The Supply Curve of Housing

by

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I.

The production of new housing plays an extremely important role in the short-run adjustments that take place in the housing market. Although several researchers have, in recent years, studied the supply response of new construction I do not feel that enough emphasis has been given to the financing of this new construction. This paper represents an attempt to fill this gap.

The housing market can be described,in general, by the model of stock demand and flow supply used for analyzing investment in physical capital.[1] From this model, we can obtain the marginal efficiency of capital curve and the marginal efficiency of investment curve that relates to the housing stock. We shall basically assume that the supply curve of new housing construction, i.e., the curve that relates the construction of new housing to the expected price of housing, has some positive slope, (see [2], [7], and [9]) and that the marginal efficiency of investment (mei)curve, the curve that relates the construction of new housing to a market rate of interest, has some negative slope.

The crucial points examined in this paper are (1) the responsiveness of the supply curve (and hence the mei curve) to price and (2) the stability of this curve (and the mei curve) with respect to the changing conditions of construction finance. In the following, therefore, we relegate to the background other factors that may influence the supply curve, such as labor and materials costs,[2] and concentrate primarily on the factors of finance.

II.

Maisel [12] has previously pointed out the importance of the construction loan to the construction industry, although he has not isolated it's effects in his empirical work. His initial effort has not, however, been continued in the research that followed. It is necessary, therefore, to reflect on the factors that make construction finance so vital to the building industry.

In the first place, the construction industry is notorious for its small equity base. The leverage position of the firms in the industry becomes fairly substantial at relatively modest levels of new production, and, as a result, the industry is considered by financial interests as a relatively risky industry.

Secondly, the rate of risk of investment projects is not independent of the amount the owners invests.[3] For one, the greater the personal investment of the entrepreneur the more is his wealth position endangered in the event if unsuccessful business. Additionally, the project (projects) is (are) "illiquid" in the sense that it (they) may be difficult to sell immediately to cover the full amount of the loan. This is particularly worrisome to financial institutions that do not want to be owners or sellers. Furthermore, this can be applied to either individual firms or in the aggregate since most developers make their return on investment by rapidly "turning over" projects. Thus, any slow down in operations threatens the existence of many such organizations. As a result financial institutions exert pressure on building organizations either in terms of explicit charges or rationing when it is felt that the builder is becoming over-committed.[4]

Thirdly, most builders are relatively small, so, consequently, they have very few substitutes for obtaining funds, and thus find themselves in a weak bargaining position vis-a-vis financial institutions.

A fourth point is the ease of entry and exit to and from the industry. As mentioned above, little capital is needed to get started and many people possess the necessary skills to build. There is also a strong desire on the part of individuals to own their own business and when final demand is high, there represents a potential for large profits. In terms of obtaining funds, however, financial institutions rate these new entrants as extreme credit risks, generally basing a large part of their lending decisions upon the past experience or history of the builder [14]. New entrants do not seem to mind, initially, the high interest rates and fees they are charged, because of the large potential for substantial earnings. However, as funds become less abundant, they find themselves highly rationed with extremely high interest costs or discounts assessed on any amount of funds that they are fortunate enough to lay their hands upon.

Finally, and perhaps the most distinguishing characteristics of the housing industry, is the fact that a large proportion of construction is "speculative building;" that is, many units are begun without a final buyer for the house. This is in marked contrast to the producer of nonresidential investment, for in the latter, orders generally precede production and thus the problems and costs associated with carrying an inventory and finding a final demander is considerably reduced.[5] Thus, funds are crucial to builders' operations both in the construction stage and in the time period it takes before a final buyer is found.

The builder will certainly pass along the cost of funds in the price of the house. However, most studies have indicated that the additional cost of funds does not significantly affect the price of the house. Schulkin [17], for example, has shown that with effective loan rates around 15%, a one percentage point change in the construction loan rate will affect the price of a single family home by approximately 0.1 per cent. Thus, it is not expected that the loan rate itself affects the price.

