Anticipating Change in Development Activity Levels

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***Abstract.* This study demonstrates how cointegration analysis of privately-owned housing within disparate areas of the United States can aid developers in anticipating changes in the level of market activity. The study analyzes change in the number of housing units within four geographic regions: the Northeast, the Midwest, the South and the West. Whereas most studies of regional variation in real estate activity have focused on short-run analysis, this research extends the examination to consider the impact of exogenous variables over a longer time frame. The study uses Citibase data from 1959 through 1995. Results indicate that the four regions move together in the long run and are driven by one common factor, but that change in the South and the West lead those in the other two regions. Results have widespread policy implications for residential and commercial developers nationwide, because change within the dominant areas may serve as indicators of developing change elsewhere.**

Introduction

Acquiring land, or long-term purchase options on land, in advance of need is a dicey proposition for large scale residential developers. Miscalculation in either direction is exorbitantly expensive. If more land is acquired than can be absorbed by market-driven development, carrying costs erode the profitability of development activity. But if insufficient land is acquired, the developer runs into a double bind, where escalating land costs put the company at an intolerable disadvantage vis-à-vis competitors who guess right about the need for advance land acquisition.

Traditional analysis of building cycles offers little guidance, because the time intervals between peaks and troughs have proven unpredictable. *Cointegration analysis* is a promising way to reduce the dimensions of the developer's problem. This technique measures the equilibrium relationship between levels of development activity in targeted geographic regions, and helps identify regions that consistently lead the cycle of resurgence and decline. Tracking the level of activity in leading regions will alert developers to wide-scale economic trends that will influence demand in their own region in the future. When the leading region posts an appropriate warning, developers

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can analyze the implications for their own region. This will help them estimate the timing of alterations to their inventory of land.

Of course, the demand for housing units within a region is also influenced by factors that are unique to the region. Examples of phenomena that would cause regional housing demand to diverge from the inter-regional trend include problems with the oil and gas industry in the 1980s and adjustments in the heavy manufacturing industry during the 1970s. Cointegration analysis will be useless in anticipating such events. Any reduction in uncertainty, however, any signal of impending economic change, will reduce the riskiness associated with large-scale residential development.

The goal of this article is to examine movements and patterns in housing units for the period of January 1959 to October 1995 to find out how housing development activity in one region may be related to that in other geographic regions and whether a particular region dominates or leads real estate development activity.

The remainder of the article is organized as follows. The next section provides a discussion of real estate cycles including a review of the literature on real estate movements relating to geographic regions. The following section provides the main empirical analyses of this study including a discussion of the results. A final section summarizes and concludes the study and reports implication for further research.

Background Analysis

Housing development in the United States has undergone substantial volatility in the last four decades. The real estate market collapse in some regions during the 1980s is legendary, and during this same time some distressed geographic areas simultaneously experienced new housing developments (Smith and Tesarek, 1991). One might have expected these distressed areas to encounter declines in housing prices to clear the market of excess vacant units. However, an increase in the demand for units was felt across many areas. Typically, the demand for additional housing units requires either population growth or changes in household formation before the quantity of housing units demanded matches the quantity of housing units supplied. The population must grow or demographic changes in household formation must occur to increase the demand for new rather than merely existing housing units. Thus, patterns in the number of housing units started over time can indicate population swings and household formation changes which directly impacts real estate development. This study examines the number of privately-owned housing units across broad geographic regions in an attempt to detect whether changes in the number of units and thus population and demographic patterns are related across regions. In effect, the study uses change in the number of privately-owned units as a proxy for residential development activity.

It is important to examine real estate development through an economic regions approach to fully understand regional real estate investment opportunities and risk (Burley, Lohr and Lankford, 1994). Geographical diversification has long been considered a tool to insulate a portfolio from region-specific market volatility. It is equally as crucial to consider regional trends that extend over complete economic cycles when seeking a well-diversified portfolio strategy. Understanding regional economic diversification and stability is important in explaining mortgage portfolio risk (Eichholtz, 1995). Examining real estate development patterns over time can indicate investment cycles and provide an indicator of future trends in other areas of real and personal investment.

