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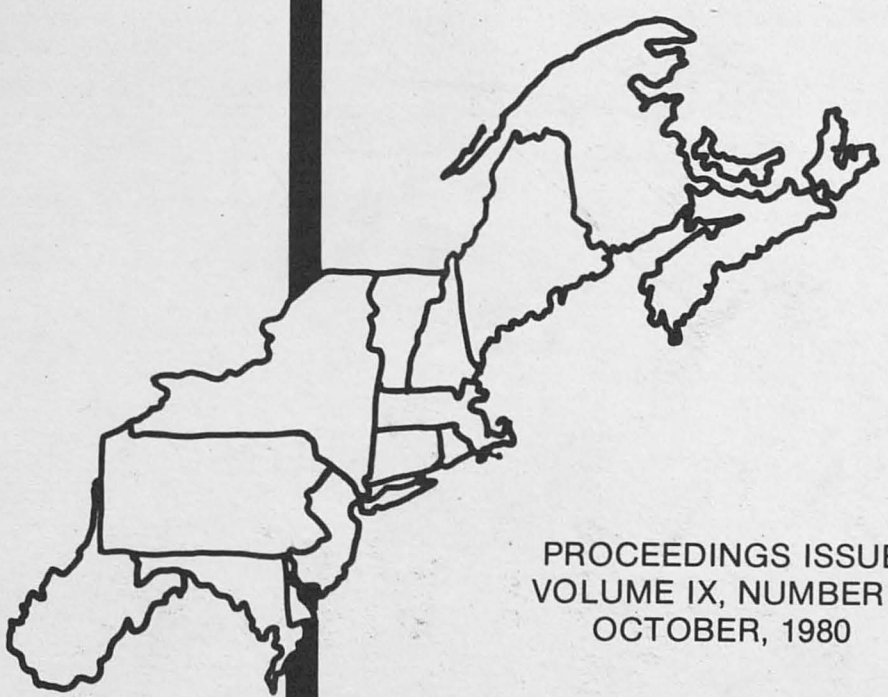

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AN ECONOMETRIC ANALYSIS OF THE NEW HAMPSHIRE HOUSING MARKET

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INTRODUCTION

For the past two decades, New Hampshire has faced rapidly increasing population levels with the main thrust occurring in the southern portion of the State. For example, between 1960 and 1975, it is estimated that New Hampshire's population has increased by approximately 35 percent (New Hampshire Office of Comprehensive Planning [1978]). Employment has grown 105.6 percent between 1940 and 1970 for the three southern counties of the State (United States Department of Commerce [1975]). This trend of economic and population expansion has important implications for the State as a whole. These phenomena have put a severe strain upon the provision of municipal services, inflated land prices and increased property taxes. How New Hampshire as a state will deal with its situation in future years will depend in part on two parameters: (1) the value judgments (or lack thereof) contained in policy decisions about how development should expand, and (2) the amount and comprehensiveness of information supplied on which to base decisions. It is the latter parameter to which this paper addresses itself.

An economic sector in disarray is the State housing market. Realtors, municipal officials, regional planners, bank loan personnel, and economic researchers are in need of a framework that will give an overview of important exogenous and endogenous factors that influence the supply-demand housing situation for New Hampshire. Many national housing market models exist (e.g., Brady [1973], de Leeuw and Gramlich [1968]), Maisel [1965]), but these frameworks overlook the fact that patterns of housing starts often differ from region to region. For example, disaggregated regional models can capture aspects of the housing market that get lost in the aggregate. The response of the buyer to interest rates can often be totally different from the response of the regional builder to interest rates. In terms of formulating State land use planning policy, information concerning the housing market and possible pattern for the future would seem to be necessary for any comprehensive overview. A national housing market model would be of limited value in this regard.

