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On the Link between Oil Price and House Prices in the U.S.: Asymmetric Evidence from State Level Data

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Since oil is used as an input in the production and delivery process, any change in its price can affect almost all sectors of an economy. Researchers have tried to assess the impact of the rising price of oil on domestic production, inflation, investment, the stock market, etc. In order to determine if inflationary effects of rising oil prices have spread to house prices in the U.S., unlike previous research, we investigate the link between oil prices and house prices by using data from each state of the U.S. Furthermore, for the first time, we engage in asymmetry analysis and find short-run asymmetric effects in almost all of the states but short-run cumulative effects or asymmetric impact in 15 states. Although we also find significant long-run asymmetric effects in 26 states, the results reveal that an increase in oil prices has contributed to house price increase in only 11 states and a decrease in oil prices lowered house prices in only three states.

Keywords

House Prices, Oil Price, Asymmetry Analysis, The United States.

1. Introduction

In 1973 when the Organization of the Petroleum Exporting Countries (OPEC) members raised the price of oil from 2.60 USD to a little over 12.00 USD a barrel, the United States (U.S.) and most of the oil importing countries experienced stagflation, mostly due to the cost-push effects of rising oil prices. The second oil crisis occurred in the post 1979 period when, due to the Iranian revolution in 1979, oil doubled in price. These abnormal increases in oil prices enticed researchers to quantify and assess the impact of rising oil prices not just on domestic prices and output, but also other macro variables. The list of studies that have assessed the impact of oil prices on domestic production and inflation includes: Gisser and Goodwin (1986), Lardic and Mignon (2008), Chen (2009), Arouri and Nguyen (2010), Aguiar-Contraria and Soares (2011), Kilian and Vigfusson (2011), Hamilton (2011), Miller and Ni (2011), Serletis and Elder (2011), Herrera et al. (2011), Engemann et al. (2011), Valadkhani et al. (2014), Aloui and Dakhlaoui (2015), and Valadkhani and Smyth (2017). The main consensus of these studies is that indeed, higher oil prices have contributed to rising prices and a declining domestic production in oil importing countries. While the above studies have been concerned with domestic output in an individual country, He et al. (2010) and Miller and Ni (2011) are concerned with economic activity at the global level.

Another strand of the literature includes studies that have looked at the impact of oil prices on stock returns. They argue that if oil prices have a significant impact on the real sector, they should also have an adverse impact on stock returns. However, not all studies support this general consensus. The list includes Park and Ratti (2008), Nandha and Faff (2008), Miller and Ratti (2009), Apergis and Miller (2009), Kilian and Park (2009), Filis (2010), Arouri et al. (2011), Elyasiani et al. (2011), and Güntner (2014).

There are also other studies that have looked at the impact of oil prices on a few other macro variables. While Rafiq et al. (2009) and Lee et al. (2011) consider the response of domestic investment to oil prices, Doğrul and Soytas (2010) assess the response of interest and unemployment rates to changes in oil prices. On the other hand, the impact of oil prices on gold prices is considered by Kumar (2017), on the exchange rate by Brémond et al. (2016), and on cotton prices by Mutuc et al. (2011).

There are only a limited number of studies that have looked into the link between the energy and housing markets. McCollum and Upton (2018) examine mortgage payment choices of homeowners who bought property in areas that are subject to a positive shock to the local economy due to the shale oil and gas boom in the U.S. By using a large loan-level dataset with detailed information on mortgage originations and mortgage payments, they find that there is a 6% reduced probability that homeowners with a property in areas that experience shale oil and gas booms will default on a mortgage payment. Wu et al. (2019) develop a theoretical model that is used to investigate the role of gasoline price shocks on housing market collapse in 2008 in the U.S. The model shows how energy price shocks impact the financial market and the macro economy based on data from 30 cities in California. They find that gasoline price shocks reduce home value with distance from the city center. Their model also predicts that the price shocks of gasoline affect homes in the suburban areas disproportionately as residents drive a longer distance and have lower income. Jacobsen (2019) is another study that assesses the effects of energy extraction in the U.S. on wage rates and housing. He finds that the recent energy boom has increased the wage rate across all sectors in the local markets. This corresponds with increases in the rent and value of local homes. As such, property owners benefited from the boom. Finally, Antonakakis et al. (2016) investigated the dynamic bond between the housing and oil markets in the U.S. Using an aggregate index of house and oil prices, they find that the relationship is generally negative which contradicts the inflationary effects of rising oil prices after controlling for other determinants of house prices. We question whether such an adverse effect is true for every state in the U.S. or if there are different results if each state is separately examined. One specific concern is to determine how house prices in large oil producing states such as Texas have responded to the shale oil boom in late 2000. In 2018, Texas produced more than 40% of the U.S. oil. If the inflationary effects of oil prices spread to all sectors of the economy including the housing market, we expect positive effects of rising oil prices on house prices. However, if an increase in oil prices reduces the purchasing power of households in terms of affording a set level of mortgage payments, demand for housing could decline which may result in a decrease in house prices.

Research in every area in the U.S. has shown that disaggregation not only reduces aggregation bias, but also reveals state-specific information that is masked by aggregate data.[1] In addition to using state level data from each state of the U.S., our study has another unique feature in that we examine whether house prices in each state respond to oil price changes symmetrically or asymmetrically. To this end, we outline our model of house price determination in Section II and introduce the methodology. The results are then presented in Section III with a summary that appears in Section IV. Finally, the sources of the data and the definition of the variables appear in the Appendix.

2. The Models and Methods

In conducting a review of the literature related to the determinants of house prices, we find many studies that have identified fundamental factors such as mortgage rate and household income as the main determinants of house prices.

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[1] For some examples on this issue, see Bahmani-Oskooee and Ghodsi (2016, 2017a, 2017b).

Examples include Chen and Patel (1998), Malpezzi (1999), Meen (2002), Apergis (2003), Gallin (2006), Chen et al. (2007), McQuinn and O'Reilly (2008), Kim and Bhattacharya (2009), Mikhed and Zemcik (2009), Zhou (2010), Holly et al. (2010), and Madsen (2012). Indeed, Case and Shiller (2003) who examine house prices in the U.S. conclude that since 1995, house prices have been mostly driven by household income and mortgage rates. Therefore, we adopt the following specification as our long-run model:

$$LnP_t = a + bLnI_t + cLnM_t + dLnO_t + \varepsilon_t \tag{1}$$

Equation (1) identifies household income (I), mortgage rate (M), and oil price (O) as the three main determinants of house prices (P). While we expect an estimate of b to be positive, we also expect an estimate of c to be negative. As for the oil prices, if we consider the inflationary effects of oil prices to spread to all sectors of the economy including the housing market, then the estimate of d is expected to be positive. On the other hand, if an increase in oil price reduces the purchasing power of households in terms of affording a set level of mortgage payments, demand for housing could decline which may result in a decrease in house prices, hence a negative estimate for d. Clearly, the extent to which house prices will react to oil price changes will depend whether a state produces or imports oil. In oil producing states such as Texas which produced 40.5% of the total oil in 2018; North Dakota which produced 11.5%, New Mexico which produced 6.3%, Oklahoma which produced 5%, and Alaska which produced 4.5%, we expect a housing boom and rising housing prices.

The coefficient estimates of Equation (1) are long-run estimates. To understand the short-run effects of all three exogenous variables, we need to incorporate a short-run dynamic adjustment process in Equation (1) by transforming the equation into an error-correction model. For this purpose, we follow the autoregressive distributed lag (ARDL) bounds testing approach in Pesaran et al. (2001) and rely on Equation (2):

$$\begin{aligned}\Delta LnP_t = \alpha &+ \textstyle\sum_{k=1}^{n1} \beta_k \Delta LnP_{t-k} + \sum_{k=0}^{n2} \delta_k \Delta LnI_{t-k} \\ &+ \textstyle\sum_{k=0}^{n3} \pi_k \Delta LnM_{t-k} + \sum_{k=0}^{n4} \theta_k \Delta LnO_{t-k} + \lambda_0 LnP_{t-1} \\ &+ \lambda_1 LnI_{t-1} + \lambda_2 LnM_{t-1} + \lambda_3 LnO_{t-1} + \mu_t\end{aligned} \tag{2}$$

The main advantage of estimating models such as Equation (2) is that the short-run and long-run effects are estimated in one step. The short-run effects are obtained from the coefficient estimates attached to the first-differenced variables. The long-run effects are obtained from the estimates of λ_1 - λ_3 which are normalized by estimating λ_0.[2] For these long-run effects to be meaningful, Pesaran et al. (2001) recommend using an *F* test to establish joint significance of the lagged level variables as a sign of cointegration. However, they show that

[2] Then by deduction, $\hat{b} = \hat{\lambda}_1/-\hat{\lambda}_0$, $\hat{c} = \hat{\lambda}_2/-\hat{\lambda}_0$, $\hat{d} = \hat{\lambda}_3/-\hat{\lambda}_0$

an *F* test in this application has a different distribution than the standard *F* test, hence they provide new critical values.

