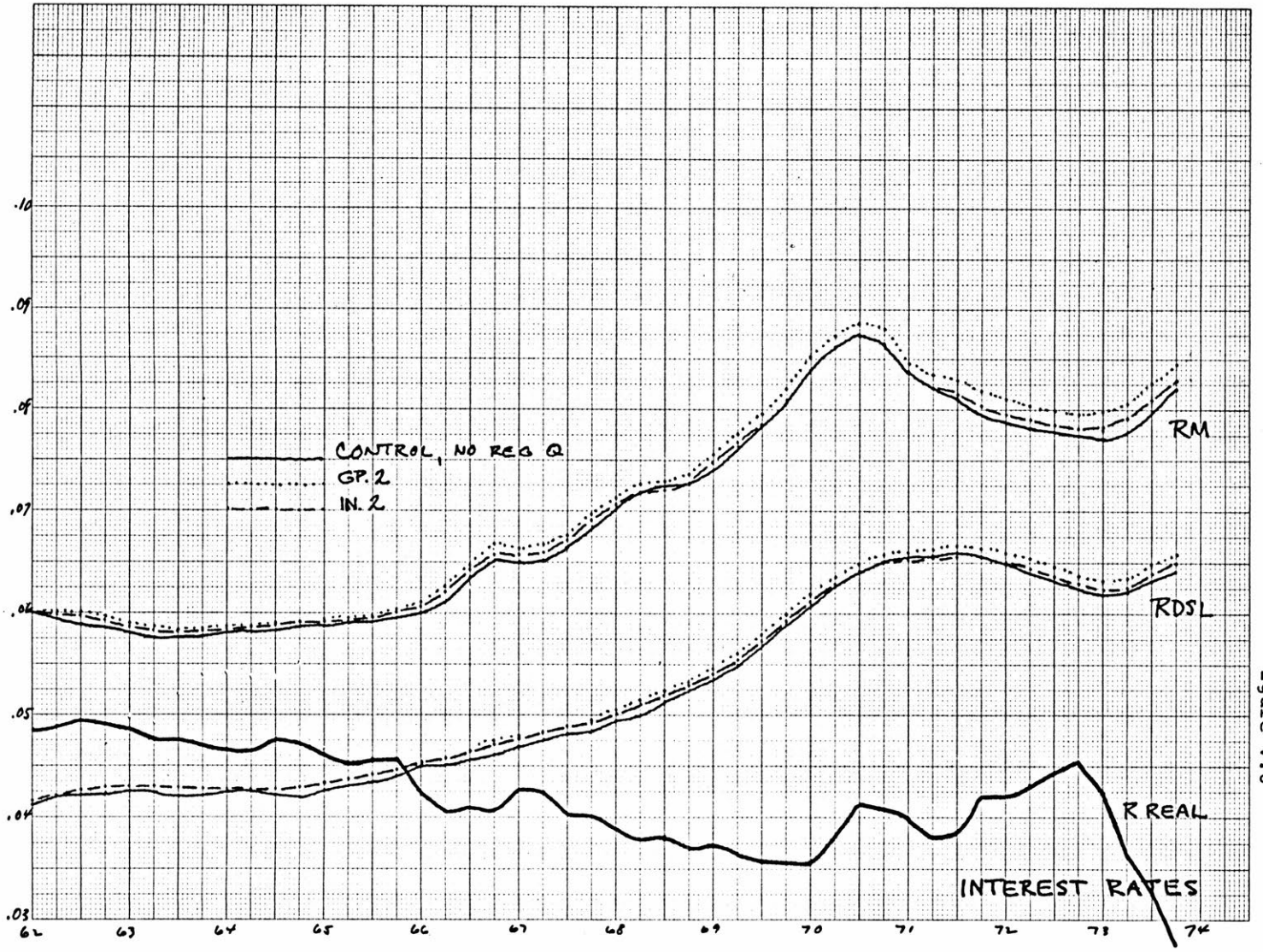


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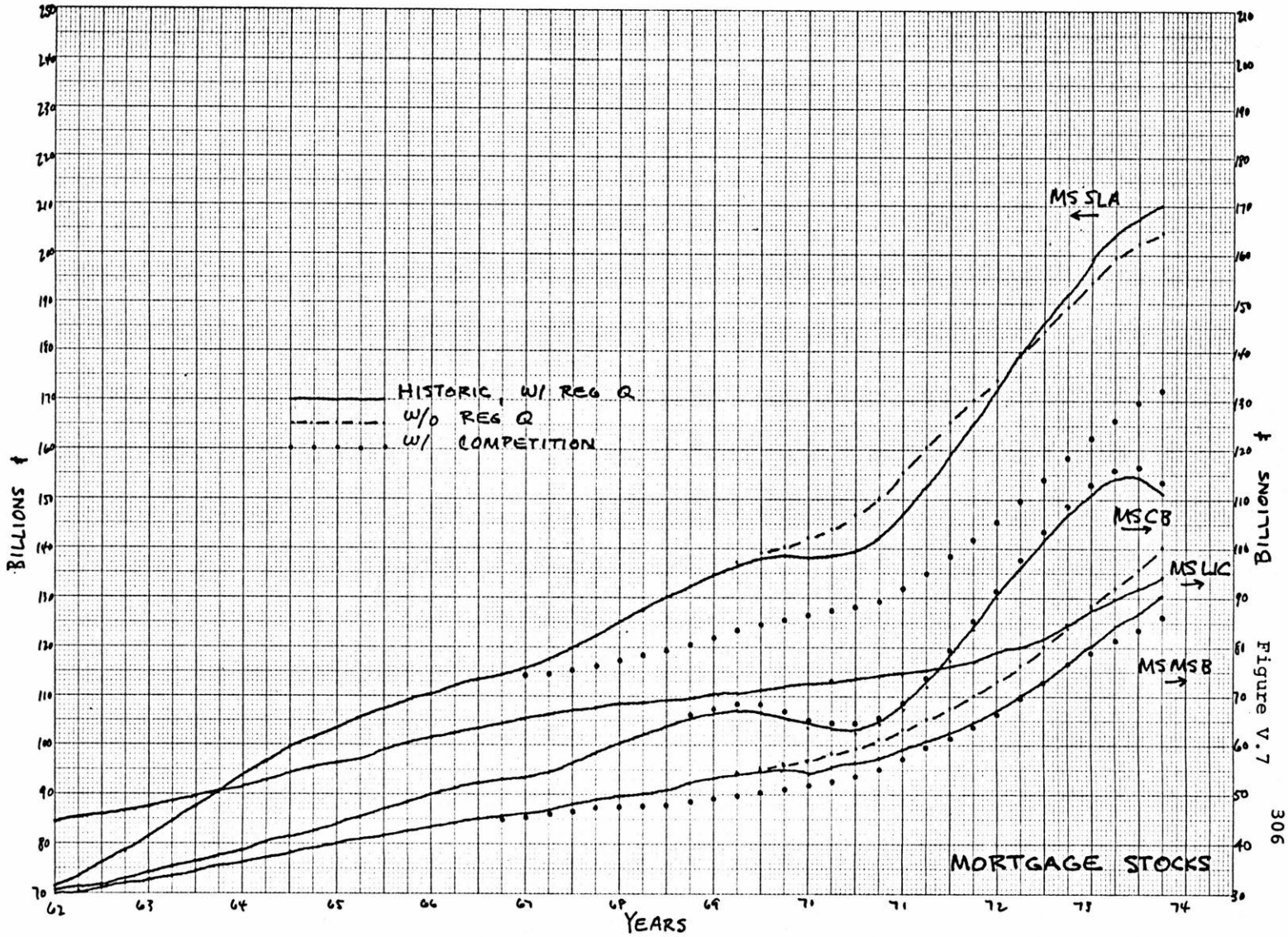


