Housing Prices and Fundamentals: The Role of a Supply Shifter

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Abstract

This paper empirically investigates cointegrating relation between housing prices and economic fundamental variables in the US housing market. Employing simple yet rigorous econometric techniques, the present paper finds strong evidence in favor of cointegrating relations in most US states when both the demand and supply side fundamental variables are included in the cointegrating regression. This casts doubt on the previous empirical work that reported weak or no cointegrating relation of housing prices with mostly demand-side fundamental variables, which may have a misspecification problem. Further, cointegrating vector estimates seem consistent with economic theories only when both side fundamental variables are used.

Keywords: Housing prices, cointegration

JEL: E32, R31

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I. Introduction

The present paper tests cointegration between housing prices and fundamentals in the US single family occupied housing market with a model that includes building cost as a supply shifter. Most of the conventional tests focus on the demand side of this relationship. Other demand side fundamentals used as explanatory variables across states with annual data from 1975 to 2009 are real income per capita and population.

The impact of building cost on housing prices is visible in the sample data. Population has been growing steadily in all states. Real income per capita has been increasing in nearly all of the states since the late 1970s. Although real housing prices vary in most states, there has been a steady increase in almost all populous states starting from 1997. This increase has been referred as a "bubble". In some of the populous states, bubble has averaged a lot more. Housing price increases averaged 11% in California, 9% in Florida, 7% in New York, 4% in Pennsylvania, 3.5% in Illinois, and 2% in Texas.

The importance of the present study lies in finding cointegration from a single equation. However as Banarjee (1999) points out especially in small samples cointegration tests are considered to have relatively low test power. The present study demonstrates that the issue of power may not be critical to finding cointegration rather it is a correctly specified model. Gallin (2006) uses both univariate and more powerful panel-data tests for cointegration and rejects it, employing to construction wage as a supply shifter. Wages are highly correlated with income, however, and may include only demand side information. In addition, wages add little to the explanation and may hide the supply side information. In the present study, we use a building cost index. Building costs are assumed competitive between states. This is more helpful in reflecting supply side information such as oil price movements than construction wages.

Moreover the paper underlines the significance of obtaining the correct signs of the estimated coefficients from univariate cointegration tests. Persistent movement among these cointegrating variables with correct signs then suggest that in the long run the housing market will reach a dynamic equilibrium and the relation among the states without cointegration is only bubbles.

The sample is single family housing price. Index is selected for the 50 states and DC. Annual data begin with the earliest available state data from 1975 and extend through 2009. Regarding the time horizon, Shiller and Perron (1985) argue more observations holding the time span fixed does not increase the power of tests. Our results, therefore, should satisfy the reader in having a finite sample of 36 observations for this time series empirical study.

Organization of the paper is as follows. Section two is the literature review. In section two we explain the model and econometric methods for the cointegration. Section four reports the regression results and interpretation. Section five is the conclusion.

II. Literature Review

The previous studies (Abraham and Hendershott 1996, Capozza, Hendershott, Mack, and Mayer 2002, Meen 2002) indicate a common thought in the housing market that even if housing prices and income move in different directions in the short-run, the steady relationship between two variables will eventually push them toward their long-run equilibrium. Most of the studies focus on finding cointegration by using powerful tests, panel regression or different sample sets. Further these studies have not mentioned the significance of obtaining correct signs in the coefficients of cointegrating variables. Although the importance of building costs has been discussed slightly in the literature the correct definition as a supply shifter has not been explained sufficiently well. There are many variables that contribute to building costs from land prices to steel, and from transportation cost to labor cost. If housing prices increase with general prices then real housing prices in the long-run are expected to be stationary. [1]

As Meen (2002) points out, in the short-run with inelastic housing supply, a positive demand shock will temporarily increase housing prices. However, when prices go above the equilibrium, this relation will follow the change in the building cost levels. Most of the following literature report cointegration only from demand side. Malpezzi (1999) tests and formulates two-equation models of housing prices in many different ways and confirms that changes in housing prices are cointegrated with income. Abraham and Hendershott (1996) estimate 30 MSAs and confirm cointegration between housing prices and income. In an another MSA study, Mikhed and Zemick (2009) use several fundamental variables to explain housing prices and find that prior to 2006 there had been a price bubble. Their univariate tests also indicate a decline in the prices for these MSAs. Holly, Pesaran, and Yamagata (2006) find in their panel study for 49 states over 29 years that housing prices are cointegrated with fundamentals (real income). Another study on dynamics of housing prices outside of US in Singapore by Hin and Cuervo (1999) find that there is a cointegration between housing prices and fundamentals such as real GDP and the prime lending rate.