Geographic qualities and local market conditions impact the effect that exogenous factors such as tax laws and inflation have on real estate investment values (Ling, 1992). Some studies have examined a limited number of cities in the U.S. to determine how single-sector economies with varying employment and economic diversity impact the investment opportunities (including housing prices) and risk of a diversified portfolio (Smith and Tesarek 1991; Rabianski 1992; Burley, Lohr and Lankford, 1994; and Clapp, Dole and Tirtifoglu, 1995). Burley et al (1994) conclude that understanding real estate cycles in various economic regions will help a portfolio manager develop a geographically diversified portfolio. Turnbull (1994) examined housing demand and determined that endogenous location choice for housing affects housing demand properties in a monocentric market environment.

Grouping economic regions or metropolitan areas and simultaneously preserving the regionality into the portfolio may allow one to develop a well-balanced risk-adjusted portfolio. Data grouped according to broad geographic areas may indicate economic trends since variables such as employment patterns, concentration of industry and commuting patterns tend to be similar within fairly large metropolitan and surrounding areas.

While geographic regions appear to have economic similarities, research examining housing starts across broad areas is limited. No study is found which provides a long term examination of the movement in the number of privately-owned housing units (and, by extension, changes in the level of construction activity) for broad geographic groupings of data. This study examines changes in the housing inventory within four broad regions in the U.S.: the Northeast, the Midwest, the South and the West and explores cointegration patterns over a long term.

Most research has focused on a short-run approach to real estate market equilibrium, *i.e.*, requiring only that the market clears or willing sellers locate willing buyers, but the long-run equilibrium indicates the level at which the market-clearing asset price equals construction costs (Ling, 1992). This study develops a real estate valuation model that includes the effect that local or regional conditions have on real estate values and determines which local economies most benefited from certain market changes such as modifications to the Tax Reform Act of 1986.

Examining real estate housing development cycles over the long-run and analyzing whether housing starts are related across regions provides valuable information. The critical advantage of this type of study on housing units is that demographic and housing formation trends can be reported and particular regions that are dominant in precipitating housing development across entire populations can be identified.

Subsequently, other real estate development patterns as well as market trends related to demographic household characteristics may be forecast from an examination of housing units demanded.

Long-run Relationship Between Housing Units Across U.S. Regions

There are few studies that use a cointegration approach to study housing demand dynamics. Since the number of privately-owned housing units in different regions are cointegrated with one common stochastic trend as shown below, this approach may provide a more in-depth understanding of the transmission mechanism of housing markets in the four geographic regions, the Northeast (*NE* or x_1), the Midwest (*MW* or x_2), the South (*SO* or x_3) and the West (*WT* or x_4). The common trend, which is primarily derived from one or two regions, is driving the whole system (*i.e.*, the four regions) in housing demand. Accordingly, when estimating the housing demand of a particular region, one should incorporate the demand of the region that is estimated to be the common trend.

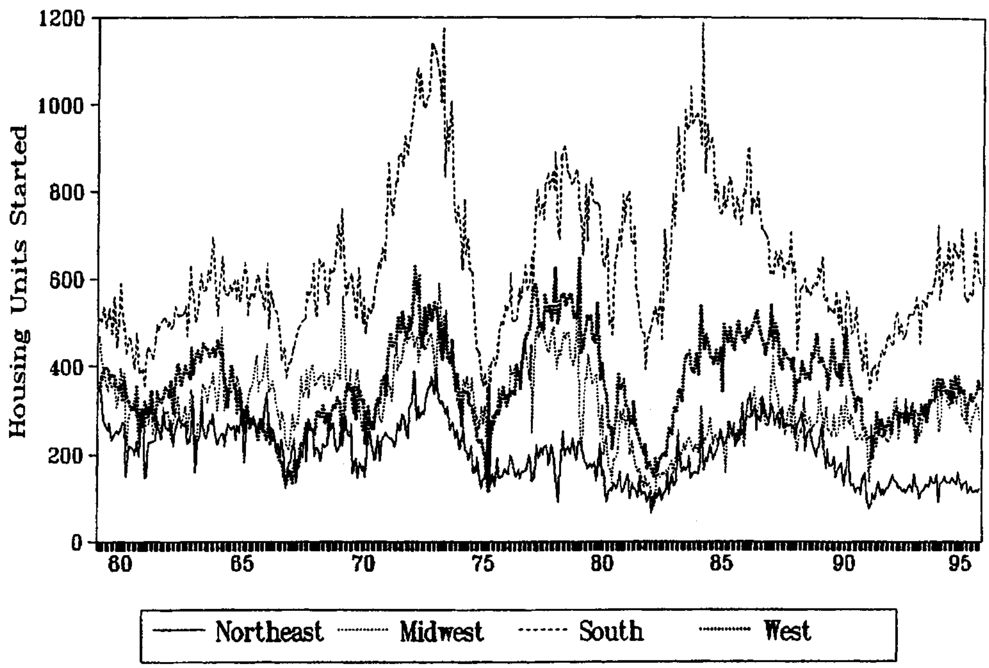
The period examined is from January 1959 to October 1995 and monthly data are obtained from the Citibase with a sample size of 442. Hereafter, $Y_t = \{y_i\} = (NE_t\ MW_t\ SO_t\ WT_t)'$. Exhibit 1 graphically depicts aggregate data on privately-owned housing. From this illustration co-movements between the four regions over the years examined can be seen, supporting the belief that housing units demanded move together across geographic regions.