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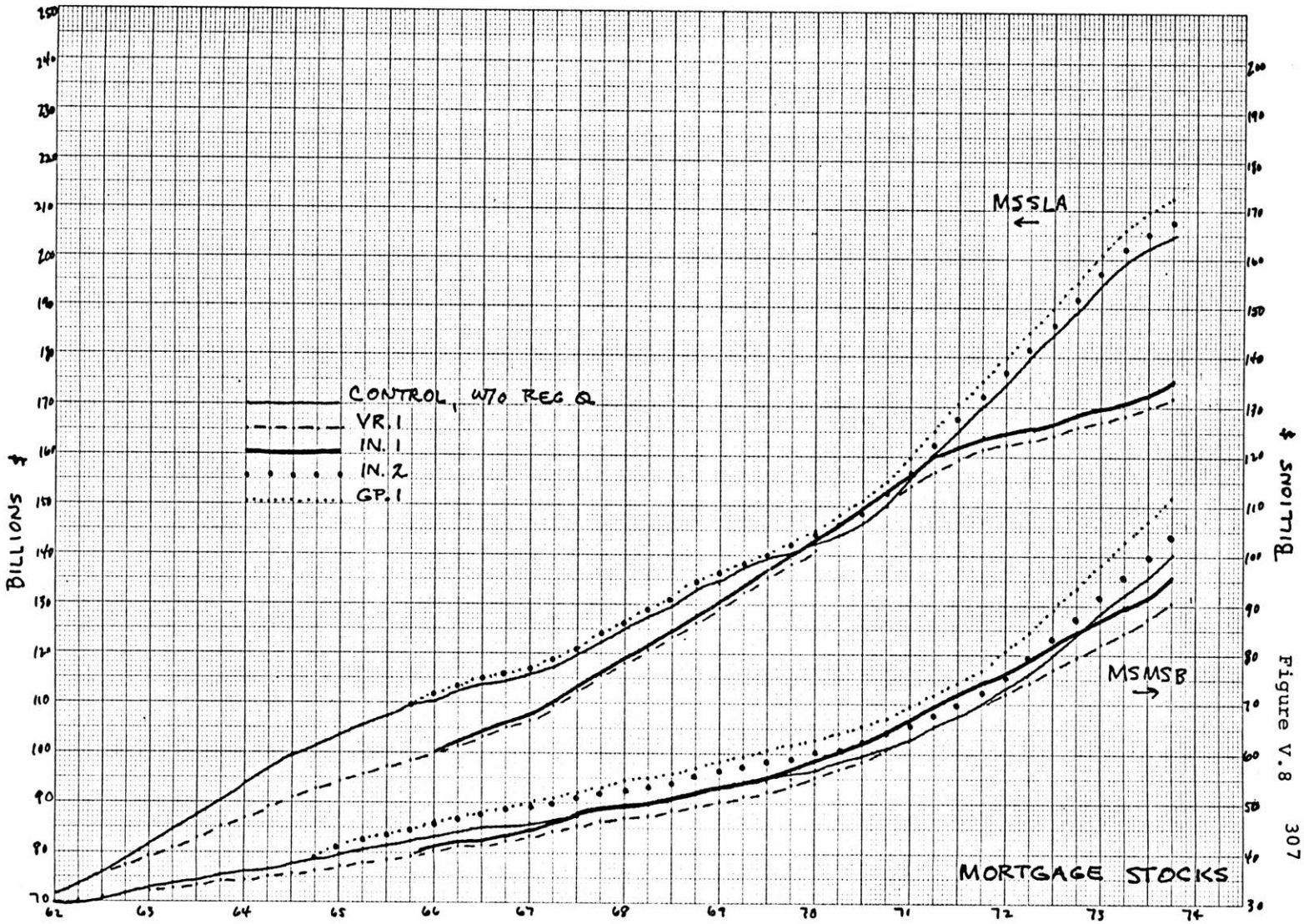


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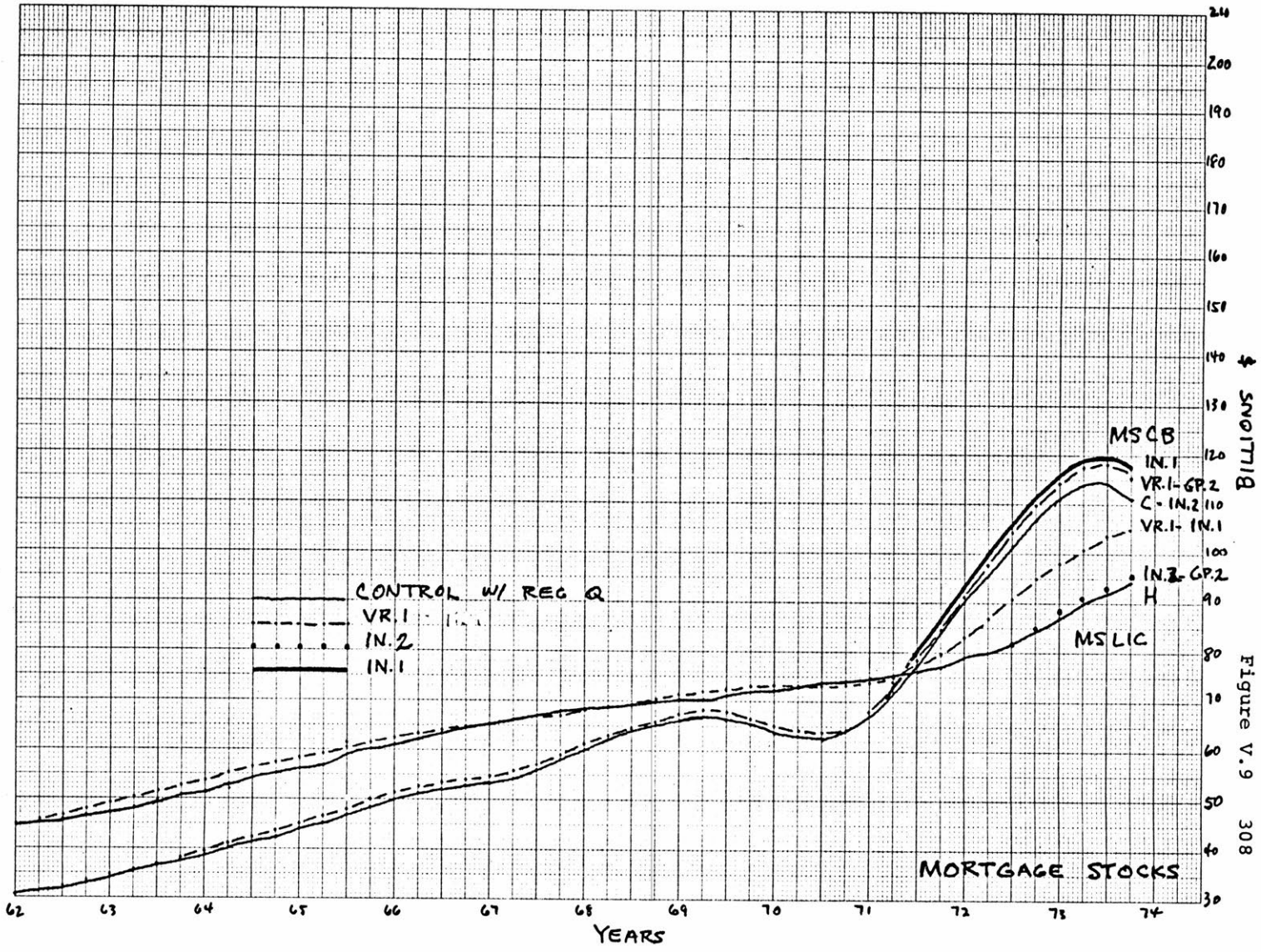


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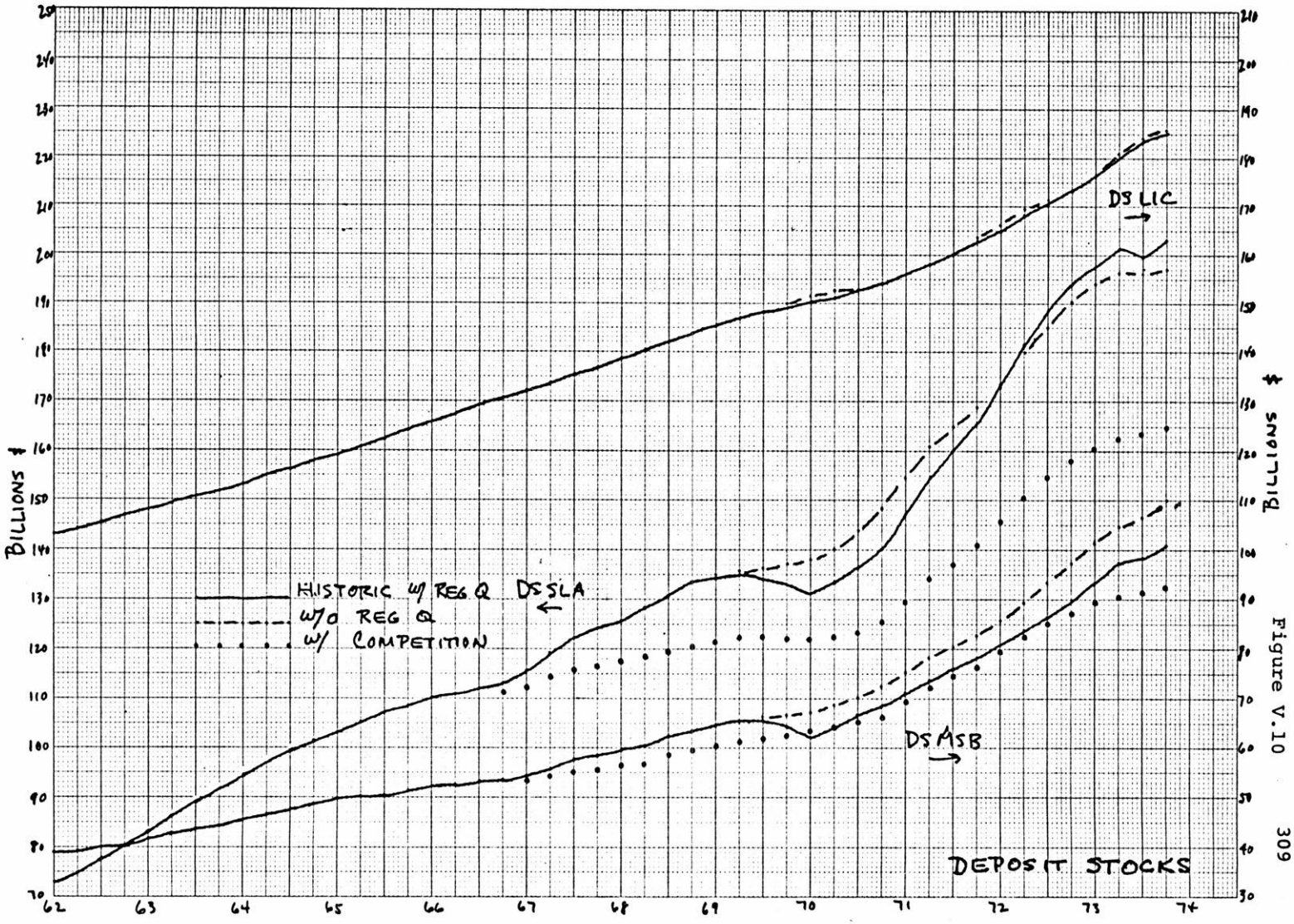


