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Las Cruces Housing Price Dynamics: 1971-2019

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LAS CRUCES HOUSING PRICE DYNAMICS: 1971-2019*

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Abstract: To examine housing price dynamics for Las Cruces, New Mexico, a theoretical model is developed that takes into account the supply and demand sides. The ARDL estimation methodology employed allows for more realistic market dynamics than prior studies of this residential real estate market, the second largest in New Mexico. A slightly larger sample size is also utilized. Results obtained corroborate evidence reported in several previous housing studies. Some unexpected outcomes also indicate that consistently reliable interlinkages between housing prices and explanatory variables may be elusive. Among the latter, an inverse relationship between apartment rents and single-family housing prices is most surprising. That outcome may be a consequence of a large university and college student population within Las Cruces. As post-secondary enrollments grow, faculty numbers also increase, potentially allowing both housing prices and apartment rents to increase simultaneously. That implies that apartments and single-unit houses may be complements rather than substitutes in college towns like Las Cruces. Additional research using data for other small- and medium-sized urban economies would be helpful.

Keywords: Housing Economics, Urban Economics, Las Cruces

JEL Classifications: R21 Housing Demand; C20 Single Equation Models; R15 Regional Econometrics

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INTRODUCTION

Residential real estate is among the most important segments of any metropolitan economy. In many urban economies, the greatest number of housing units are existing, or previously built, single-family residential homes. Although it is the second-largest metropolitan economy in New Mexico, to date, relatively few studies analyze the Las Cruces housing sector.

One recent effort examines factors that influence Las Cruces housing price fluctuations (Fullerton et al., 2021). Results in that study indicate that local housing price changes are correlated with local income variations and national housing price movements. The empirical framework employed does not allow for elaborate dynamic patterns. Given that, plus the exploratory nature of the research, confirmation of the empirical outcomes reported would be useful.

This study extends the earlier inquiry in two manners. First, it updates the data sample by including additional information. Second, it employs a different estimation methodology that allows for more intricate temporal linkages than those contemplated in the original study.

Subsequent sections of the study are as follows. Section two provides a brief review of the theoretical model. Section three summarizes the data employed and the empirical results obtained. Section four encapsulates principal outcomes and offers concluding remarks.

THEORETICAL MODEL

The supply function is based upon DiPasquale and Wheaton (1994). As shown in Equation (1), the housing stock (S) is expected to increase as the real price per unit (P) increases. The annual rate of depreciation is δ. The $_t$ subscript is a time index. Model parameters in Equation (1) are α_0, α_1, and α_2.

$$\Delta S_t = \alpha_0 + \alpha_1 P_t - \delta S_{t-1}$$

$$S_t - S_{t-1} = \alpha_0 + \alpha_1 P_t - \delta S_{t-1}$$

$$S_t = \alpha_0 + \alpha_1 P_t - \delta S_{t-1} + S_{t-1}$$

$$S_t = \alpha_0 + \alpha_1 P_t + (1-\delta) S_{t-1}$$

$$S_t = \alpha_0 + \alpha_1 P_t + \alpha_2 S_{t-1}$$

The variables shown above include the Las Cruces housing supply, or stock, per capita, denoted by S, and the median real price per single-family housing units in Las Cruces is indicated by P. An annual time index is denoted by the subscript t. In Equation (1), the variable S is hypothesized to be positively correlated with the contemporaneous lag of P and with a one-year lag of S. As P increases, home builders will be able to construct more expensive single-family housing units because higher costs of material and labor can be covered (DiPasquale and Wheaton, 1994). A depreciation/

demolition rate coefficient is also included. The rate of demolition is generally less than 2 percent of the existing stock.

