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Working Paper 84-90

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Abstract

INTEREST RATES, INFLATION, AND SPECIFICATION BIAS IN HOUSING MODELS

Previous literature has predominately used the nominal interest rate to measure interest rate effects on housing demand and investment. To the extent that real interest rates and inflation rates have different impacts on housing, it is unclear what effects the nominal interest rate is measuring. This paper presents a model to explain the impact of real interest rates and inflation on housing demand and investment. The paper also demonstrates the problems of using the nominal interest rate to explain investment behavior when inflation exists.

The stock- and flow-supply models developed demonstrate the negative effect of real interest rates on housing prices. From this negative price effect, the model shows the indirect negative impact of real rates on housing investment. The empirical results confirm these negative relationships and also show that a positive relationship exists between expected inflation and house prices. Expected inflation rates are shown to lead to a reduction in the output of new housing. The paper also provides a test which proves that the use of the nominal interest rate can lead to serious specification bias in estimation.

INTEREST RATES, INFLATION, AND SPECIFICATION BIAS IN HOUSING MODELS

I. Introduction

Numerous papers have investigated the impact of nominal interest rates on housing demand and investment [See Arcelus and Meltzer (1973), Brady (1973), Fair (1971), Kearl and Mishkin (1977) Maisal (1968), DeRosa (1978), Smith (1969) and Swan (1972)]. All of these studies and others use the nominal interest rate [for a partial review see Kearl, Rosen and Swan (1975)]. Since in the Fisherian framework the nominal interest rate is composed of two factors, the real interest rate and the expected rate of inflation, it is not clear which effect the above studies are measuring. This is relevant because the real interest rate and the rate of inflation have different impacts on housing investment and demand. Both DeRosa (1978) and Kearl and Mishkin (1977) recognize some of the problems in using the nominal interest rate, but neither examine in detail the specification difficulties.

The purpose of this study is to present a simple diagrammatic model explaining the impact of real interest rates and inflation on housing demand and investment and to provide empirical estimates of their relative magnitudes. The paper also demonstrates the problems of using the nominal interest rate when examining investment behavior.

The paper is arranged in the following fashion. In Section II, the relationship between real interest rates and the individual consumer's demand for housing is presented. Section III outlines a short-run model to explain the rate of output of new housing in the aggregate market. This section demonstrates the negative effect of real interest rates on housing prices. From this negative price effect the model demonstrates the indirect impact of real interest rates on housing investment. Section IV incorporates into the model the effect of inflation on housing prices and investment and demonstrates the inappropriateness of using the nominal interest rate. Section V presents empirical evidence on the impact of real interest rates and inflation on housing. Also a test of specification bias is presented when the nominal rather than the real interest rate is used.

II. The Market for Housing Stock

Housing has the characteristics of being durable and illiquid with relatively high transaction costs. The market for such a good can be captured by assuming that the consumer buys with the intent of holding the durable for a significant length of time. Whether he actually does so is irrelevant to his demand behavior. It is sufficient that he plans to do so.

A consumer's demand for housing is based on a demand for the service provided by the housing units purchased. In order to maximize utility over time, a consumer must secure some designated flow of housing services provided by some specified level of housing units. Thus derived from a demand for a flow of housing services is a demand for a stock of housing. Once consumers have acquired the optimal flow of housing services, they will not alter their level of housing consumption until the current holding of housing stock becomes nonoptimal. The price an individual is willing to pay for housing is determined by the interaction of this demand with the existing supply. On the basis of this stock price, a flow of housing investment is created that maximizes profits to the producers.

Housing is unique among major consumer goods both for its relative durability and illiquidity. Because of this durability, a means must be established to relate the value of the flow of housing services provided to the purchase price of a unit of housing stock. One means of doing this is to relate the present value of the flow of services to the acquisition price by discounting at the appropriate rate. The individual would be expected to experience a decline in marginal utility of housing consumption as the stock of housing units acquired increases. This produces a demand curve for a utility maximizing consumer that is downward sloping. Associated with each demand curve is a real rate of interest and, other things being equal, the lower the real interest rate the greater the individual's demand for housing[1] [See Kau and Keenan (1980) (1981].

One might argue that a long lived durable, such as housing, is purchased in the present with the purpose in mind of providing services in the future as well as the present. Real-interest-rate changes alter the relative costs of present versus future consumption. Increased real interest rates reduce the desired present consumption of housing, but increase desired future consumption. If future consumption comes from present purchases, rising real interest rates may very well have no effect or even possibly a positive effect on the demand for housing. Theoretical studies by Kau and Keenan (1980)(1981) indicate that if the consumers of housing are net debtors then the real interest effect will always be negative. The empirical results in this paper confirm the negative interest effect on the demand for housing.

