VARIANCE IN HOUSING STARTS— A SUPPLYSIDE PHENOMENON

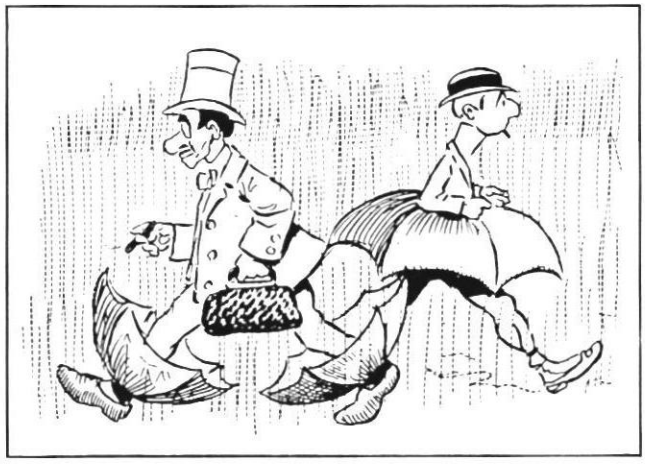
A model is developed to understand the impact of changes in the term structure of interest rates on housing starts.

by Daniel M. Cashdan, Jr.

The economic literature on housing consumption and production is rich from the microanalysis of the elasticity of demand for housing to the macro analysis studying the impact of national monetary and fiscal policies on the general home building industry. Economists and politicians are aware of the role the housing industry holds as the leading economic indicator. As President Reagan said at the National Association of Realtors® Convention in March 1982, "We will work to restore health to our ailing housing industry and in so doing help to restore health to our national economy."[1]

The purpose of this article is to develop a model that describes the impact of changes in the term structure of interest rates on housing starts. The model is then empirically tested paying particular attention to its sensitivity towards changes in short-term rates. A framework is presented that illustrates the variance in housing starts is in part a short-run phenomena of changes in the term structure of interest rates. The article concludes with a discussion, from the supply side, of the home builders' sensitivity to short, medium and long-term interest rates as independent aspects of the cost function. (The results of the empirical tests are based on quarterly data as reported in the BCD.)

There are two caveats of results which should be mentioned. First, highly correlated series of data such as short and long-term interest rates can create statistical problems when included on the right hand side of a multi-variate regression equation. However, these problems of autocorrelation can be avoided by using the levels and absolute and percent differences done for



these tests. The second caveat deals with the results of the correlation between housing starts and FHA secondary market mortgage yields found to be positive. This result disputes DRI estimates that a 100-basis point increase in effective rates reduces the volume of housing starts by 225,000 units within 12 months. Thus, a 1% mortgage rate increase would lead to a 12% decline in annual housing starts in today's market.[2] Several points serve to reduce the discrepancy of the results.

First, Brady found a similar result when disaggregating housing starts by type of mortgage—FHA, VA and conventional. Specifically, Brady found conventional construction varies inversely with the cost of mortgage credit, but that FHA housing is relatively unaffected by FHA mortgage yields.[3] Second, "the effective mortgage market interest rate, which is the relevant cost of capital in the housing market, links the mortgage market to the demand for real estate production. Requests for mortgage credit are derived from the demand for real estate production and existing real estate assets. Any increase in the demand for real estate production resulting from more requirements for housing services, causes a boost in the need for mortgage credit."[4] In other words, there

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are two factors affecting the demand curve: a strong rightward shift due to increased household formation and real income and a leftward shift due to increased mortgage rates. The results from 1950-1980, show the first effect to be greater than the second.

According to Reid, the elasticity of housing appears to be between 1.5 and 2.0 for the period 1918-1960[5], and the relationship has not changed in any significant manner. This reinforces the statement that increases in real household income have led to a rightward shift in the demand curve.

One final explanation to consider is that a multidimensional relationship exists between the total available supply of credit, its rate of change and the rate of change in the demand for credit from the various economic sectors of the economy, the housing industry being one of many users.