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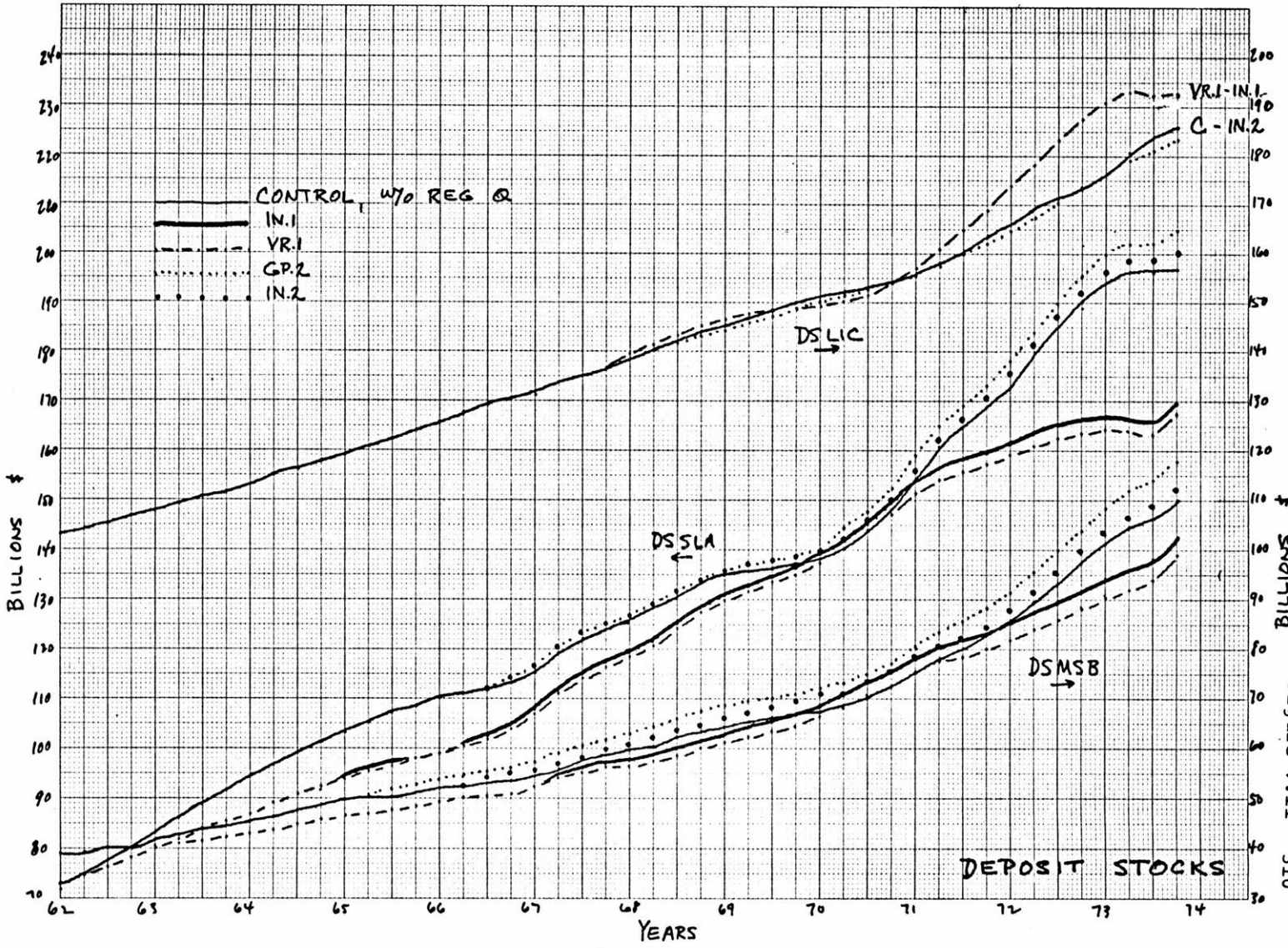


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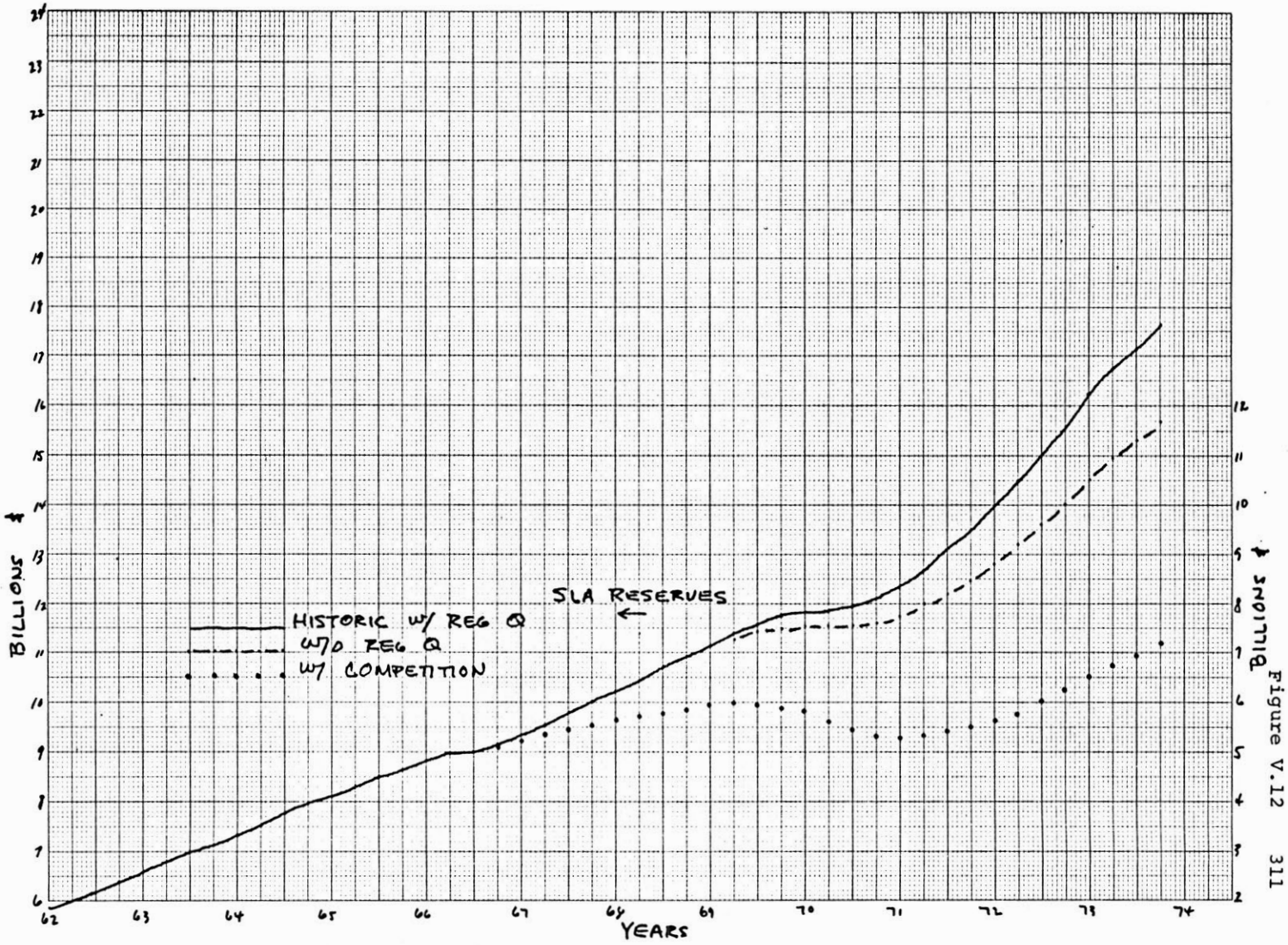