Thus far, the main assumption behind Equation (2) is that the effects of all of the variables on house prices are symmetric. However, Bahmani-Oskooee and Ghodsi (2016) who estimate Equation (2) without including oil prices argue and demonstrate that the effects of fundamentals could be asymmetric. We extend their arguments, analysis, and approaches to oil prices. We argue that the rate at which house prices respond to an increase in oil prices could be different than that at which they respond to a decrease in oil prices. Suppose oil prices rise by 10% which contributes to an increase in house prices by 10% in an oil producing state. Does a 10% decline in oil prices lead to a 10% decline in house prices? Most likely not, since the public may perceive the 10% decline in oil prices to be temporary and do not change their investing pattern. Indeed, recent abnormal declines in oil prices and the absence of response of house prices support our argument and hence comprise an asymmetric response. Following their approach and Shin et al. (2014), each exogenous variable in Equations (1) and (2) is decomposed into two time-series variables by using the partial sum concept. For example, consider the price of oil, LnO_t. First, changes in LnO_t are constructed as ΔLnO_t which includes positive values for oil price increases and negative values for oil price declines. The two new variables are then constructed as:

$$POSO_t = \sum_{j=1}^{t} \max(\Delta LnO_j, 0)\,, NEGO_t = \sum_{j=1}^{t} \min(\Delta LnO_j, 0) \qquad (3)$$

In Equation (3), the POSO which denotes the partial sum of positive changes in oil prices measures only the increase in oil prices. By the same token, the NEGO which denotes the partial sum of negative changes, measures only the decrease in oil prices. By going through the same procedure, we also generate partial sums of positive and negative changes in household income, *I,* as POSI and NEGI as well as partial sums of positive and negative changes in the mortgage rate, *M,* as POSM and NEGM.[3] The next step is to replace each of the three exogenous variables in Equations (1) and (2) by their partial sums to arrive at:

$$\begin{aligned}\Delta LnP_t = \alpha &+ \sum_{k=1}^{n1} \beta_k \Delta LnP_{t-k} + \sum_{k=0}^{n2} \delta_k^+ \Delta POSI_{t-k} \\ &+ \sum_{k=0}^{n3} \delta_k^- \Delta NEGI_{t-k} + \sum_{k=0}^{n4} \Psi_k^+ \Delta POSM_{t-k} \\ &+ \sum_{k=0}^{n5} \Psi_k^- \Delta NEGM_{t-k} + \sum_{k=0}^{n6} \eta_k^+ \Delta POSO_{t-k} \\ &+ \sum_{k=0}^{n7} \eta_k^- \Delta NEGO_{t-k} + \rho_0 LnP_{t-1} + \rho_1 POSI_{t-1} \\ &+ \rho_2 NEGI_{t-1} + \rho_3 POSM_{t-1} + \rho_4 NEGM_{t-1} \\ &+ \rho_5 POSO_{t-1} + \rho_6 NEGO_{t-1} + \xi_t\end{aligned} \qquad (4)$$

[3] More precisely, $POSI_t = \sum_{j=1}^{t} \max(\Delta LnI_j, 0)$, $NEGI_t = \sum_{j=1}^{t} \min(\Delta LnI_j, 0)$, $POSM_t = \sum_{j=1}^{t} \max(\Delta LnM_j, 0)$, and $NEGM_t = \sum_{j=1}^{t} \min(\Delta LnM_j, 0)$.

The model outlined above is another error-correction model which is referred to as an asymmetric error-correction model where, again, the short-run effects are reflected by the coefficients attached to the first-differenced variables. The long-run effects are reflected by the estimates of ρ_1-ρ_6 normalized on ρ_0. Shin et al. (2014) demonstrate that the approach in Pesaran et al. (2001) to estimate Equation (2) is equally applicable to Equation (4). They even recommend using the same high critical values of the *F* test for the cointegration for both Equations (2) and (4). The new terms to be used for Equation (4) are asymmetric cointegration and a nonlinear ARDL model, whereas the conventional terms associated with Equation (2) are symmetric cointegration and a linear ARDL model.

After Equation (4) is estimated by using a lag selection criterion, a few asymmetry assumptions can be tested. Since our main purpose is to show the asymmetric effects of oil prices on house prices, we shall concentrate on oil prices. First, short-run asymmetric effects will be verified if at the same lag k, the estimate of η^+ is different than that of η^-. Second, short-run impacts or cumulative asymmetric effects of oil prices will be established by using the Wald test if we conclude that $\sum \hat{\eta}_k^+ \neq \sum \hat{\eta}_k^-$.[4] Third, there will be evidence of adjustment asymmetry if ΔPOSO and ΔNEGO accept different lag orders. Finally, if the Wald test supports $\hat{\rho}_5/-\hat{\rho}_0 \neq \hat{\rho}_6/-\hat{\rho}_0$, the long-run asymmetric effects will be established.

3. Results

In this section, we present the estimates of both the linear error-correction model (Equation (2)) and the nonlinear model (Equation (4)) by using quarterly data over the period 1976Q1-2016Q3 from each state of the U.S. and the District of Columbia (D.C.). Since the data are quarterly, a maximum of eight lags are imposed onto each first-differenced variable and Akaike Information Criterion (AIC) is used to select an optimum model. Thus, the reported results and all of the statistical tests pertain to optimum models. Furthermore, since different estimates and test statistics are subject to different critical values, we have provided these critical values and their sources in the notes for each table and used them to indicate the significance of each estimate by one * (10% level) and two ** (5% level). We begin with the estimates of the linear models that are reported in Table 1.

From the short-run estimates reported in Panel A, we gather that the oil price (i.e., Δ*LnO*) variable carries at least one significant coefficient in 40 states. In

[4] In most instances, some of the short-run coefficients are insignificant and some are significant. Testing for their cumulative asymmetric effects becomes necessary. For more ,see Shin et al. (2014, p. 293).

most states, the coefficient estimates are negative, which imply that increased oil prices have a negative impact on house prices in the short run, in line with Antonakakis et al. (2016) who use a different method and aggregate U.S. data. Note that the list includes the three largest oil producing states (i.e., Texas, Oaklahoma, and New Mexico) and 37 other states, some of which produce some oil. In order to identify states in which short-run effects translate into long run effects, we move to Panel B which reports the normalized long-run coefficient estimates. As can be observed, oil prices (i.e., *LnO*) carry a significant coefficient in only Alaska and Michigan. While in Alaska the long-run effects of rising oil prices are positive, they are negative in Michigan. These estimates are meaningful since they are supported by either the *F* test for cointegration or by an alternative test, known as ECM_{t-1}, which is reported in Panel C.[5]

Panel C reports three additional diagnostic statistics. In order to ensure that the residuals are autocorrelation-free, we report the Lagrange multiplier statistic as LM. As can be observed, LM is significant in none of the models, which supports the lack of serial correlation. We also test the stability of the short-run and long-run coefficient estimates by using CUSUM and CUSUMSQ tests on the residuals of each model. These tests are reported in Panel C as QS and QS^2 due to space constraint. Furthermore, stable estimates are indicated by “S” and unstable ones by “US”. Clearly, all of the estimates are stable. Finally, we report the size of the adjusted R^2 to determine the goodness of fit in each model.

[5] Under the alternative test, we use the normalized long-run coefficient estimates and long-run model (Equation (1)) and generate the error term, which is denoted as ECM. We then move back to Equation (2) and replace the linear combination of lagged level variables with ECM_{t-1}. When this new specification is estimated after imposing the same optimum number of lags from Panel A of Table 1, cointegration or convergence to the long run equation is supported if ECM_{t-1} carries a significantly negative coefficient,. However, the *t*-test that is used to evaluate the significance of the estimated coefficient is not a standard *t*-test. It has a new distribution for which Pesaran et al. (2001, p. 303) also provide new critical values. Note that Banerjee et al. (1998) do the same with an Engle-Granger cointegration approach. Also note that for consistency when we move from one state to another, we stay with the same model that includes a lagged error-correction term. It is possible that cointegration is rejected by the F and ECMt-1 tests in the linear model but not in the nonlinear model (e.g. Alabama). For this reason, the error-correction term is retained in all cases to observe the changes when we move from a linear to nonlinear model.

