Is Housing Investment a Leading Indicator of Economic Development?

I-Chun Chen*, Ishita Dey**, Hsiao-Shan Yang***

Abstract

In this paper, we examine whether residential investment (RI) could be a leading indicator of general economic activity and its role in the general economy in a four variable system. The results suggest that residential investment Granger causes Gross Domestic Product (GDP) and GDP Granger causes non-residential investment (NRI). Moreover, residential investment impacts financial and economic variables both directly and indirectly.

I. Introduction

It is a common perception among economists that the United States has invested too much in housing (Mills, 1987 and Hendershott, 1989). Housing investment would then be expected to have a less favorable impact on GDP as compared to other kinds of investment. In particular, Mills (1987) noted that the marginal productivity of housing is a little more than half the returns to non-housing capital. This would seem to suggest a misallocation of capital towards housing and thus a corresponding decline in GDP growth.

In the first part of the paper we attempt to examine the differences in the role of residential and non-residential investment in GDP (Green, 1997). In particular, we look at the relationship between residential investment, non-residential investment and GDP using Granger tests. The results from this part indicate that residential investment appears to Granger cause GDP, while non-residential investment appears not to Granger cause GDP. After having established that residential investment contains leading information for a nation's economic activity, we try to analyze in the second part, the specific role that residential investment plays and how it interacts with other important economic and financial variables in a four variable system (Penm and Terrell, 1994). Our results indicate that residential investment directly affects GDP and interest rates and it indirectly affects money supply.

---

* Ph.D. State University of New York at Buffalo.

** Corresponding author. Department of Housing and Consumer Economics, University of Georgia, 111 Dawson Hall, 305 Sanford Drive, Athens, GA 30602. E-mail: idey@uga.edu.

*** Institute for Genomic Biology, Business, Economics and Law of Genomic Biology (BioBEL), University of Illinois at Urbana-Champaign, 2122 IGB, MC-195, 1206 West Gregory Drive, Urbana, IL 61801

The paper is organized as follows. Section II gives a detailed description about the data. Section III presents our empirical methodology. Section IV presents the results from our analysis and Section V concludes.

II. Data

We use quarterly data from 1959-I to 2005-IV for both parts of our analysis. Initially, we started with non-seasonally adjusted data but we couldn't reject the null hypothesis of a seasonal unit root by the test suggested by Hylleberg, Engle, Granger and Yoo (1990). Hence, we shifted to seasonally adjusted data. For the first part of our analysis we use real residential investment, real non-residential investment and real GDP. This data is obtained from the Bureau of Economic Analysis (BEA). The variables are converted in real terms by dividing it by the Consumer Price Index (CPI). The CPI has a base year of 1982-84 and is from the Bureau of Labor Statistics (BLS). Residential investment has three major components: construction of new single-family homes, construction of new multifamily housing, and "other structures," which consists primarily of improvements and brokers' commissions. The first is the largest component of residential investment and accounts for 50 percent of residential investment. Non-residential investment is defined as construction of factories, machines etc.

In the second part of our analysis, we analyze the interaction of residential investment in a four variable system which comprises of unemployment rate, money supply and interest rate. Unemployment rate represents the number of people who are 16 years or over and are unable to find work as a percent of the total labor force and is from the Bureau of Labor Statistics (BLS). The money supply measure that we use is M3[1]. M3 is the broadest measure of money supply and it is the sum of currency, demand deposits, saving accounts and all kinds of certificate of deposits, repurchase agreements and deposits in terms of Eurodollars. We use a measure of nominal interest rate[2] (i) which is the 90-day Treasury bill rate. Data on M3 and i is from the Federal Reserve Bank. In doing the unit test for M3, we found that M3 is integrated of order 2 or I(2) series. We use data on real money supply by dividing M3 with CPI. Real money supply and real residential investment are in logarithms, while unemployment rate and nominal interest rate are in levels. This specification gives us better estimates in terms of lower p values in relation to a model where all variables are in levels and where all variables are in logarithms. Moreover, taking logarithms of real money supply and real residential investment would facilitate comparison in percentage terms, since the other two variables; interest rate and unemployment rate are already in percentage terms.

---

1 Results using M2 are reported in the appendix
2 Results using real interest rate (r) are in the appendix

In the appendix, we report our results from other specifications. The specification that we report in the paper seems to be closest to the paper by Penm and Terrell (1994), where a similar specification is done for Australia.