Review Of Housing Theory

The economic literature concerning housing is abundant including the publication of *Housing and Income* in 1962 by Margaret Reid of The University of Chicago. The relationship of housing demand and supply, as affected by changes in normal income, interest rates, inflation and population, often have been studied.

Housing Demand

Housing demand is elastic with respect to the cost of credit. "The ultimate demand for additional housing units must come either through net household formation or the more rapid replacement of existing stock".[6] This basic demographic factor, coupled with the high post World War II population shift towards the West and Sun Belt regions and a rising national and personal income, explains the overall strength of the home building industry.

Housing, as any durable good, is a function of planned consumer consumption in a given period. With a rigorous analytical proof and basic intuitive consideration, one is lead to accept that "the overall impact of interest rates on the demand for consumer durables to be unambigously negative".[7] Thus, as real interest rates rise, the expectation is not for a reduction in quantity demanded, but a shift towards a less expensively produced product. Evidence of this change is seen in the decreased size of new homes and lot sizes over the past 30 years.

Finally, on the demand side the effects of inflation must be considered. Many authors view inflation as a major factor causing the increase in aggregate demand and consumption of home ownership[8]. However, according to Fama and Schwert the relationship between interest rates and inflation is a component effect where CPI reflects the mean price change across all goods. They argue that changes in the price of goods are not equivalent but relative. However, "as one looks at unexpected inflation rates of the longer differencing intervals, a noticeable tendency towards increased similarity of behavior is observed".[9] People buy homes in inflationary times to lock in lower interest rates since inflation will increase the value of the property.

But to the home buyer, housing does not represent a speculative investment as does a common stock or commodity. Rather, the housing investment is made for the purpose of utilizing the home over a long period of time, (owners of second homes are not considered to represent a significant portion of the market). Therefore, by relying on the argument of Fama and Schwert, the price of all shelter will rise so the consumer will be unable to profit from the inflated value of the home while maintaining equivalent housing in a similar location.

Housing exhibits the classic income and substitution effects associated with normal or superior goods. This means that as the price of housing rises, people will seek to economize on their consumption of other goods in an effort to maintain their current level. This is obvious in the case of a tenant whose rent has been raised. The tenant typically will begin to give up purchases such as eating out, movies, etc., in order to meet the new higher cost of housing.

This example also can be applied to the new home buyer. As long-term interest rates rise, the would be buyer must economize on costs charged in a similar manner, i.e., paid over an extended period of time (this argument is consistent with the Permanent Income Hypothesis). These items are the least expensive complements of the home. Buyers can still satisfy demand quantitatively with an effectively reduced real income by compromising qualitatively. Thus, in the long run demand tends to vary with respect to quality not quantity and is independent of inflation.

In summary, housing demand is essentially elastic with the highest degree of correlation, 96%[10], being between demand and net new household formations. Interest rates have a negative effect on consumption creating downward pressure on such characteristics as lot size and actual square footage. Housing consumption and income have an asymptotic relationship where all but the very highest income brackets have a housing to income ratio greater than one. And finally, the effect of unanticipated inflation tends to have similar long-term effects across all markets, and does not affect the quantity of housing demand, only the nominal price.

Housing Supply

The importance of the home building industry, as a leading economic indicator, is widely accepted. This industry employs a large percentage of the contruction trades plus, there is a tremendous multiplier effect on other producers of durable goods such as, household appliances, carpeting and furniture.

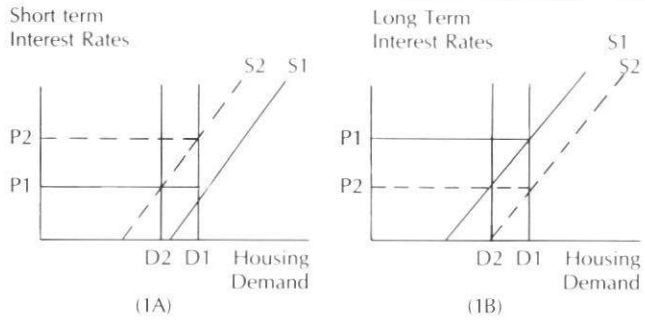
If housing demand equals supply and the format can be estimated with relative certainty, how is the volatility in housing starts explained? The consensus is that in the short-run home builders are extremely sensitive to credit