Capozza, Hendershott, Mack, and Mayer (2002) is the one of the few studies where supply shifter construction cost is used in a city-level panel study for 62 Metropolitan Statistical Areas (MSA) in the US. Authors test real housing price dynamics and find correlation with the fundamentals such as city size, real income growth, population growth, and real construction costs. Galin (2006) is the only study where housing prices are not cointegrated with income in a city-level panel of 95 MSAs over 23 years. The author states that even powerful tests are not significant enough to reject the null hypothesis of no cointegration.

[1] Here Meen (2002) states that changes in house prices can be forecasted partly and they are not random walk.

The univariate regression results from state level sample in the present paper noticeably demonstrate that in the US housing market there is cointegration between house prices and fundamentals in some states when we incorporate both demand and supply shifters. The approach in this study is confirming these results without relying on panel study which requires stronger assumptions. We simply finalize the results by only single equation in all states. Furthermore our findings not only support cointegration in most states but also explain the significance of obtaining the correct signs in the equation. However, there is no significant evidence when we employ only demand shifters income and population.

III. The Housing Market Model

The relationship of the housing price and fundamentals can be seen by analyzing housing supply and demand. The proposed quantity of owner-occupied housing demand depends on the real price of house , real income per capita , population , and other stochastic demand shifters . The housing supply depends on the real price of house , building cost , population , and other stochastic supply shifters :

(1)

(2)

The housing price and the quantity of house demanded can be written as a function of exogenous variables:

(3)

Solution for the proposed model will be a log-linearized where the log of housing price is related to the logs of the rest of the derived variables. Coefficients of this log-linearized model are assumed unchanged and other unobserved components of the model are assumed stationary. Housing price and fundamentals are cointegrated with unit roots. The relationship in (3) will depend on the elasticities of supply and demand. The idea will be testing for cointegration. There may be many reasons why such a cointegrating relationship may not exist. Unstable price elasticities of supply, rapid changes in demographics may affect the price elasticity of demand or local taxes may not be stationary.

A long-run equilibrium relationship between the housing prices and fundamentals such as income would require cointegration. To elaborate the theory, we follow Poterba (1984) and Topel and Rosen (1988). The model assumes housing is proportional to the stock of housing, indicated by . The demand for housing can be shown as

, (4)

where is the rental rate for a unit of housing and is a vector of demand shifters. For simplicity assume that follows a random walk:

A straightforward approach to explain the structural model of the housing market is the present-value model where the amount of rent should equal the user cost of housing. Gallin (2006) suggests that if taxes, maintenance, and the risk premium are ignored one may write the housing price as

, (5)

where is the price of housing, is the expectations operator conditional on information available at time and is the discounte rate. Substituting (4) into (5) yields

, (6)

According to Gallin (2006) in the short run if is fixed then new investments can be written as

, (7)

where is the vector of housing supply shifters. The law of motion for capital

, implies

, (8)

where is the lag operator.

We can show that a solution to (8) has real roots for reasonable values for and

, (9)

where is the housing prices. Assuming and in (9) housing prices, demand shifters, and supply shifters are cointegrated in the model, if elements have unit roots. In other words, housing prices are cointegrated with stochastic demand shifters in .

Based on this theory, we can continue with cointegration tests for state-level housing prices and fundamentals. The hypothesized regression is

, (10)

where indexes variables and indexes time. If the residuals are stationary, then it can be concluded that the ’s are cointegrated. We follow augmented Engle-Granger (AEG) test for cointegration as in Engle and Granger (1987), a two-step procedure. First estimated residuals are obtained by estimating (10) with ordinary least squares. The next step is to do an ADF test on the residuals.

IV. Empirical Results

Real housing prices, real income per capita, and population for all states come from St. Louis FRED database. Average national building cost is obtained from Robert J. Shiller’s website. The building cost index mixes 20-city average steel, cement, and lumber prices as a materials component, and includes 20-city average skilled and unskilled labor wages. Over the sample period building cost index has an average of 84.5 and standard error of 1.23.