To fill this existing void a New Hampshire housing market model was developed. The main objective was to estimate appropriate housing supply and demand relationships rather than focus explicitly on the mortgage market. The latter market was included because of the strong influence it has upon the housing sector. Given the available sources, quarterly data were utilized for the period 1970 to 1978. Emphasis was placed upon private single unit housing investment. Inclusion of multi-unit starts would tilt the analysis towards a business oriented investment decision, where the motivation to build has the potential to be speculative and thus a resulting effect that would be difficult to capture. Two stage least squares estimation procedures were employed.

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The paper is organized as follows. The next section contains a presentation of the model. Empirical results are introduced in the third section. The final section lays out the conclusions of the study.

MODEL

The model presented is a quarterly version of the New Hampshire residential construction sector. The model views housing investment in the context of two components—a demand and a supply relationship. In addition, supply and demand functions in the mortgage market are specified and their role in housing is estimated within a simultaneous equation framework.

As stated previously, quarterly data for New Hampshire from the first quarter of 1970 to the fourth quarter of 1978 form the basis for the study. Choice of this estimation period resulted from the unavailability of appropriate State data prior to 1970. Short descriptions of each data series along with their particular symbols are noted in the appendix to the paper.

Housing Market

Demand for Housing Investment: The demand for housing investment is shown by equation (1).

$$(1)\quad HI^{D}_{t} = b_{o} + b_{1}MR_{t} + b_{2}P_{t} + b_{3}HStock_{t-1} + b_{4}PCAPI_{t} + b_{5}T + \sum_{I=2}^{4} d_{I}D_{I}$$

The demand for housing investment (HI^{D}) is specified to be a function of nominal mortgage rate (MR), new housing price (P), lagged value of existing housing stock (HStock), personal per capita income (PCAPI), a time trend (T) and seasonal dummy variables (D). Estimated parameters are designated by b_1 through b_5 and d_2 through d_4, b_0 is the intercept, and t depicts the time period.

The mortgage rate and the price of new housing gauge the relative cost of purchasing a new home or undertaking housing investment. The choice of the nominal rather than real mortgage rate, that is the nominal rate corrected for inflationary trends, was prompted by the existence of what Poole [1972] defined as financing gap.[1] Higher mortgage costs associated with the increased nominal rate are incurred immediately, while appreciation in the value of the house with inflation is not realized until the house is sold some time in the future. The demand for housing starts is expected to decrease with the increase in the relative cost of new housing investment.

The stock variable is incorporated to measure the effect of existing structures on demand for new single unit housing activity. Included in this stock valuation are multiple unit structures, recognizing the total housing stock as being the relevant variable. A negative relationship between new housing demand and the existing housing stock is hypothesized.

The per capita income and time trend variables are included to capture economic and demographic changes in New Hampshire

[1]See Poole (1972) for an interesting discussion.

over the estimation period. Both variables are expected to have a positive effect on new housing demand. The growth of per capita income translates into increases in funds available for housing purchases, while the trend variable will pick up the growth in population, family formation and other factors of this type influencing demand over the period.

Finally, the quarterly dummy variables are added to the demand equation to estimate the degree of seasonality apparent in housing investment data series.[2] The variables D_2, D_3 and D_4 represent the second, third and fourth quarters respectively for each year in the data period. The first quarter dummy variable has been omitted to preclude perfect multicollinearity or what is often referred to as the "dummy variable trap,"[3] The influence of the first quarter upon the demand for housing may be derived from the constant term in the equation. Viewing Figure 1, one may infer, *a priori*, similar positive coefficients on the D_2, D_3 and D_4 variables, while the first quarter's influence on housing starts and housing investment should be negative and of a stronger degree.