availability. As Maisel points out, "many people seem to have assumed that movements in credit have caused starts to fluctuate by altering the underlying demand for dwellings."[11] Maisel argues that the volatility in housing starts should be viewed as an inventory phenomenon where builders are sensitive to the increase in inventory and will halt production until inventory levels are reduced. He sees changes in inventory due mainly to the tightening of mortgage markets and the resulting slowdown in home purchases.

Review graphs 1A and 1B, where D1 represents long run demand for housing and D2 represents short run deviations from the overall housing demand. Graph 1A shows supply sensitivity to changes in short and intermediate term interest rates. As short-term rates rise the supply curve will shift from S1 to S2, home builders must decide to raise price to P2 or to adjust supply to D2. Given that incomes are fixed in the short run, point (P2, D1) is unobtainable for buyers, therefore home builders immediately shift to point (P1, D2). The gap between D1, D2 is what is often referred to as excess, or pent-up demand. In order to return to point (P1, D1), builders must economize in other cost items thus returning to supply curve S1. If this process were instantaneous, supply would not be interrupted. But, it takes considerable time to find less expensive materials and designs.

Graph 1B shows the demand sensitivity to changes in long-term rates. A rise in such rates causes the demand curve to shift from D1 to D2. This demonstrates a temporary drop in quantity demanded similar to that in 1A, and a drop in price which reflects a decrease in affordability which corresponds to a prior discussion of income and substitution effect. As builders economize on cost, equilibrium will be reached at point (P2, D1) along supply curve S2. This represents a cheaper product which meets the consumer's new budget constraint and satisfies long run demand.

Demand Sensitivity to Changes in Short (1A) and Long Term Interest Rates (1B).



P = Nominal cost of housing where the cost of financing is the independent variable

An Interest Rate Yield Curve Explanation Of Housing Start Volatility

A strong relationship should exist between the variance of short and long-term interest rates and housing starts. Builders, like other producers in the economy, face a term structure of interest rates where long-term rates are more stable than short-term, the latter representing the current cost of capital for construction, and the former reflecting the cost of capital to home buyers. Theoretically the difference between short, medium and long-term rates represents costs or expectations priced out relative to each other in the financial markets. A clear delineation between rates is examined to determine their relationship with housing starts.

Short-term interest rates change with the prime rate. This component of the term structure has the greatest variance and represents a direct cost to home builders. The interest costs of a construction project are charged at a floating rate typically prime plus 200 basis points. This loan will be charged on the outstanding balance of the construction loan. As nominal interest rates rise, this component of construction costs increases faster than any other component of the development. While other costs rise due to inflation, there is a need to finance more nominal dollars for a given project. At the same time nominal interest rates have risen as well. Consequently, an inflated nominal interest rate is financing the purchase of inflated material and labor prices! This is a dramatic change and should certainly support the assertion that home builders are particularly sensitive to changes in short-term interest rates.

Medium-term forward rates represent the cost of financing inventories, in this case being unsold homes. While the actual sensitivity of home builders to forward rates will not be discussed, there is agreement that they are highly sensitive to these future rates.