*** Table 1 ***

Table 1 reports results of three different AEG tests run for three different models. In the first column income is the only explanatory variable. Having only one variable, cointegration is confirmed only in five states, California, Hawaii, Maine, Maryland, and South Dakota. In the middle column, two demand shifter fundamentals income and population are incorporated. Results do not change as expected with more demand shifters in the equation. California, DC, Iowa, Maryland, and South Dakota are the significant states with cointegration. No other state is reported as significant. In the last column population is dropped and a supply shifter building cost is added with the demand shifter income to test the housing price and fundamentals relationship. Results change dramatically compared to other one-variable and two-variable models' cointegration tests. Cointegration is confirmed in twenty states, including populous states such as Arizona, Florida, Georgia, and North Carolina.

Canonical Cointegrating Regression (CCR)

Park's (1992) CCR method estimates the cointegrating vector, with a number of advantages. The main idea of CCR is to implement least square estimation via transformed variables using the long-run covariance matrix of , so that the LS estimator is asymptotically efficient. CCR is as efficient as the ML procedure of Johansen (1988) but is robust to distributional assumptions because it is nonparametric.[2]

[2] Johansen Test was also employed for this study. Cointegration is confirmed at least in one variable in 32 states only.

*** Table 2 ***

Table 2 reports the first model using CCR cointegration regression where housing price is a function of only one demand shifter, income. CCR cointegration is displayed in H(p,q) column under the null hypothesis of cointegragtion. Except in Arkansas, Iowa, Missouri, Oklahoma, South Dakota, and West Virginia cointegration is confirmed in almost all states. However it is seen in the coefficient column that the demand shifter income is either insignificant in nine states or has the wrong sign in thirteen states. This is not expected in this study regardless of the cointegration results.

*** Table 3 ***

Table 3 reports the next model where two demand shifter income and population are employed. On the contrary of the expectation of explaining the function with only demand side, cointegration is not confirmed in seventeen states. Under the coefficient column in thirty eight states demand shifters both or separately has the wrong signs. Populous states like Pennsylvania, Georgia, Michigan, and Illinois are some of the examples. While one expects to see income per capita to have positive sign in model 2 but in these states it has negative sign although cointegration is confirmed. Some information is still hidden in this model when two demand shifters are used.

*** Table 4 ***

Finally in the last table we employ one demand shifter income and one supply shifter building cost in explaining house prices. The results again change dramatically in this model as with the Augmented Engle Granger test. Cointegration is confirmed for almost all states except in California, Michigan, South Dakota, Texas, and Wisconsin. Also coefficients are now significant and have the correct signs for the most states. Failing to confirm cointegration especially in California and Texas is expected because of the large housing markets in metropolitan cities Los Angeles, San Francisco, Houston, and Dallas. This evidently suggests bubbles in housing market. However without relying on panel study which requires stronger assumptions, the model as a whole explains this hidden information by including building cost in a single equation for each state.

V. Conclusion

Choosing the right supply and demand shifters is a critical part of the study of housing market dynamics. In order to reflect more supply information, the current study incorporates building cost to test the relationship between housing prices and fundamentals in the US single family housing market at the state level. This study confirms that housing prices and fundamentals are linked by a long-run equilibrium relationship in most states. Cointegration is tested with Augmented Engle Granger and canonical cointegrating regression test for the analysis in three different models for each of the states.

There is no significant evidence to support cointegration when only demand shifters are employed in the housing market model. The present paper reveals that even with low power univariate regression methods there is cointegration between housing prices and fundamentals in most states when both supply and demand shifters are incorporated. The previous literature has been improved with deterministic and correctly specified work by using a finite small sample. Persistent movements among variables have provided much stronger cointegration results determined by the fundamentals.

When the model including both demand and supply shifters is specified more correctly, cointegration is confirmed in most states. In the states such as California, Michigan, South

Dakota, Texas, and Wisconsin with no cointegration, the relationship between housing prices and fundamentals are nothing but bubbles. The present paper also suggests that the housing market will eventually reach equilibrium in the long run.

