5 Housing Investment

5.1 Introduction

In this chapter the equation explaining housing investment will be discussed. Housing starts have been treated as exogenous in the chapter, and housing investment has essentially been taken to be a function of current and lagged values of housing starts. Given housing starts, housing investment is rather easy to explain, and so this chapter can be brief. Much more substantiative issues regarding the housing sector will be discussed in Chapter 8, where equations explaining the monthly level of housing starts are developed. In Section 5.2 the basic equation explaining housing investment will be derived, and in Section 5.3 the results of estimating the equation will be presented.

5.2 Determining Housing Investment from Housing Starts

The OBE constructs the quarterly figures on housing investment for the national income accounts from monthly figures. The monthly figures on housing investment are constructed by applying a set of given weights, extending over a seven-month period, to the (seasonally unadjusted) number of housing units started each month times the average cost per start for that month. The investment figures constructed in this way are then seasonally adjusted.

Using the *value* of seasonally adjusted quarterly housing starts (at annual rates) and quarterly housing investment, Maisel [35] takes .41, .49, and .10 to be the respective weights for current, one-quarter-lagged, and two-quarter-lagged housing starts in his housing investment equation. These weights are derived from the monthly weights used by the OBE to construct the unseasonally adjusted housing investment figures.

Let HS_i denote the number of housing starts during month i. Since seven months is assumed by the OBE to be the time taken to build a house, IH_i is

$$IH_i = a_0 HS_i + a_1 HS_{i-1} + a_2 HS_{i-2} + a_3 HS_{i-3} + a_4 HS_{i-4} + a_5 HS_{i-5} + a_6 HS_{i-6}, \qquad (5.1)$$

where a_0 is the average expenditure per house in month i for houses started in month i, a_1 is the average expenditure per house in month i for houses started in month $i-1$, and so on. The specification in (5.1) is not meant to imply that the $a_0, a_1, \ldots, a_6$ coefficients are constant over time: they will certainly vary as the average cost of a house varies.

Equation (5.1) implies that quarterly housing investment is

$$\begin{aligned} IH_i + IH_{i-1} + IH_{i-2} = {} & a_0 HS_i + (a_0 + a_1)HS_{i-1} + (a_0 + a_1 + a_2)HS_{i-2} \\ & + (a_1 + a_2 + a_3)HS_{i-3} + (a_2 + a_3 + a_4)HS_{i-4} \\ & + (a_3 + a_4 + a_5)HS_{i-5} + (a_4 + a_5 + a_6)HS_{i-6} \\ & + (a_5 + a_6)HS_{i-7} + a_6 HS_{i-8} \ . \end{aligned} \tag{5.2}$$

Equation (5.2) states that quarterly housing investment is a function of the number of housing starts of the three months of the current quarter and the number of starts of the previous six months. In the work of Maisel referred to above, quarterly housing investment is taken to be a weighted average of the number of housing starts for the current quarter, $HS_i + HS_{i-1} + HS_{i-2}$, the number of starts of the previous quarter, $HS_{i-3} + HS_{i-4} + HS_{i-5}$, and the number of starts of the quarter before that, $HS_{i-6} + HS_{i-7} + HS_{i-8}$, each of the quarterly housing starts figures being seasonally adjusted and multiplied by the average cost of a house for that quarter.

To use the particular weighted average discussed above requires knowledge of the average cost per house in each quarter. For large-scale models this variable could be explained within the model, as Maisel does for the Brookings model, but an explanation of this variable is beyond the scope of the model developed in this study. Rather than attempt to use the above weights, therefore, a somewhat cruder approach was followed.

Let HS_{it} denote the number of housing starts during the ith month of quarter t, i running from 1 to 3. Then the quarterly seasonally adjusted level of housing starts for quarter t, HSQ_t, is defined to be:

$$HSQ_t = (HS_{1t} + HS_{2t} + HS_{3t})SQ_t, \tag{5.3}$$

where SQ_t is the quarterly seasonal adjustment factor.[1] Quarterly seasonally adjusted housing investment, IH_t, is then assumed to be a linear function of

[1] For the work below, the HSO_t series was seasonally adjusted by a simple ratio to moving average process. For purposes that will be explained in Chapter 12, only data through 652 were used in the construction of the seasonal adjustment coefficients. (The coefficients were actually quite insensitive to changes in the sample period.) The figures for SQ_t are presented in Appendix A.

HSQ_t, HSQ_{t-1}, HSQ_{t-2}, and of the current level of GNP:

$$IH_t = b_0 HSQ_t + b_1 HSQ_{t-1} + b_2 HSQ_{t-2} + c_1 GNP_t + c_0 + u_t, \quad (5.4)$$

where c_0 is the constant term and u_t is the error term. Since the HSQ variables in equation (5.4) are not in dollar terms and since the average cost per house is likely to be a function of the level of money GNP, the GNP variable has been added to the equation in an attempt to pick up the influence of prices on quarterly housing investment.

It is admittedly a long step from equation (5.1) to equation (5.4). The b_i coefficients in equation (5.4) cannot be derived from the weights used by the OBE to construct the housing investment figures because the housing starts variables in equation (5.4) are not in value terms. The a_j coefficients in equation (5.1) are in units of expenditures per house per month, and in the specification of equation (5.4) it is implicitly assumed that the a_j coefficients are of such a nature that the quarterly aggregate HSQ can be used and that the effects of price changes can be adequately reflected in the GNP variable. There is, of course, no guarantee that the coefficients in equation (5.4) will be stable over time. A detailed examination of the housing sector should certainly attempt to explain fluctuations in the price of houses and should also disaggregate housing starts into at least single and multiple dwelling units. For present purposes, however, the results presented below of estimating equation (5.4) appear to be adequate.