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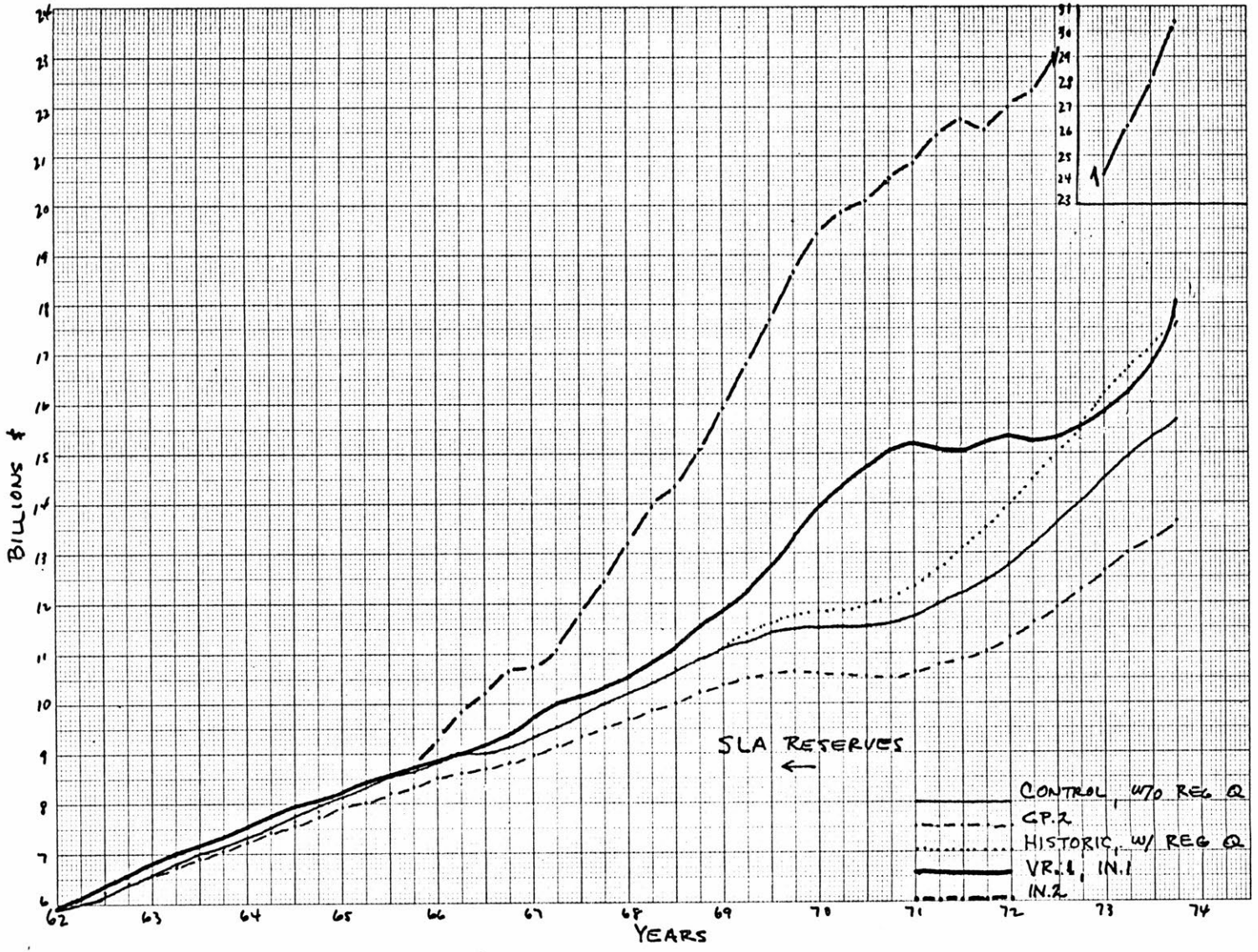
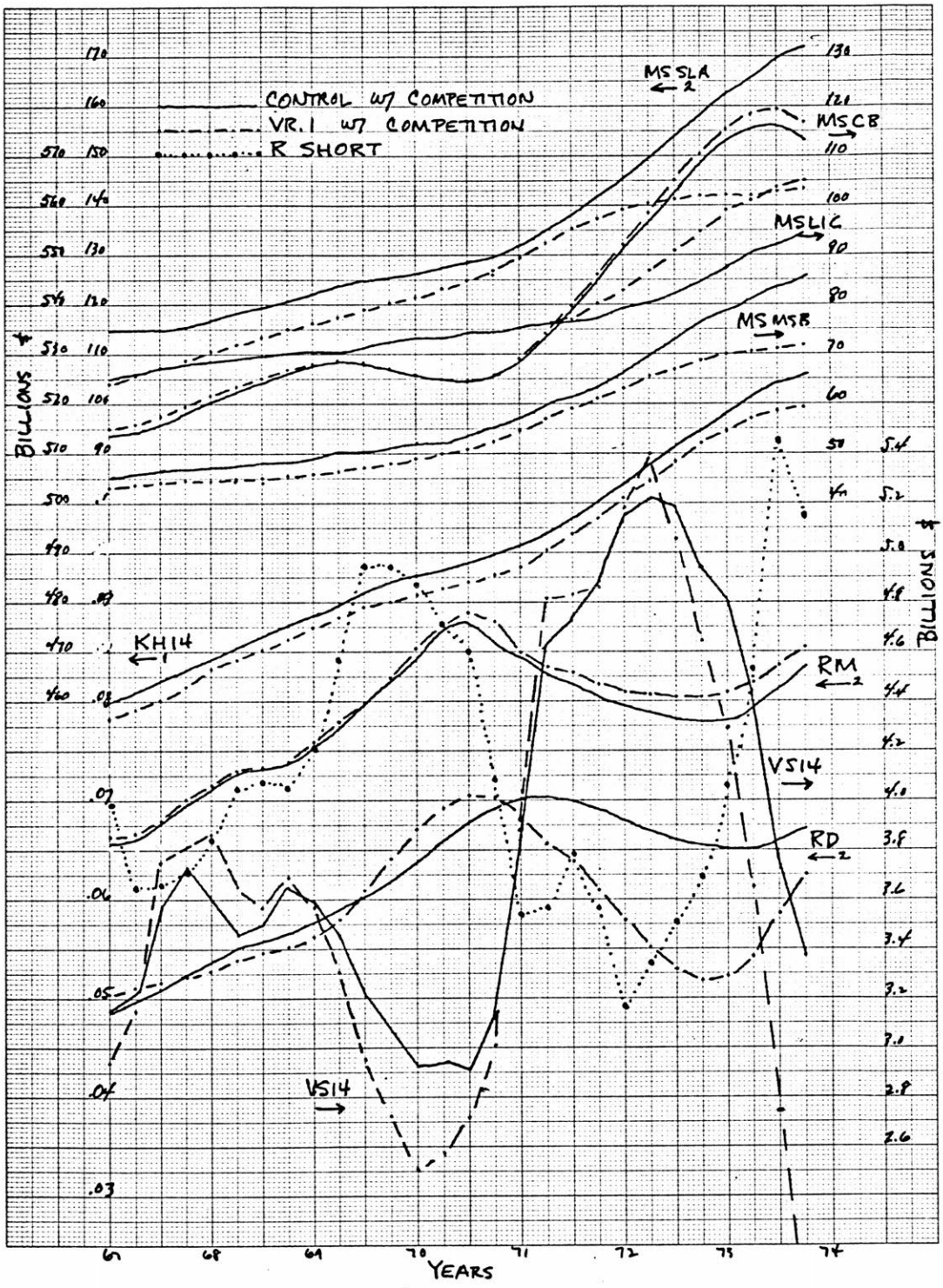
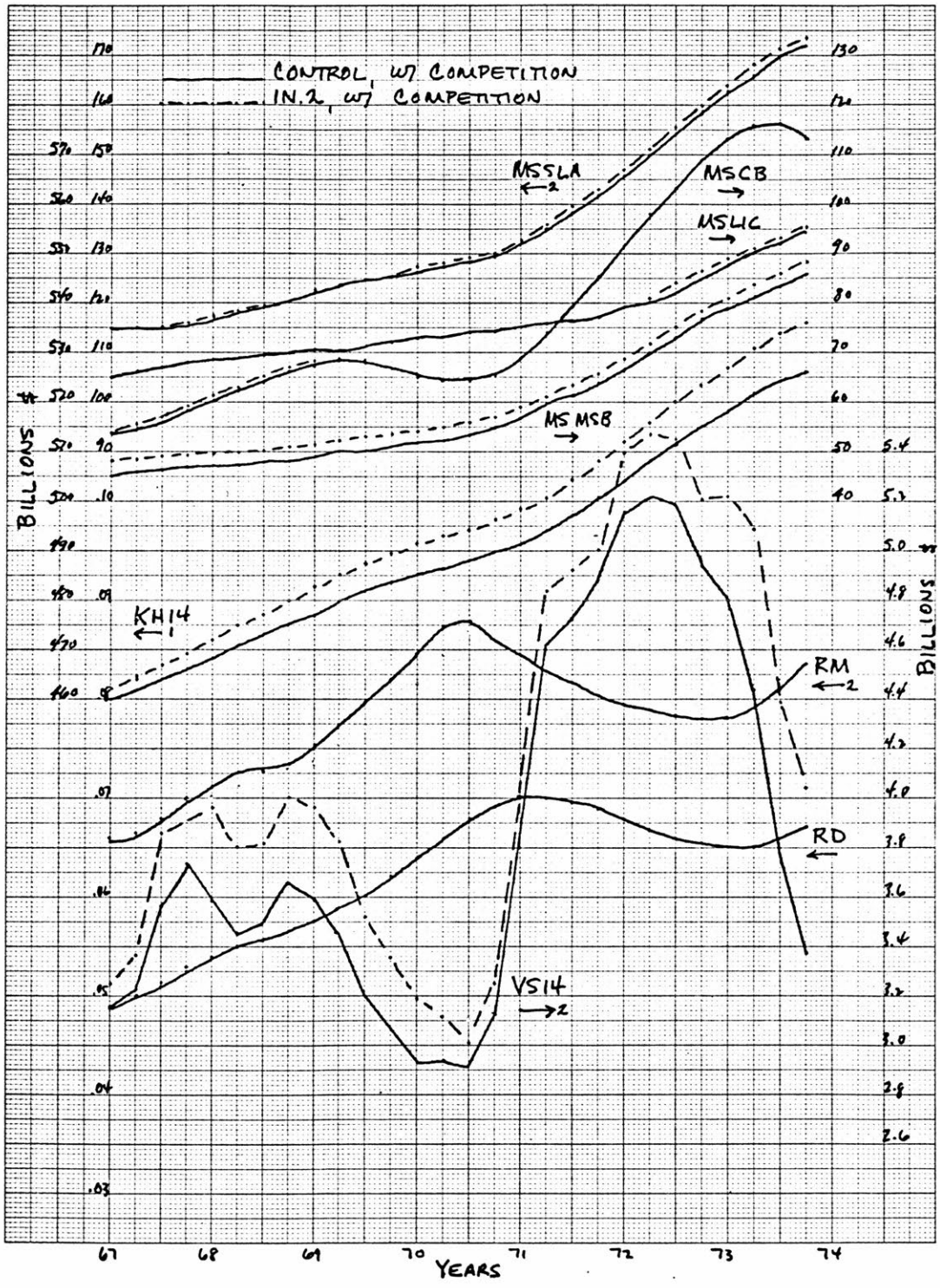