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Table – 1 Augmented Engle/Granger Univariate Cointegration Test Results

	ADF Test Statistics				ADF Test Statistics		
STATES	**Y**	**Y-POP**	**Y-BC**	**STATES**	**Y**	**Y-POP**	**Y-BC**
Alabama	-1.17	-1.28	-4.97***	**Montana**	-2.77	-2.97	-4.13**
Alaska	-3.10	-3.11	-3.27	**North Carolina**	-1.16	-3.45	-4.36**
Arkansas	-1.25	-2.18	-4.49**	**North Dakota**	-1.23	-1.79	-5.44***
Arizona	-1.82	-1.51	-3.93*	**Nebraska**	-1.22	-2.08	-2.28
California	-3.52**	-3.68*	-3.51	**Nevada**	-3.00	-2.65	-3.38
Colorado	-1.62	-1.62	-3.73*	**New Hampshire**	-2.54	-2.40	-2.78
Connecticut	-2.46	-2.72	-2.43	**New Jersey**	-2.76	-2.75	-2.76
Delaware	-2.37	-2.82	-3.08	**New Mexico**	-1.84	-2.02	-2.60
D.C.	-3.03	-3.94*	-2.84	**New York**	-2.21	-2.16	-2.39
Florida	-2.91	-2.04	-4.08**	**Ohio**	-1.96	-3.06	-2.28
Georgia	-0.62	-2.36	-3.91*	**Oklahoma**	-1.51	-1.82	-2.94
Hawaii	-3.80**	-3.82*	-3.77*	**Oregon**	-1.90	-2.01	-3.30
Idaho	-1.15	-1.24	-3.96*	**Pennsylvania**	-2.52	-2.76	-2.95
Illinois	-1.56	-2.60	-2.83	**Rhode Island**	-2.94	-3.02	-2.65
Indiana	-1.64	-2.28	-2.94	**South Carolina**	-1.52	-2.80	-3.33
Iowa	-2.63	-4.13**	-2.21	**South Dakota**	-3.97**	-4.52**	-7.11***
Kansas	-1.89	-1.46	-2.61	**Tennessee**	-1.35	-2.90	-4.83***
Kentucky	-1.49	-2.11	-4.82***	**Texas**	-1.52	-1.49	-2.02
Louisiana	-1.70	-1.74	-3.05	**Utah**	-1.97	-1.90	-3.76*
Maine	-3.29*	-3.30	-3.06	**Virginia**	-2.24	-2.14	-3.21
Maryland	-3.87**	-3.91*	-3.55	**Vermont**	-1.79	-2.29	-2.56
Massachusetts	-3.03	-3.04	-3.05	**Washington**	-2.39	-2.39	-2.92
Michigan	-2.60	-2.84	-3.95*	**Wisconsin**	-1.76	-1.75	-4.15**
Minnesota	-1.49	-1.98	-3.20	**West Virginia**	-1.07	-2.49	-3.66*
Missouri	-1.34	-3.13	-4.41**	**Wyoming**	-1.56	-1.56	-3.52
Mississippi	-1.10	-1.23	-5.37***				

Notes: Critical Values for 35 sample-size are calculated from MacKinnon (2010); for 2 variables -4.228, -3.516, -3.168, for 3 variables -4.732, -3.994, -3.633, for 1%, 5%, and 10% respectively.

Table – 2 Model 1 CCR Results (1-inp)