Supply of Housing Investment: The specification of the supply equation for the housing sector is shown by equation (2).

$$(2)\quad HI_t^S = c_o + c_1 MR_t + c_2 P_t + c_3 HStock_{t-1} + c_4 SFLO_{t-1} + c_5 MATIN_t + c_6 T + \sum_{I=2}^{4} d_I D_I$$

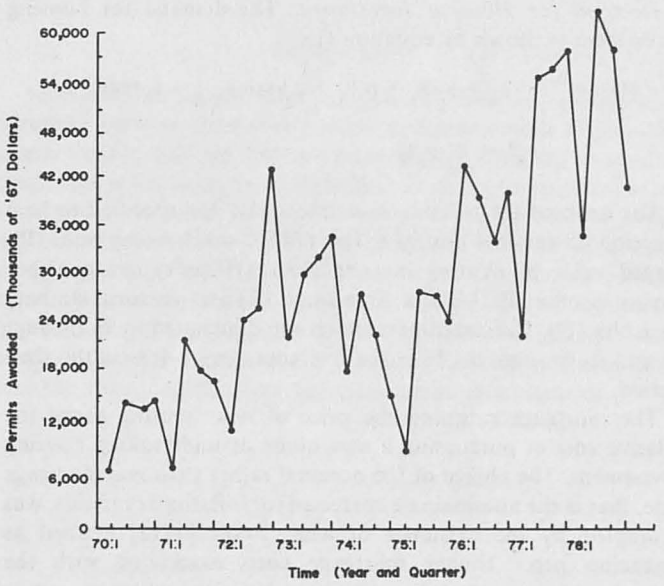

FIGURE 1.
Valuation of Single Unit New Hampshire Housing Permits, 1970:1-1978:4

The supply of new private single-unit housing (HI^S) is taken to be a function of the mortgage rate (MR), the price of new construction (P), the existing residential housing stock (HStock), the net savings flow at New Hampshire financial institutions (SFLO) lagged one period, a construction materials price index (MATIN), a time trend (T) and quarterly dummy variables (D). Estimated parameters are designated by c_1 through c_5 and d_2 through d_4, c_o is the constant, and t depicts the time period.

The supply equation in our housing sector is included to represent the construction side of the market. An alternative specification of the model would be to combine the mortgage and housing sectors, incorporating the variables into a two equation system. This approach is often chosen, abstracting from the residential builders influence upon housing activity and specifying the supply for housing equation as representative of the financial side of the market.[4] Due to the residential construction industry's role as a constraint on the housing market, we attempt to capture this effect by formulating the model as a two-sector, four equations system.

The financial variables affecting the supply of housing are the price of financing the construction activity as well as the availability of funds for building. These variables are introduced as the mortgage rate and net savings flow, respectively. The mortgage rate is expected to have a negative effect upon supply, with an increased flow of funds hypothesized as having a positive influence. The bond rate may have been included as a return on alternative investment opportunities. However, the possibility of introducing multicollinearity into the estimation procedure, i.e., the mortgage rate moving historically with the bond rate, as well as the nature of single unit construction as compared to the more speculative nature of housing investment in multiple unit structures, precluded the addition of the variable.

The housing stock variable is included in the supply equation to capture any effects on housing construction activity from the depreciation of existing structures. This stock variable is a proxy due to the scarcity of current stock data outside of census years. However, the growth in total housing stock as an influence on housing supply should be estimated, with the relationship being positive. This interaction is due to the accelerated replacement of depreciated housing stock as the size of the stock itself increases.[5]

The price variable specified in the supply equation measures the relative return to the builder on the housing investment. Increases in housing prices relative to construction costs should result in a rise in housing construction activity on the supply side. The price variable in our model is approximated from housing valuations attached to permits awarded. There do not exist data series at the New Hampshire state level which would provide the actual market prices desired for estimation purposes. Thus, this proxy has been chosen.

Building material costs in the housing sector are represented in our model by the construction materials price index. This variable, although representative of materials utilized in all types of construction, should provide a good indication of cost trends in the residential construction sector. The materials price index is postulated to have a negative effect upon the supply of housing investment.

Finally, the time trend and seasonal dummy variables are included in the supply equation as specified in the demand function. Similar relationships are expected to be estimated as were hypothesized for these variables in the demand specification.