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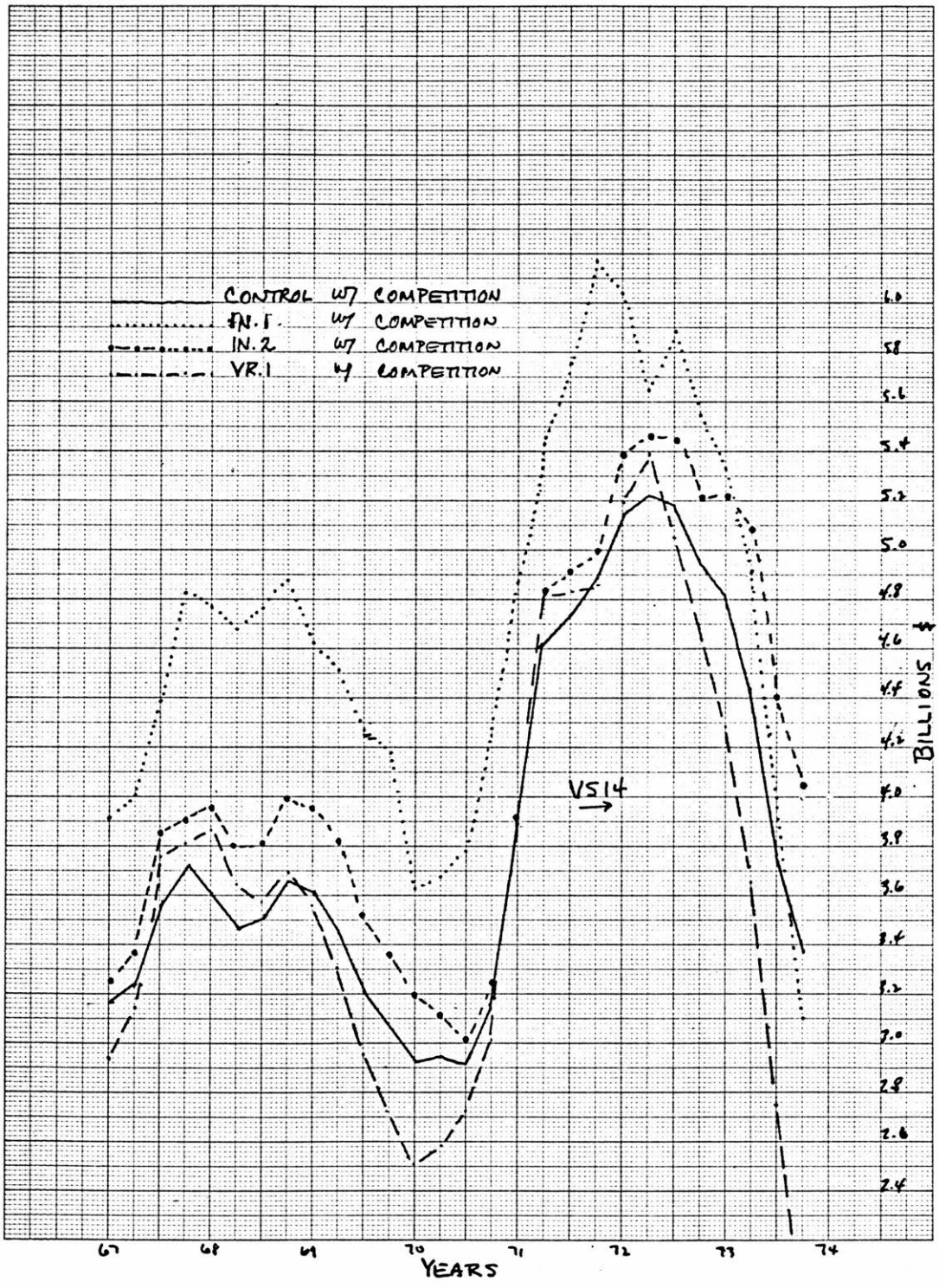


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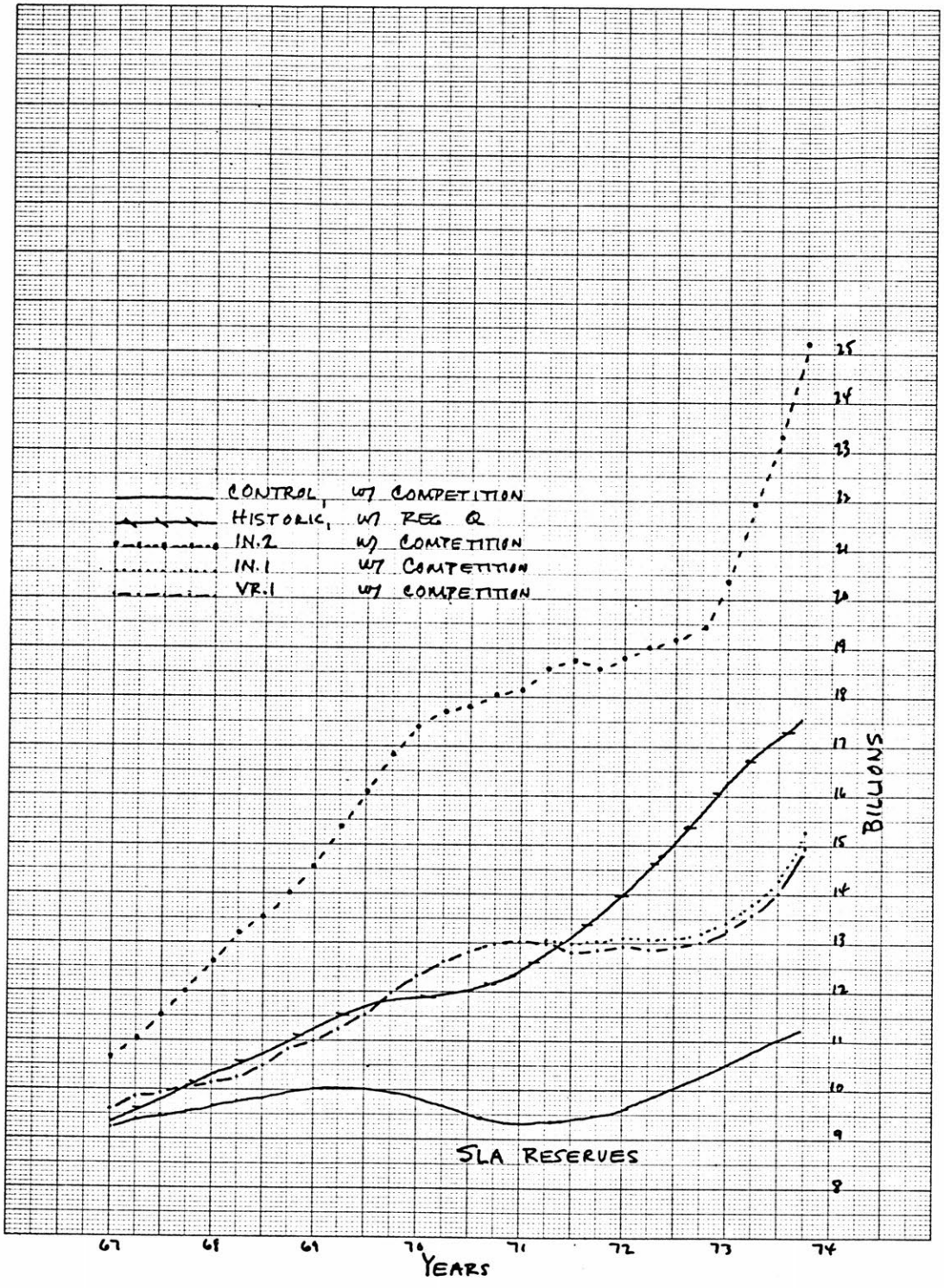
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Figure V.16