CCR Cointegration Results					
	Coeff. (St. Err.)	**H(p,q)**		**Coeff. (St. Err.)**	**H(p,q)**
STATES	**Model 1**	**Stat (p-value)**	**STATES**	**Model 1**	**Stat (p-value)**
Alabama	-0.14(0.19)	1.60(0.21)***	**Montana**	1.59(0.49)	0.15(0.70) ***
Alaska	2.24(0.31)	0.24(0.63)***	**North Carolina**	0.34(0.04)	0.06(0.80) ***
Arkansas	-0.36(0.34)	4.26(0.04)	**North Dakota**	0.73(0.45)	2.56(0.11) ***
Arizona	0.10(0.55)	0.52(0.47)***	**Nebraska**	0.13(0.42)	2.47(0.12) ***
California	2.15(0.17)	0.46(0.50)***	**Nevada**	0.59(0.29)	0.55(0.46) ***
Colorado	0.79(0.28)	1.05(0.31)***	**New Hampshire**	0.33(0.17)	1.48(0.22) ***
Connecticut	0.53(0.46)	0.56(0.45)***	**New Jersey**	0.90(0.26)	0.13(0.72) ***
Delaware	1.09(0.25)	0.05(0.82) ***	**New Mexico**	0.50(0.52)	0.41(0.52) ***
DC	1.55(0.62)	0.58(0.45) ***	**New York**	1.83(0.36)	1.81(0.18) ***
Florida	-0.07(0.27)	1.41(0.24) ***	**Ohio**	-0.14(0.31)	2.43(0.12) ***
Georgia	0.30(0.04)	1.46(0.23) ***	**Oklahoma**	-0.70(1.51)	3.94(0.05)
Hawaii	2.80(0.43)	0.68(0.41) ***	**Oregon**	1.81(0.09)	0.65(0.42) ***
Idaho	0.58(0.14)	0.05(0.81) ***	**Pennsylvania**	0.70(0.33)	0.00(0.95) ***
Illinois	0.85(0.17)	0.03(0.87) ***	**Rhode Island**	1.27(0.25)	1.16(0.28) ***
Indiana	-0.05(0.17)	0.48(0.49) ***	**South Carolina**	0.39(0.00)	0.86(0.35) ***
Iowa	0.20(0.97)	6.40(0.01)	**South Dakota**	0.53(0.15)	4.22(0.04)
Kansas	-0.40(0.97)	2.27(0.13) ***	**Tennessee**	-0.05(0.15)	2.52(0.11) ***
Kentucky	0.20(0.26)	0.73(0.39) ***	**Texas**	-1.13(0.44)	0.03(0.87) ***
Louisiana	-0.35(0.56)	1.16(0.28) ***	**Utah**	0.67(0.40)	0.83(0.36) ***
Maine	0.94(0.23)	0.00(0.97) ***	**Virginia**	0.63(0.10)	0.06(0.81) ***
Maryland	0.92(0.12)	0.00(0.98) ***	**Vermont**	0.57(0.21)	0.15(0.70) ***
Massachusetts	1.14(0.23)	0.50(0.48) ***	**Washington**	1.61(0.19)	0.03(0.86) ***
Michigan	0.91(0.20)	0.02(0.89) ***	**Wisconsin**	0.75(0.37)	0.10(0.75) ***
Minnesota	0.65(0.16)	0.14(0.71) ***	**West Virginia**	-0.13(0.68)	3.05(0.08)
Missouri	-0.16(0.21)	10.06(0.00)	**Wyoming**	0.65(0.58)	1.88(0.17) ***
Mississippi	-0.37(0.35)	0.20(0.65) ***			

Notes: Stat and p-values in H(p,q) column with three asterisks indicate significant critical values for the corresponding states. (Under the null hypothesis of cointegration p-values > 10% are significant)

Table – 3 Model 2 CCR Results (2-inp)