III. Empirical Methodology

The concept of Granger causality is defined as: if lagged values of a stationary variable X1 can improve the ability to predict another stationary variable X2 after controlling for lagged values of X2, X1 is said to Granger cause X2. In the first part, we use this concept to analyze the lead-lag relationship between residential investment, non-residential investment and GDP (Granger (1969); Sims (1972) and Geweke, Meese and Dent (1983)). In particular, we analyze four sets of causal relationships: GDP-residential investment, residential investment-GDP, non-residential investment-GDP and GDP-non-residential investment. In order to check for consistency of our results we use three specifications to test for Granger causality. More specifically, Granger tests are performed on detrended data, which are called short-run tests. The tests are also performed on level data called long-run tests. In both these specifications, equation (1) is used to test the hypothesis in equation (2).

$$X_2(t) = \sum_{i=1}^{J} a_j X_2(t-j) + \sum_{i=1}^{J} b_j X_1(t-j) + \alpha + \beta T + u(t) \quad (1)$$

$$H_0 : b_j = 0, j = 1, \ldots\ldots, J \quad (2)$$

As an alternative, we also estimate equation (1) in first differences (Green, 1997). However, if the data is stationary this will result in overdifferencing. On the other hand, if the variables are cointegrated then it will produce a misspecified result. We begin by checking the stationarity of the variables to find out if they are non-stationary and in case they are, whether they are integrated of the same order. We then do the cointegration tests. The following regressions are performed:

$$Investment_{jt} = \alpha + \beta_j GDP_t + u_{jt} \quad (3)$$

where j = 1,2 1: residential investment 2: non-residential investment

To test for cointegration, Augmented Dickey-fuller or ADF (Dickey and Fuller, 1979) unit root tests are performed on u_{jt}. In case of u_{1t},we can reject the null hypothesis of a unit root at 10% significance level under the specification of no intercept and no trend. For u_{2t}, we can reject the null hypothesis of a unit root at 10% significance level under the specification of intercept and no trend and at 1% under the specification of no intercept and no trend. We then proceed to test for Granger causality using the error correction model or ECM (Engle and Granger, 1987). The form of the model is:

$$\Delta X_2(t) = \alpha + \sum_{j=1}^{k} a_j \Delta X_2(t-j) + \sum_{j=1}^{k} b_j \Delta X_1(t-j) + \beta_z Z_{t-1} + \beta T + \eta(t) \quad (4)$$

Here Z_{t-1} is a vector of error terms from equation (3). β_Z is called the speed of adjustment parameter. We now use (4) to test the hypothesis in (2).

The number of lags chosen in equation (1) and (4) will have an important impact on the decision to reject or not reject the null hypothesis in equation (2).We follow two approaches (Green, 1997) to specify the number of lags. The first is to test the hypothesis using six lags (Guilkey and Salami, 1982) at the 99% confidence level. Second, we also specify the lags recursively by using the AR model in the short-run case. The lags which are got from the short-run model are then also used in the long-run and ECM model. Once again the hypothesis is rejected or not rejected at the 99% confidence interval.

Finally, since our data pertains to a long period, we also check for the structural stability of the parameters across time. This is particularly important since causality which may be found over relatively long periods may not be present within shorter sub periods. In order to test coefficient stability tests we use the CUSUM of squares test put forth in Brown, Durbin and Evans (1975). To reinforce our results we also use the Chow test to check for structural break. Using either of the methodology we find no evidence of structural break.

In the second part of our paper, we test for non-stationarity of the four variables in our analysis using ADF tests. Since all the four variables are integrated of the same order we check for cointegration between these four variables using Johansen procedure (1988, 1991). We then estimate an error correction model, impulse response and variance decomposition to gain a better understanding on the lead-lag relationship between residential investment and other macro-economic variables.

IV. Results

(a) The Relationship between Residential Investment, Non-Residential Investment and GDP

(i) Unit Root Tests

ADF tests on residential investment, non-residential investment and GDP indicate that we cannot reject the null hypothesis of a unit root in all the three cases. All of them are integrated of order 1 or I(1). This can be seen from Table 1.

The results in the table are consistent across all three specifications, namely, no intercept and trend, intercept and no trend, intercept and trend and all of them except the one for non -residential investment, which has intercept and trend hold at 1% significance level.