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Figure V.17



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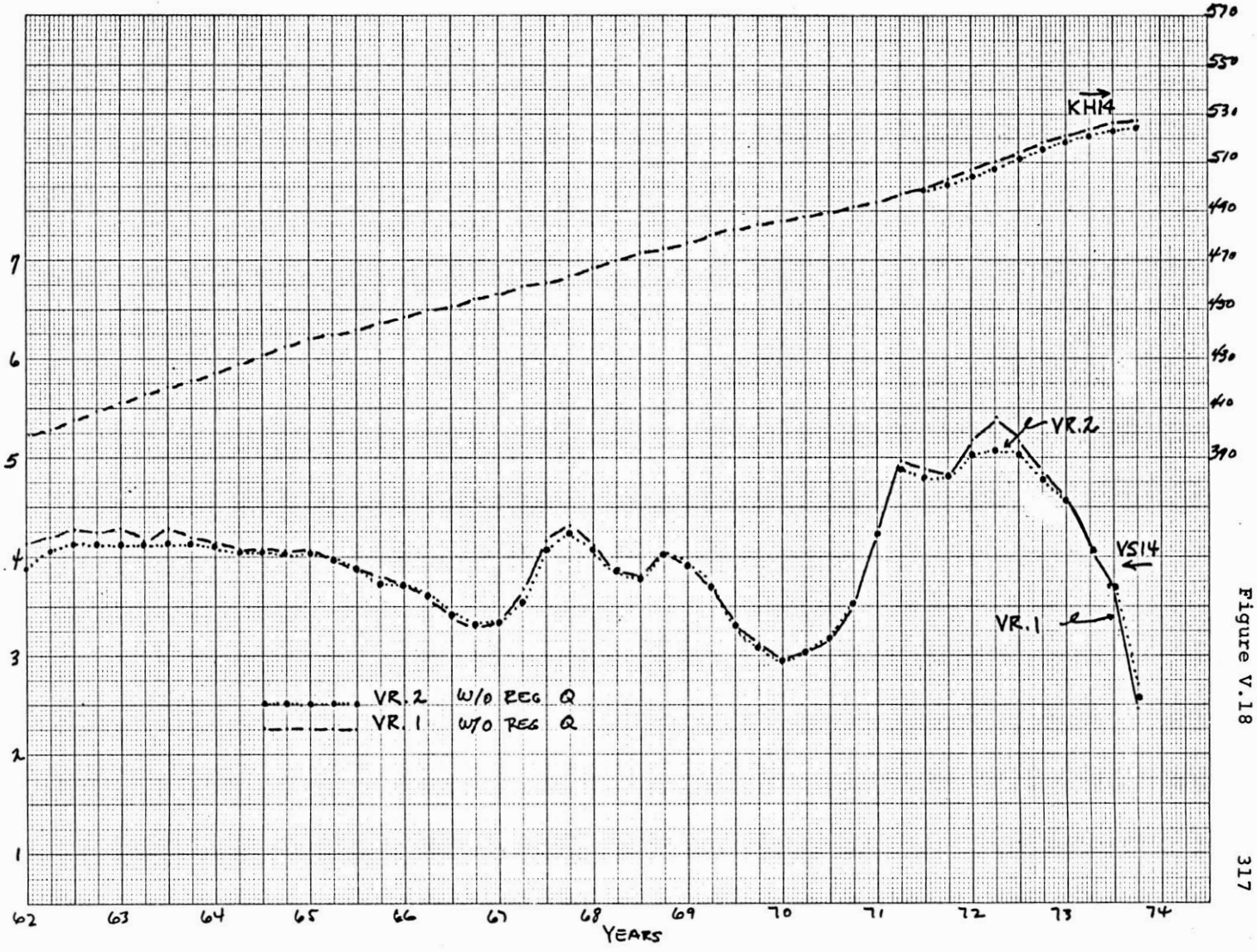
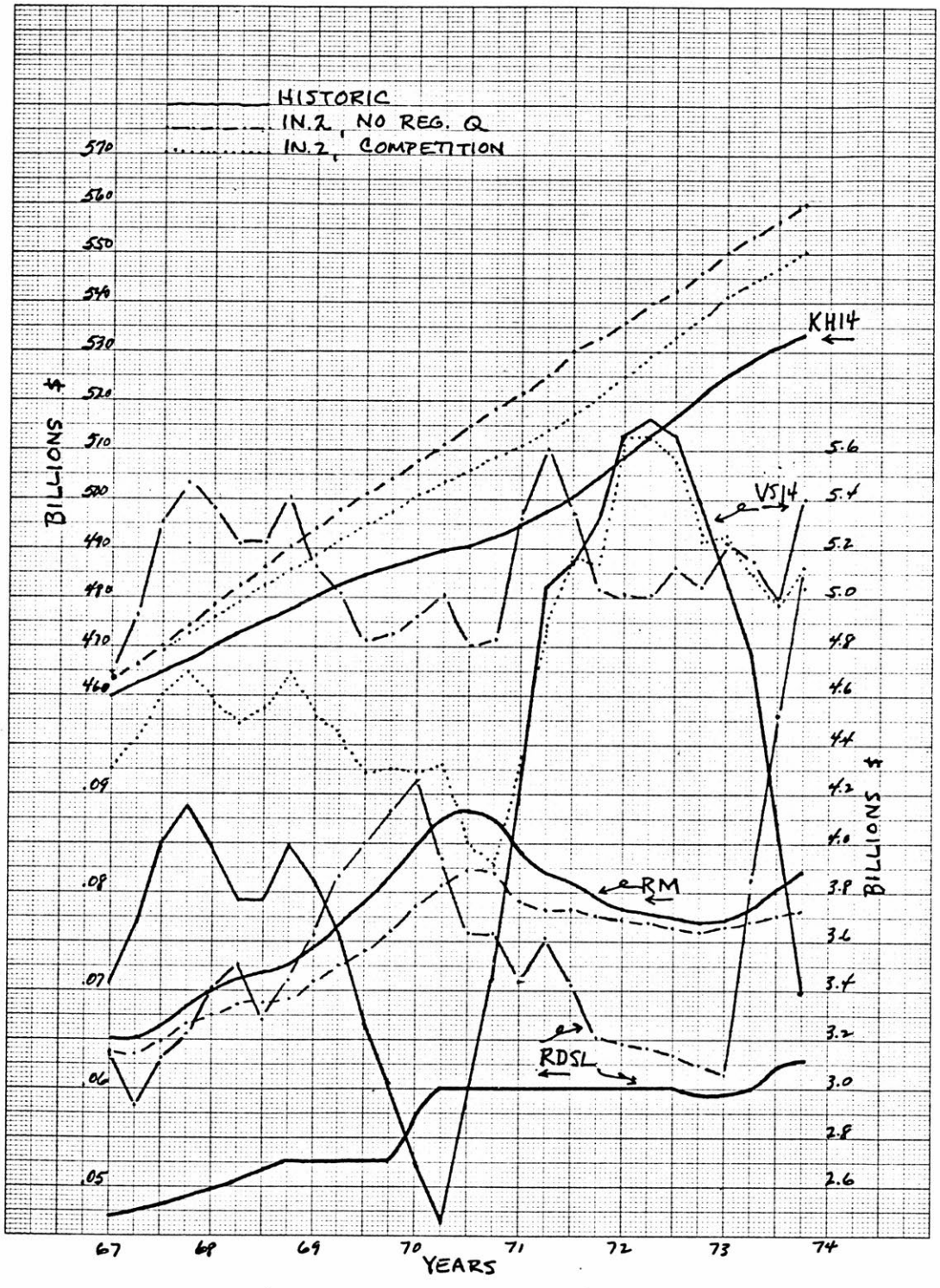
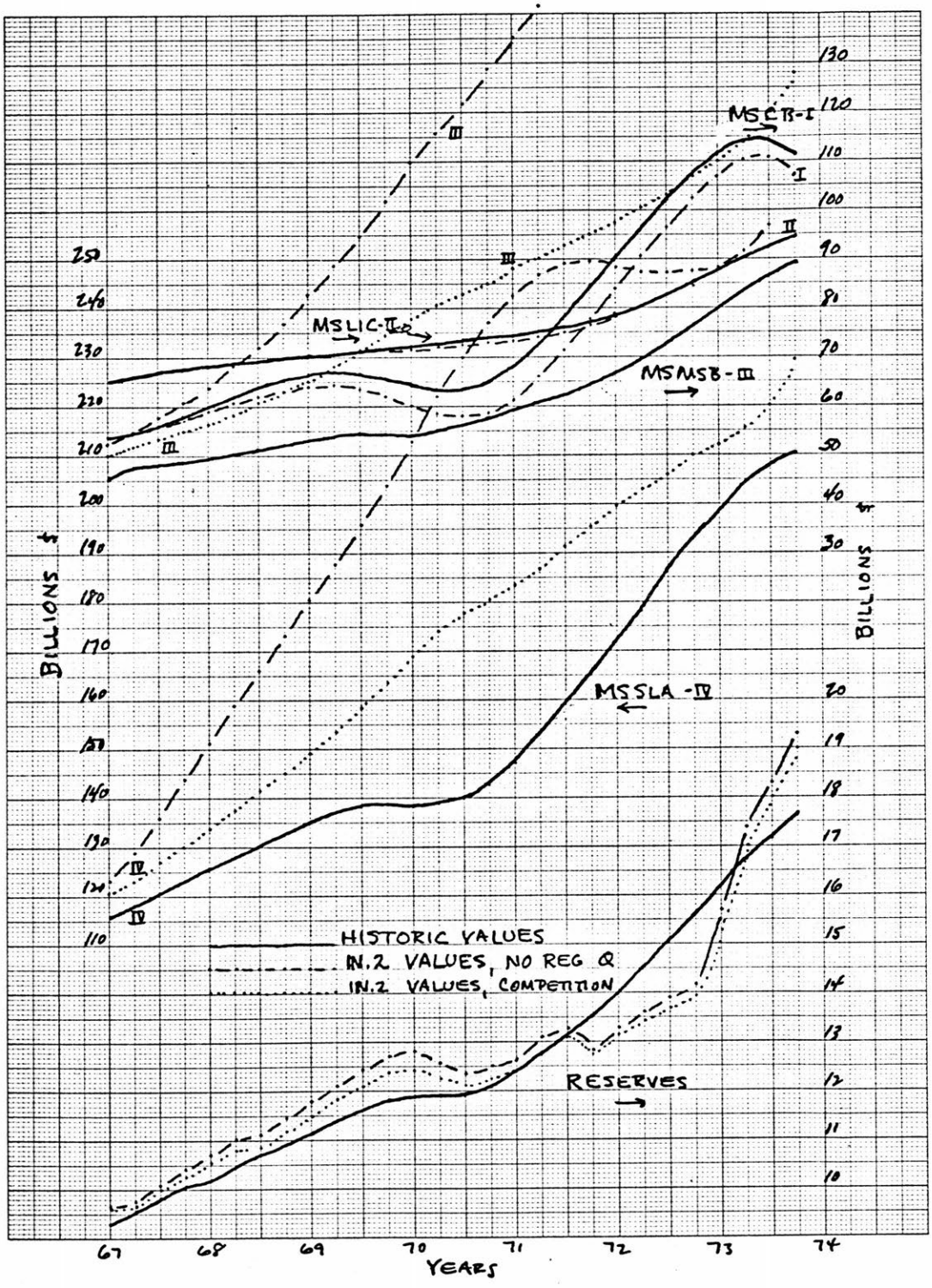