The ADF (Dickey and Fuller, 1979, 1981) unit root results represented in Panel A of Exhibit 2 do not reject the null hypothesis that the series of the (log) housing units, x_i's, have a unit root. These results show that x_i's can be characterized as $i(1)$ or nonstationary processes and, therefore, they can wander extensively. The results are consistent with the notion that the economic/market factors affecting housing demands, such as mortgage interest rates, GDP, and the unemployment rate, varied substantially during the period examined. The housing demands, therefore, also fluctuated significantly.

Since the housing markets of the four regions are influenced by these economic/ market factors, demand for privately-owned housing units should move together in the regions and should not diverge over the long run. Similarly, short-term interest rates may individually move up and down significantly, but they should not move apart remarkably over the long run. Cointegration, which can describe the existence of this equilibrium or stationary relationship among $i(1)$ series, is used to analyze the long-run Granger-causality of these four regions' housing units. The theory of cointegration is fully developed in Engle and Granger (1987).

Johansen (1988, 1991) has developed the maximum likelihood estimator for a cointegrated system. The Johansen tests are reasonably robust to various non-normal distributions (see Cheung and Lai, 1993; Gonzalo, 1994; and Lee and Tse, 1996).

Exhibit 1
Privately-Owned Housing Units
January 1959–October 1995



Let Y_t be the nx1 vector of the series; $n = 4$ in the current study. If Y_t is cointegrated, it can be presented by the following vector error correction model (VECM):

$$\Delta Y_t = \mu + \Pi Y_{t-1} + A_1 \Delta Y_{t-1} + \cdots + \Delta Y_{t-k+1} + e_t, \tag{1}$$

where μ is a $n \times 1$ vector of drift, Π and A_i's are $n \times n$ matrices of parameters and e_t is a $n \times 1$ white noise vector. The long-run relationship matrix, Π, has reduced rank of $r < n$ and can be decomposed as $\Pi = \alpha\beta'$, both α and β are of dimensions of $n \times r$. α denotes the error correction (or equilibrium adjustment) matrix, and β spans the cointegrating (equilibrium relationship) vectors. The Johansen *trace* and λ_{max} test statistics for the null hypothesis that there are at most r cointegrating vectors with $0 \leq r \leq n$ and thus $(n - r)$ common stochastic trends are, respectively,

$$trace = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i), \tag{2a}$$

$$\lambda_{\max} = -T \ln(1 - \lambda_{r+1}), \tag{2b}$$

where λ_i is the i^{th} greatest squared canonical correlation.

Exhibit 2
Unit Root and Cointegration Tests

Panel A: ADF Unit Root Tests[a]

	NE	*MW*	*SO*	*WT*	Critical Values (5%)
H_0: $\alpha_1 = 0$	−2.80	−3.14	−2.61	−2.64	−3.41
H_0: $\alpha_1 = \alpha_2 = 0$	3.92	4.97	3.46	3.50	6.25

Panel B: Johansen Cointegration Tests[b]

	Cointegration Vectors, β			
β_1	1.00	13.10	3.70	−12.47
β_2	1.00	−0.43	0.03	−0.24
β_3	1.00	1.08	−0.39	1.59