Table 1. Results of Unit Root Tests

Variables	*Specification*	*Level (p values)*	*First Diff (p values)*
NRI	No intercept, no trend	0.938	0.000
	Intercept, no trend	0.762	0.000
	Intercept, trend	0.026	0.000
RI	No intercept, no trend	0.976	0.000
	Intercept, no trend	0.987	0.000
	Intercept, trend	0.805	0.000
GDP	No intercept, no trend	1.000	0.000
	Intercept, no trend	0.996	0.000
	Intercept, trend	0.799	0.000

Notes: RI is residential investment and NRI is non-residential investment

(ii) Granger Causality Tests

Tables 2a and 2b show the results with different lag specifications. In Table 2a Granger causality is tested with lags set at six (Guilkey and Salemi, 1982) and Table 2b shows the results of Granger causality tests with lags selected by AR(q) model fitting.

Table 2a. Results of Granger Causality Tests (# of lags=6)

Null hypothesis	P-value		
	Short-run model	Long-run model	ECM
NRI doesn't cause GDP	0.0887	0.1787	0.4304
GDP doesn't cause NRI	0.011	0.0024	0.0024
RI doesn't cause GDP	<0.001	<.0001	<.0001
GDP doesn't cause RI	0.2872	0.0775	0.1472

Table 2b. Results of Granger Causality Tests (lag selected recursively)

Null hypothesis	P-value			
	q	Short-run model	Long-run model	ECM
NRI doesn't cause GDP	3	0.0995	0.2277	0.3738
GDP doesn't cause NRI	3	0.0087	0.0002	0.0045
RI doesn't cause GDP	3	<.0001	<.0001	<.0001
GDP doesn't cause RI	2	0.8441	0.1002	0.1478

From Tables 2a and 2b, we cannot reject the null hypothesis that non-residential investment does not cause GDP and GDP does not cause residential investment at the 99% level of confidence. However, the 2^{nd} and the 3^{rd} null hypotheses are rejected at 99% confidence level.

From Table 2a, residential investment granger causes GDP and this is observed in all three specifications. Moreover, we can also see that GDP granger causes non-residential investment in the long run and ECM specifications. If we use the lag which we selected recursively by the AR model, the granger causality among these three variables are more consistent. Irrespective of our specification, we obtain consistent results, which show that residential investment Granger causes GDP and GDP Granger causes non-residential investment. Hence, we can conclude that different types of investment indeed play different roles in the economy.

(iii) Structural Break Test

The data used to test Granger causality is from 1959-I to 2005-IV. It contains more than 4 decades of data and incorporates several important policy changes, hence we check for structural breaks in order to prevent estimation errors. Two well known methods for testing structural break are CUSUM of squares test and Chow test. Based on the result from Granger causality test, we use equation (5) to test for structural break. The detrended data (short-run model) is used in the estimation.

$$GDP(t) = \sum_{j=1}^{3} a_j GDP(t-j) + \sum_{j=1}^{3} b_j RI(t-j) + e(t) \qquad (5)$$

where RI represents residential investment and e is a residual term. The lags are from the AR model. Figure1 represents the result of CUSUM of squares test. The graph shows no structural break during the period 1959I - 2005IV, since the errors lie in the 5% significance level band.

Chow test has also been used to test for structural break. The null hypothesis that "there is no structural break" is not rejected even at 90% confidence level given one break during 1965I - 2000IV. Results of Chow tests are given in Table 3.

To summarize after Granger causality tests and checks of structural break, we can say that there is a unidirectional causality existing between RI and GDP and between GDP and NRI.

$$\text{RI} \rightarrow \text{GDP} \rightarrow \text{NRI}$$

The first relationship follows from the fact that residential investment is often taken to be a good predictor of GDP in the economy. In the US, sales from Home Depot and Target are

Figure 1. CUSUM of Squares Test.