The aggregate demand curve for the stock of housing is derived by summing the demand curves for all individual's who are actual or potential consumers of housing services and who would have some demand on the housing stock. The

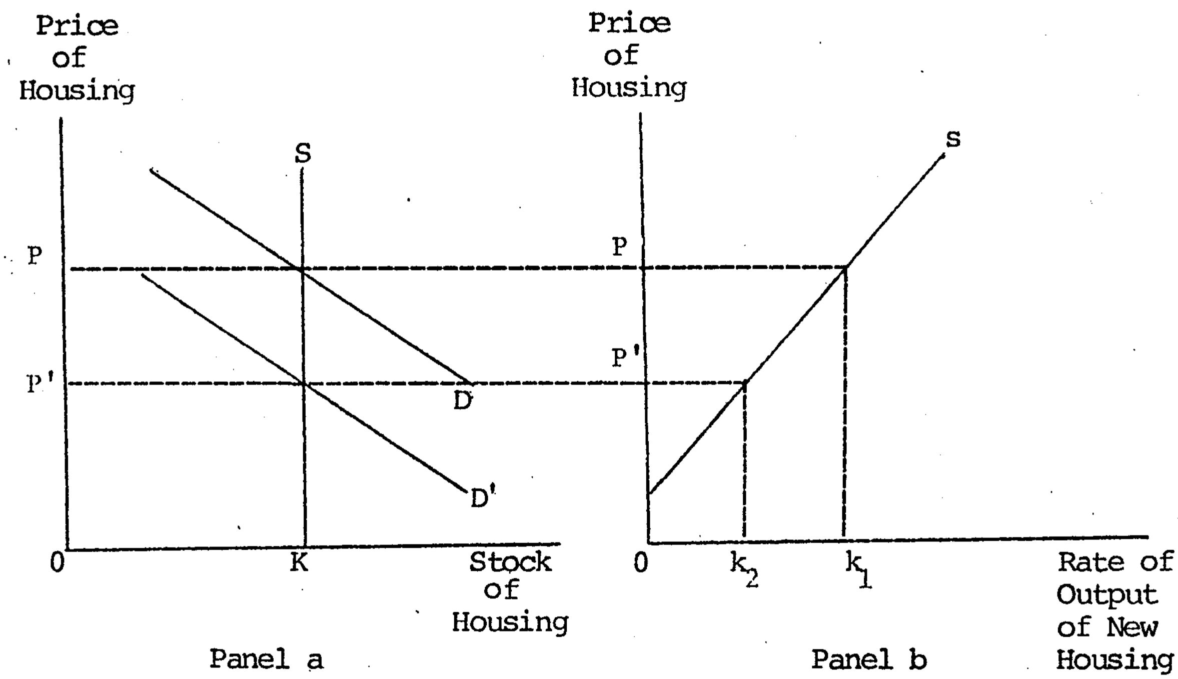

Fig. 1. Short-run housing market and the construction industry

demand curve in Figure 1 (Panel a) relates the quantity of housing stock desired to the market price, P, of the housing stock. P is the present value of the house. The supply curve of the housing stock is inelastic with respect to price since the annual increase in the supply of housing stock is small relative to the total. Thus, the influence of demand predominates over supply in the determination of the market price. This statement can be made without denying the fact that supply effects must certainly affect the outcome in the long run. Since the stock cannot be assumed to be fixed over the long run, the market price of the housing stock will be affected by construction activity. In the very short run, however, the supply of the stock can be taken as a given quantity. If the short-run housing market is in equilibrium, the existing stock of housing is always optimal in the sense that the price of the stock will adjust so that each consumer is content to hold that portion of housing currently contained in a portfolio of assets[2] [see Kearl (1975)].

III. Real Interest Rates and Housing Investment

In addition to the stock-supply schedule shown in Figure 1 (Panel a), we also have a flow-supply schedule relating the rate of output of new housing (Investment) to homebuilders' expectations of market price (See Figure 1, Panel b). The supply schedule (Panel b) is such that the rate of output is a function of market price and a vector of costs faced by the residential construction industry. Given the market price of housing, the rate of output of new housing can be determined if the supply schedule for the construction sector is less than infinitely elastic. This would be the case since the costs of construction increases as the rate of output increases and the resulting supply curve is upward sloping. Equilibrium in this market is obtained by the equality of the demand and supply prices for the flow of new housing [Witte, 1963].