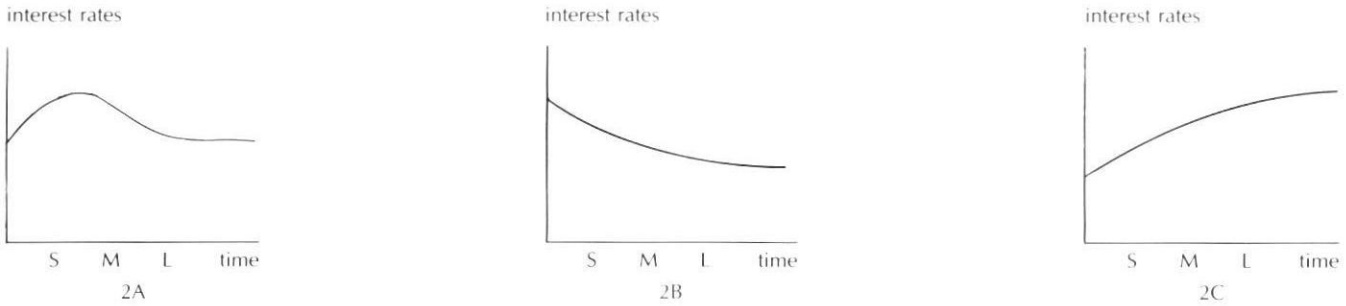
In Figure 2A short-term rates are expected to rise above long-term rates. The home builder sees the possibility of high interest and inventory costs. In this situation, builders will reduce production considerably while slowly depleting inventory levels.

In Figure 2B, rates are expected to decline. This represents the most desirable market to enter as the actual cost of capital and inventory will be declining over the life of the project. Thus, builders can be expected to seek permits, begin construction and exhibit a willingness to expand inventories.

In Figure 2C, rates are expected to rise over time, and this is often thought to be the normal shape of the term structure. (See Sharpe)[11]. Depending on the slope of the curve, this situation should not be unsettling to home builders, although inventories will be kept to a minimum (here again, Maisel's argument holds).

Due to the development of financial futures' markets, like the Chicago Board of Trade, much of the uncertainty associated with future spot rates is eliminated through appropriate interest rate hedging strategies. This only reduces cost uncertainty and does not serve to reduce cost.

Three Examples of the Term Structure of Interest Rates



Mortgage rate changes, or variances on long-term rates, represent a demand constraint as opposed to a direct cost of production. In general, a rise in interest rates of any long-term debt instrument has a substantial affect on the associated coupon or payment. In the case of home mortgages, even a small variance in mortgage rates induces a relatively large change in monthly mortgage payments. Thus, the hypothesis is formulated that a rise in long-term rates dampens the demand for debt in general, and decreases the supply of credit available for mortgage financing causing a northwest shift of the supply curve.

Tests And Results

To test the previously stated hypothesis the following series found in the BCD are included: Quarterly Housing Starts, Prime Lending Rate, Secondary Market Yield on FHA Mortgages and the CPI from 1950-51 through 1983-84.

As stated at the beginning of this article, regression tests were performed using ordinary least squares, utilizing the minitab statistical package on the DEC 20 at The University of Chicago. The results of these tests are presented in Tables A-F.

Table A sets the level of housing starts as the independent variable. Three separate regressions are tested by altering the right hand side variables. Test #1 finds the concurrent and once lagged levels of prime rate to be both statistically significant and negative with coefficients of −.5583 and −1.1629, respectively. This regression also yields an important test statistic for CPI, in the current quarter, with a positive coefficient of .6828. FHA yields were not found to be significant.

Test #2 is of interest since in examining an equation which included both nominal and real long and short-term interest rates, the computer rejected the series as being too highly correlated. To overcome this problem nominal rates were excluded and real rates and CPI were tested. The resulting R^2 and D.W. were identical to Test #1. And again, the resulting significant variables were real short-term rates with a 1 period lag and CPI. [Real rates are defined as the nominal rate minus the CPI.]

Test #3 used the same right hand side variables as Test #1 with the addition of two variables, the level of housing starts lag 1 and the level of housing starts lag 2. Not surprisingly, the R^2 went from a fairly low .362 to a fairly high .881. There were only two significant variables, start lag 1 and the prime rate in the current quarter. The strength of the level of starts overwhelms the other variables.

Considering the variables in Table A, the prime rate in the current quarter was significant in three out of three cases (including the test for prime real rate) and prime lag 1 in two out of three cases. CPI in the current quarter was significant in two out of three cases with starts lag 1 as being the most significant variable measured.