Table 1 Estimates of Linear ARDL Model

Linear ARDL	Alaska	Alabama	Arkansas	Arizona
Panel A: Short-Run				
ΔLnI_t	0.66(2.28)**	0.57(3.8)**	0.32(3.23)**	0.44(2.56)**
ΔlnI_{t-1}			-0.09(0.69)	0.2(0.88)
ΔlnI_{t-2}			-0.06(0.44)	-0.48(2.12)**
ΔlnI_{t-3}			-0.09(0.65)	0.34(1.45)
ΔlnI_{t-4}			0.15(1.16)	-0.35(1.54)
ΔlnI_{t-5}			-0.29(2.38)**	-0.14(0.63)
ΔlnI_{t-6}			-0.01(0.12)	0.36(2.27)**
ΔlnI_{t-7}			0.19(2.17)**	
ΔLnM_t	0.05(1.49)	-0.09(3.33)**	-0.08(3.46)**	-0.14(4.42)**
ΔLnM_{t-1}		-0.08(3.07)**	-0.06(2.51)**	
ΔLnM_{t-2}				
ΔLnM_{t-3}				
ΔLnM_{t-4}				
ΔLnM_{t-5}				
ΔLnM_{t-6}				
ΔLnM_{t-7}				
ΔlnO_t	-0.02(0.64)	-0.01(0.96)	-0.02(2.63)**	-0.01(1.05)
ΔlnO_{t-1}	-0.05(1)	0(0.2)		
ΔlnO_{t-2}	0.02(0.47)	-0.01(0.87)		
ΔlnO_{t-3}	-0.05(1.57)	-0.01(0.35)		
ΔlnO_{t-4}		-0.01(0.7)		
ΔlnO_{t-5}		0.02(2.03)**		
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	-9.3(1.35)	1.5(0.22)	-3.18(0.24)	3.32(0.34)
LnI_t	0.7(1.97)**	0.17(0.55)	0.39(0.62)	0.11(0.28)
LnM_t	0.32(1.65)*	0.01(0.08)	0.16(0.41)	-0.17(0.4)
LnO_t	0.16(2.51)**	0.04(0.72)	-0.03(0.22)	0.15(1.63)
Panel C:Diagnostic				
F	3.19	1.76	0.95	3.3
ECM_{t-1}	-0.16(3.68)*	-0.06(2.37)	-0.03(1.13)	-0.04(2.5)
LM	2.65	0.2	2.6	0.14
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.3	0.52	0.43	0.59

(***Continued…***)

(Table 1 Continued)

Linear ARDL	California	Colorado	Connecticut	Delaware
Panel A: Short-Run				
ΔLnI_t	0(0.07)	0.19(2.03)**	0.3(3.08)**	0.01(0.7)
ΔlnI_{t-1}			-0.05(0.35)	
ΔlnI_{t-2}			-0.27(1.88)*	
ΔlnI_{t-3}			0.36(2.53)**	
ΔlnI_{t-4}			-0.17(1.7)*	
ΔlnI_{t-5}				
ΔlnI_{t-6}				
ΔlnI_{t-7}				
ΔLnM_t	-0.06(2.75)**	-0.05(2.47)**	-0.11(4.79)**	-0.12(3.48)**
ΔLnM_{t-1}	0.07(3.25)**	-0.04(1.18)		0.04(0.76)
ΔLnM_{t-2}		0.01(0.44)		-0.1(1.94)*
ΔLnM_{t-3}		0.03(1.49)		0.14(2.81)**
ΔLnM_{t-4}				-0.07(2.11)**
ΔLnM_{t-5}				
ΔLnM_{t-6}				
ΔLnM_{t-7}				
ΔlnO_t	-0.03(3.38)**	-0.03(3.45)**	-0.02(2.15)**	0(0.14)
ΔlnO_{t-1}		-0.02(2.2)**		
ΔlnO_{t-2}				
ΔlnO_{t-3}				
ΔlnO_{t-4}				
ΔlnO_{t-5}				
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	7.78(0.4)	-7.04(0.69)	-1.55(0.1)	1.33(0.18)
LnI_t	0.06(0.07)	0.7(1.67)*	0.35(0.53)	0.27(0.77)
LnM_t	-0.54(0.97)	-0.07(0.15)	0.05(0.12)	-0.09(0.37)
LnO_t	-0.07(0.56)	-0.09(0.55)	-0.04(0.36)	-0.01(0.14)
Panel C:Diagnostic				
F	4.45**	2.67	2.27	3.11
ECM_{t-1}	-0.02(2.78)	-0.02(1.66)	-0.02(2.67)	-0.05(3.15)
LM	0.05	0.05	1.56	0.45
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.76	0.51	0.67	0.39

(***Continued…***)

(Table 1 Continued)

Linear ARDL	Florida	Georgia	Hawaii	Iowa
Panel A: Short-Run				
ΔLnI_t	-0.01(0.46)	0.29(2.81)**	4.17(8.03)**	-0.02(0.16)
ΔlnI_{t-1}		-0.19(1.75)*	1.12(1.28)	0.16(1.2)
ΔlnI_{t-2}			0.26(0.32)	-0.31(2.39)**
ΔlnI_{t-3}			-1.24(1.47)	0.12(0.94)
ΔlnI_{t-4}			-0.68(0.8)	-0.2(1.58)
ΔlnI_{t-5}			-0.54(0.65)	0.47(3.72)**
ΔlnI_{t-6}			1.77(3.16)**	-0.23(2.42)**
ΔlnI_{t-7}				
ΔLnM_t	-0.11(4.15)**	-0.08(4.01)**	-0.09(0.84)	-0.08(2.58)**
ΔLnM_{t-1}		0.04(1.88)*	-0.11(0.71)	
ΔLnM_{t-2}			0.06(0.4)	
ΔLnM_{t-3}			-0.05(0.33)	
ΔLnM_{t-4}			-0.4(2.63)**	
ΔLnM_{t-5}			0.41(4.11)**	
ΔLnM_{t-6}				
ΔLnM_{t-7}				
ΔlnO_t	-0.02(2.03)**	-0.01(0.82)	0.06(1.47)	-0.01(3.09)**
ΔlnO_{t-1}	-0.01(1.36)	-0.02(2.44)**	0.07(1.86)*	
ΔlnO_{t-2}				
ΔlnO_{t-3}				
ΔlnO_{t-4}				
ΔlnO_{t-5}				
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	11.29(0.87)	6.37(0.79)	52.34(0.46)	-7.72(0.63)
LnI_t	-0.21(0.41)	-0.04(0.11)	-2.04(0.38)	0.77(1.31)
LnM_t	-0.4(0.88)	-0.14(0.47)	-1.94(0.6)	-0.04(0.14)
LnO_t	0.1(1.01)	0.03(0.51)	-0.21(0.58)	-0.27(1.52)
Panel C:Diagnostic				
F	4.31*	2.83	2.47	5.18**
ECM_{t-1}	-0.03(2.79)	-0.03(2.27)	-0.05(0.86)	-0.05(1.97)
LM	0.97	0.03	0.02	0.02
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.64	0.57	0.6	0.51

(*Continued…*)

(Table 1 Continued)

Linear ARDL	Idaho	Illinois	Indiana	Kansas
Panel A: Short-Run				
ΔLnI_t	0.38(2.38)**	0.26(2.41)**	0.18(2.64)**	0.07(1.04)
ΔlnI_{t-1}	0.27(1.3)			-0.06(0.62)
ΔlnI_{t-2}	0.21(1)			-0.14(1.43)
ΔlnI_{t-3}	-0.53(2.54)**			-0.09(0.9)
ΔlnI_{t-4}	-0.07(0.34)			0.17(2.43)**
ΔlnI_{t-5}	0.32(1.56)			
ΔlnI_{t-6}	-0.29(1.4)			
ΔlnI_{t-7}	0.29(1.89)*			
ΔLnM_t	-0.12(3)**	-0.06(2.98)**	-0.07(5)**	-0.03(1.83)*
ΔLnM_{t-1}		0.03(1.41)		-0.09(3.54)**
ΔLnM_{t-2}				0.07(2.75)**
ΔLnM_{t-3}				-0.03(1.16)
ΔLnM_{t-4}				0.05(1.84)*
ΔLnM_{t-5}				-0.07(2.87)**
ΔLnM_{t-6}				0.04(2.46)**
ΔLnM_{t-7}				
ΔlnO_t	0.02(1.27)	-0.02(2.56)**	-0.02(3.64)**	-0.02(3.71)**
ΔlnO_{t-1}	-0.04(1.83)*	-0.02(1.95)*	-0.02(2.82)**	-0.02(2.34)**
ΔlnO_{t-2}	0(0.16)	0.01(1.5)		
ΔlnO_{t-3}	-0.03(1.07)			
ΔlnO_{t-4}	-0.01(0.29)			
ΔlnO_{t-5}	0.03(1.88)*			
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	2.71(0.32)	3.74(0.13)	-2.6(0.21)	32.61(0.17)
LnI_t	0.13(0.32)	0.2(0.16)	0.49(0.9)	-0.26(0.04)
LnM_t	-0.09(0.29)	-0.24(0.38)	-0.06(0.18)	-2.59(0.2)
LnO_t	0.13(1.48)	-0.35(1.07)	-0.43(1.4)	-2.21(0.2)
Panel C:Diagnostic				
F	2.38	1.53	3.92*	2.43
ECM_{t-1}	-0.06(2.29)	-0.02(1.22)	-0.02(1.51)	0(0.21)
LM	0.52	0.17	1.93	0.15
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.56	0.47	0.56	0.55

(***Continued…***)

(Table 1 Continued)