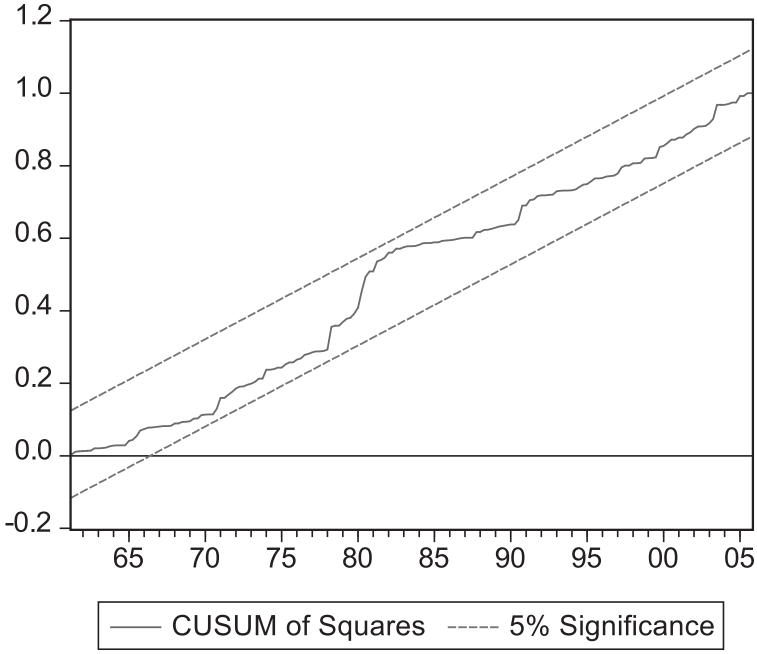


Table 3. Chow Test

Break point	F-statistic	P-value
1965-I	0.6621	0.6803
1970-I	0.5512	0.7685
1975-I	0.2059	0.9745
1980-I	0.4785	0.8237
1985-I	0.6383	0.6994
1990-I	0.9010	0.4954
1995-I	0.6908	0.6573
2000-I	0.7165	0.6367

seen as indicators of future economic growth. Exogenous factors like tax breaks could encourage people to invest more in new homes and at the same time a fall in the tax rate would by the multiplier effect increase GDP.

The second arrow highlights the role of inventories in predicting business cycles. When there is a recession, companies add to their inventories and during an expansion they drain their inventories. When GDP increases, it means that past inventories would be drained out and after that companies will begin to add to their plant and equipment. This can explain why GDP is a predictor of NRI and will not be predicted by NRI.

(b) Four Variable System: Residential Investment, Unemployment Rate, Real Money Balance and Interest Rate

In part(a) we have proved that residential investment Granger causes GDP. To better investigate the leading indicator characteristics of residential investment we investigate its role in a four variable system. Unemployment rate is taken as a measure of economic activity and money market is represented by real money balances and the interest rate. We can use either the vector auto regression (VAR) or ECM to check the lead-lag relationship between unemployment rate, real money balances and interest rate depending on the cointegrating relationship between the variables. If the four variables form a cointegrating relationship we need to apply the ECM.

(i) Unit Root Testing

We start our analysis by testing for unit roots in the variables under consideration. Table 4 shows the unit root test results for these four variables using ADF tests. The unit root test with level data cannot be rejected at the level of 90% confidence. Moreover, the unit root tests with first differenced data are rejected at more than 95% confidence level. Hence we can conclude that these four variables are all I(1) series and all the first differenced data are stationary.

(ii) Cointegration

Since all the four variables are I(1) we can check the cointegrating relationship between them. We use the Johansen procedure to check for the cointegrating relationship. Table 5 shows the test results.

The above table shows that we can reject the null hypothesis of no cointegration but cannot reject the null hypothesis that there is at most one cointegrating vector between them by both the trace and the max test. Hence, we infer that there is one cointegrating vector between all the four variables, which necessitates the use of an ECM instead of a VAR.

(iii) ECM Estimation

Table 6 presents the results from the ECM estimation. The first row shows the dependent variables, namely, change in unemployment rate, change in real rate of interest, change in logarithm of real residential investment and change in logarithm of real money supply. The first column depicts the independent variables which are also in the form of first differences. In the table, we only report those coefficients which are significantly different from zero at

Table 4. Results of Unit Root Tests[3]

Variables	*Specification*	*Level*	*First Diff*
i	No intercept, no trend	–0.764	–5.809***
	Intercept, no trend	–2.248	–5.789***
	Intercept, trend	–2.297	–5.858***
UR	No intercept, no trend	–0.673	–4.516***
	Intercept, no trend	–2.414	–4.505***
	Intercept, trend	–2.406	–4.493***
Log(RI)	No intercept, no trend	2.128	–7.33***
	Intercept, no trend	–0.031	–4.927***
	Intercept, trend	–3.600	–4.960***
LOG(M3/CPI)	No intercept, no trend	2.556	–2.707**
	Intercept, no trend	–1.158	–3.815***
	Intercept, trend	–2.898	–3.841***