The flow supply of housing is regulated by the price at which builders can sell new units. Since the rate of output of new housing has a negligible effect on the total housing stock over the short run, the market price at which new units can be sold is assumed to be independent of construction activity. This produces a perfectly elastic demand curve in the construction sector that is a direct counterpart to the inelastic supply curve in the market for the housing stock [See Kearl (1975)]. Thus, for each market price there is some unique rate of output of housing by the construction sector.[3] Additions to the stock of housing will continue as long as the relationship between housing prices and construction costs create profit opportunities for the construction industry, i.e., as long as there is actual or expected excess demand. However, there are two equilibrium conditions in the housing market which must be satisfied at any time: (1) the market price must be such as to induce consumers to hold the existing stock of housing and (2) the rate of output of new housing must be such as to equate the marginal supply price with the market price.[4] Long-run equilibrium would occur if the price, P, for the housing stock, generated just enough new construction (k_1 in Fig. 1, panel b) to replace housing wearing out in that time period. Prices above this level would result in additions to the stock that in future periods would force the housing stock price to return to P.

To illustrate the real interest rate effect, with the stock of housing given, let the real rate increase. This increase in the rate of interest lowers the present value of the flow of housing services associated with this level of stock creating excess supply for housing at the prevailing price. Thus, as shown in Figure 1, the aggregate demand curve shifts to the left (from D to D') and the market price of housing must fall (from P to P') so that the market is cleared.[5] This decrease in the market price creates a flow disequilibrium which is followed by a lower rate of output of new housing (from k_1 to k_2), the rate being that for which the marginal supply price is equal to the new market price [Witte (1963)].

The interest elasticity of housing investment is actually the interest elasticity of the rate of output of new housing. This elasticity is comprised of two other elasticities: (1) the elasticity of demand price with respect to the real interest rate, and (2) the elasticity of the rate of output of new housing with respect to the market price of housing. The first elasticity is the capitalized value of housing services with respect to the real rate of interest. This elasticity determines the change in demand for housing as a result of a change in the market rate of interest. The second elasticity is simply the supply elasticity of the housing industry.

IV. Nominal Interest Rates, Inflation and Housing Investment

With inflation the dichotomy between the nominal and real interest rate becomes relevant. In the previous section it was demonstrated how an increase in the real interest rate reduces demand, and through its effect on price, housing investment. This is not the case with a change in the nominal interest rate holding constant the real rate. In a nonrestricted-perfectly efficient market the change in the nominal rate of interest has no effect on the real price of housing nor the rate of housing investment. The price of housing increases in nominal terms by the rate of inflation but so does everything else. Thus, no real change occurs. This is commonly called neutral inflation. This also implies that neutrality exist for nominal interest rate changes holding the real rate constant.

There are two main exceptions, among others, which eliminate the possibility of neutral inflation. One is the impact of legal-institutional restrictions in the mortgage market; the other is the relative price effect of inflation.

Various institutional restrictions have limited the ability of the mortgage market to respond to changes in nominal interest rates. For example, Regulation Q was a restriction on the rate of interest that savings and loans could pay on passbook accounts. Regulation Q, during periods of inflation and high nominal interest rates, results in disintermediation. This artificially reduces the supply of mortgage money and shifts downward the demand for housing, thus reducing housing investment. Regulation Q is now phased out. But for this study and most studies cited, Regulation Q was a significant determinant. A second restriction is usury laws which have approximately the same impact. A ceiling is placed on the maximum interest rate. When inflation moves the nominal rate above this ceiling there is a reduction in available mortgage funds which reduces housing demand and investment. Also, a third restraint occurs when nominal interest rate increases, that are due to inflation, result in greater mortgage payments relative to income. This tilting effect [Kearl, (1975)] will have a negative impact on demand unless financial institutions develop alternative mortgage instruments such as graduated payment mortgages.

Because of these institutional and legal restrictions, changes in the nominal interest rate would appear to have the same negative effect as a change in the real rate of interest. This has led to many misleading causal statements concerning the impact of nominal interest rates on housing. For example, it has often been stated that housing is interest rate sensitive; so that a national policy which effects nominal interest rates through changes in expected inflation results in excessive cyclical behavior in the housing market. Such statements seem to be based on confusion between the effects of real and nominal interest rates. Housing is a long-term durable, thus some real interest rate sensitivity is expected. But past extremes in housing cycles are more likely related to changes in the nominal rate because of inflation. As pointed out nominal interest rate changes without legal restrictions have no effect on housing. Thus it is the institutional constraints such as types of mortgages, Regulation Q, and usury laws that lead to the extreme cycles not interest rates. Relaxing these restrictions may result in housing not being as sensitive to the types of fiscal and monetary policy which effect nominal interest rates through inflation.