Table A

Prediction of Level of Housing Starts Coefficient (T-Ratio)

Variable	Test #1	Test #2	Test #3
Prime	−.5583		−.5134
	(2.02)		(4.30)
$Prime_{-1}$	−1.1629		.0362
	(4.13)		(.26)
FHA Yield	.9077		.2304
	(1.34)		(.73)
$FHA\ Yield_{-1}$	.7273		.3327
	(1.20)	(1.25)	
CPI	.6828	1.0321	.06499
	(4.00)	(1.85)	(.81)
CPI_{-1}	−.2230	−.6586	−.07249
	(1.25)	(1.18)	(.91)
Real/Short		−.5583	
		(2.02)	
$Real/Short_{-1}$		−1.1629	
		(4.13)	
Real FHA		.9077	
		(1.34)	
$Real/FHA_{-1}$		.7272	
		(1.20)	
$Starts_{-1}$			1.0154
			(11.14)
$Starts_{-2}$			−.12313
			(1.38)
R^2	.362	.362	.881
D.W.	.44	.44	2.08

Table B

Prediction of Change in Housing Starts Coefficient (T-Ratio)

Variable	Test #4	Test #5	Test #6
Change in Prime	−.3740 (3.09)	−.3399 (1.46)	−.45 (3.83)
Change in $Prime_{-1}$	−.2815 (2.12)	−.2815 (2.12)	−.3574 (2.70)
Change in $Prime_{-2}$	−.2025 (1.74)	−.5217 (1.93)	−.1254 (1.08)
Change in FHA	−.0747 (.27)		−.173 (.65)
Change in FHA_{-1}	.7053 (2.32)	7053 (2.32)	5593 (1.90)
Change in FHA_{-2}	.1382 (.46)		−.0293 (.10)
Change in CPI	−.04429 (.54)		−.08178 (1.03)
Change in CPI_{-1}	.03192 (.42)		.02153 (.24)
Change in CPI_{-2}	−.181 (2.38)		−.20843 (2.84)
Change in Real Prime		.0304 (.11)	
Change in Real $Prime_{-1}$		−.3192 (1.03)	
Change in Real FHA		−.0747 (.27)	
Change in Real FHA_{-1}		.1382 (.46)	
Change Starts Last Period			.00691 (.08)
Change Starts Two Periods			.27125 (3.48)
R^2	.403	.403	.458
D.W.	2.00	2.00	1.98

Table B tests the change in the level of housing starts as a dependent variable against the change in various right hand side variables. Test #4 finds the change in prime rate, the change in prime rate lag 1 and the change in prime rate lag 2 as all significant with coefficients of −.3704, −.2815, and −.2025. The change in yields on FHA mortgages, with a 1 period lag, was found to be significant with a coefficient of .7053, and the change in CPI with a 2 period lag was found significant with a coefficient of −.181. Note that the R^2s are somewhat better than in Table A for similar variables, and that in Tables B, C and D, the D.W. are at very acceptable levels.

Test #5 encountered similar results as Test #2 with regard to correlations. In this case, CPI was excluded with the results being identical to those of Test #4.

Test #6 included the same variables as Test #4 with the addition of two variables, the changes in starts lag 1 and lag 2. These results are somewhat different from the similar Test #3 on the levels.

In this case the increase in R^2 is relatively small—.403 to .458. And it is the housing start 2 period lag variable which is significant not the 1 period lag variable. Again, the change in prime rate and the change in prime rate lag 1 are significant. The yield on FHA mortgages lag 1 and the change in CPI lag 2 also are found to be noteworthy.

The interesting result of this table is that, in all cases, change in prime rate is found to be statistically significant and negative. The change in yield on FHA mortgage was found to be positive and significant with a 1 period lag. CPI was significant and negative with a 2 period lag. The most interesting aspect of Table B is in Test #6 where the first difference of housing starts was found to be insignificant and the 2 period lag difference generated a much smaller benefit to the equation than the test level of starts in Test #3.