Housing demand, D, is specified in a manner similar to DiPasquale and Wheaton (1994) and Fullerton and Kelley (2008). As was the case in Equation (1), P is the real median price for a stand-alone dwelling in Las Cruces. INC is real per capita income for Las Cruces. RM denotes the real mortgage rate, calculated as the difference between the nominal mortgage rate and the personal consumption expenditures deflator inflation rate. The real monthly rent variable, RENT, controls for competition from the non-owner portion of the residential real estate market. The national real median price for single-family houses, NHP, is included in Equation (2) to account for the investment motive that underlies housing demand.

$$D_t = \beta_0 + \beta_1 INC_t - \beta_2 RM_t + \beta_3 RENT_t + \beta_4 NHP_t - \beta_5 P_t \quad (2)$$

Equation (3) develops an expression for P by equating Equations (1) and (2) and solving for P. The result expresses P as a function of contemporaneous lags of INC, RM, RENT, and NHP. It also includes a one period lag of S as a right-hand regressor.

$$S_t = D_t$$

$$\alpha_0 + \alpha_1 P_t + \alpha_2 S_{t-1} = \beta_0 + \beta_1 INC_t - \beta_2 RMt + \beta_3 RENT_t + \beta_4 NHP_t - \beta_5 P_t$$

$$\alpha_1 P_t = \beta_0 - \alpha_0 + \beta_1 INC_t - \alpha_2 S_{t-1} - \beta_2 RM_t + \beta_3 RENTt + \beta_4 NHP_t - \beta_5 P_t$$

$$\alpha_1 P_t + \beta_5 P_t = \beta_0 - \alpha_0 + \beta_1 INC_t - \alpha_2 S_{t-1} - \beta_2 RM_t + \beta_3 RENT_t + \beta_4 NHP_t$$

$$(\alpha_1 + \beta_5) P_t = \beta_0 - \alpha_0 + \beta_1 INC_t - \alpha_2 S_{t-1} - \beta_2 RM_t + \beta_3 RENT_t + \beta_4 NHP_t$$

$$P_t = (\beta_0 - \alpha_0 + \beta_1 INC_t - \alpha_2 S_{t-1} - \beta_2 RM_t + \beta_3 RENT_t + \beta_4 NHP_t) / (\alpha_1 + \beta_5)$$

$$P_t = \gamma_0 + \gamma_1 INC_t + \gamma_2 S_{t-1} + \gamma_3 RM_t + \gamma_4 RENT_t + \gamma_5 NHP_t \quad (3)$$

The algebra for Equation (3) yields a specific hypothesis for each of the explanatory variable reduced form coefficients. Two of the five slope parameters above are hypothesized to be negative: $\gamma_2 < 0$; $\gamma_3 < 0$. The three remaining slope parameters are postulated to be positive: $\gamma_1 > 0$; $\gamma_4 > 0$; $\gamma_5 > 0$. Because it has fairly reasonable data requirements, Equation (3) offers a good starting point for analyzing prices in smaller urban housing markets.

Greater detail on the various components associated with this model are found in Fullerton et al. (2021). Results in that study indicate that local income, INC, and national housing prices, NHP, provide useful information regarding Las Cruces housing prices. The specification shown in Equation (3) does not allow for very elaborate dynamic linkages between the regressors and P. To provide better insights on that aspect of the Las Cruces housing market, an autoregressive distributed lag (ARDL) modeling framework is employed. An ARDL approach is useful because it can capture both short-run and long-run dynamics associated with local housing prices (Pesaran et al., 2001; Ozturk and Acaravci, 2011).

SAMPLE DATA

Table 1 lists the names, descriptions, units, and sources of all of the variables that have been collected for the data sample. Of the six variables included in the data set, four of the variables were missing observations: median Las Cruces single-family housing price (P), median 2-bedroom apartment rent (RENT), single-family housing stock (S), and real mortgage rate (RM). For P, RENT, and RM, linear regression equations are applied to impute the missing values (Friedman, 1962). As for single-family housing stock (S), percentage changes in households and population were used to extrapolate the per capita housing stock data (Sweet and Grace-Martin, 2012). Each variable was converted from nominal to real figures except for the single-family housing stock.