The two equations of our housing market are assumed to be closed by the identity in equation (3):

$$(3)\quad HI_t = HI_t^D = HI_t^S$$

An alternative to this assumption of equilibrium will be discussed in the latter portion of the paper.

[2]The seasonality of residential construction activity is more pronounced when viewing monthly housing starts. See Fair [1973], Mills [1972] and Dunn [1979] for discussion in this area.

[3]For an in depth explanation see Maddala [1977].

[4]Housing supply being unconstrained by construction costs, etc., follows from the assumption of a very elastic real supply of houses. For econometric evidence of this approach see Muth [1960] and Cassidy and Valentini [1972]; also Dunlap and Mills [1968] and Swan [1971] for industry studies.

[5]See Swan [1976, p. 835] for a brief analysis of this relationship.

Mortgage Market

Demand for Mortgage Funds: The demand for mortgage funds is specified in equation (4).

$$(4)\quad MF^D_t = g_0 + g_1 MR_{t-1} + g_2 PCAPI_t + g_3 HStock_{t-1} + g_4 HI_t + g_5 T$$

Mortgage demand (MF^D) is taken to be a function of the mortgage rate (MR) lagged one period, personal per capita income (PCAPI), the existing housing stock (HStock) from the previous period, housing investment (HI) and a time trend (T). Of course, g_1 through g_5 are estimated coefficients, g_0 is the intercept, and t denotes the time period.

Our demand for mortgage funds specification is simplistic in that it abstracts from any stock adjustment process. However, we have attempted to capture the influence of the key variables on the demand for mortgage funds. Consumers or households, in general, wish to distribute their net worth among various financial and real assets in a fashion to maximize some form of a utility function. Thus, there exists some "optimal" stock of mortgage debt households wish to hold. In including the mortgage rate, per capita income and the existing housing stock, major determinants of the households' portfolio choice are specified. Further refinement of the mortgage market in future development of the model would include a stock adjustment procedure and possibly an interest rate differential, that is the rate spread on the mortgage rate and the rate on an asset, i.e., bonds.[6]

The cost of a new mortgage is represented by the mortgage rate in equation (4). Mortgage demand is expected to decrease with increases in the price of mortgage financing. The mortgage rate from the previous period was utilized in lieu of the current rate, on the assumption that the household would more likely observe this rate than the prevailing one.[7]

The existing housing stock should be positively related to the demand for mortgage flows. This results through growth in physical assets available for collateral, an increase in net worth or through the depreciation effect discussed in regard to the housing investment supply equation above. Mortgage activity involving remortgaging or seeking mortgage loans to repair or replace existing structures provides examples of this.

The remaining variables: housing investment, per capita income and the time trend are all anticipated to be positively related to the desired level of mortgage holdings. The increase in the demand for mortgage flows as a result of housing investment activity follows from the necessity for funds to finance housing activity. A rise in real per capita income would provide an addition to households' net worth, translating into a distribution of the increase among the various real and financial assets available to them. Hence, there follows an upward movement in the level of desired mortgage flows. The time trend variable, as before, will capture the demographic and other economic growth effects, as well as the general trend movement of mortgage flows developing over the estimation period.

Supply of Mortgage Funds: The supply of mortgage funds (MF^S), equation (5), is seen as a function of the bond rate (IR), the existing stock of mortgages (MStock) lagged one quarter, savings deposit (SFLO) and subsidized mortgage flows (SMF) from the previous period and a time trend variable (T). Estimated coefficients are represented by h_1 through h_5, h_0 is the constant, and t depicts the time period.

$$(5)\quad MF^S_t = h_0 + h_1 IR_t + h_2 MStock_{t-1} + h_3 SFLO_{t-1} + h_4 SMF_{t-1} + h_5 T$$

The supply of mortgage flows, like the demand, is viewed as a portfolio adjustment process. Lending institutions desire to hold optimal levels of a wide range of assets, depending on their relative returns as well as their liquidity. Thus, there exists some "desired" level of mortgages, being a function of alternative returns, deposit flows and existing levels of mortgage stocks. Estimation of the effects of these determinants of the desired stock of mortgages is performed utilizing the interest rate on bonds, savings flows to financial institutions and the existing mortgage stock. *A priori*, there exists a negative relationship between the return on alternative assets, the bond rate, as well as the existing stock of mortgages, and mortgage supply. A positive correlation is anticipated between savings flows and the desired level of mortgage stock.