**:5% significant level; ***1% significant level.

Table 5. Johansen Test

	Null hypothesis	λ value
Trace test	No cointegration	73.36153**
	At most one conintergration	17.01912
	At most two conintergration	4.523138
	At most three conintergration	1.477030
Max-eigenvalue test	No cointegration	56.34241**
	At most one conintergration	12.49598
	At most two conintergration	3.046108
	At most three conintergration	1.477030

**:5% significant level

3 Critical values: No intercept and no trend 1%: –2.6, 5%: –1.95, 10%: –1.62
Intercept and no trend 1%: –3.51, 5%: –2.89, 10%: –2.58
Intercept, trend 1%: –4.04, 5%: –3.45, 10%: –3.15

any of the three significance levels.

In case of the second column which is the equation for unemployment rate, the growth in the last period's real money supply enters the equation with a negative sign, which is consistent with the notion that money granger causes output. The change in the last quarter's residential investment affects the unemployment rate directly, indicating that residential investment is a forerunner to the changes in the level of economic activity.

From the third column we can infer that the nominal interest rate is explained by the level of economic activity, which is measured by a change in the unemployment rate. A fall in unemployment or a rise in output, will increase money demand and hence impact interest rate positively. The effect of real residential investment on i can be explained directly in the sense that if people want to borrow money to buy new houses then i would rise. It can also have an indirect effect because RI by affecting output leads to an increase in money demand and hence leads to a rise in i. This pattern is more evident from Figure 2.

In the fourth column, the results indicate that a fall in i, would reduce mortgage rates, boost up the demand for new houses and in turn promote the construction of new houses. Both the lags are significant showing that the response of housing investment takes some time to materialize. Money supply and residential investment would be linked through the interest rate channel indirectly. If money supply is high then there can be an expectation that economy is going to be buoyant in the future and people expect that their wages are going to be higher. Hence, they invest more in new houses.

The relationship in the last column shows the negative effect of last quarter's interest rate on the next quarter's money supply. This is a little difficult to explain, given that we expect the causality to be the other way round. Penm and Terrell (1994) also find that a two period lagged interest rate will affect money supply negatively.

The lead-lag relationships in the specification are summarized in Figure2. Residential investment appears to play a significant part as it affects the economic activity and interest rate directly. Moreover, it also has an indirect effect on money supply through its effect on interest rate. These results suggest that residential investment plays an important role in the economy and can be regarded as a leading indicator for economic activity. Nominal interest rate appears to be important too in influencing the level of economic activity. One period lagged interest rate explains real money supply and residential investment directly. It also has an indirect impact on the level of economic activity, given by the unemployment rate.

(iv) Impulse Response Analysis

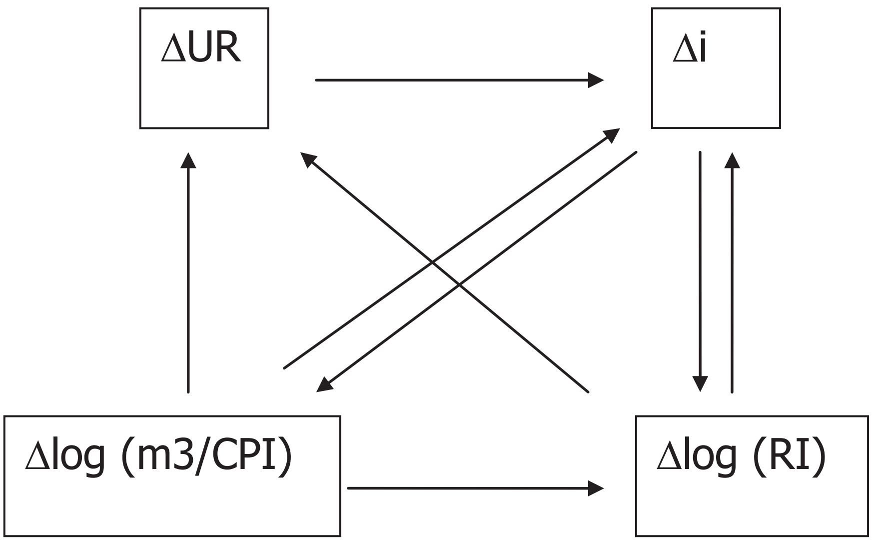
The impulse response to an innovation of one standard deviation in the residential investment is plotted in the Figure3. It is evident from the figure that a one standard deviation shock to residential investment would lead to an initial decline in unemployment