Figure V.18

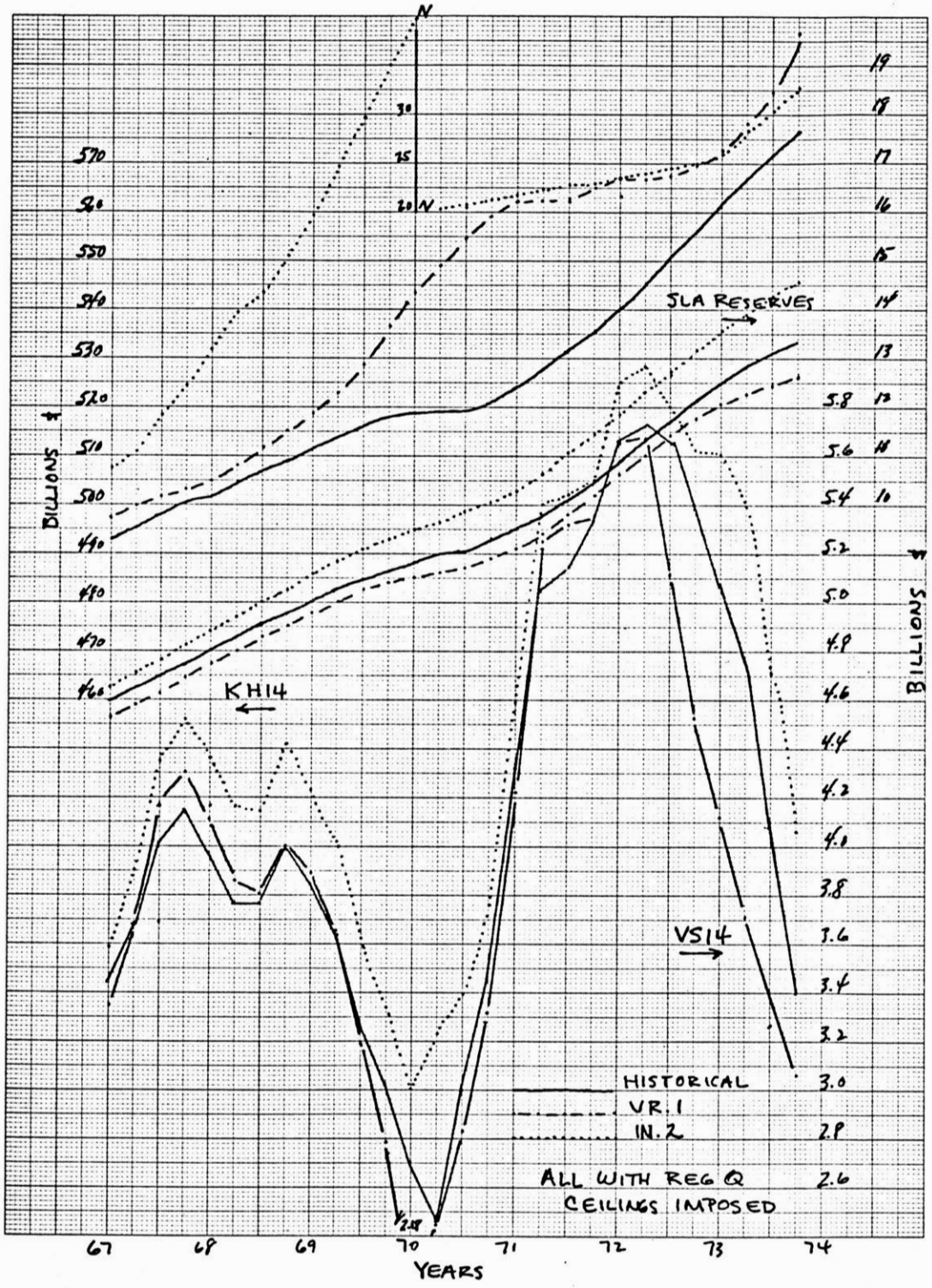


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Figure V.21



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V. CAVEATS AND CONCLUSIONS

All of the simulation results must be interpreted within the context of a history of generally increasing nominal interest rates. I have tried to indicate, where possible, when conclusions drawn within the discussion would change with a different history. It would be useful, for a more complete understanding of the results to see the simulations over a different history. It might be possible to essentially run the model backwards, but such a task must remain the topic for future work.

All innovations are introduced beginning in 1962. This was done in order to get as long as history as possible. It does, however, always allow for the transition of the new instruments to take place during periods of relatively stable rates. Again, the conclusions drawn need to be tempered with an understanding of this fact. It would be possible to examine alternative introduction periods, for example, 1966:4, 1969 or 1973, that would be of considerable interest. In these cases, one would not get to examine anything but the (sometimes) short transition period. It seems unlikely that the results would change much - but such a study may be of interest. It too remains as a topic for later work.

I have examined the following deposit rate assumptions:

1 continued deposit regulation

2 removal of ceilings

3 excess reserve pay-out

4 competitive

Clearly this is an area in which the quantitative results are sensitive to the assumptions made. Two further possible assumptions were suggested in the text: indexed deposits and fixed spread deposit-mortgage rate relationships. It is not clear that further simulation work in this area would be profitable. It does seem, however, that an area of profitable further research might be the historic relationship between reserves and deposit rate setting behavior. Incorporating reserves formally in a model may provide some of the answers sought.

Although I have no desire to recapitulate the points brought out in the discussion of Section V, certain surprising results are briefly highlighted here.

First, I think the simulations provide insights into variable rate contracts that, ex-post seem very reasonable, but about which there is a good deal of confusion. I refer to the historic pattern of lower short than long interest rates and the simple fact that a variable rate instrument would provide a short rate return. This means less term-structure intermediation, which means less competitive deposit rates and less mortgage lending. Extended discussion of this pattern is found in the text. I believe the conclusion is quite simple: hedging with variable rate instruments (by making the term of the mortgage match the term of deposits on the short side) is not as attractive for housing as it might appear. This

leads to a second conclusion: the dual-rate type instrument fails to work because it combines this effect with the inflation-distortion effects on the demand side caused by high nominal long mortgage rates.

Third, a changing pattern of deposit flows is important in this model and thus in the simulations. Specialization in mortgage lending benefits housing and instruments which channel more savings to the deposit sector or change the mix within the sector toward those institutions with more diversified portfolios result in fewer mortgages being made. Again, the details of this process are pursued in the discussion of Section V.

Fourth, instruments can substantially benefit thrift institutions, particularly savings and loan associations, without benefitting housing and may for reasons in item three actually lead to decreased mortgage lending. That is, savings and loan associations do better but they may do so on a smaller volume of business and the decrease in volume of lending may not be offset elsewhere.

Fifth, the model demonstrates a fair amount of multi-single family substitution. Although this is not surprising, but rather is more or less obvious, the changing mix of single-multi family starts resulting from the various innovations ought to be part of policy discussions over these innovations.

Finally, the evidence is strong that indexation and/or a Tucker like graduation proposal are superior to straight

variable rate instruments. The price level adjusted mortgage in particular seems a simple and attractive alternative to the current system of housing finance. However, it does work to some degree by eliminating the capital gain from obtaining and holding fixed interest mortgages in times of generally increasing interest rates. What the implications of this re-distribution, discussed in more detail in Section V are for housing cannot be answered within this model nor research framework.

CHAPTER V: APPENDIX

TECHNICAL SUMMARY AND PROGRAMMING NOTES

A. New Instrument Equations

As developed in the text, the key equations necessary for simulating the new instrument plans are PAY (Payment on mortgages), INT (interest on mortgages) and REP (repayments of principal). In addition, Qpay and $\hat{T}$ should be calculated for use in the housing equations. Five equations define these variables in a form that is general enough to cover all instruments. Then for each simulation, three parameters - y, u, z - must be set at values appropriate for the particular instrument. y is the interest rate used in calculating PAY and will equal RM, RMS or rm. u is the graduation rate and is set according to the terms of the graduated contract. z is the interest rate used for calculating INT and will equal y except for the dual rate mortgage scheme. v, the vintage, is the quarter in which the mortgage is initiated (first payments come in the following quarter) and t is the current quarter index.