Table 1. Variable Names, Definitions, and Units of Measure

Variable	Definition	Units of Measure	Sources
P	Las Cruces Real Median Single-Unit Housing Price	2012 Real $, 1000s	IHS and BRMP
INC	Las Cruces Real Income Per Capita	2012 Real $, 1000s	BEA and Census
S	Las Cruces Single-Family Housing Stock Per Capita	SF Houses Per Person	IHS, Economy.com, and BRMP
RM	Real Mortgage Rate	Percent	BRMP
RENT	Las Cruces Real Median 2-BR Apartment Rent	2012 Real $, 1000s	HUD and BRMP
NHP	USA Real Median SF Housing Price	2012 Real $, 1000s	FRED and BRMP

Notes:
BEA, U.S. Bureau of Economic Analysis.
Census, U.S. Census Bureau.
Economy.com, Moody's Analytics Economy.com.
FRED, Federal Reserve Bank of St. Louis Economic Data.
HUD, U.S. Department of Housing and Urban Development.
IHS, IHS Markit, formerly Wharton Econometrics.
BRMP, University of Texas at El Paso Border Region Modeling Project.

Summary statistics for each of the variables are reported in Table 2. Over the course of the 49-year sample period, P, the real price of single-family housing units in Las Cruces ranges from a minimum of $71.73 thousand in 1971 to a maximum of $163.04 thousand in 2007. As in many other regions, the price peak occurred during the global housing bubble (Kim and Renaud, 2009).

Real per capita income (INC) tallies a low of $16.27 thousand in 1971 and reaches a maximum of $34.23 thousand in 2019. Although the peak years differ for P and INC, the correlation coefficient between the two variables is 0.925. S, per capita single-family housing stock, reached a low of 0.193 in 1993 and 1994 before ascending to 0.255 in 2019. Although a greater supply of single-family housing stock is generally associated with lower prices, the variables P and S are positively correlated with each other over time.

Table 2. Summary Statistics

Statistic	P	INC	S	RM	RENT	NHP
Mean	$117.891	$23.483	0.218	4.526	$638	$202.695
Median	$115.921	$21.249	0.215	3.888	$634	$193.016
Maximum	$163.039	$34.231	0.255	10.485	$763	$304.221
Minimum	$68.743	$15.401	0.193	-1.221	$584	$115.496
Std Dev	$25.019	$5.864	0.016	2.415	$40	$53.169
Skewness	-0.113	0.426	0.687	0.458	0.911	0.293
Kurtosis	2.256	1.734	2.793	3.251	4.137	2.070
Coef Var	0.212	0.250	0.074	0.534	0.062	0.262

(1)

Notes:
Sample Period: 1971-2019
P, INC & NHP are monetary units expressed in 2012 constant thousands of dollars.
RENT is monetary units expressed in 2012 constant dollars per month.
Std Dev is an acronym used for standard deviation due to space constraints.
Coef Var is an acronym used for coefficient of variation due to space constraints.

The real mortgage rate, RM, reaches negative territory during the first global oil shock in 1974 at -1.2 percent. Due to several factors, including fairly tight monetary policy, RM rose to 10.49 percent in 1982 (Brazleton, 1994). RM and P have a negative correlation coefficient of -0.081. Adjusted for inflation, the median 2-bedroom apartment rent in Las Cruces, RENT, registers a nadir of $584 per month in 1996 and an apex of $763 per month in 2014. The median real national single-family housing price, NHP, posts a minimum of $115.496 in 1971 and achieves an apex of $304.221 thousand in 2017. The correlation coefficient for P and NHP is 0.901.

ECONOMETRIC METHODOLOGY AND EMPIRICAL

Variations in the median price of single-family housing are analyzed utilizing an autoregressive distributed lag (ARDL) approach. The model includes five independent variables as shown in Equation (3) and described in Tables 1 and 2. With the exception of RM, all of the data are transformed using natural logarithms prior to parameter estimation. Performing that step on the non-zero "amount" variables in the sample helps ensure that the normality assumption is satisfied (Gelman and Hill, 2006).

Lag length selection for the unit root ADF tests was determined using the Akaike information criterion (Pindyck and Rubinfield, 1998). First differencing is required to induce stationarity in all of the variables. After first differencing, all of the variables are stationary at the standard 5-percent significance threshold (Table 3).