The subsidized mortgage flow is included to gauge the response to federal purchases or guarantees of mortgage commitments on the supply of mortgage flows. Increased subsidized mortgage flows should exert a positive influence upon mortgage supply.

Finally, the time trend variable is specified in the mortgage market supply equation in a manner similar to that in the demand function. Analogous results are anticipated.

Equation (6) displays the assumption of equilibrium in the mortgage market in our model:

$$(6)\quad MF_t = MF^D_t = MF^S_t$$

ESTIMATION RESULTS

The above model was estimated utilizing the two stage least squares option of the TSP package program at the University of New Hampshire.[8] The endogenous variables in our system of equations include the mortgage rate, price, net mortgage flow and the value of housing investment. Estimation results and relevant statistics may be found in Table 1.

Viewing the estimates for the housing market, the significant coefficients, with the exception of lagged stock of housing in the demand equation, all exhibit correct signs. The mortgage rates in both equations show negative signs as does that of the construction materials price index in the supply equation. The parameters on the stock of housing are positive, contrary to our expectation of a negative coefficient in the demand equation, although this estimate is only slightly significant. As anticipated, the time trend variables exhibit positive coefficients, mirroring the economic and demographic trends alluded to in the discussion of the model above. Finally, the dummy variables for the second, third, and fourth quarters have positive coefficients of similar magnitude as postulated, with the constant terms exhibiting the negative effect of the first quarter on housing activity.

Looking at the R^2, the demand and supply specifications explain approximately three fourths of the variation in the dependent variable. In addition, the presence of serially correlated residuals from the estimation procedure is ruled out by the Durbin-Watson statistic for both equations.

[6] In effect we are assuming a perfect rate of stock adjustment. For a complete analysis of supply and demand relationships in the mortgage market utilizing stock adjustment processes as well as interest rate differentials, see Gramlich and Jaffee [1972].

[7] Lagged values of the mortgage rate have often been used in econometric housing market analyses. For example, Fair [1973], Gramlich and Jaffee [1972] and Swan [1971].

[8] It should be noted that the R^2 that is the result of the 2SLS estimation from TSP is not valid since it could be negative as indicated by the warning statement in the TSP manual. Therefore, the appropriate R^2 was calculated. For discussion of this criticism of invalid R^2's, see Tomek [1973] and Basmann [1962].

Table 1

Estimation Results

HOUSING MARKET

Equation 1: Demand for Housing Investment

$$HI^{D}_{t} = \underset{(44527.)}{-58556.} - \underset{(1.3574)}{0.3394P_{t}} - \underset{(1603.35)}{5498.04MR^{**}_{t}} + \underset{(0.0207)}{0.0382HStock^{*}_{t-1}}$$

$$- \underset{(41.8615)}{23.1685PCAPI_{t}} + \underset{(911.23)}{1950.86T^{**}} + \underset{(2282.44)}{8861.37D_{2}^{**}}$$

$$+ \underset{(2269.90)}{7439.63D_{3}^{**}} + \underset{(2755.09)}{8271.24D_{4}^{**}}$$

$R^2 = .720^{**}$
Standard Error of Regression = 4727.07
Durbin-Watson Statistic = 1.826