What is expected, however, is that the administration of the construction loan will affect the developer and the supply curve of housing will, therefore, depend upon a given availability and cost of credit to the housing industry. This credit availability may be a function of the long-run rate of interest relevant to the final demand for housing, but it may also be subject to other things such as credit rationing. Regardless of what causes it to change, it is discernable that when funds become harder to get P^s will rise, as in the accompanying chart, say from P_0^S to P_1^S. A loosening of credit will result in a movement in the opposite direction.

Now, it can be shown that the mei curve shifts when the flow supply curve shifts. Given that the mei curve shows that d housing investment will be produced at the rate of return being earned on the existing capital stock, a change in credit conditions will cause the mei function to rotate and to shift. This is depicted in the accompanying chart. The reason for the shift in the mei is that the replacement cost of housing is now higher and consequently the rate of return for the given housing stock

is lower.

This particular result can help explain some of the extreme volatility in the construction of new housing. This variability has been explained in the past solely in terms of a high interest elasticity of the demand for housing. But, if P_t^s is a function of i, the supply curve of housing shifts with changes of i, as shown, which causes the mei curve to rotate and reinforce the movement in production caused by the adjustment in final demand. If the supply curve did not rise with the increase in interest rate, new production would be IH_3 rather than IH_2. Changes in this market can be magnified due to the effect of credit on builder's activies.

III.

The movements of the supply curve of housing cause the identification problem to arise in efforts to statistically estimate this relationship. One doesn't know, for example, whether an effort results in a demand curve, or a supply curve, or a conglomerate of the two.[6] If, as was assumed above, interest rates on, or credit availability of, construction loans are not independent of the mortgage market interest rate then identification problems may occur.

As the mortgage rate moves from i_o to i_1, where $i_o < i_1$, the demand price of housing will fall from $P^d(i_o)$ to $P^d(i_1)$, the supply curve shifts from P_o^s to P_1^s and the flow equilibrium changes from IH_1 to IH_2. If we attempt to estimate this relationship we get two sample points $(P^d(i_o), IH_1)$ and $(P^d(i_1), IH_2)$. It is obvious that the estimated supply curve estimated would be much more elastic with respect to price than either of the actual supply curves. Furthermore, the more elastic the actual curves are, the more elastic the estimated curve. Since so little account has been taken of the construction loan process in the empir-

ical work to date it is perhaps not surprising that little relationship was shown between housing starts and price.

This identification problem would also be present in estimating the mei curve as applied to housing. As a consequence data would imply a much more elastic mei curve than is present in either of the individual curves.

In addition, we find that we have another problem of identification that is relevant in estimating the above relationships. This problem relates to whether the supply curve itself can be distinguished from the mei curve. Since the mei curve is a reduced form curve, it should include variables that existed in the demand curve for the stock of houses as well as the variables included in the supply curve. Thus, one must be careful in estimation that the two can be distinguished.

IV.

A demand curve is necessary in estimation for two reasons. One, demand and supply are determined simultaneously so that appropriate statistical techniques require a demand curve to be estimated at the same time the supply curve is estimated. Secondly, to obtain derived estimates of the mei curve, a reduced form curve, we must have an estimated demand curve available.

The demand curve for a given housing stock has been fairly well analyzed and my work will not stray far from the accepted determinants of demand. Equation (2) provides a short-run approximation of such a demand curve (f indicates the partial derivative of the function with respect to the i^{th} argument).

$$(1) \qquad \frac{K}{N} = f\left(\frac{Y^P}{N}, \frac{P_H}{P_G}, \frac{R/P_H}{IA}, \frac{V}{N}\right)$$

$$f_1, f_3, f_4 \gtrless 0; \; f_2, < 0$$

The definition of variables follows:

K = stock of housing capital

N = population

Y_p = real permanent income

P_H = price of housing

P_G = price of all goods and services

R = rent

IA = cost of capital to housing industry

V = vacancies

Following Muth [15], the housing stock can be thought of in terms of standard units. If we assume that the market, on average, makes the correct judgement about prices,we can select a specific unit as standard and then divide the prices of all other units by the price of the standard one. This gives the number of standard unit equivalents in each unit of the existing stock. The total stock of existing units would then be the sum of these standard unit equivalents which is nothing more than the constant dollar value of the stock which is the variable K.