		Critical Values			Critical Values	
	Trace	5%	1%	λ_{max}	5%	1%
$r = 3$ ($m = 1$)	7.18	8.18	11.65	7.18	8.18	11.65
$r = 2$ ($m = 2$)	25.86	17.95	23.52	18.69	14.90	19.19
$r = 1$ ($m = 3$)	52.86	31.52	37.22	27.07	21.07	25.75
$r = 0$ ($m = 4$)	91.99	48.28	55.43	39.06	27.14	32.14

[a]The ADF test is based on the following OLS:

$$\Delta y_{it} = \alpha_0 + \alpha_1 y_{i,t-1} + \alpha_2 t + \sum_{l=1}^{L} \Delta y_{i,t-l},\ i = 1, 2, 3 \text{ and } 4.$$

The critical values are available in Fuller (1976:373).

[b]The critical values are obtained from Osterwald-Lenum (1992). Results reported for $k = 2$ are qualitatively the same for $k = 1$ to 4.

The results of the Johansen tests are reported in Panel B of Exhibit 2. It demonstrates that the four series are cointegrated with $r = 3$, indicating that there is one common stochastic trend in the cointegration system. The lag length k equal to two in the VECM (1) is chosen by the Schwarz information criteria (SIC). The results (available upon request) are qualitatively the same for $k = 1$ to 4. The VECM results are not discussed in detail but are reported in the Appendix.

Before examining the cointegrating relationship by exploring the common trend among series, it is important to test whether any of the variables, $y_{i,}$ $i = 1, .., 4$, are not involved in the cointegrating relations. The null hypothesis H_0: y_i is not contained in all three cointegration vectors, *i.e.*, $\beta_{ij} = 0$, $j = 1,2,3$, is tested by the likelihood ratio test:

$$T \sum_{i=1}^{r} \ln[(1 - \lambda_i^*)/(1 - \lambda_i)], \tag{3}$$

where λ_i^* is the i^{th} largest eigenvalue from the model under the null and is distributed as χ^2 in Equation (3). Since the null is rejected for each variable in the system, as shown in Panel A of Exhibit 3, all four regions should be considered in examining the long-run relationships between housing units in different U.S. regions.

Panel B reports the results of the null hypothesis, with a test statistic similar to Equation (3), that y_i is weakly exogenous in the cointegrating system (*i.e.*, not adjust to the long-run disequilibrium errors), with the null being H_0: $\alpha_{ij} = 0, j = 1,2,3$. While the null is rejected for the Northeast and Midwest regions at any conventional significance levels, it is not rejected for the South (with p-value = .055) and is marginally rejected for the West (with p-value = .014). This means that the South and, marginally, the West are weakly exogenous and Granger-causes other variables in the long run. More specifically, the housing markets of the South and West react to the changing economic environment more rapidly than do those of the Northeast and Midwest. Therefore, the housing demands of the South and West lead the other two regions.

The long-run causality relationships are analyzed in more detail by estimating the common stochastic trend that drives the whole system. Examining the common patterns in cointegration systems can facilitate a more thorough understanding of the equilibrium relationship between data sets than using only the vector error correction

Exhibit 3
Hypothesis Testing of Cointegration (β), Adjustment (α) and Common Factor (α_1) Spaces

	y_i			
	NE	*MW*	*SO*	*WT*
Panel A: H_0: $\beta_{ij} = 0$, $j = 1,2,3$ (*i.e.*, y_i is not contained in the cointegrating vectors).				
t-Stat, $\chi^2(3)$	19.1	26.2	12.7	22.9
p-value	.000	.000	.000	.000
Panel B: H_0: $\alpha_{ij} = 0$, $j = 1, 2, 3$ (*i.e.*, y_i is weakly exogenous in the cointegration system.				
t-Stat, $\chi^2(3)$	18.37	25.30	7.60	10.6
p-value	.001	.000	.055	.014
Panel C: H_0: $(\alpha'_\perp)_i = 0$, (*i.e.*, y_i is not included in the common stochastic trend, $f_t = \alpha'_\perp Y_t$.				
Estimation of $\alpha'_\perp$	1.00	−2.94	6.19	7.92
t-Stat, $\chi^2(2)$	8.18	3.76	11.56	17.93
p-value	.002	.053	.001	.000

models in Equation (1). As suggested by Stock and Watson (1988), Y_t can be described by the following common-factor model:

$$Y_t = \Theta \, f_t + g_t, \tag{4}$$

where f_t is the common factor scalar, Θ is the loading vector and g_t is the transitory component. In the current context, the common factor is assumed to be driven by some common economic/markets forces in the cointegrating system comprised by the four regions.