Equation 2: Supply of Housing Investment

$$HI^{S}_{t} = \underset{(41940.0)}{-46034.6} - \underset{(1.34193)}{0.85594P_{t}} - \underset{(2505.67)}{4285.75MR^{*}_{t}}$$

$$+ \underset{(0.018726)}{0.05874HStock^{**}_{t-1}} - \underset{(0.03938)}{0.04163SFLO_{t-1}}$$

$$- \underset{(525.78)}{1086.14MATIN^{**}_{t}} + \underset{(891.97)}{3155.81T^{**}} + \underset{(2539.9)}{11321.7D_{2}^{**}}$$

$$+ \underset{(2546.7)}{9229.8D_{3}^{**}} + \underset{(2683.9)}{7570.7D_{4}^{**}}$$

$R^2 = .752^{**}$
Standard Error of Regression = 4527.43
Durbin-Watson Statistic = 1.965

*Significant at the .10 level
**Significant at the .05 level
Standard errors are in parentheses

In the mortgage market, variable coefficients are of the correct sign, excluding the housing stock and time trend parameters in the demand equation. The incorrect sign in two out of three instances involving the housing stock variable might be explained by the necessity to construct the data series with additional new housing investment and some constant depreciation rate, given actual census totals at only a small number of points over the estimation period. In the case of the time trend variable in the demand for mortgage equation, perhaps the flow of mortgage funds from outside of the State relatively increased over the period. A common problem in formulating a housing model using a smaller unit of analysis is capturing the interregional flow of funds.[9] This could also explain the insignificant estimates of the savings flow parameters in the supply equations in both the housing and mortgage markets. The net flow of savings deposits to financial institutions is historically an important determinant of the level of housing activity.

The remaining significant coefficients in the mortgage markets include in the demand equation, the mortgage rate, per capita

[9]The problem lies not only in measuring flows, into and out of the region, but where the funds originated as well as where they are going. For a general discussion of national and regional models and related problems, see Ricks [1973, pp. 157-176].

Table 1

(continued)

MORTGAGE MARKET

Equation 4: Demand for Mortgage Funds

$$MF^{D}_{t} = \underset{(103212.)}{570620.^{**}} - \underset{(4411.2)}{28513.2MR^{**}_{t-1}} + \underset{(71.98)}{401.35PCAPI^{**}_{t}}$$

$$- \underset{(1263.32)}{6431.94T^{**}} + \underset{(0.4370)}{0.1729HI_{t}} - \underset{(0.03438)}{0.194105HStock^{**}_{t-1}}$$

$R^2 = .761^{**}$
Standard Error of Regression = 9428.69
Durbin-Watson Statistic = 1.842

Equation 5: Supply of Mortgage Funds

$$MF^{S}_{t} = \underset{(66153.)}{255356.^{**}} - \underset{(4946.9)}{22933.1IR^{**}} - \underset{(0.0474)}{1.0843MStock^{*}}$$

$$+ \underset{(505.67)}{1470.43T^{**}} + \underset{(0.0882)}{0.10086SFLO_{t-1}} + \underset{(0.4674)}{0.1549SMF_{t-1}}$$

$R^2 = .542^{**}$
Standard Error of Regression = 13042.0
Durbin-Watson Statistic = 2.240

*Significant at the .10 level
**Significant at the .05 level
Standard errors are in parentheses

income and the constant with the bond rate, lagged stock of mortgages, the time trend and the constant being statistically significant in the supply specification. The significance of the rate of return on alternative assets and the existing stock of mortgages in determining the net flow of mortgages lends credence to the concept of portfolio adjustment discussed above in regards to mortgage supply.

Viewing the R^2's for the mortgage market equations, both are significant with the demand specification explaining roughly three fourths and the supply function variables over one-half of the total variance in the net flow of mortgage funds over the estimation period. Looking at the Durbin-Watson statistics, the absence of serial correlation is found in both equations.