A vintage scheme has been developed to track all the relevant variables and provide in storage all the appropriate information about each vintage of mortgages. At the beginning of period t, the thrift institution receives payment (PAY(v,t-1)): a combination of interest payment (INT(v,t-1)) and payment on principal or repayment (REP(v,t-1)). It announces the payment due at the beginning of period t+1, as the appropriate function of these known variables, and the mortgage stock that exists as

period t begins (after accounting for payments received). In the case of price level adjusted mortgages, the stock is adjusted by the inflation rate and this will consequently affect the size of payments to be announced for the next period, but not the payments received at the beginning of period t, nor their division between INT and REP.

Then at t=v (i.e. for mortgages originated during the current quarter)

$$Qpay = (y-u)*(1/(1-((1+y)/(1+u))^{-T(v)+v})$$

and

M(v,v) = gross mortgage flows during quarter t

For all vintages from 1962:1 to t-1,

$$PAY(v,t)=(1-a(v)) * (y-u) * (1/(1-((1+y)/(1+u))^{-T(v)+t-1})* M(v,t-1)$$

$$INT(v,t)=z * M(v,t-1)$$

$$REP(v,t)=PAY(v,t)-INT(v,t)+a(v)*M(v,t-1)$$

$$M(v,t)=M(v,t-1)-REP(v,t)+B$$

where a(v) is the proportion of mortgages prepaid and B=0 for every instrument except the price level adjusted. For PLA mortgages

$$B = (P(t)/P(t-1)-1) * M(v,t-1).$$

In this case, the household pays INT(v,t) as interest but the thrift institution receives, as interest,

$$INT(v,t)+B.$$

In addition, as noted in the text, the aggregate amounts for PAY, INT and REP are determined by summing over v. Then REP

TABLE V.A.1

INTEREST RATES USED TO CALCULATE PAY AND INT

MORTGAGE TYPES	$y(v,t)$	$z(v,t)$
Conventional	RM(v)	RM(v)
VR: single rate	RMS(t)	RMS(t)
VR: dual rate	RM(v)*	RMS(t)
GP: fixed	$RM(v)-u_o$	RM(v)
GP: new issue	RM(v)-u(v)	RM(v)
GP: Tucker	RMS(t)-u(v)	RMS(t)
GP: Tucker-dual	*	RMS(t)
PLA: indexed	$RM(v)-P^e$	$RM(v)-P^e$
GP-VR		

* Some smoothing rule

t indicates that all mortgages, whenever issued, have interest rate terms determined by the current market

v indicates that each vintage of mortgages retains its interest rate terms throughout its amortization period.

and INT are separated, where required into the various intermediary proportions using the lagged mortgage stocks as the weights.

B. Instrument Parameters

Table V.A.1 presents a summary of the relevant interest rates for the various proposals.

The parameter settings and brief comments on the mortgage instruments discussed in the text are:

GP.1

$y = RM(v)$

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

$z = RM(v)$

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

GP.2

$y = RM(v)$

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

$z = RM(v)$

VR.1

$y = RMS(t-1)$

$u = 0$

$z = RMS(t-1)$

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

VR.2

$y = RM(t-1)$

$u = 0$

$z = RMS(t-1)$

IN.1

$y = RMS(t-1)$

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

$z = RMS(t-1)$

The Tucker Plan has the effect of keeping the variable v-u equal to the constant value determined by inital conditions.

IN.2

$y = rm(v)$

$u = 0$

$z = rm(v)$

The values determined in this way are real values. There are alternative, and equivalent, ways to transform these to nominal values. One possibility, for example, is to index the mortgage stock base used in calculating (1) to (4). That is, define $NM(v,t-1) = M(v,t-1)\ P(t-1)/P(v)$, and use NM instead of M in the equations. Care must also be taken to account for the lender's capital gain in determining his income, and the outstanding value of the mortgage stock.

In addition to this basic coding, several other changes should be noted. First, account for prepayments of mortgages as well as standard repayments. With regard to prepayments, we

assume if a mortgage vintage has initial maturity T (in quarters), then each quarter 1/T is prepaid. This has the effect of changing the effective maturity for the vintage from T to T/2. This is roughly in line with the observed facts, where initial maturities run 20 years, but average effective maturities are on the order of 10 years. Second, for the variable rate schemes, changes as outlined in the text will be made for the deposit-rate setting equations.

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

C. Model Determination of RM, RMS, and rm.

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

(5) $MS = a_o + a_1 (RM-RCB)$

(6) $MD = b_o - b_1 (RM-RCB)$

(7) $MD = MS$

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

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

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

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

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

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

(10) $RMS^* = RM^* + (RCP - RCB)$

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

(11) $rm^* = RM^* - RP.$

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

Turning now to a more complicated model, the actual mortgage sector allows for rationing the mortgage sector in that the mortgage rate RM adjusts only slowly to the market equilibrium of (8). It could be argued, particularly with RMS, that the adjustment might, in fact, be somewhat slower.

That is, if a lender is slow to adjust a short rate, then he is off for one quarter; if he is slow to adjust a long rate, however, he must live with it for the full maturity of the contract. On the other hand, for our variable rate mortgages, the rate RMS and the deposit rate RD will be closely tied. Moreover, given the interest elasticities of savers and the elimination of Regulation Q. lenders may be forced to respond quickly with their deposit rate as other short-term rates move, and this in turn would force a fast adjustment of RMS in order to generate the required income to pay RD. Thus, again, we agree with the principle that the speed of adjustment might change, but we see no strong case for the direction of the change. Thus, simulations left this parameter unchanged.

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

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

where X_L is some unobserved rate that measures the opportunity cost of funds to households. It was assumed that X_L is proportional to RCB; that is

(13) $X_L = c_2 \, RCB$

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

(14) $MD = c_o - c_1 (RM - RCB) - c_1(1-c_2) \, RCB$

This differs from the specification in (6) above in that RCB enters as a variable by itself. Moreover, it turns out that the two methods described above - (i) solving for RM and then

deriving RMS and rm, (the programming method); or (ii) directly solving for RMS and rm (the text method) - give different answers in these two cases because of the RCB term. Or more basically, it is clear that when we shift to a short-rate market, then the relevant X must change. When the direct substitution method is used, implicitly it is assumed that $X_S = c_2$ RCP. When RM is solved first, then X_S = RCP - $c_1(1-c_2)$RCB.

This comes about as follows:

$X_L = c_2$ (RCB)

$X_S = X_L$ + RCP - RCB

$= RCP - (1 - c_2)$ RCB

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

Neither technique can be known to be correct, however, and thus, as above, we opt for the simple coding aspects when RM is solved directly and RMS and rm derived by (10) and (11).

D. The Jaffee SLA Sector

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

MINT interest income on mortgage portfolio

OINT other income, net of all (non-interest) costs

FHLB interest paid to FHLBB on advances

TAXS taxes paid

INCAT income after taxes and FHLA interest

DINT interest paid to depositors

TRANS reserve transfers

RES stock of reserves

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

The estimate equation for OINT is:

$$\text{OINT:}\quad \underset{(1.4)}{-.04} - \underset{(9.4)}{.01}\,(\text{Deposits, SLA}) + \underset{(4.4)}{.03}\,\Delta\,(\text{Deposits, SLA})$$

$$+.004\ \underset{(3.1)}{RCB(Deposits, SLA)} - .003\ \underset{(2.3)}{RCB(Mortgages, SLA)}$$

$R^2 = .92$, DW = 2.5 SER = .04 1953-1970.

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

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BIOGRAPHICAL NOTE

James Russell Kearl was born in Logan, Utah May 27, 1947 and grew up in a small community in Cache Valley, Utah working in his Father's lumber yard. He attended Utah State University from 1965 to 1966 and then from 1969 to 1971. From 1966 to 1969, for thirty months, he served a mission for his Church to the Philippines. In 1971 he graduated magna cum laude from Utah State having completed requirements for B.A. degrees in mathematics and economics. While there, he was elected to membership in Phi Kappa Phi and Blue Key.

In April, 1971 he was awarded a Danforth Graduate Fellowship and entered M.I.T. in September of that year. From December, 1971 until June, 1974, Mr. Kearl was a research assistant for the National Bureau of Economic Research. During 1972, he served as bibliographer and project consultant for Xerox Readings in Economics.

In June, 1974 he organized, with a number of other researchers, a mortgage study group at M.I.T. Franco Modigliani was the project director.

Mr. Kearl was a visiting instructor of economics at Brigham Young University the summer of 1973 and a teaching fellow at Harvard University from September of that year until June, 1974.

In April, 1975 he was granted a Social Sciences Research Council award for post doctoral study in the area of his dissertation.

He is the co-author, with F. M. Fisher and R. M. Solow of "Aggregate Production Functions: Some CES Experiments" M.I.T. Working Paper #136, publication forthcoming; co-author with Craig Swan and Ken Rosen of "Financial Determinants of Housing Demand: A Survey", publication forthcoming in the Boston Federal Reserve Bank's Conference Series; co-author with Dwight Jaffee of "Macroeconomic Simulations of Alternative Mortgage Instruments", also appearing in the Boston Fed volume; co-author with Ken Rosen of "Housing and Mortgage Markets and the Behavior of FNMA and FHLB", a Harvard and M.I.T. Joint Center for Urban Studies working paper and co-author with Jim McDonald and Bart Jensen of two papers reporting Monte Carlo studies of CES and VES parameter estimates.

He is married to Linda Durrant and has two daughters, Jocelyn (age 3) and Candace (age 6 months).

Finally, he enjoys basketball, would rather be sailing, is happy <u>not</u> to be working in a lumber yard and is eternally grateful to Planters for the development of dryroasted peanuts.