Table 6. Error Correction Model

	Δ UR	*Δ i*	*Δ Log (RI)*	*ΔLog (M3/CPI)*
Error correction term		–0.109** (0.024)	0.003** (0.001)	
ΔUR(–1)	0.494** (0.085)	–0.515** (0.297)		
ΔUR(–2)				
ΔR(–1)		–0.265** (0.089)	–0.008** (0.004)	–0.003** (0.001)
ΔR(–2)		–0.384** (0.091)	–0.006** (0.003)	
Δ Log(RI)(–1)	–1.804** (0.569)	3.510* (1.743)	0.347** (4.386)	
Δ Log(RI)(–2)			0.204** (0.077)	
Δ Log(M3/CPI)(–1)	–3.980* (2.377)		1.445 (0.330)	0.667** (0.079)
Δ Log(M3/CPI)(–2)		–25.599** (8.340)	–0.731** (0.328)	
constant			–0.599** (0.328)	0.003** (0.001)

Note: Standard errors are in parenthesis; *:10% significance level; **significant at 5% or less

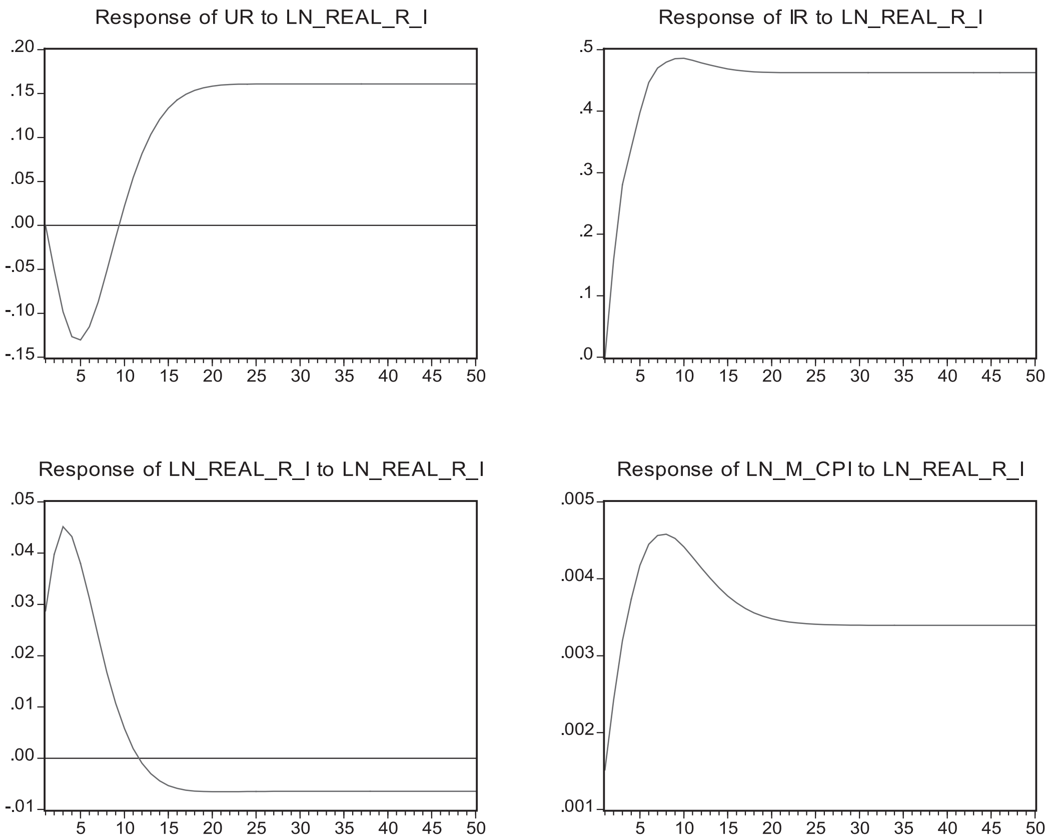
Figure 2. Lead Lag Relationships



rate and an increase in interest rate and money supply. However, in the long run after the impact of the shock dies down unemployment rate tends to increase. In the short run, when more houses are being built, it will increase the demand for labor and hence reduce the unemployment rate and GDP will tend to rise too. In the long run, after construction of new houses stops, the demand of labor will decrease and induce an increase in unemployment rate. The unemployment rate remains constant after about five years.