Linear ARDL	Kentucky	Louisiana	Massachusetts	Maryland
Panel A: Short-Run				
ΔLnI_t	0.28(3.63)**	0.27(3.18)**	0.2(2.08)**	0.21(1.5)
ΔlnI_{t-1}	-0.01(0.06)		-0.22(2.32)**	
ΔlnI_{t-2}	-0.05(0.51)			
ΔlnI_{t-3}	0.07(0.74)			
ΔlnI_{t-4}	-0.18(1.77)*			
ΔlnI_{t-5}	-0.01(0.14)			
ΔlnI_{t-6}	0.27(2.95)**			
ΔlnI_{t-7}	-0.2(2.64)**			
ΔLnM_t	-0.03(2.2)**	-0.04(2.02)**	-0.07(3.73)**	-0.07(3.19)**
ΔLnM_{t-1}	0.01(0.68)			
ΔLnM_{t-2}	0.01(0.54)			
ΔLnM_{t-3}	-0.07(3.29)**			
ΔLnM_{t-4}	0.04(2.79)**			
ΔLnM_{t-5}				
ΔLnM_{t-6}				
ΔLnM_{t-7}				
ΔlnO_t	-0.02(3.61)**	-0.03(3.65)**	-0.01(1.95)*	-0.02(2.17)**
ΔlnO_{t-1}	-0.01(1.79)*	-0.01(1.97)**		-0.01(0.49)
ΔlnO_{t-2}	0.01(1.7)*			-0.02(1.72)*
ΔlnO_{t-3}	-0.02(1.82)*			0.02(2.2)**
ΔlnO_{t-4}	0(0.21)			
ΔlnO_{t-5}	0.02(2.55)**			
ΔlnO_{t-6}	-0.02(2.72)**			
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	-11.98(1.84)*	-12.71(1.05)	-16.06(1.72)*	8.38(0.68)
LnI_t	0.9(2.82)**	0.88(1.47)	1.09(2.64)**	-0.02(0.05)
LnM_t	0.19(1.14)	0.21(0.8)	0.18(0.71)	-0.45(1.21)
LnO_t	-0.18(1.29)	0.03(0.24)	-0.01(0.17)	0.03(0.36)
Panel C:Diagnostic				
F	4.62**	3.08	4.48**	4.44**
ECM_{t-1}	-0.04(1.83)	-0.03(2.17)	-0.03(3.96)**	-0.03(2.93)
LM	2.45	0.42	0.07	0.11
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.68	0.48	0.73	0.61

(***Continued…***)

(Table 1 Continued)

Linear ARDL	Maine	Michigan	Minnesota	Missouri
Panel A: Short-Run				
ΔLnI_t	0.75(3.03)**	0.06(1.68)*	0.03(1.7)*	0.04(2.16)**
ΔlnI_{t-1}	0.72(2.25)**			
ΔlnI_{t-2}	-0.36(1.43)			
ΔlnI_{t-3}				
ΔlnI_{t-4}				
ΔlnI_{t-5}				
ΔlnI_{t-6}				
ΔlnI_{t-7}				
ΔLnM_t	-0.12(2.46)**	0(0.45)	-0.07(3.39)**	-0.03(1.63)
ΔLnM_{t-1}	0.07(0.93)			
ΔLnM_{t-2}	-0.07(1)			
ΔLnM_{t-3}	-0.04(0.5)			
ΔLnM_{t-4}	0.03(0.45)			
ΔLnM_{t-5}	-0.08(1.1)			
ΔLnM_{t-6}	0.18(2.46)**			
ΔLnM_{t-7}	-0.14(3.07)**			
ΔlnO_t	0.01(1.2)	-0.03(3.43)**	-0.01(1.51)	-0.02(2.84)**
ΔlnO_{t-1}			-0.01(1.74)*	-0.02(1.9)*
ΔlnO_{t-2}				
ΔlnO_{t-3}				
ΔlnO_{t-4}				
ΔlnO_{t-5}				
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	-14.3(1.92)*	-15.3(1.58)	-12.79(1.46)	-10.88(1.64)
LnI_t	1.05(2.88)**	1.07(2.41)**	0.89(2.26)**	0.77(2.47)**
LnM_t	0.25(1.17)	0.09(0.49)	0.24(0.93)	0.25(1.62)
LnO_t	0.08(1.29)	-0.23(2.17)**	-0.02(0.18)	-0.02(0.33)
Panel C:Diagnostic				
F	2.52	6.90**	2.8	3.5
ECM_{t-1}	-0.09(3.15)	-0.05(3.48)*	-0.03(2.59)	-0.05(3.1)
LM	3.96	3.36	0.92	1.45
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.5	0.46	0.53	0.5

(***Continued…***)

(Table 1 Continued)

Linear ARDL	Mississippi	Montana	North Carolina	North Dakota
Panel A: Short-Run				
ΔLnI_t	0.54(2.66)**	0.53(4.32)**	0.16(2.47)**	0.2(1.93)*
ΔlnI_{t-1}	-0.13(0.49)	-0.45(2.86)**	-0.11(1.16)	-0.32(2.37)**
ΔlnI_{t-2}	0.09(0.35)	-0.26(1.66)*	-0.12(1.31)	0.43(3.6)**
ΔlnI_{t-3}	0.26(1)	0.21(1.29)	0.14(2.09)**	-0.27(2.28)**
ΔlnI_{t-4}	0.22(0.84)	-0.02(0.13)		0.11(0.96)
ΔlnI_{t-5}	-0.82(3.12)**	0.22(1.62)		0.09(0.74)
ΔlnI_{t-6}	-0.27(1.03)			-0.27(2.89)**
ΔlnI_{t-7}	0.66(3.37)**			
ΔLnM_t	-0.07(1.73)*	-0.07(1.51)	-0.06(3.5)**	-0.01(0.18)
ΔLnM_{t-1}	-0.16(2.48)**	0.01(0.2)		0.19(2.03)**
ΔLnM_{t-2}	0.06(1.46)	-0.04(0.68)		-0.08(0.82)
ΔLnM_{t-3}		0.2(3.16)**		0.19(2.09)**
ΔLnM_{t-4}		-0.13(2.99)**		-0.18(3.12)**
ΔLnM_{t-5}				
ΔLnM_{t-6}				
ΔLnM_{t-7}				
ΔlnO_t	-0.02(0.97)	-0.01(0.71)	-0.01(1.93)*	0.01(0.77)
ΔlnO_{t-1}	-0.01(0.24)	-0.03(1.71)*	-0.02(2.41)**	
ΔlnO_{t-2}	0.01(0.6)			
ΔlnO_{t-3}	-0.03(1.83)*			
ΔlnO_{t-4}				
ΔlnO_{t-5}				
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	-14.75(1.61)	-14.1(1.49)	1.15(0.25)	-9.71(2.08)**
LnI_t	0.93(2.08)**	1.08(2.22)**	0.2(1.04)	0.84(3.43)**
LnM_t	0.47(2.06)**	0.2(0.73)	-0.01(0.07)	0.12(0.77)
LnO_t	0.05(0.77)	0.01(0.09)	0.02(0.36)	0.05(0.86)
Panel C:Diagnostic				
F	2.75	2.24	2.12	5.05**
ECM_{t-1}	-0.08(2.29)	-0.09(2.54)	-0.04(2.45)	-0.15(2.92)
LM	0.01	0.58	0.27	0.03
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.5	0.59	0.51	0.43

(***Continued…***)

(Table 1 Continued)

Linear ARDL	Nebraska	New Hampshire	New Jersey	New Mexico
Panel A: Short-Run				
ΔLnI_t	-0.07(1.17)	0.35(2.81)**	0.23(2.27)**	0.22(1.63)
ΔlnI_{t-1}	0.03(0.35)		-0.19(1.76)*	
ΔlnI_{t-2}	-0.11(1.79)*			
ΔlnI_{t-3}				
ΔlnI_{t-4}				
ΔlnI_{t-5}				
ΔlnI_{t-6}				
ΔlnI_{t-7}				
ΔLnM_t	-0.02(1.26)	-0.09(2.9)**	-0.04(2.1)**	0(0.07)
ΔLnM_{t-1}		-0.04(1.35)		-0.13(3.48)**
ΔLnM_{t-2}				0.09(3.43)**
ΔLnM_{t-3}				
ΔLnM_{t-4}				
ΔLnM_{t-5}				
ΔLnM_{t-6}				
ΔLnM_{t-7}				
ΔlnO_t	-0.02(3.16)**	-0.01(0.85)	-0.02(2.7)**	-0.03(2.88)**
ΔlnO_{t-1}	-0.01(1.37)	-0.02(2.16)**		-0.02(1.8)*
ΔlnO_{t-2}				
ΔlnO_{t-3}				
ΔlnO_{t-4}				
ΔlnO_{t-5}				
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	-15.46(1.28)	-13.91(2.3)**	-7.41(0.66)	-5.02(0.95)
LnI_t	1.11(1.79)*	0.96(3.45)**	0.69(1.39)	0.49(1.98)**
LnM_t	0.3(0.93)	0.39(1.82)*	-0.06(0.19)	0.2(1.15)
LnO_t	-0.24(1.17)	0.07(1.09)	-0.01(0.15)	0.06(1.2)
Panel C:Diagnostic				
F	4.12*	4.30*	3.15	2.17
ECM_{t-1}	-0.03(1.78)	-0.05(4.12)**	-0.03(3.27)	-0.06(2.44)
LM	2.87	0.62	0.24	0.04
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.42	0.56	0.68	0.42

(*Continued…*)

(Table 1 Continued)