Real permanent income is used , in this study, as a proxy for wealth holdings. The variable $(R/P_H)IA$ generally represents the portfolio decision of wealth holders in terms of other assest where (R/P_H) is the rate of return on a standard unit of housing capital and i is the opportunity cost of other investment alternatives. The final variable represents the economic need of the housing market to have an empty portion of the stock to facilitate trade and mobility.[7]

The actual form to be estimated, however, has the price of housing as the dependent variable. Thus, rather than assuming that the price is given, we will assume that the stock is given and rearrange the equation to meet our specifications. Also, since the actual stock of housing capital

and the level of vacancies are now implictly on the right hand side of the equation we will combine the two into the vacancy rate, v.

$$(2) \qquad \frac{P^*_H}{P_G} = h\left(\frac{Y_p}{N}, \frac{R/P_H}{IA}, v\right)$$

$$h_1, h_2 > 0; \; h_3 < 0$$

Turning to the the supply side, and assuming, as before, that the market correctly evaluates the value of the units being produced the correct dependent variable should be the real investment in residential construction as opposed to the number of housing starts.[8]

$$(3) \qquad IH = g\left(\frac{L}{P_G}, \frac{M}{P_G}, \frac{P^*_H}{P_G}, IA, CA\right)$$

$$g_1, g_2, g_4, g_5 < 0; \; g_3 > 0$$

The first three variables represent the price of labor, materials and the expected price of houses; the latter because of the speculative nature of much residential construction. Often the price of housing and the cost are put together in ratio form to determine the profitability of new housing. Due to the desire to isolate the effects of price on new construction the variables will be separated in the present study: the relative profitability of production will be caught by the presence of all the relevant costs and revenues.

The next two variables are those deemed most important in this paper for the specification of the supply curve. The first of these, the interest rate, IA, represents the cost of construction funds and the availability. Although the cost of funds does not add a great deal to the price of a house, a rise in this cost increases the pressure or develop a greater

cash flow in order to cover the interest payments. Also, the higher interest rate may indicate that people will have greater difficulty in obtaining final mortgages and thus will raise the probability that houses will stay on the market longer and the builder won't be turning over his equity as rapidly as previously. The sign attached to this variable should be negative.

The next variable,CA, is aimed at picking up the fees and extra costs of construction loans. These charges over and above the interest charge can be quite volatile in the face of changing credit conditions. Since data on these fees and charges are not available we use as a proxy, SPR, the difference between the interest rates on high-grade securities, IA, and lower-grade securities, IB. As credit becomes less available, it is recognized that the spread between high-grade and lower-grade securities increases. As credit becomes more available the spread narrows. It is therefore assumed that the movement in this spread reflects, to some extent, the charges and fees less credit worthy borrowers pay as money loosens or tightens. This variable should also affect real investment in housing negatively.

No variable has been included to cover construction for replacement. In most studies, replacement investment has been taken to be a constant proportion of the housing stock. Given that the need for replacement depends upon many endogenous and exogenous factors it is hard to conceive of it as a constant proportion of the stock of houses over a given number of years. For one thing there are economic factors that go into the endogenous determination of the relevant replacement amount necessary.[9] In addition, replacement demand depends upon the pace and nature of such things as urban renewal, and highway construction. These certainly do not proceed at an

even pace and have no relationship whatsoever to the existing stock of housing: thus, for the present we will assume that replacement investment is just picked up in the constant term of the regression equation.

V.

The empirical results are shown in the attached Table and consist of a stock demand curve for housing, a flow supply curve and two reduced form, mei, curves. The data used in estimation are quarterly, and seasonally adjusted, from 1955-2 to 1973-3. The starting date is due to a lack of earlier time series information on certain variables. The sources of the data are found in the appendix. The equations are as expected with appropriate signs and levels of significance. The demand curve and the reduced form equations were estimated using instrumental variables.