An increase in output raises the demand for money and interest rate tends to rise. The Federal Reserve increases the supply of money to meet the demand and we observe an increment in the real money supply too in the short run. In the long run, unemployment rate falls thereby leading to a concomitant decline in interest rates and money supply.

Figure 3. Response to Cholesky One S.D. Innovations



(v) Variance Decomposition

Forecast error variance decomposition of a variable tells us what proportion of the variance is due to its 'own' shocks versus the shocks to 'all other variables'. Tables (7a-7d) show variance decomposition of unemployment rate, interest rate, log of real residential investment and log of real money supply. The forecast horizon ranges from 1-24 quarters.

It is typical for a variable to explain almost all of its forecast error variance at short horizons and smaller portion at longer horizons. In the short run, which lasts for about a year, residential investment shock can explain 5% of fluctuation in unemployment rate but its explanatory power increases to 10 % in 24 quarters. Residential investment shock explains a much larger fraction of the movement in interest rate: 17% at 8 quarters horizon, 25% at the 24 quarters horizon. As for the real money supply, only a small portion of the forecast error variance is attributed to residential investment shock whether it is the short or the long run. It could be due to the fact that residential investment affects money supply indirectly by impacting nominal interest rate first.

V. Conclusion

In this paper, we examined the role of residential investment as a leading indicator of general economic activity. In the first part, we test the granger causality among residential investment, non-residential investment and GDP. The results suggest that residential investment granger causes GDP and GDP granger causes non-residential investment. In the second part, we examine the role of residential investment in the general economy in a four variable system. Some enlightening lead-lag relationships emerge from the analysis. Residential investment impacts financial and economic variable both directly and indirectly.

Variance Decompositions

Table 7a. Unemployment Rate

Period	*S.E.*	*Unemployment rate (UR)*	*Interest rate (i)*	*Log (RI)*	*Log (M3/CPI)*
1	0.232	100.000	0.000	0.000	0.000
4	0.774	93.280	0.537	4.702	1.479
8	1.152	81.359	4.597	5.178	8.864
12	1.354	72.524	8.996	4.308	14.170
16	1.512	66.716	11.51	6.225	15.545
20	1.654	63.076	12.81	8.687	15.418
24	1.785	60.680	13.613	10.685	15.019

Table 7b. Interest Rate

Period	*S.E.*	*Unemployment rate (UR)*	*Interest rate (i)*	*Log(RI)*	*Log(M3/CPI)*
1	0.830	20.428	79.572	0.000	0.000
4	1.633	37.509	53.511	8.231	0.749
8	2.442	39.937	42.445	17.227	0.391
12	3.009	39.546	38.479	21.656	0.319
16	3.464	39.221	36.750	23.716	0.313
20	3.862	39.061	35.787	24.847	0.305
24	4.223	38.969	35.152	25.582	0.296

Table 7c. Log Real Residential Investment

Period	*S.E.*	*Unemployment rate (UR)*	*Interest rate (i)*	*Log (RI)*	*Log (M3/CPI)*
1	0.032	14.997	4.877	80.126	0.000
4	0.090	4.224	5.422	78.063	12.290
8	0.141	15.970	12.552	48.081	23.395
12	0.176	29.169	15.534	31.538	23.758
16	0.200	37.006	16.626	24.444	21.923
20	0.221	41.944	17.213	20.532	20.312
24	0.238	45.416	17.617	17.870	19.097

Table 7d. Log Real Money Supply

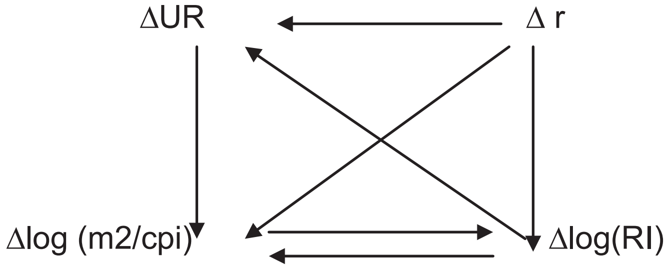
Period	*S.E.*	*Unemployment rate (UR)*	*Interest rate(i)*	*Log (RI)*	*Log (M3/CPI)*
1	0.008	2.159	6.037	3.629	88.176
4	0.031	2.775	10.852	3.390	82.982
8	0.057	2.947	11.376	3.393	82.284
12	0.078	3.322	11.729	3.050	81.899
16	0.095	3.626	11.945	2.711	81.718
20	0.109	3.822	12.077	2.467	81.634
24	0.122	3.948	12.161	2.301	81.590