Table 3. Augmented Dickey-Fuller Unit Root Test Results

Series	Computed Statistic	Probability
D(LP)	-3.95	0.0035
D(LINC)	-7.25	0.0000
D(LS)	-2.92	0.0499
D(LRM)	-6.27	0.0000
D(LRENT)	-2.98	0.0442
D(LNHP)	-4.68	0.0004

Notes:
Sample period, 1971-2019.
All data transformed using natural logarithms prior to differencing.
Intercept, without trend outcomes presented.
MacKinnon (1996) one-sided P values.

Estimation results for the ARDL model are reported in Table 4. Of particular relevance is a lag structure that goes substantially beyond that of the theoretical starting point provided by Equation (3). Two autoregressive lags of P, plus multi-year lags of S, RM, and RENT, are included in the empirical counterpart to Equation (3).

Table 4. ARDL Model

Variable	Coefficient	Std. Error	t-statistic	Probability
LP(-1)	0.874	0.162	5.403	0.0000
LP(-2)	-0.281	0.141	-1.990	0.0561
LINC	0.0779	0.085	0.916	0.3670
LS	-0.551	0.483	-1.139	0.2638
LS(-1)	0.344	0.764	0.450	0.6560
LS(-2)	-1.111	0.782	-1.420	0.1663
LS(-3)	0.835	0.743	1.124	0.2701
LS(-4)	0.900	0.504	1.784	0.0850
LRM	0.007	0.003	2.355	0.0255
LRM(-1)	0.001	0.004	0.237	0.8147
LRM(-2)	-0.006	0.003	-2.178	0.0377
LRENT	-0.158	0.103	-1.539	0.1346
LRENT(-1)	-0.183	0.108	-1.690	0.1017
LRENT(-2)	-0.107	0.112	-0.955	0.3472
LRENT(-3)	-0.254	0.106	-2.402	0.0229
LNHP	0.222	0.068	3.255	0.0029
C	5.695	1.427	3.990	0.0004

Variable	Coefficient	Std. Error	t-statistic	Probability
R-squared	0.991		Mean dep. var.	4.786
Adj. R-squared	0.987		S.D. dependent var.	0.186
S.E. Regression	0.021		Akaike info. crit.	-4.576
Sum sq. resid.	0.013		Schwarz criterion	-3.900
Log likelihood	122.252		Hannan-Quinn crit.	-4.323
F-statistic	211.212		Prob(F-statistic)	0.0000
Durbin-Watson	2.340			

Notes:

Sample Period: 1971-2019. All data transformed using natural logartithms.

Residuals from the estimated ARDL equation are well behaved. Results from a Breusch-Godfrey Lagrange Multiplier (LM) test in Table 5 indicate that serial correlation is not present in the residuals (Asteriou and Hall, 2016). Outcomes for a Breusch-Pagan-Godfrey LM heteroscedasticity test in Table 6 further indicate that the residuals are homoscedastic.

Table 5. Breusch Godfrey LM Serial Correlation Test Results

Test	Computed Statistic	Probability
F(2, 27)	2.878	0.0736
Chi-squared	8.083	0.0176

Table 6. Breusch-Pagan-Godfrey Heteroscedasticity Test Results

Test	Computed Statistic	Probability
F(16, 29)	1.285	0.2702
Chi-squared	19.085	0.2643

Table 7 reports the outcomes of the ARDL bounds test. The computed F-statistic of 5.871 exceeds upper bound critical values calculated by Narayan (2005). That implies that a cointegrating relationship does exist and corroborates evidence obtained by Abraham and Hendershott (1996), Malpezzi (1999), and Capozza et al. (2004). It differs, however, from what is uncovered for other regional real estate markets by Gallin (2006). The CUSUM and CUSUMSQ test results shown in Figures 1 and 2 confirm the stability of the model parameters (Greene, 2000). Computed statistics for both tests remain within the 5-percent critical bounds.