A second major reason for the non-neutrality of inflation with regards to housing is related to inflationary hedging and taxes. The recent high inflation rates have increased the cost of holding currency and goods which are not a good store-of-value. This has resulted in a movement out of currency into goods that are a store-of-value [see Kessel and Alchian (1962)]. Thus, the interaction of inflation and taxes has also increased the demand for real estate and other durables [See, Dougherty and Van Order (1982), Hendershott and Hu (1979) (1981), Hendershott (1980), Villani (1979), Schwab (1982) and Feldstein (1978) (1981)]. Inflation increases the real (relative) price of housing by increasing the demand for goods that are an inflationary hedge.

In summary the use of the nominal rate of interest in empirical models is of less use during inflationary periods. The nominal rate is a composite factor which includes many counter-vailing effects. The next section demonstrates that the specification bias resulting from using the nominal interest rate is relatively more serious than the measurement error due to errors-in-variable problems when calculating the real mortgage rate.

V. Interest Rates, Inflation, and Specification Bias: An Empirical Test

The equations used in testing the hypotheses concerning specification bias, the significance of the real interest rate and the impact of inflation are estimated using a pooling-time series procedure. The equations are treated as recursive with the predicted value of price ($\hat{P}_{ij}$) being used in the investment equation. The housing data base is a pooled cross-section of annual observations on sixteen SMSAs in the United States over the period 1972 through 1977.[6] The ordinary least squares estimates showed no evidence of significant serial correlation. All variables are logged and adjusted by the inflation rate to represent real values. The model is

$$(1)\ P_{ij} = a_0 + a_1 Pop_{ij} + a_2 Y_{ij} + a_3 r_{ij} + a_4 S_{ij} + a_5 \dot{P}_i + a_6 U_j + a_7 M_{ij} + e_i$$

$$(2)\ HS_{ij} = b_0 + b_1 C_{ij} + b_2 \hat{P}_{ij} + b_3 M_{ij} + b_4 \dot{P}_i + b_5 U_j + e_i$$

where i = the time period,

j = the particular SMSA,

P_{ij} = the price of housing,

Pop_{ij} = the population of the SMSA,

Y_{ij} = the per-capita income,

r_{ij} = the real mortgage interest rate,

S_{ij} = the stock of housing,

U_j = the existence of an usury law,

$\dot{P}_i$ = the expected inflation rate,

HS_{ij} = housing starts,

C_{ij} = the Robert S. Means index of housing construction costs, and

M_{ij} = the level of mortgage loans outstanding in thrift institutions, (See Appendix for a list of Variables and Sources).

The price equation (1) is a reduced-form representation of the supply and demand for housing. This equation is used to estimate the price-real interest elasticity. Population (Pop_{ij}) and income (Y_{ij}) are expected to have a positive relationship to price, with the stock variable (S_{ij}), a measure of housing supply, expected negative. The mortgage loans outstanding (M_{ij}) and usury laws (U_j) are used to measure the effects of legal restrictions in the housing market. They are expected to have a positive and negative impact on demand, respectively. The variable $\dot{P}_i$ is an approximation of expected inflation which has a positive impact on the real relative price of housing. The variable $\dot{P}_i$ provides a measure of the inflation-elasticity of demand. This approach should result in the mortgage rate (r_{ij}) being an approximation of the real interest rate, as represented by Fisher's equation.[7] The theoretical model indicates that higher real interest rates will lead to lower housing prices.

TABLE I

THE DETERMINTS OF HOUSING PRICES AND HOUSING INVESTMENT (STARTS)
FOR 16 SMSAs FROM 1972-1977. A RECURSIVE, POOLING-TIME SERIES RESULTS

	Constant	Predicted Price $(\hat{P}_{ij})$	Real Interest Rate r_{ij}	Expected Inflation $\dot{P}_i$	Income Y_{ij}	Population Pop_{ij}	Stock of Housing S_{ij}	Construction Cost C_{ij}	Mortgage Funds MF_{ij}	Usury Laws U_j	R^2	d.f.
(1) Price of Housing (P_{ij})	-12.154 (-6.88)*		-1.207 (-4.16)*	0.264 (1.64)*	0.415 (1.75)*	0.105 (0.88)	-0.117 (-0.87)		-0.009 (-0.35)	-0.047 (1.60)	.57	88
(2) Housing Investment (HS_{ij})	42.733 (6.11)*	1.970 (2.31)*		-6.629 (-5.12)*				-3.224 (-4.03)*	0.395 (6.30)*	-0.286 (-2.41)*	.42	90

*t-values in parentheses significant at the .05 level.