Table C

Prediction of Percent Change in Housing Starts

Variable	Test #7	Test #8
% Change in Prime	−.22678 (2.63)	−.24629 (2.89)
% Change in $Prime_{-1}$	−.21244 (2.64)	−.16684 (2.04)
% Change in FHA	.2712 (1.34)	.2394 (1.22)
% Change in FHA_{-1}	.7355 (3.57)	.6178 (2.96)
Change in CPI	−.007662 (1.55)	.005734 (1.16)
Change in CPI_{-1}	−.000150 (.03)	−.00160 (.33)
% Change Starts		.18136 (2.29)
R^2	.379	.404
D.W.	1.84	2.25

Table C examines the role of percent changes in various right hand side variables as determinants of the percent change in housing starts. Test #7 yields a significant statistic for the percent change in prime rate and in prime rate lag 1 (again both coefficients are negative). The one period lag value for yields on FHA mortgages is both significant and positive. In this case, the R^2 of .379 is lower for absolute differences but higher for levels.

Test #8 is identical to Test #7 with the additional variable of percent change in housing starts being significant and similar to Test #5.

These two models indicate there is no real benefit to

Table D

Simple One Variable Regression to Compare Prediction Level to Prediction of Change

Variable	Test #9	Level
$Level_{-1}$	.90679 (25.41)	
$Change_{-1}$		.26299 (3.14)
R^2	.829	.069
D.W.	1.41	2.08

Table E

Correlation of Selected Variables

Correlation % in Change	Short	Long	Correlation	Changes in Short	Changes in Starts
Long	−.423		Change in Starts	−.355	
Starts	−.366	.327	Change in $Long_{-1}$	−.386	.492
	Correlation Nominal $Short_{-1}$ Long .961			Correlation Real $Short_{-1}$ Long .911	

using percent change as opposed to absolute difference in predicting quarterly housing start changes.

Table D points out the striking difference between testing for levels of housing starts as opposed to changes using only starts or changes as the independent variable, using housing starts in the current period as the dependent variable.

Table E is designed to highlight some of the interesting correlations found in this data. Note the negative correlation between starts and short-term interest rates and the positive correlation between starts and long-term interest rates. Also interesting is the relationship between the change in short and long-term interest rates which is negative and the extremely high correlation between the level of long-term and short-term rates with a 1 period lag.

Table F

Standard Deviation of Various Quarterly Series 1950 through 1983

Housing Shifts (H.S)	3.2607
Change in H.S	1.3794
Prime Rate (P.R.)	3.9449
Change in P.R.	1.0826
FHA Mortgage Yield (M.Y)	3.1762
Change in FHA M.Y	0.4505

Table F gives the standard deviation for housing starts, prime rate and FHA mortgage yields as levels and first differences. As expected, short-term rates are far more volatile than long-term especially when the standard deviation of the differences are compared.

Summary and Conclusion

The housing industry is important to the country because shelter is its output, and it is vital to economists because historically this enterprise has provided advance warning of changes in the direction of business cycles. Generally, housing is a leading indicator out of recessions. By a multiplier effect of increasing the demand for other durable goods such as appliances and furniture, housing production and consumption have beneficial economic effects.

While many economists have studied the demand for housing in great detail, few have considered the components of housing supply preferring to view home builders as profit seekers who supply housing until the marginal profit is zero, without examining the economic components of cost.

This article examined the builder's decision-making process in two steps. First, by asserting that the volatility of the home building industry, or of housing starts, is a phenomenon tied directly to changes in the term structure of interest rates; secondly, by arguing that short-term rates, represented by the prime rate, are a cost of production; that medium-term rates (excluded from the empirical testing) represent the cost of carrying inventory; and that long-term rates represent a constraint on demand not directly on supply.

This argument was tested empirically with the result that in all cases the prime rate is negatively correlated with housing starts. Thus, the hypothesis was supported. Long-term rates were only significant with a 1 period lag, and shown to be correlated positively with housing starts. Finally, while the average R^2 for these tests ranged from .3 to .45, the high R^2 from Test #3 was .881. In that test, which included levels of housing starts with a one period lag, the only other significant variable was the prime rate. Therefore, in the prediction of housing starts, while other variables such as nominal income must be considered, the argument presented here is supported by the data.

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