Based on the duality of the cointegrating relations in Johansen (1991) and the common factors, Gonzalo and Granger (1995) show that:

$$f_t = \alpha'_{\perp} Y_t, \tag{5}$$

where $\alpha'_{\perp}$ is an orthogonal matrix of α. The likelihood ratio test of the null hypothesis that y_i is not included in the common factor is distributed as χ^2 in Equation (1). See Gonzalo and Granger for detailed derivation of this test statistic. In Panel C of Exhibit 3, $\alpha'_{\perp}$ is estimated to be (1.00 − 2.94 6.19 7.92), *i.e.*, the common factor $f_t = NE_t - 2.94 \times MW_t + 6.19 \times SO_t + 7.92 WT_t$. Thus, the South and West have higher weights in f_t, suggesting that these two regions are the dominant regions in the long run. Moreover, the test statistic of the null that y_i is not included in the common trend is larger for the South (with p-value = .001) and West (p-value = .000), while the null is not reject (with p-value = .053) for the Midwest. These results parallel the previous results, indicating that the South and the West respond to the changing economic environment more rapidly than do the other regions.

In sum, the overall results show that all the regions are involved in the cointegration system with the South and West being the dominant regions in privately-own housing units. The Midwest plays the least important role in the long-run causal relationship.

Conclusion

This study provides an analysis of long-run trends in the number of privately-owned houses (and by extension, the level of residential development activity) in the U.S. by using a multivariate time-series model of four broad geographic regions in the: Northeast, Midwest, South and West. The results indicate that the level of residential development activity in these four regions are cointegrated with one common stochastic trend. The common trend causes the movement in housing units across these regions in the long run, and interestingly the South and West regions are dominant. These results have widespread implications in that residential development activity across the entire U.S. is related but the South and the West regions dominate the movements. Housing demand is primarily determined by population and demographic changes, and the discovery of dominant regions has widespread marketing implications for developers. Since the South and West are influential in projecting trends in housing starts, development activity in these regions can be considered indicative of other household patterns and demographic changes.

Further research may be helpful in addressing more refined geographic regions to locate which areas in the South and the West are the primary determinants of movements. Given the renowned real estate volatility in Texas and southern Louisiana during the 1980s and similar eras, one may find that more delineated areas like these may be responsible for determining residential development activity over much larger geographic regions.

Appendix

Error Correction Models

$\Delta Y_t = \mu + \alpha_1 Z_{1,t-1} + \alpha_2 Z_{2,t-1}, + \alpha_3 Z_{3,t-1} = A_1 \Delta Y_{t-1} + e_t,$

	Dependent Variable			
	ΔNE_t	ΔMW_t	ΔSO_t	ΔWT_t
$Z_{1,t-1}$	−0.003	−0.010	−0.008	0.005
	(−1.7)	(−5.1)	(−2.8)	(2.7)
$Z_{2,t-1}$	−0.124	0.071	−0.038	0.049
	(−4.2)	(1.7)	(−0.7)	(1.4)
$Z_{3,t-1}$	−0.019	−0.023	0.016	−0.023
	(−2.3)	(−2.1)	(1.1)	(−2.4)
ΔNE_{t-1}	−0.339	0.045	0.018	−0.113
	(−7.4)	(0.7)	(0.2)	(−2.1)
ΔMW_{t-1}	0.049	−0.236	0.159	0.063
	(1.4)	(−4.8)	(2.5)	(1.5)
ΔSO_{t-1}	0.004	0.002	−0.442	−0.006
	(0.2)	(0.1)	(−9.5)	(−0.2)
ΔWT_{t-1}	0.039	−0.040	0.127	−0.273
	(1.0)	(−0.7)	(1.8)	(−5.8)
Constant	10.09	26.83	12.82	−4.83
	(2.5)	(4.8)	(1.8)	(−1.0)

$Z_{j,t-1} = \beta_j' Y_{t-1}$, $j = 1,2,3$ are the error terms. t-Statistics are in the parentheses.

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