CONCLUSIONS

The analysis of this paper suggests that New Hampshire's housing market is significantly influenced by the mortgage rate, lagged housing stock, time trend, and seasonal dummy variables when consideration is given to both supply and demand. Supply of housing investment is inversely affected by the cost of construction materials. New Hampshire's mortgage market from the demand side is influenced by the mortgage rate, per capita income, time trend and housing stock. The supply side is affected by the interest rate, mortgage stock and time trend. The significance of variables in our model follows closely estimation results in national housing models, but a difference lies with the magnitude of the estimated parameters. From a State policy viewpoint, the size of the estimated coefficients should be noted.

It is felt that any subsequent effort in the estimation of a New Hampshire housing market model would require refinement in a number of areas. Among these would be further availability of appropriate data, consideration for stock adjustment processes, and an attempt to capture the significance of the interregional flow of funds upon housing investment. Furthermore, the assumption of

equilibrium in the housing market could be relaxed and a disequilibrium model of New Hampshire housing investment developed.[10]

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APPENDIX

Data[11]

D_I: Quarterly dummy variable for the Ith quarter, I = 2,3,4.

HI: Housing investment; valuation in thousands of dollars of Private Single-Unit Housing Permits granted in New Hampshire permit issuing places. Source: Construction Reports, U.S. Bureau of the Census, Series C-40.

HS: Housing Starts; Private Single-Unit Housing Permits granted in New Hampshire permit issuing places. Source: Construction Reports, U.S. Bureau of the Census, Series C-40.

HStock: Estimated New Hampshire housing stock valuation in thousands of dollars. Source: U.S. Bureau of the Census, U.S. Census of Housing, 1960, Pt. 5. U.S. Census of Housing, 1970, Pt. 31.

IR: Moody's Aab corporate bond rate series in units of 100. Source: Federal Reserve Bulletin.

MATIN: Wholesale Prices and Price Indices, construction materials. Source: Bureau of Labor Statistics.

MF: Net mortgage flow at New Hampshire commercial banks, mutual savings banks and savings and loan institutions in thousands of dollars. Source: Assets and Liabilities, Commercial and Mutual Savings Banks. Federal Deposit Insurance Corporation. FSLIC-Insured Savings and Loan Associations Combined Financial Statements. New England Economic Indicators, Federal Reserve Bank of Boston.

MR: Effective rate based on contract rate and points for 25 year mortgages with 20% down payment at selected thrift institutions in the New Hampshire region in units of 100. Source: New England Economic Indicators, Federal Reserve Bank of Boston.

MStock: Stock of residential mortgage loans at New Hampshire commercial banks, mutual savings banks and savings and loan institutions in thousands of dollars. Source: Assets and Liabilities, Commercial and Mutual Savings Banks, Federal Deposit Insurance Corporation. FSLIC-Insured Savings and Loan Associations Combined Financial Statements. New England Economic Indicators, Federal Reserve Bank of Boston.

Price: Average valuation of single unit New Hampshire housing permits awarded. $Price_t = HI_t / HS_t$.

SFLO: Net change in savings deposits at New Hampshire Commercial Banks, mutual savings banks and savings and loan institutions in thousands of dollars. Source: Assets and Liabilities, Commercial and Mutual Savings Banks, Federal Deposit Insurance Corporation. FSLIC-Insured Savings and Loan Associations Combined Financial Statements. New England Economic Indicators, Federal Reserve Bank of Boston.

SMF: Net flow of FHA and VA subsidized mortgage loans at New Hampshire Commercial Banks, mutual savings banks, and savings and loan institutions in thousands of dollars. Source: Assets and Liabilities, Commercial and Mutual Savings Banks, Federal Deposit Insurance Corporation. FSLIC-Insured Savings and Loan Associations Combined Financial Statements. New England Economic Indicators, Federal Reserve Bank of Boston.

[10]The equilibrium identity in equations [3] and [6] follow from the hypothesis that forces adjust so as to clear the market during the period. The concept of estimating markets in disequilibrium was first analyzed by Fair and Jaffee [1972]. Further research applying a maximum likelihood approach was undertaken by Amemiya [1974] and Maddala and Nelson [1974].

[11]Data expressed in dollars utilizes 1967 as the base year.