Several different forms of the equations and the variables were tried without additional success. For example, the model was estimated in log-linear form and the various prices in the equation were tested when deflated by a general price index to obtain relative values. Also, permanent real income per capita was used but the fit was worsened. The reason for the failure of relative price variables to show up cannot easily be explained; perhaps permanent prices would be more relevant than the variables used. Neither population nor relative prices contributed to the explanatory power of the model.

The variable $(R/P_H)/IA$ has a non-significant coefficient both in current periods and lagged. Running (R/P_H) and i separately showed that the coefficient of (R/P) was insignificant and the sign IA was negative and the coefficient was significantly different from zero. Thus, we can surmise that either the real return from housing was constant over the time period used in estimation or that the variable was poorly designed and thus

did not adequately represent the true economic variable. The final estimation of the model contained only the opportunity cost of housing. Since a good series was not available over the whole time span on mortgage interest rates, the yield on high grade bonds was used as a proxy for this cost.

An effort was also made to determine whether labor costs or materials costs influenced the level of investment in housing (IH). The results were disappointing when either levels of costs or relative costs were used in estimation. In both cases, the variables L and M had positive signs and thus were felt to be un acceptable in the final specification of the model. Lagging these variables or using a distributed lag form to represent an expected level of labor and/or materials costs did not alter the signs of the coefficients. Apparently, there is a problem of identification here as we seem to be picking up the supply curve of these resources rather than the demand curve.

Looking more closely at the estimated demand curve, the only variable that needs additional explanation is the distributed lag variable incorporating past levels of the price of housing. This addition results from the change of a stock demand model, where the price is a specific price and the variable being determined is the desired level of the stock, into a demand price model, where the dependent variable is hypothetical and the stock, or, as in the present case the vacancy rate, is the specific value. Therefore, since demand price can differ from the actual price, peoples' expectations of price behavior is crucial. The distributed lag form of an expectations variable is included to catch this influence.

The supply curve also conforms to our expectations. The demand price of housing P* is actually the most important variable for new construction because it represents the disequilibrium pressures in stock demand and supply.

The only question concerning this variable is that it enters in currently in the supply equation. Several lagged relationships were tried but the current quarter value performed the best. One reason why this might be true is that housing starts are based upon expected future demand price, but current construction, which is represented by IH, the constant dollar national income investment in residential structures, is based upon the current demand price. A change in this demand price may slow up completions but, unless the future demand price is significantly affected, housing starts may not drop off. Recent work comparing housing starts and completions supports this showing that starts don't always result in a regular supply of completions [6].

The two interest rate variables need some explanation. The spread variable SPR enters into the equation with a two period lag while the level of interest rates enters in with a one period lag. Since residential structures take six to nine months to complete it could be surmised that what the equation is showing is the influence of the availability of funds at the start of construction (the spread variable) and the cost of funds, on average, over the period of construction. The level of interest can be defined as 'an average' value because of the prevalence of variable interest rates on many construction loans.[10]

The next question to be addressed concerns the marginal efficiency of investment (mei) curve and the identifiability of the supply curve. Two forms of the mei curve are presented, the major difference being that in one curve the remains of the price expectation variable from the demand price equation is included while in the other it is removed. There are two reasons for this. In the first equation, the variable is not significantly different from zero and leaving it out does not affect to any degree the coefficients of the other variables.

More importantly, though, in solving for the mei curve, all price vari-

ables should drop out. The price variable included in the demand curve is an expected variable that helps reflect a disequilibrium situation: This situation should be picked up by interest rate differentials in the mei curve. Consequently, there should be no price variable in the mei curve and this provides the first information we have on the identification of the supply curve; it should contain a price variable and the mei curve should not.

In case there is a question as to whether the specific specification of the demand price variable is the reason for a significant price bariable in the supply equation, the supply equation was also tested using a distributed lag variable for expected price. The result was as follows.

$$(5) \quad IH_t = \underset{(1.0934)}{-2.510} \underset{(0.5062)}{- 3.134\ SPR_{t-2}} \underset{(0.2755)}{- 0.601\ IA_{t-1}} \underset{(0.0398)}{+ 0.912\ IH_{t-1}} + \underset{(2.0167)}{4.2593} \sum_{i=1}^{7} PH_{t-i}$$

The distributed lag variable has a positive coefficient that is significantly different from zero. Thus, the reported supply curve is not seemingly dependent upon the demand price variable used.