Linear ARDL	Nevada	New York	Ohio	Oklahoma
Panel A: Short-Run				
ΔLnI_t	0.24(1.46)	0.21(1.89)*	0.19(2.29)**	0.2(2.45)**
ΔlnI_{t-1}				-0.15(1.19)
ΔlnI_{t-2}				-0.14(1.09)
ΔlnI_{t-3}				0.2(2.45)**
ΔlnI_{t-4}				
ΔlnI_{t-5}				
ΔlnI_{t-6}				
ΔlnI_{t-7}				
ΔLnM_t	-0.06(1.72)*	-0.11(3.66)**	-0.07(4.49)**	-0.06(3.06)**
ΔLnM_{t-1}		0.05(1.04)		-0.05(1.67)*
ΔLnM_{t-2}		-0.04(0.96)		0.04(1.42)
ΔLnM_{t-3}		0.11(2.44)**		-0.03(0.85)
ΔLnM_{t-4}		-0.11(2.37)**		0(0.09)
ΔLnM_{t-5}		0.09(1.89)*		0.01(0.29)
ΔLnM_{t-6}		-0.07(2.28)**		-0.02(0.85)
ΔLnM_{t-7}				0.04(2.15)**
ΔlnO_t	-0.02(1.36)	-0.02(1.41)	-0.03(4.74)**	-0.02(2.95)**
ΔlnO_{t-1}	-0.02(1.44)			-0.02(1.96)**
ΔlnO_{t-2}				0.02(1.83)*
ΔlnO_{t-3}				-0.02(1.95)*
ΔlnO_{t-4}				
ΔlnO_{t-5}				
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	-2.78(0.52)	-11.67(1.11)	12.95(0.45)	19.13(0.65)
LnI_t	0.31(1.53)	0.84(1.85)*	-0.17(0.14)	-0.61(0.47)
LnM_t	0.3(1.08)	0.04(0.17)	-0.42(0.66)	-0.59(0.59)
LnO_t	0.05(0.59)	0.05(0.85)	-0.75(1.46)	-0.01(0.03)
Panel C:Diagnostic				
F	3.69	5.47**	5.76**	3.22
ECM_{t-1}	-0.05(3.34)	-0.06(4.33)**	-0.02(1.48)	-0.02(1.18)
LM	0.87	2.24	0.12	0.6
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.57	0.51	0.61	0.54

(***Continued…***)

(Table 1 Continued)

Linear ARDL	Oregon	Pennsylvania	Rhode Island	South Carolina
Panel A: Short-Run				
ΔLnI_t	0.46(2.93)**	0.17(2.08)**	0.15(0.93)	0.25(2.47)**
ΔlnI_{t-1}	-0.27(1.15)		-0.07(0.3)	
ΔlnI_{t-2}	-0.22(1.34)		-0.28(1.23)	
ΔlnI_{t-3}			0.69(3.05)**	
ΔlnI_{t-4}			-0.39(2.39)**	
ΔlnI_{t-5}				
ΔlnI_{t-6}				
ΔlnI_{t-7}				
ΔLnM_t	-0.08(2.57)**	-0.08(4.13)**	-0.11(3.59)**	-0.09(4.64)**
ΔLnM_{t-1}	-0.04(0.9)	0.02(0.6)		
ΔLnM_{t-2}	-0.04(0.83)	-0.04(1.75)*		
ΔLnM_{t-3}	0.14(3.15)**			
ΔLnM_{t-4}	-0.11(2.51)**			
ΔLnM_{t-5}	0.12(2.89)**			
ΔLnM_{t-6}	-0.13(2.99)**			
ΔLnM_{t-7}	0.06(2.22)**			
ΔlnO_t	-0.02(1.58)	-0.02(2)**	0(0.58)	-0.01(1.47)
ΔlnO_{t-1}	-0.02(1.78)*	-0.02(1.99)**		0(0.09)
ΔlnO_{t-2}				-0.02(1.73)*
ΔlnO_{t-3}				-0.01(0.64)
ΔlnO_{t-4}				-0.01(0.49)
ΔlnO_{t-5}				0(0.28)
ΔlnO_{t-6}				0.02(2.11)**
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	-8.67(0.79)	-1.02(0.11)	-19.27(1.65)*	12.32(1.31)
LnI_t	0.84(1.77)*	0.35(0.86)	1.38(2.35)**	-0.29(0.69)
LnM_t	-0.16(0.42)	-0.11(0.56)	0.25(0.86)	-0.37(1.19)
LnO_t	-0.06(0.54)	0.01(0.27)	-0.05(0.57)	0.03(0.5)
Panel C:Diagnostic				
F	3.6	3.67	2.36	3.26
ECM_{t-1}	-0.05(2.71)	-0.05(3.61)*	-0.04(2.96)	-0.05(2.25)
LM	0.03	1.05	0.17	0.17
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.6	0.57	0.63	0.52

(***Continued…***)

(Table 1 Continued)

Linear ARDL	South Dakota	Tennessee	Texas	Utah
Panel A: Short-Run				
ΔLnI_t	0.09(0.57)	0.22(1.67)*	0.01(0.91)	0.45(3.37)**
ΔlnI_{t-1}	0.13(0.61)	-0.09(0.48)		
ΔlnI_{t-2}	-0.25(1.21)	-0.3(1.61)		
ΔlnI_{t-3}	0.31(1.54)	0.26(2.07)**		
ΔlnI_{t-4}	0.08(0.39)			
ΔlnI_{t-5}	-0.52(2.55)**			
ΔlnI_{t-6}	-0.78(3.66)**			
ΔlnI_{t-7}	1.15(7.74)**			
ΔLnM_t	-0.01(0.38)	-0.04(1.78)*	-0.02(1.29)	-0.11(3.97)**
ΔLnM_{t-1}		-0.08(2.33)**	-0.06(2.51)**	-0.06(1.59)
ΔLnM_{t-2}		0.07(2)**	0.09(3.59)**	0.07(2.8)**
ΔLnM_{t-3}		0.05(1.49)	-0.07(2.55)**	
ΔLnM_{t-4}		-0.09(2.48)**	0.06(2.19)**	
ΔLnM_{t-5}		-0.01(0.41)	-0.02(0.85)	
ΔLnM_{t-6}		0.01(0.18)	-0.04(1.45)	
ΔLnM_{t-7}		0.03(1.38)	0.05(2.8)**	
ΔlnO_t	-0.01(1.05)	-0.01(1.26)	-0.03(4.84)**	-0.03(3)**
ΔlnO_{t-1}		-0.02(1.66)*		
ΔlnO_{t-2}				
ΔlnO_{t-3}				
ΔlnO_{t-4}				
ΔlnO_{t-5}				
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	-0.27(0.02)	0.06(0.01)	-5.85(0.39)	8.29(0.48)
LnI_t	0.39(0.64)	0.25(1.4)	0.53(0.78)	-0.01(0.02)
LnM_t	-0.16(0.33)	0.02(0.15)	0.04(0.09)	-0.51(0.67)
LnO_t	-0.11(0.71)	0.04(1.24)	-0.02(0.09)	-0.01(0.06)
Panel C:Diagnostic				
F	2.53	2.85	3.72	2.33
ECM_{t-1}	-0.09(1.33)	-0.08(2.9)	-0.02(1.41)	-0.02(1.57)
LM	0.12	0.29	0.06	0.02
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.61	0.47	0.54	0.52

(***Continued…***)

(Table 1 Continued)

Linear ARDL	Virginia	Vermont	Washington	Wisconsin
Panel A: Short-Run				
ΔLnI_t	0.15(1.35)	0.1(1.45)	0.03(1.59)	0.28(2.01)**
ΔlnI_{t-1}	-0.1(0.64)			-0.23(1.56)
ΔlnI_{t-2}	-0.51(3.37)**			
ΔlnI_{t-3}	0.39(3.49)**			
ΔlnI_{t-4}				
ΔlnI_{t-5}				
ΔlnI_{t-6}				
ΔlnI_{t-7}				
ΔLnM_t	-0.11(5.24)**	-0.08(0.85)	-0.07(2.91)**	-0.08(2.91)**
ΔLnM_{t-1}	0.03(1.38)	-0.15(1.06)	0.05(1.93)*	0.08(2.08)**
ΔLnM_{t-2}		-0.07(0.48)		-0.09(2.3)**
ΔLnM_{t-3}		0.11(0.76)		0.09(2.13)**
ΔLnM_{t-4}		-0.36(2.59)**		-0.09(2.34)**
ΔLnM_{t-5}		0.45(3.22)**		0.02(0.43)
ΔLnM_{t-6}		-0.18(1.98)**		0.08(1.91)*
ΔLnM_{t-7}				-0.05(2.01)**
ΔlnO_t	-0.01(1.14)	0(0.28)	-0.02(2.71)**	-0.01(2.79)**
ΔlnO_{t-1}	-0.04(2.81)**			
ΔlnO_{t-2}	0.02(2.12)**			
ΔlnO_{t-3}				
ΔlnO_{t-4}				
ΔlnO_{t-5}				
ΔlnO_{t-6}				
ΔlnO_{t-7}				
Panel B: Long-Run				
Constant	9.49(0.78)	-7.1(0.79)	-8.27(1.11)	-19.51(1.3)
LnI_t	-0.1(0.19)	0.71(1.62)	0.74(2.35)**	1.3(1.86)*
LnM_t	-0.44(1.12)	0.1(0.33)	-0.02(0.07)	0.26(0.65)
LnO_t	0.07(0.98)	0.02(0.29)	-0.03(0.4)	-0.35(1.16)
Panel C:Diagnostic				
F	3.19	1.8	3.29	3.93*
ECM_{t-1}	-0.03(2.34)	-0.14(2.55)	-0.04(2.89)	-0.03(1.52)
LM	1.36	1.43	0.11	0.07
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.57	0.42	0.53	0.42