CCR Cointegration Results				CCR Cointegration Results			
	Coeff. (St. Err.)		H(p,q)		Coeff. (St. Err.)		H(p,q)
STATES	**Y**	**POP**	**Stat (p-value)**	**STATES**	**Y**	**POP**	**Stat (p-value)**
Alabama	-2.17(0.89)	5.35(2.21)	1.32(0.25)***	**Montana**	2.77(0.54)	-2.76(0.94)	10.14(0.00)
Alaska	2.25(0.24)	0.18(0.08)	0.00(0.95) ***	**North Carolina**	-1.12(0.18)	1.50(0.18)	1.30(0.26) ***
Arkansas	-3.78(0.83)	6.58(1.54)	0.01(0.93) ***	**North Dakota**	0.53(0.41)	2.58(2.15)	4.99(0.03)
Arizona	2.69(0.41)	-0.83(0.40)	0.09(0.77) ***	**Nebraska**	-2.58(0.68)	8.54(2.23)	10.86(0.00)
California	0.84(0.37)	0.53(0.29)	1.44(0.23) ***	**Nevada**	2.06(0.39)	-0.42(0.10)	5.59(0.02)
Colorado	3.54(0.85)	-2.36(0.82)	3.37(0.07)	**New Hampshire**	4.12(1.36)	-5.81(2.36)	5.50(0.02)
Connecticut	-0.91(0.74)	10.23(3.66)	0.06(0.81) ***	**New Jersey**	2.12(0.22)	-1.43(0.68)	1.68(0.20) ***
Delaware	0.72(0.74)	0.23(0.85)	0.70(0.40) ***	**New Mexico**	2.78(0.66)	-2.14(0.59)	0.97(0.33) ***
DC	1.88(0.20)	2.59(0.54)	0.38(0.54) ***	**New York**	1.99(0.26)	0.41(1.41)	0.06(0.81) ***
Florida	6.54(1.17)	-4.05(0.94)	7.08(0.01)	**Ohio**	-1.42(0.36)	6.94(1.58)	5.05(0.03)
Georgia	-1.00(0.36)	0.92(0.32)	2.21(0.14) ***	**Oklahoma**	1.40(0.73)	-2.94(1.20)	15.43(0.00)
Hawaii	3.51(0.55)	-0.14(0.48)	0.22(0.64) ***	**Oregon**	1.68(1.01)	-0.50(1.46)	0.13(0.72) ***
Idaho	0.58(0.91)	-0.04(0.70)	0.24(0.63) ***	**Pennsylvania**	-0.49(0.40)	7.56(3.05)	0.02(0.88) ***
Illinois	-0.20(0.49)	2.99(1.57)	0.64(0.42) ***	**Rhode Island**	0.69(0.50)	2.91(1.64)	0.00(0.97) ***
Indiana	-1.02(0.49)	2.19(1.09)	0.02(0.88) ***	**South Carolina**	-1.81(0.36)	2.62(0.47)	0.70(0.40) ***
Iowa	-0.69(0.17)	7.27(0.79)	10.37(0.00)	**South Dakota**	-0.29(0.53)	3.02(1.95)	4.82(0.03)
Kansas	6.24(1.07)	-13.20(2.27)	3.09(0.08)	**Tennessee**	-1.73(0.48)	2.99(0.71)	5.58(0.02)
Kentucky	-1.09(0.39)	3.40(0.98)	1.36(0.24) ***	**Texas**	2.57(0.61)	-2.24(0.48)	2.07(0.15) ***
Louisiana	0.52(0.53)	-0.10(1.03)	2.31(0.13) ***	**Utah**	2.42(0.80)	-0.88(0.54)	0.54(0.46) ***
Maine	2.03(1.22)	-3.23(3.65)	0.23(0.63) ***	**Virginia**	1.58(0.09)	-1.16(0.33)	1.65(0.20) ***
Maryland	1.28(0.55)	-0.33(0.93)	1.44(0.23) ***	**Vermont**	2.74(0.41)	-5.43(1.03)	1.02(0.31) ***
Massachusetts	2.18(0.14)	0.04(1.16)	1.22(0.27) ***	**Washington**	1.80(0.89)	-0.21(0.85)	0.28(0.59) ***
Michigan	-1.38(0.39)	6.25(0.96)	0.11(0.74) ***	**Wisconsin**	1.45(1.11)	-0.71(2.35)	0.43(0.51) ***
Minnesota	-0.05(1.11)	1.65(2.06)	7.22(0.01)	**West Virginia**	0.93(0.12)	7.12(0.45)	4.34(0.04)
Missouri	-2.18(0.57)	4.46(1.15)	3.11(0.08)	**Wyoming**	0.88(0.23)	-0.94(0.40)	3.48(0.06)
Mississippi	-0.90(1.19)	1.78(3.61)	0.97(0.33) ***				

Notes: Stat and p-values in H(p,q) column with three asterisks indicate significant critical values for the corresponding states. (Under the null hypothesis of cointegration p-values > 10% are significant)

Table – 4 Model 3 CCR Results (2-inp S & D)