At this time a short note on estimating expected price changes and the real interest rate is in order. There is a problem in estimating the expected price change when the data represents the actual price change. Various techniques have been used to measure expected price changes. Different lag structures or survey data on expectations are typically used. In all cases no completely accurate measure has been found; they all have errors-in-variable problems. This paper chooses to use actual price changes as a measure of expected price changes. It is assumed that the two are highly correlated. Efficient markets and rational expectation theories would suggest that actual price changes are the best predictors of expected price changes. In any case, one of the main purposes of this paper is to demonstrate the inappropriateness of using the nominal interest rate. This can be accomplished even with a rather poor measure of real interest rates and expected inflation.

The housing starts equation (2) is used to test the elasticity of the rate of output of new housing with respect to the price of housing. The rate of output of new housing is considered a function of the cost of construction (labor, materials, long and short-term financing costs), the price of housing, usury laws, and the flow of mortgage funds provided by thrift institutions. Construction costs (C_{ij}) and usury laws are expected to have a negative sign, whereas the predicted price of housing ($\hat{P}_{ij}$) and mortgage funds (M_{ij}) would have a positive relationship. Available mortgage funds are used to capture the impact of various institutional constraints, such as Regulation Q, on the developer and housing starts. The expected inflation rate ($\dot{P}_i$) measures the impact of inflation not captured in the predicted price variable ($\hat{P}_{ij}$). Since the positive effects on housing starts is obtained through the predicted price variable the expected impact of $\dot{P}_i$ on housing starts is unknown. Most likely $\dot{P}_i$ in equation (2) will measure negative expectations and uncertainty of the developer resulting from inflation.

The empirical results appear in Table 1. The interest rate variable is negative and significant in the housing price equation (1). This confirms our theoretical prediction of a negative real interest effect on housing prices. The expected inflation rate, $\dot{P}_i$ is positive as expected. Income is significant and positive as expected. Mortgage funds, population and usury laws are insignificant. The elasticity of price with respect to the real interest-rate and inflation is -1.207 and 0.264, respectively.

There have been few studies in which the real interest rate elasticity has been measured, thus comparisons are not possible. The inflation-elasticity of demand, indicates that a 1% change in expected inflation leads to a .264% change in the relative (real) price of housing. This supports arguments by Kessel and Alchian (1962) and Feldstein, et. al. (1978)(1981) that inflation induces relative price changes.

The housing investment equation (2) behaves as expected. The predicted price variable ($\hat{P}_{ij}$) is positive and significant. The elasticity of housing starts with respect to housing prices is 1.97. Since the interest elasticity of housing investment is the product of the two previously mentioned elasticities, i.e., the elasticity of price with respect to the interest rate (-1.207) and the elasticity of the rate of output of new housing with respect to housing prices (1.97), the elasticity of housing starts with respect to the interest rate is -2.37. This confirms our theoretical model that an increase in real interest rates results in a decrease in the rate of output of new housing, through its affect on housing price. Construction costs have a negative effect as expected. Expected inflation and usury laws have a negative effect confirming the hypotheses that these variables represent the additional negative effects of legal constraints on the builder's rate of return. Mortgage loan availability has the expected positive effect.

A. Specification Bias and Interest Rates.

The possibility of specification bias in previous studies is tested by taking our equations with the real interest rate and inflation and substituting the nominal interest rate. In this case the nominal rate is the sum of the two omitted variables. A simple F-test can be used to determine if the substitution is acceptable.[8] The results reveal an F equal to 7.80 which is significant at the 5% level. This means that using the nominal rate of interest leads to serious specification bias. The nominal interest rate was positive and significant (the coefficient is 0.806). The coefficient on the nominal rate represents the combination of two effects: the negative impact of real interest rates and the positive impact of expected inflation. The resulting coefficient is a composite value with little interpretive consequences.