(***Continued…***)

(Table 1 Continued)

Linear ARDL	West Virginia	Wyoming	District of Columbia
Panel A: Short-Run			
ΔLnI_t	0.53(2.31)**	0.01(0.06)	0.36(2.3)**
ΔlnI_{t-1}		-0.01(0.05)	0.17(0.8)
ΔlnI_{t-2}		-0.01(0.06)	-0.1(0.5)
ΔlnI_{t-3}		0.08(0.46)	0.08(0.42)
ΔlnI_{t-4}		0.09(0.5)	0.51(2.56)**
ΔlnI_{t-5}		-0.12(0.67)	-0.49(3.26)**
ΔlnI_{t-6}		0.23(1.98)**	
ΔlnI_{t-7}			
ΔLnM_t	0.05(0.8)	-0.11(2.99)**	-0.03(0.74)
ΔLnM_{t-1}	-0.18(2.06)**	0.06(1.64)	-0.08(1.27)
ΔLnM_{t-2}	-0.01(0.07)		0.09(1.54)
ΔLnM_{t-3}	0.12(2.01)**		-0.09(2.34)**
ΔLnM_{t-4}			
ΔLnM_{t-5}			
ΔLnM_{t-6}			
ΔLnM_{t-7}			
ΔlnO_t	-0.03(2.95)**	-0.01(1.71)*	-0.03(1.65)
ΔlnO_{t-1}			
ΔlnO_{t-2}			
ΔlnO_{t-3}			
ΔlnO_{t-4}			
ΔlnO_{t-5}			
ΔlnO_{t-6}			
ΔlnO_{t-7}			
Panel B: Long-Run			
Constant	-76.88(0.72)	-6.86(0.31)	-14.39(0.66)
LnI_t	3.67(0.74)	0.9(0.82)	1.27(1.14)
LnM_t	2.52(0.76)	-0.23(0.24)	-0.22(0.4)
LnO_t	0.91(0.77)	-0.56(0.74)	0.05(0.41)
Panel C:Diagnostic			
F	6.80**	4.24*	2.25
ECM_{t-1}	0.03(0.68)	-0.02(0.94)	-0.05(2.35)
LM	0.11	0.64	0.57
QS (QS^2)	S(S)	S(S)	S(S)
Adjusted R^2	0.5	0.35	0.05

Notes:

a. Numbers in parentheses are absolute values of the *t*-ratios and * (**) indicates significance at the 10% (5%) confidence level.
b. At the 10% (5%) significance level when there are three exogenous variables (k=3), the upper bound critical value of the *F* test is 3.77 (4.35). This comes from Pesaran et al. (2001; Case III in Table CI, page 300). The lower bound critical values are 2.72 and 3.23 respectively.
c. At the 10% (5%) significance level when there are three exogenous variables (k=3), the upper bound critical value of the *t*-test for significance of ECM_{t-1} is -

3.46 (-3.78). This comes from Pesaran et al. (2001, Case III in Table CI, page 303). The lower bound critical values are -2.57 and -2.86 respectively.

d. LM denotes Lagrange multiplier test of residual serial correlation. It is distributed as $\chi 2$ with one degree of freedom since we are testing for 1st order serial correlation. Its critical value at the 10% (5%) level is 2.71 (3.84).

How do the results change if we move to the estimates of the nonlinear models that are reported in Table 2? Again, focusing on the effects of oil price changes, we gather that either ΔPOSO or ΔNEGO carries at least one significant coefficient in every state except Arizona, Delaware, Rhode Island, and Vermont based on the short-run estimates in Panel A. As can be observed, all five largest oil producing states are on the list now (i.e., Texas which produced 40.5% of the total oil in 2018; North Dakota which produced 11.5%, New Mexico which produced 6.3%, Oklahoma which produced 5%, and Alaska which produced 4.5%). The increase in the number of states in which oil price changes have short-run effects on house prices must be attributed to the nonlinear adjustment of oil prices. Furthermore, the size of the coefficient estimates attached to the ΔPOSO and ΔNEGO variables at the same lag order is different in almost all of the states, thus supporting the short-run asymmetric effects of oil prices on house prices. However, the sum of the coefficients attached to ΔPOSO is significantly different than that attached to ΔNEGO in only 19 states, including Alaska, Arkansas, Florida, Iowa, Illinois, Kansas, Kentucky, Massachusetts, Michigan, Minnesota, Mississippi, Nebraska, New Hampshire, Oklahoma, Oregon, South Dakota, Tennessee, Wisconsin, and Wyoming. This is due to the fact that the Wald test reported as Wald-Short in Panel C is significant in these states which supports short-run cumulative or impact asymmetry.[6] In how many states would short-run asymmetric effects last into the long-run? To answer this question, we consider the estimates of the normalized long-run coefficient estimates from Panel B.

From the long-run estimates, we gather that either the POSO or NEGO variable carries a significant coefficient that is supported by either the F or ECM_{t-1} test for cointegration in 15 states. Again, this increase in the number of cases from two in the linear model to 15 in the nonlinear model must be attributed to the nonlinear adjustment of oil prices. The 15 states are: Alabama, Arizona, Florida, Georgia, Hawaii, Idaho, Indiana, Michigan, North Carolina, Nebraska, Nevada, Oregon, South Carolina, Tennessee, and Wyoming. As can be observed, the results are state-specific. For example, the decrease in oil prices lowers house prices in Alabama, while this is not the case in Arizona. All in all, an increase in oil prices raises house prices in the long run in the 11 states of Alabama, Arizona, Florida, Georgia, Idaho, North Carolina, Nevada, Oregon, South Carolina, Tennessee, and Wyoming. As argued earlier, this is due to the inflationary effects of rising oil prices. However, a decrease in oil prices lowers

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[6] Also note that there is evidence of adjustment asymmetry in most states, since the number of lags assigned to ΔPOSO and ΔNEGO is different.

Table 2 Estimates of Nonlinear ARDL Models

Nonlinear ARDL	Alaska	Alabama	Arkansas	Arizona
Panel A: Short-Run				
$\Delta POSI_t$	0.19(1.51)	-0.08(1.32)	-0.16(1.03)	0.38(1.7)*
$\Delta POSI_{t-1}$			-0.14(0.56)	0.17(0.55)
$\Delta POSI_{t-2}$			0.19(0.79)	0.04(0.15)
$\Delta POSI_{t-3}$			-0.17(0.75)	0.35(1.14)
$\Delta POSI_{t-4}$			0.39(1.73)*	-0.32(1.04)
$\Delta POSI_{t-5}$			-0.2(0.96)	-0.63(2.08)**
$\Delta POSI_{t-6}$			-0.38(1.95)*	0.7(3.36)**
$\Delta POSI_{t-7}$			0.19(1.27)	
$\Delta NEGI_t$	1.11(1.91)*	1.59(6.07)**	0.69(3.57)**	0.73(1.75)*
$\Delta NEGI_{t-1}$	0.89(1.05)	0.15(0.4)	-0.04(0.14)	0.5(0.84)
$\Delta NEGI_{t-2}$	-0.27(0.32)	-1.59(4.19)**	-0.46(1.35)	-1.34(2.13)**
$\Delta NEGI_{t-3}$	-0.1(0.13)	1.07(2.89)**	0.02(0.07)	-0.54(0.89)
$\Delta NEGI_{t-4}$	-1.86(2.4)**	0.75(2.06)**	-0.35(1.13)	-0.52(0.97)
$\Delta NEGI_{t-5}$	2.75(3.67)**	-0.9(3.2)**	-0.06(0.22)	0.97(2.39)**
$\Delta NEGI_{t-6}$	-1.9(3.77)**		0.37(2.08)**	
$\Delta POSM_t$	0.22(1.86)*	0.02(1.37)	-0.04(0.86)	-0.11(1.82)*
$\Delta POSM_{t-1}$	0.17(1.06)			
$\Delta POSM_{t-2}$	-0.27(2.3)**			
$\Delta NEGM_t$	0.08(1.64)	-0.17(4.08)**	-0.13(2.99)**	-0.24(3.87)**
$\Delta NEGM_{t-1}$		-0.15(3.47)**	-0.11(2.85)**	0.04(0.51)
$\Delta NEGM_{t-2}$				-0.04(0.44)
$\Delta NEGM_{t-3}$				0.17(2.28)**
$\Delta NEGM_{t-4}$				-0.1(1.87)*
$\Delta POSO_t$	-0.01(0.24)	-0.01(0.3)	-0.02(1.14)	-0.02(0.92)
$\Delta POSO_{t-1}$	-0.14(1.71)*	0.02(0.59)	0.01(0.26)	
$\Delta POSO_{t-2}$	0.1(1.2)	-0.05(2.51)**	-0.01(0.35)	
$\Delta POSO_{t-3}$	-0.14(2.63)**		-0.05(1.91)*	
$\Delta POSO_{t-4}$			0(0.06)	
$\Delta POSO_{t-5}$			0.02(0.92)	
$\Delta POSO_{t-6}$			0.02(0.63)	
$\Delta POSO_{t-7}$			-0.03(1.99)**	
$\Delta NEGO_t$	-0.03(1.31)	-0.02(1.2)	0(0.08)	0.01(0.81)
$\Delta NEGO_{t-1}$		0.01(0.28)		
$\Delta NEGO_{t-2}$		-0.04(2.56)**		
Panel B: Long-Run				
Constant	5.38(41.38)**	4.92(64.48)**	5.11(22.09)**	4.95(13.55)**
$POSI_t$	0.47(1.72)*	-0.44(1.26)	-0.91(0.63)	-2.88(1.78)*
$NEGI_t$	4.19(9.54)**	3.42(6.01)**	2.57(3.19)**	7.19(2.67)**
$POSM_t$	0.5(3.91)**	0.13(1.34)	0.21(0.75)	0.07(0.16)
$NEGM_t$	0.21(1.55)	-0.2(1.75)*	-0.05(0.18)	-1.36(1.54)
$POSO_t$	0.02(0.63)	0.1(3.68)**	0.15(2.42)**	0.31(2.81)**
$NEGO_t$	-0.06(1.27)	0.09(2.69)**	0.01(0.08)	0.12(0.83)
Panel C:Diagnostic				
F	7.63**	4.99**	2.11	3.83*
ECM_{t-1}	-0.4(6.04)**	-0.18(4.89)**	-0.07(2.86)	-0.05(3.31)
LM	0.002	0.44	3.49	0.79
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.46	0.67	0.61	0.7
Wald Test:				
Wald-Short	10.86**	0.16	11.10**	0.12
Wald-Long	0.0009	5.17**	0.55	0.002