Table 7. ARDL Bounds Test

Test	Computed Statistic	K
F-statistic	5.781	5

Critical Value Bonds

Significance	I(0) Bound	I(1) Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

Figure 1: Cumulative Sum Structural Break Test Results

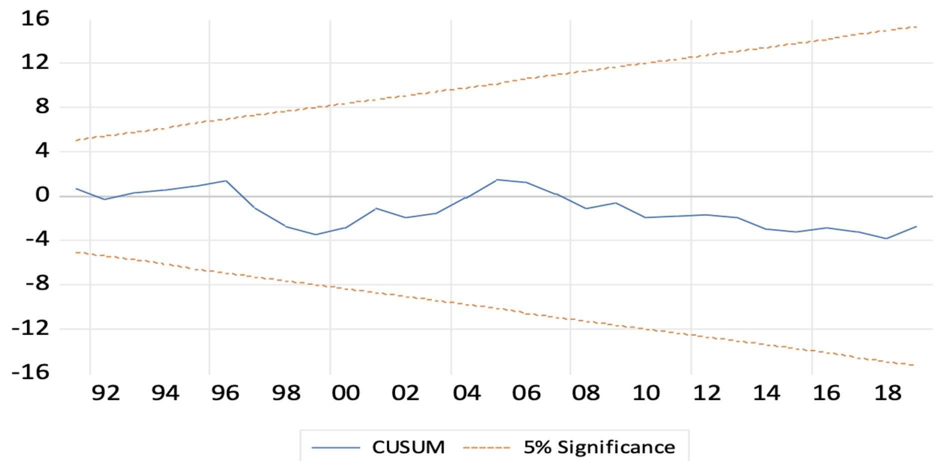
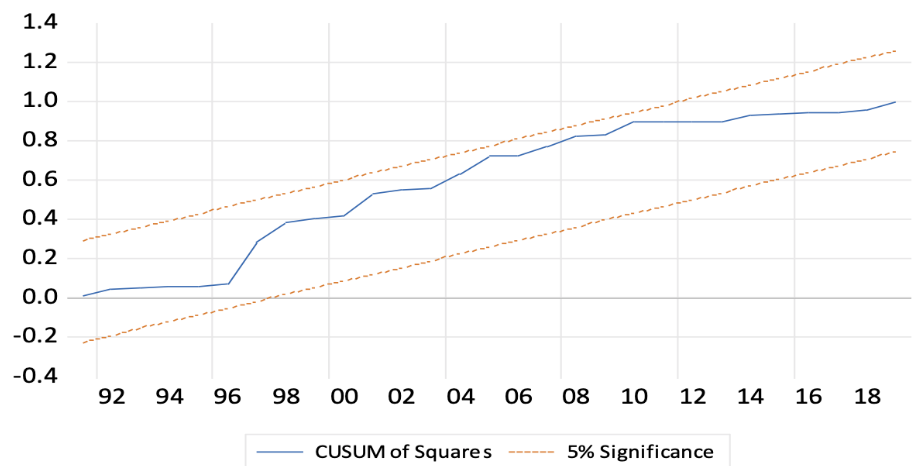


Figure 2: Cumulative Sum of Squares Structural Break Test Results



Tables 8 and 9 summarize the estimation output for the long-run cointegrating and the long-run level models. Table 9 contains several unexpected outcomes. The slope coefficient for INC, the local real income variable, is positive, as hypothesized. However, the standard deviation for that coefficient is also fairly large, indicating that the relationship is somewhat unreliable. The coefficient magnitude is, however, economically plausible (Ziliak, 2008). In contrast to what is expected, the parameter estimate for S, the per capita housing stock, is greater than zero and statistically significant.