Appendix

(a) Using Log (M2/CPI) and real interest rate (r)

Figure 4a

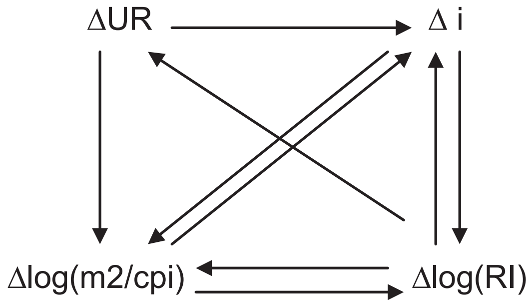
Lead-lag relationship using log (M2), real interest rate, real residential investment and unemployment rate



(b) Using M2 and nominal interest rate (i)

Figure 4b

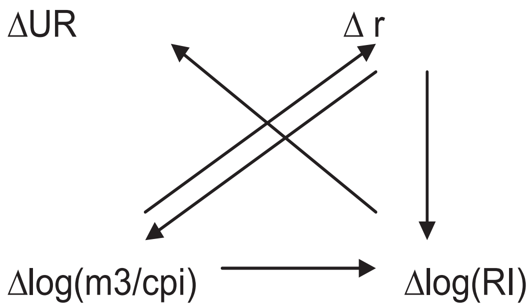
Lead-lag relationship using log (M2), nominal interest rate, real residential investment and unemployment rate



(c) Using money supply (M3/CPI) and real interest rate (r)

Figure 4c

Lead-lag relationship using log(M3), real interest rate, real residential investment and unemployment rate



References

Brown, Durbin and Evans, (1975), "Techniques for Testing the Constancy of Regression Relationships over Time", *Journal of the Royal Statistical Society*, Series B37, 149-162.

Dickey D. And W. Fuller, (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association*, 74, 427-431.

Enders, Walter, (1995), *Applied Econometric Time Series*, John Wiley & Sons

Engle, R. and C. Granger, (1987), "Cointegration and Error Correction: Representation, Estimation, Testing", *Econometrica*, 55, 251-276.

Geweke, J., R. Meese and W. Dent, (1983), "Comparing Alternative Tests of Causality in Temporal Systems: Analytical Results and Experimental Evidence", *Review of Economics and Statistics*, 21, 161-194

Granger, C., (1969), "Investigating the Causal Relationships by Economteric Models and Cross-Spectral Methods", *Econometrica*, 37(3), 424-38

Green, Richard K., (1997), "Follow the Leader: How Changes in Residential and Non-Residential Investment Predict Changes in GDP", *Real Estate Economics*, 25, 253-270.

Guilkey, D. and M. Salemi, (1982), "Small Sample Properties of Three Tests for Granger-Causal Ordering in a Bivariate Stochastic System", *Review of Economics and Statistics*, 64(4), 668-708.

Hendershott, P., (1989), "Comment on social returns to housing and other fixed capital", *Journal of the American Real Estate and Urban Economics Association*, 17, 212-217.

Hylleberg, S., Engle, R.F., Granger, C.W.J. and Yoo, B.S. (1990), "Seasonal Integration and Cointegration", *Journal of Econometrics*, 44, 215-38

Johansen, S. (1988), "Statistical analysis of cointegration vectors", *Journal of Economic Dynamic and Control*, 12, 231-54.

Johansen, S. and Juselius, K. (1990), "Maximum likelihood estimation and inference on cointegration with applications for the demand for money", Oxford Bulletin of Economics and Statistics (52), 169-210.

King, Rober G., Chalres I. Plosser, James H. Stock and Mark W. Watson, (1991), "Stochastic Trends and Economic Fluctuations", *American Economic Review*, 81, 819-840.

Mills E., (1987), "Has the United States Overinvested in housing?", *Journal of the American Real Estate and Urban Economics Association*,15(1), 601-616.

Penm, Jammie H. and R.D. Terrell, (1994), "Is Housing Activity a Leading Indicator?", *Economic Record*, 70, pp. 241-252.

Sims, C. (1977), "Exogeneity and Causal Ordering in Macroeconomic Models". (C. Sims, ed.) New Methods in Business Cycle Research: Proceedings from a Conference. Federal Reserve Bank of Minneapolis: Minneapolis, MN.