(***Continued…***)

(Table 2 Continued)

Nonlinear ARDL	California	Colorado	Connecticut	Delaware
Panel A: Short-Run				
$\Delta POSI_t$	0.02(0.41)	0.07(1.54)	0.42(3.06)**	0.19(2.65)**
$\Delta POSI_{t-1}$				
$\Delta NEGI_t$	0.05(0.24)	0.4(1.68)*	0(0.01)	0.09(0.29)
$\Delta NEGI_{t-1}$	-0.08(0.29)		0.28(1.01)	0.74(2.07)**
$\Delta NEGI_{t-2}$	-0.41(1.9)*		-0.52(2.52)**	-0.75(2.64)**
$\Delta NEGI_{t-3}$				
$\Delta POSM_t$	-0.02(0.49)	0.06(1.49)	-0.08(1.8)*	-0.22(3.3)**
$\Delta POSM_{t-1}$	0.08(2.26)**			
$\Delta POSM_{t-2}$				
$\Delta NEGM_t$	-0.16(3.7)**	-0.16(4.07)**	-0.15(3.43)**	-0.07(1.08)
$\Delta NEGM_{t-1}$	0.07(1.2)	-0.04(0.78)	-0.14(2.29)**	0.08(0.94)
$\Delta NEGM_{t-2}$	-0.03(0.46)	0.09(2.26)**	0.12(1.96)*	-0.21(2.4)**
$\Delta NEGM_{t-3}$	0.05(0.86)		-0.07(1.7)*	0.29(3.31)**
$\Delta NEGM_{t-4}$	0.02(0.41)			-0.17(1.87)*
$\Delta NEGM_{t-5}$	-0.09(1.76)*			0.09(1.06)
$\Delta NEGM_{t-6}$	0.11(2.05)**			0.09(1.05)
$\Delta NEGM_{t-7}$	-0.09(2.48)**			-0.12(2.03)**
$\Delta POSO_t$	-0.02(1.41)	-0.01(0.44)	-0.03(2.03)**	-0.01(1.21)
$\Delta POSO_{t-1}$		-0.01(0.33)		
$\Delta POSO_{t-2}$		-0.02(1.51)		
$\Delta POSO_{t-3}$				
$\Delta NEGO_t$	-0.03(2.4)**	-0.04(3.62)**	0(0.07)	-0.02(0.84)
$\Delta NEGO_{t-1}$				
Panel B: Long-Run				
Constant	4.39(10.9)**	4.5(19.79)**	4.44(11.22)**	5.39(18.06)**
$POSI_t$	0.75(0.43)	1.69(2.12)**	0.61(0.44)	3.39(2.19)**
$NEGI_t$	4.32(2.24)**	0.95(0.47)	1.48(0.44)	-1.3(0.68)
$POSM_t$	-0.36(0.61)	-0.36(0.87)	0.32(0.5)	-1.26(2.36)**
$NEGM_t$	0.07(0.1)	0.65(1.57)	-0.05(0.07)	-0.43(0.83)
$POSO_t$	0.07(0.43)	0.05(0.32)	-0.11(0.71)	-0.24(1.09)
$NEGO_t$	-0.2(0.88)	-0.21(1.13)	0.02(0.08)	0.24(1.3)
Panel C:Diagnostic				
F	2.68	2.31	1.78	3.43
ECM_{t-1}	-0.03(3.06)	-0.04(2.59)	-0.03(2.77)	-0.06(3.36)
LM	0.13	0.9	1.56	1.85
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.81	0.58	0.7	0.52
Wald Test:				
Wald-Short	0.09	0.42	1.09	0.64
Wald-Long	1.92	0.3	14.33**	2.54

(*Continued…*)

(Table 2 Continued)

Nonlinear ARDL	Florida	Hawaii	Idaho	Kansas
Panel A: Short-Run				
$\Delta POSI_t$	0.17(0.93)	1.44(5.43)**	0.05(0.64)	0.02(0.18)
$\Delta POSI_{t-1}$	-0.38(1.59)			-0.21(1.97)**
$\Delta POSI_{t-2}$	0.39(2.26)**			
$\Delta NEGI_t$	0.38(1.45)	7.52(7.63)**	0.76(2.17)**	0.09(1.56)
$\Delta NEGI_{t-1}$	0.58(1.61)	2.63(1.55)	-0.4(0.85)	
$\Delta NEGI_{t-2}$	-0.94(3.37)**	-1.58(0.94)	1.05(2.29)**	
$\Delta NEGI_{t-3}$		-1.72(1.03)	-0.91(1.95)*	
$\Delta NEGI_{t-4}$		-2.61(1.62)	-0.32(0.69)	
$\Delta NEGI_{t-5}$		-3.62(2.26)**	1.16(2.61)**	
$\Delta NEGI_{t-6}$		8.96(6.45)**	-1.52(3.49)**	
$\Delta NEGI_{t-7}$		-4.85(5.52)**	0.62(1.88)*	
$\Delta POSM_t$	-0.13(2.55)**	-0.3(1.9)*	0.01(0.11)	0.01(0.73)
$\Delta POSM_{t-1}$		-0.23(1.47)	0.08(0.96)	
$\Delta POSM_{t-2}$			0.03(0.3)	
$\Delta POSM_{t-3}$			-0.14(2.04)**	
$\Delta NEGM_t$	-0.16(3.38)**	0.33(2.09)**	-0.28(3.95)**	-0.08(2.85)**
$\Delta NEGM_{t-1}$	-0.01(0.12)	-0.05(0.22)	0.06(0.55)	-0.13(2.93)**
$\Delta NEGM_{t-2}$	0.01(0.18)	0.19(0.9)	-0.16(1.54)	0.07(2.19)**
$\Delta NEGM_{t-3}$	0.01(0.16)	-0.06(0.29)	0.15(1.45)	
$\Delta NEGM_{t-4}$	0.17(2.61)**	-0.51(2.43)**	0.14(1.44)	
$\Delta NEGM_{t-5}$	-0.12(2.03)**	0.52(3.62)**	-0.15(1.46)	
$\Delta NEGM_{t-6}$	0.08(1.28)		0.2(2.01)**	
$\Delta NEGM_{t-7}$	-0.09(2.14)**		-0.2(2.93)**	
$\Delta POSO_t$	0(0.23)	0.01(0.47)	0.03(0.94)	-0.01(0.96)
$\Delta POSO_{t-1}$	0.04(1.26)		-0.02(0.39)	0(0.19)
$\Delta POSO_{t-2}$	-0.04(1.41)		-0.01(0.18)	-0.03(1.5)
$\Delta POSO_{t-3}$	0(0.04)		-0.1(2.08)**	0.01(0.49)
$\Delta POSO_{t-4}$	-0.03(1.02)		0.06(2.12)**	-0.01(0.58)
$\Delta POSO_{t-5}$	0.05(2.48)**			0.03(1.67)*
$\Delta POSO_{t-6}$				-0.03(2.63)**
$\Delta NEGO_t$	-0.03(1.87)*	0.08(3.48)**	0.01(0.4)	-0.03(3.03)**
$\Delta NEGO_{t-1}$	-0.04(2.43)**		-0.08(2.42)**	-0.02(1.76)*
$\Delta NEGO_{t-2}$			0.03(0.78)	
$\Delta NEGO_{t-3}$			0.03(0.72)	
$\Delta NEGO_{t-4}$			-0.1(2.84)**	
$\Delta NEGO_{t-5}$			0.06(2.63)**	
Panel B: Long-Run				
Constant	5.07(12.77)**	4.68(53.89)**	4.94(38.94)**	5.31(6.58)**
$POSI_t$	-3.05(1.54)	2.88(9.91)**	0.3(0.69)	-4.09(0.8)
$NEGI_t$	4.43(2.67)**	4.9(5.25)**	3.9(4.52)**	5.8(1.04)
$POSM_t$	-0.12(0.3)	-0.13(0.87)	0.16(0.76)	0.55(0.6)
$NEGM_t$	-1.11(1.31)	-0.13(0.8)	-0.14(0.65)	-0.3(0.3)
$POSO_t$	0.21(1.97)**	0.01(0.47)	0.09(1.73)*	0.21(0.77)
$NEGO_t$	0.01(0.08)	0.15(3.63)**	0.09(1.21)	-0.42(0.59)
Panel C:Diagnostic				
F	5.06**	6.30**	4.29*	2.54
ECM_{t-1}	-0.05(3.47)*	-0.5(6.87)**	-0.18(4.6)**	-0.01(0.92)
LM	1.12	1.48	2.67	0.003
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.77	0.75	0.73	0.57
Wald Test:				
Wald-Short	10.50**	0.36	0.42	8.01**
Wald-Long	1.46	0.78	0.04	7.79**