Table 8. Long-Run Cointegrating Model

Variable	Coefficient	Std. Error	t-statistic	Probability
C	5.695	1.427	3.990	0.0004
LP(-1)	-0.407	0.073	-5.538	0.0000
LINC	0.078	0.085	0.916	0.3670
LS(-1)	0.417	0.139	2.995	0.0056
LRM(-1)	0.002	0.002	0.761	0.4531
LRENT(-1)	-0.702	0.187	-3.744	0.0008
LNHP	0.222	0.068	3.255	0.0029
D(LP(-1))	0.281	0.141	1.990	0.0561
D(LS)	-0.551	0.483	-1.139	0.2638
D(LS(-1))	-0.623	0.528	-1.180	0.2477
D(LS(-2))	-1.734	0.536	-3.236	0.0030
D(LS(-3))	-0.900	0.504	-1.784	0.0850
D(LRM)	0.007	0.003	2.355	0.0255
D(LRM(-1))	0.006	0.003	2.178	0.0377
D(LRR)	-0.158	0.103	-1.539	0.1346
D(LRR(-1))	0.361	0.129	2.805	0.0089
D(LRR(-2))	0.256	0.106	2.402	0.0229
R-squared	0.723		Mean dep. var.	0.015
Adj. R-squared	0.634		S.D. dependent var.	0.033
S.E. Regression	0.020		Akaike info. crit.	-4.796
Sum sq. resid.	0.013		Schwarz criterion	-4.317
Log likelihood	122.252		Hannan-Quinn crit.	-4.615
F-statistic	8.083		Prob(F-statistic)	0.0000
Durbin-Watson	0.0000			

Notes:
Sample period, 1971-2019.
All data transformed using natural logarithms.

The regression coefficient for RM, the real mortgage rate, is also positive but is very close to zero and economically insignificant. The third slope parameter in Table 9 with a sign that runs counter to what is hypothesized is that for RENT, the real apartment rent regressor. The negative sign for the RENT coefficient indicates that stand-alone housing units and apartment units in Las Cruces are not substitutes, but complements. That intriguing possibility may be related to the important role that higher education plays in the Mesilla Valley. When enrollments at New Mexico State University and Doña Ana County Community College increase, apartment rents also increase. The consequent increases in business and economic activity are also likely to increase the demand for owner-occupied housing and raise single-family home prices. The inclusion of INC in the model specification is designed to control for that channel of causality, so additional inquiry is merited.

Table 9. Long-Run Coefficients

Variable	Coefficient	Std. Error	t-statistic	Probability
LINC	0.191	0.197	0.972	0.3391
LS	1.024	0.305	3.361	0.0022
LRM	0.005	0.006	0.786	0.4382
LRENT	-1.725	0.392	-4.401	0.0001
LNHP	0.545	0.164	3.326	0.0024

Notes:

Sample period, 1971-2019.

All data transformed using natural logarithms.

Similar to what is reported in Fullerton et al. (2021), the real national housing price, NHP, slope coefficient is greater than zero in Table 9. Potentially reflective of the popularity of Las Cruces as a retirement location for residents from larger urban economies with higher residential real estate prices, the magnitude of this elasticity is fairly large (LCB, 2019). It indicates that when NHP increases by 10 percent, P increases by 5.45 percent. Higher values of NHP tend to be associated with greater mobility. Migrants who sell houses in one region tend to bid up housing values in retirement destinations such as Las Cruces. As posited above, investment motives also contribute to this result (Miles, 2019).

A one-year lag of the residuals from the long-run cointegrating model in Table 8 is employed as a regressor in the error correction model specification. Estimation outcomes for the short-run error correction regression are reported in Table 10. As expected, most of the short-run elasticities are smaller in magnitude than the corresponding long-run elasticities. Results in Table 8 do not support many of the model hypotheses.

The constant term indicates that real housing prices contain a deterministic component and increase by approximately $5.70 per year (2012 constant dollars). A one-year lag of the dependent variable, D(P), is used as a regressor. That implies a relatively pronounced inertial component in short-run housing price movements in Las Cruces. Both results partially corroborate the residential real estate investment rate of return hypothesis (D'Lima and Schultz, 2020).

In contrast to the long-run results, the lags of the per capita stock variable, S, exercise the hypothesized downward impact on price in Table 10. That is not the case for the real mortgage rate, RM. Both estimated parameters for RM are positive and surpass the 5-percent significance criterion. That is different from what has been documented in other studies (Chong, 2020) and may reflect the prevalence of alternate channels of influence in the Las Cruces housing market (Hattapoglu and Hoxha, 2021).