VI. Summary

This paper has examined the impact of changes in the real interest rate and inflation on housing demand and investment. When inflation rates are low the distinction between nominal and real interest rates is of less significance. The nominal rate would in this case provide a reasonable estimate of the impact of interest rates on demand for the economic good being studied. Thus, the nominal rate has often been used in empirical research because of the ease in measurement. With inflation the nominal rate ceases to be useful; yet most studies continue to use it. This leads to serious specification bias in many housing models. The effect of nominal interest rates on demand is a composite of many variables the net result of which could be either negative or positive and would vary with time or place. The empirical section of this study indicates the extent of such misspecification.

After correcting for the bias resulting from the use of the nominal rate of interest this study provides some estimates of real interest-price elasticity of demand (-1.207), the price-investment elasticity of quantity supplied (1.97), the interest-investment elasticity of quantity supplied (-2.37), and the inflation-elasticity of demand for housing of (0.264).

APPENDIX

List of Variables and Sources

P = Market Price of Housing - Available on a monthly basis for 16 SMSAs from the U.S. Federal Home Loan Bank Board, Home Mortgage Interest Rates and Terms (January, 1965 - December, 1977). The annual figures were obtained by taking the average of the monthly numbers.

R = Mortgage Interest Rate - Available on a monthly basis for 16 SMSAs from the U.S. Federal Home Loan Bank Board, Home Mortgage Interest Rates and Terms (January 1965 - December, 1977). The annual figures were obtained by taking the average of the monthly numbers. The real mortgage rate was obtained by subtracting the actual price changes from the nominal mortgage rate.

S = Existing Stock of Housing - The existing stock of housing by SMSA for 1960 was obtained from the U.S. Bureau of Census, Census of Housing. The annual stock was calculated for each year by adding the level of housing starts.

HS = Housing Starts - Number of new housing permits issued per month by SMSA form the U.S. Department of Commerce, Construction Review. Annual figures were obtained by summing the monthly numbers.

C = Robert S. Means index of construction costs, Building Construction Cost Data. The index numbers are the average of four of the leading construction and appraisal indices. The index is annual and is used as a proxy for the costs of construction faced by the homebuilder.

Pop= Annual estimates of the level of population for various SMSAs are available in the Sales Management Magazine, Survey of Buying Power.

M = Level of Mortgage Funds - Available by SMSA on an annual basis from the U.S. Federal Home Loan Bank Board, Selected Balance Sheet Data, for Federally insured Savings and Loan Associations.

Y = Annual estimates of per capita income for various SMSAs are available in the Sales Management Magazine, Survey of Buying Power.

U = A dummy variable for the existence of usury laws. One if there was a restriction, zero if not.

$\dot{P}$ = Inflation as measured by the actual change in P over the time period 1972-77.

FOOTNOTES

1. In addition to changes in the interest rate, changes in other exogeneous variables such as population or income may cause shifts in the demand curve for housing.

2. Vacancies are assumed to remain at some desired level at all times. Since information is unavailable on vacancy rates by regions, these rates are assumed to be equilibrium rates and are ignored in the estimation of the model. However, the possible effects of a vacancy rate being higher or lower than the desired rate should be recognized. For example, a vacancy rate above normal would indicate a need for a further price decline and would act as a signal to reduce output of new housing.

3. This implies that builders could never build too many units. The assumption that builders cannot overbuild, though unrealistic, is made due to the difficulty in measuring builders' expectations and its importance in the development of the model. It might be well noted that builders' expectations play an important role in determining the rate of new construction since builders often build in anticipation of future demand for housing. Thus, the construction process is not necessarily a simple step-by-step process whereby increased demand is followed up by increased output, but the process becomes much more complex as builders construct new homes not only to meet present demand but also in anticipation of uncertain future demand.

4. Witte [29] has shown these conditions to be true in the case of investment by firms in capital goods.

5. Kearl [1975] has shown that even though the housing price is demand determined, any individual consumer will have negligible influence on market demand and will thus be led to treat price as a parameter beyond control.

6. This time period is appealing since over this period, inflation rates were a much higher rate relative to previous years. Also, after 1979, the Federal Home Loan Bank Board provides only combined data on mortgage rates, etc. and does not distinguish between new and existing housing.

7. Our study investigates the impact of changes in the real rate of interest on demand for housing. Recent evidence suggests that significant changes do occur in the real interest rate. [See the comments on Fama (1975) by Carlson (1977), Joines (12), Nelson and Schwort (1977) and the reply by Fama (1977) and Levi and Makin (1978)].

8. The F-test is: $F = \frac{RSS-URSS}{T-K}$,

where,
RSS = restricted sum of squares
URSS = unrestricted sum of square, and
T-K = degrees of freedom.

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