CCR Cointegration Results				CCR Cointegration Results			
	Coeff. (St. Err.)		H(p,q)		Coeff. (St. Err.)		H(p,q)
STATES	Y	BC	Stat (p-value)	STATES	Y	BC	Stat (p-value)
Alabama	0.66(0.04)	1.49(0.09)	0.26(0.61) ***	**Montana**	1.41(0.21)	0.86(0.29)	0.49(0.48) ***
Alaska	1.87(0.42)	0.30(0.34)	0.00(0.95) ***	**North Carolina**	0.82(0.04)	1.25(0.08)	0.01(0.94) ***
Arkansas	0.50(0.06)	1.55(0.12)	0.10(0.76) ***	**North Dakota**	0.54(0.05)	2.17(0.09)	0.74(0.39) ***
Arizona	1.72(0.21)	1.98(0.36)	0.07(0.79) ***	**Nebraska**	0.63(0.22)	1.71(0.41)	0.00(0.99) ***
California	1.90(0.13)	-0.15(0.25)	5.19(0.02)	**Nevada**	0.55(0.48)	0.52(0.64)	1.16(0.28) ***
Colorado	2.12(0.23)	2.46(0.42)	0.32(0.57) ***	**New Hampshire**	0.14(0.46)	-0.08(0.86)	0.50(0.48) ***
Connecticut	1.17(0.63)	0.20(1.27)	0.03(0.86) ***	**New Jersey**	2.07(0.97)	1.77(2.19)	0.08(0.78) ***
Delaware	0.93(0.36)	0.07(0.48)	0.01(0.92) ***	**New Mexico**	0.93(0.14)	1.28(0.23)	0.17(0.68) ***
DC	2.35(0.30)	3.71(0.80)	0.01(0.93) ***	**New York**	2.74(0.52)	2.08(0.97)	0.75(0.39) ***
Florida	1.82(0.22)	2.90(0.40)	1.17(0.28) ***	**Ohio**	-0.01(0.23)	0.53(0.15)	1.55(0.21) ***
Georgia	0.98(0.10)	1.79(0.24)	0.08(0.77) ***	**Oklahoma**	0.75(0.20)	2.53(0.29)	0.19(0.66) ***
Hawaii	3.02(0.47)	0.41(0.61)	1.27(0.26) ***	**Oregon**	2.08(0.22)	1.34(0.34)	0.43(0.51) ***
Idaho	1.16(0.06)	1.50(0.12)	0.80(0.37) ***	**Pennsylvania**	0.09(0.45)	-0.11(0.29)	0.01(0.93) ***
Illinois	0.86(0.14)	0.65(0.09)	1.46(0.23) ***	**Rhode Island**	1.04(0.51)	-0.36(0.96)	0.31(0.58) ***
Indiana	0.23(0.12)	0.39(0.19)	1.62(0.20) ***	**South Carolina**	0.89(0.05)	1.39(0.11)	0.16(0.69) ***
Iowa	0.90(0.28)	2.07(0.38)	0.11(0.75) ***	**South Dakota**	0.85(0.08)	1.16(0.16)	3.69(0.06)
Kansas	0.65(0.16)	1.99(0.26)	0.04(0.85) ***	**Tennessee**	0.88(0.05)	1.60(0.11)	0.03(0.87) ***
Kentucky	0.73(0.07)	1.01(0.13)	1.95(0.16) ***	**Texas**	0.33(0.14)	1.91(0.22)	3.32(0.07)
Louisiana	0.80(0.12)	2.30(0.23)	0.19(0.66) ***	**Utah**	2.01(0.22)	2.13(0.38)	1.16(0.28) ***
Maine	1.12(0.29)	0.22(0.64)	0.02(0.90) ***	**Virginia**	0.92(0.17)	1.06(0.18)	0.00(0.99) ***
Maryland	1.30(0.23)	0.97(0.35)	0.42(0.52) ***	**Vermont**	0.69(0.21)	0.68(0.43)	0.05(0.82) ***
Massachusetts	1.86(1.08)	1.08(2.60)	0.11(0.75) ***	**Washington**	1.43(0.23)	0.00(0.42)	0.43(0.51) ***
Michigan	1.36(0.22)	0.63(0.32)	4.00(0.05)	**Wisconsin**	1.44(0.10)	1.42(0.17)	2.98(0.08)
Minnesota	1.24(0.12)	1.63(0.27)	0.11(0.74) ***	**West Virginia**	0.65(0.09)	2.12(0.14)	2.04(0.15) ***
Missouri	0.76(0.07)	1.21(0.11)	0.54(0.46) ***	**Wyoming**	0.88(0.13)	2.11(0.26)	0.23(0.63) ***
Mississippi	0.53(0.08)	1.87(0.17)	1.84(0.18) ***				

Notes: Stat and p-values in H(p,q) column with three asterisks indicate significant critical values for the corresponding states. (Under the null hypothesis of cointegration p-values > 10% are significant)