Table `10. Error-Correction Model

Variable	Coefficient	Std. Error	t-statistic	Probability
C	5.695	0.896	6.355	0.0000
D(LP(-1))	0.281	0.101	2.775	0.0095
D(LS)	-0.551	0.396	-1.392	0.1747
D(LS(-1))	-0.623	0.450	-1.385	0.1767
D(LS(-2))	-1.734	0.453	-3.832	0.0006
D(LS(-3))	-0.900	0.429	-2.099	0.0446
D(LRM)	0.007	0.002	3.123	0.0040
D(LRM)(-1))	0.006	0.002	2.720	0.0109
D(LRENT)	0.158	0.076	-2.076	0.0469
D(LRENT(-1))	-0.361	0.098	3.690	0.0009
D(LRENT(-2))	0.254	0.088	2.877	0.0075
COINTEQ(-1)	-0.407	0.064	-6.348	0.0000

Notes:

Sample period, 1971-2019.

All data transformed using natural logarithms.

The sum of the real rent, RENT, parameter estimates in Table 10 is positive as anticipated. This is in partial alignment with research that emphasizes the importance of taking into account the rental side of residential real estate markets when analyzing housing prices (Campbell et al., 2009; Gallin, 2008). Surprisingly, no lags of NHP, the real median national housing price, are included in the error correction model.

The last regression coefficient in Table 10 is that estimated for the one-year lag of the long-run cointegrating model residuals. The error correction term is negative as hypothesized. The magnitude of it implies that nearly 41 percent of any housing price disequilibrium will dissipate within one year in Las Cruces. Slightly less than 2.5 years are required for any deviation from the long-run equilibrium price to fully disappear. That is fairly close to what is calculated for national housing price disequilibrium adjustment by Riddel (2004).

CONCLUSION

Residential real estate represents an important sector of all metropolitan economies. While housing prices receive a lot of research attention, relatively few analyses are conducted for small- and medium-sized economies. Historically, that has resulted from data constraints. This study employs a theoretical model that takes into account both supply and demand side aspects of housing markets, but does not have very extensive data requirements.

Data are collected for Las Cruces, the second largest metropolitan economy in New Mexico. The sample period covers 1971 through 2019. As might be anticipated, the data exhibit interesting patterns of variability for this era of wide-ranging economic conditions.

An autoregressive distributed lag (ARDL) modeling procedure is used to allow for realistic housing market dynamics. Empirical results support a number of individual outcomes documented in other studies. Several unexpected results are also obtained that depart from what is implied by the underlying theoretical framework. In particular, the results indicate that rental apartments and single-family housing may be complements rather than substitutes in college towns like Las Cruces. More research using data for other small- and medium-sized real estate markets seems warranted.

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The authors of this publication are UTEP Professor and Trade in the Americas Chair Tom Fullerton and UTEP Border Region Modeling Project Associate Director and Economist Steven Fullerton. Dr. Fullerton holds degrees from UTEP, Iowa State University, Wharton School of Finance at the University of Pennsylvania, and University of Florida. Prior experience includes positions as economist in the Executive Office of the Governor of Idaho, international economist in the Latin America Service of Wharton Econometrics, and senior economist at the Bureau of Economic and Business Research at the University of Florida. Steven Fullerton has published research on Major League Baseball, the National Football League, and housing price fluctuations in Las Cruces.

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Professor Barraza is an award winning economist who has taught at several universities in Mexico and has published in academic research journals in Mexico, Europe, and the United States. Dr. Barraza currently serves as Research Provost at UACJ. Professor Fullerton has authored econometric studies published in academic research journals of North America, Europe, South America, Asia, Africa, and Australia. Dr. Fullerton has delivered economics lectures in Canada, Colombia, Ecuador, Finland, Germany, Japan, Korea, Mexico, the United Kingdom, the United States, and Venezuela.

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Contributors to the book include economic researchers from The University of Texas at El Paso, New Mexico State University, The University of Texas Pan American, Texas A&M International University, El Colegio de la Frontera Norte, and the Federal Reserve Bank of Dallas. Their research interests cover a wide range of fields and provide multi-faceted angles from which to examine border economic trends and issues.

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