5.3 The Results

Because of the lack of good data on housing starts before 1959, equation (5.4) was estimated for the shorter sample period. The results were:

$$\begin{array}{l} IH_t = \underset{(5.37)}{.0242} HSQ_t + \underset{(4.45)}{.0230} HSQ_{t-1} + \underset{(1.66)}{.0074} HSQ_{t-2} + \underset{(13.12)}{.016}\ \widehat{GNP_t} - \underset{(2.31)}{3.53} \\ \hat{r} = \underset{(3.01)}{.449} \\ \mathrm{SE} = .582 \\ R\Delta^2 = .792 \\ 36 \text{ observ.} \end{array} \quad (5.5)$$

$$[1, IH_{t-1}, GNP_{t-1}, CD_{t-1}, CN_{t-1}, CS_{t-1}, V_{t-1}, V_{t-2}, G_t, MOOD_{t-2}, PE2_t, PE2_{t-1}, HSQ_t, HSQ_{t-1}, HSQ_{t-2}, HSQ_{t-3}].$$

IH_t is the amount of nonfarm residental fixed investment during quarter t

seasonally adjusted at annual rates in billions of current dollars.[2] HSQ is defined in (5.3) and is seasonally adjusted at quarterly rates in thousands of units. It refers only to nonfarm housing starts.

All of the variables except HSQ_{t-2} are significant in equation (5.5) and the fit is good. About 80 percent of the variance of the change in IH_t has been explained by the equation, and the standard error is low relative to the accuracy expected of the overall model. Serial correlation is moderate. HSQ_{t-2} was left in equation (5.5) even though it was not significant because theoretically it belongs in the equation: the data that make up HSQ_{t-2} are used by the OBE in the construction of IH_t.

Equation (5.5) was chosen as the basis equation determining housing investment, but other equations were estimated before arriving at this decision. A time trend was added to equation (5.5) to see if there were trend factors affecting the relationship specified in (5.5). This did not appear to be the case, since the time trend was not significant. An equation similar to (5.2) was also estimated, in which quarterly housing investment was regressed against the one current and the eight lagged values of the *monthly* housing starts variables.[3] Current GNP and a constant term were also included in the equation, as they were in equation (5.5). Current GNP was added in an attempt to pick up the influence of prices on housing investment. The basic difference between this equation and equation (5.5) was that this equation did not put any constraints on the coefficients of the monthly housing starts variables, as does equation (5.5).[4] Considering the large number of variables included and the relatively small number of observations, the results of estimating this equation were reasonably good. The results did not, however, appear to be an improvement over the results in (5.5). The constraints imposed by (5.5), in other words, did not appear to be very restrictive. The standard error of the regression, which is adjusted

[2] Actually, the housing starts series is strictly relevant only for the new nonfarm dwelling unit component of nonfarm residential fixed investment. Since investment in new nonfarm dwelling units is by far the largest and most volatile component of nonfarm residential fixed investment and since at least some of the other components (such as broker's commissions) are likely to fluctuate with housing starts as well, it was decided not to disaggregate nonfarm residential fixed investment any further.

[3] As above, let HS_{it} denote the number of housing starts during the ith month of quarter t, i running from 1 to 3. Then IH_t was regressed against HS_{3t}, HS_{2t}, HS_{1t}, HS_{3t-1}, HS_{2t-1}, HS_{1t-1}, HS_{3t-2}, HS_{2t-2}, and HS_{1t-2}. IH_t is seasonally adjusted, but the HS_{it} series are not, and so in the regression three seasonal dummy variables were added to pick up any seasonality in the relationship between the HS_{it} variables and IH_t.

[4] Aside from the question of seasonal adjustment, equation (5.5) constrains the coefficients of HS_{3t}, HS_{2t}, and HS_{1t} to be equal, as well as the coefficients of HS_{3t-1}, HS_{2t-1}, and HS_{1t-1}, and the coefficients of HS_{3t-2}, HS_{2t-2}, and HS_{1t-2}. This can be seen from the discussion in footnote 3 and the definition of HSQ in equation (5.3).

for degrees of freedom, was actually smaller for equation (5.5) than for the other equation. Equation (5.5) was thus chosen over this other equation as the basic equation determining housing investment.

Notice that fewer of the basic instrumental variables were used for equation (5.5) than were used for the equations estimated in the previous two chapters: CD_{t-2}, CN_{t-2}, and CS_{t-2} were omitted from the list of instruments. Since four extra variables (the current and the three lagged values of HSQ) had to be added to the list for equation (5.5), CD_{t-2}, CN_{t-2}, and CS_{t-2} were omitted from the list in order to keep the number of instrumental variables reasonably small relative to the number of observations. As discussed in Fair [17], using a large number of instruments to estimate the equations may increase the small sample bias of the estimates. In the particular case of the housing investment equation, it actually made little difference how many instrumental variables were used, since there was little evidence of simultaneous equation bias in the equation. This can be seen from the results in Appendix B.