The level of interest rates in both mei formulations are not significantly different from zero, raising some question about the interest elasticity of the mei curve. The vacancy rate also doe not show up significantly.[11] We can approach this problem by comparing the directly estimated mei curves with the mei curve derived from the estimated demand and supply curves. The derived result is as follows.

$$(6) \quad IH_t = -2.2134 - 3.0188\ SPR_{t-2} - 0.0883\ IA_t - 0.6405\ IA_{t-1} + 0.8860\ IH_{t-1} + 0.0022\ Y_t^P - 0.1011\ V_t + 5.8494 \sum_{i=1}^{7} PH_{t-i}$$

All the derived mei coefficients are within two standard errors of the

directly estimated mei curve. Thus we have some feeling that the directly estimated relationship is correct. The conclusion we can draw from this is that the mei curve is fairly elastic with respect to the market interest rate as a result of a relatively interest elastic demand for the housing stock. The determinancy of flow equilibrium therefore, comes from the supply side which, as we saw earlier, causes the mei curve to shift and rotate with the availability of construction funds. There should be some concern over whether the mei curve is correctly specified or not: however, since it is a derived curve, it would seem that more weight should be put on the structural estimates which are statistically significant.

Overall, the estimated supply curve closely fits the actual behaviour of the housing market in the sample period. Not only is the coefficient of correlation high and the standard error low, but the ability to pick up turning points in the series is quite high. These can be seen in the accompanying chart. The model picks up turning points at the trough in 1958-II, 1967-II but appears to be premature in 1970-II. At peaks the model seems to be correct in 1963-IV and 1973-III although it does not catch the turns coming in 1959 and 1969.

VI.

In summary, it has been shown that, at least in the short-run, a significant positive relationship exists between the real investment in residential housing and the price of the housing.

In addition, the analysis indicated that the demand curve and the supply curve are affected by different factors so that they may move independently of one another. Thus, the demand for the housing stock may significantly raise the demand price of housing, but due to supply constraints,

i.e. lack of cost or cost of construction funds, there may be little additional investment in residential construction. Conversely, there may be ample funds for construction lending, but due to depressed levels of permanent income, etc., the demand price of housing may not be high enough to encourage production. Both cases have been observed in recent history.[12].

FOOTNOTES

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1. For a thorough description of this model see [19] pp. 163-70.

2. Economists have not generally found the case for a positively sloped supply curve in the real resources used in the process of building (management, labor, materials); these are assumed to have a fairly elastic supply curve to the industry. See Swan [21] and Gibson [9] for rather thorough descriptions of the labor and materials requirements for housing. Land costs may play a role in the positive slope of the supply curve, particularly as society pushes out on the marginal land in use at the edge of cities.

3. Kalecki [11].

4. Maisel [12], p.129 in [16], refers also to the discounts builders may have to pay in order to obtain funds.

5. This would, of course, increase the riskiness of lending to a speculative builder. The institutions that require final commitments at the time they lend the construction funds are in a better position because they are pretty well assured that they can get out from under their investment.

6. See Malinvaud [13], p. 601-6 or Fisher [4] for a more complete description of this problem.

7. Maisel [12] has previously applied the idea of a "normal" number of unused units to the housing market. The concept has more popularly been used in the analysis of the labor market.

8. All the tests reported in the paper were tried using housing starts rather than constant dollar investment in residential structures. Although the differences in results were minor, investment in residential structures was used for the very reason that it represented the actual work that was being done in the quarter under review and not just what was started.

9. A recent exposition of this point of view is found in [3].

10 The prevalence of variable rate loans is much in evidence in the work reported in [14].

11 The capital stock variable was also tried in the directly estimated mei curve but its coefficient possessed the wrong sign.

12 See Fisher [5], p. 127-28 for a description of this problem.

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