(***Continued…***)

(Table 2 Continued)

Nonlinear ARDL	**Georgia**	**Iowa**	**Illinois**	**Indiana**
Panel A: Short-Run				
$\Delta POSI_t$	0.24(1.67)*	-0.03(0.16)	-0.24(3.58)**	-0.01(0.2)
$\Delta POSI_{t-1}$	-0.27(1.98)**	0.89(3.64)**		
$\Delta POSI_{t-2}$		-0.78(2.98)**		
$\Delta POSI_{t-3}$		0.2(0.76)		
$\Delta POSI_{t-4}$		-0.25(1.05)		
$\Delta POSI_{t-5}$		-0.14(0.63)		
$\Delta POSI_{t-6}$		0.27(1.94)*		
$\Delta NEGI_t$	0.26(2.85)**	-0.03(0.19)	0.72(3.93)**	0.44(3.45)**
$\Delta NEGI_{t-1}$		-0.77(3.01)**	-0.37(1.54)	-0.11(0.66)
$\Delta NEGI_{t-2}$		0.12(0.44)	0.13(0.53)	0.02(0.12)
$\Delta NEGI_{t-3}$		0.11(0.39)	0.41(1.69)*	-0.04(0.25)
$\Delta NEGI_{t-4}$		-0.3(1.17)	-0.41(1.74)*	0.18(1.08)
$\Delta NEGI_{t-5}$		1.67(6.69)**	0.2(0.89)	0.1(0.61)
$\Delta NEGI_{t-6}$		-0.87(3.14)**	-0.36(2.11)**	-0.01(0.04)
$\Delta NEGI_{t-7}$		-0.46(2.11)**		-0.28(2.41)**
$\Delta POSM_t$	-0.02(1.12)	0.05(1.04)	0.06(1.7)*	0.01(1.14)
$\Delta POSM_{t-1}$		0.13(2.1)**	0.08(2.56)**	
$\Delta POSM_{t-2}$		-0.02(0.25)		
$\Delta POSM_{t-3}$		-0.1(2.27)**		
$\Delta NEGM_t$	-0.17(5.51)**	-0.15(2.95)**	-0.21(5.77)**	-0.19(7.89)**
$\Delta NEGM_{t-1}$	0.09(2.62)**			
$\Delta NEGM_{t-2}$				
$\Delta POSO_t$	0(0.18)	-0.02(3.02)**	-0.03(2.04)**	-0.02(2)**
$\Delta POSO_{t-1}$	-0.03(1.8)*		-0.05(3.26)**	-0.02(2.07)**
$\Delta NEGO_t$	-0.01(1.14)	0(0.24)	0(0.42)	-0.01(1.13)
$\Delta NEGO_{t-1}$	-0.03(2.73)**	-0.01(0.24)		-0.02(2.23)**
$\Delta NEGO_{t-2}$		-0.02(1.15)		
$\Delta NEGO_{t-3}$		0.03(1.18)		
$\Delta NEGO_{t-4}$		-0.06(2.53)**		
$\Delta NEGO_{t-5}$		0.02(0.85)		
$\Delta NEGO_{t-6}$		0.03(2)**		
Panel B: Long-Run				
Constant	4.95(47.5)**	4.19(7.89)**	4.78(42.96)**	4.74(31.89)**
$POSI_t$	-0.19(0.42)	-0.63(0.27)	-3.03(2.82)**	-0.15(0.19)
$NEGI_t$	2.99(3.58)**	1.5(1.06)	8.5(6.2)**	3.83(3.26)**
$POSM_t$	-0.19(1.06)	0.79(1.02)	0.45(2.11)**	0.2(1.1)
$NEGM_t$	-0.32(1.65)	-0.15(0.33)	-1.1(3.53)**	-0.75(1.95)*
$POSO_t$	0.12(3.02)**	-0.35(1.31)	0.08(1.11)	-0.23(1.82)*
$NEGO_t$	0.1(1.71)*	-0.31(1.35)	-0.03(0.42)	0(0.02)
Panel C:Diagnostic				
F	3.2	4.14*	6.26**	5.35**
ECM_{t-1}	-0.09(4.32)**	-0.05(1.35)	-0.08(3.99)**	-0.06(2.49)
LM	0.24	1.95	0.27	0.45
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.63	0.71	0.64	0.69
Wald Test:				
Wald-Short	0.72	6.32**	5.12**	0.63
Wald-Long	8.98**	13.69**	31.67**	9.92**

(*Continued…*)

(Table 2 Continued)

Nonlinear ARDL	**Kentucky**	**Louisiana**	**Massachusetts**	**Maryland**
Panel A: Short-Run				
$\Delta POSI_t$	-0.09(2.19)**	-0.09(1.68)*	0.43(3.09)**	-0.01(0.25)
$\Delta POSI_{t-1}$			-0.2(1.46)	
$\Delta NEGI_t$	0.75(5.78)**	0.63(3.81)**	-0.36(1.57)	0.48(1.62)
$\Delta NEGI_{t-1}$	-0.06(0.33)		-0.47(2.13)**	-0.43(1.47)
$\Delta NEGI_{t-2}$	-0.34(1.88)*			
$\Delta NEGI_{t-3}$	0.14(0.75)			
$\Delta NEGI_{t-4}$	-0.43(2.45)**			
$\Delta NEGI_{t-5}$	0.14(0.82)			
$\Delta NEGI_{t-6}$	0.54(3.22)**			
$\Delta NEGI_{t-7}$	-0.32(2.29)**			
$\Delta POSM_t$	0.05(3.86)**	0.06(1.95)*	-0.05(1.53)	0(0.11)
$\Delta POSM_{t-1}$			0.04(1.35)	
$\Delta NEGM_t$	-0.1(4.58)**	-0.12(3.76)**	-0.1(2.72)**	-0.11(3.15)**
$\Delta NEGM_{t-1}$	0.01(0.21)			-0.03(0.56)
$\Delta NEGM_{t-2}$	0.07(2.15)**			0.01(0.12)
$\Delta NEGM_{t-3}$	-0.11(3.7)**			-0.04(0.73)
$\Delta NEGM_{t-4}$	0.05(2.57)**			0.08(1.62)
$\Delta NEGM_{t-5}$				-0.02(0.51)
$\Delta NEGM_{t-6}$				-0.07(2.07)**
$\Delta POSO_t$	-0.01(1.21)	0(0.28)	-0.02(1.82)*	0(0.07)
$\Delta POSO_{t-1}$	-0.03(2.21)**	-0.01(0.27)	-0.02(1.71)*	-0.01(0.54)
$\Delta POSO_{t-2}$	0.01(0.52)	-0.04(2.89)**		-0.07(2.89)**
$\Delta POSO_{t-3}$	0(0.18)			0.05(1.83)*
$\Delta POSO_{t-4}$	-0.03(1.86)*			-0.04(1.49)
$\Delta POSO_{t-5}$	0.03(1.96)**			0.05(2.69)**
$\Delta POSO_{t-6}$	0.01(0.79)			
$\Delta POSO_{t-7}$	-0.02(1.98)**			
$\Delta NEGO_t$	-0.02(2.19)**	-0.05(5.16)**	0(0.3)	-0.02(1.96)**
$\Delta NEGO_{t-1}$	0.01(0.71)			
$\Delta NEGO_{t-2}$	0(0.36)			
$\Delta NEGO_{t-3}$	-0.01(0.61)			
$\Delta NEGO_{t-4}$	0(0.28)			
$\Delta NEGO_{t-5}$	0.02(1.83)*			
$\Delta NEGO_{t-6}$	-0.03(3.79)**			
Panel B: Long-Run				
Constant	4.95(61.27)**	4.96(9)**	4.64(13.52)**	4.59(17.3)**
$POSI_t$	-0.72(1.74)*	-3.98(0.94)	1.94(1.01)	-0.29(0.24)
$NEGI_t$	4.55(6.91)**	7.03(1.79)*	-3.25(0.54)	2.76(0.97)
$POSM_t$	0.4(3.45)**	0.33(0.54)	0.08(0.11)	-0.04(0.11)
$NEGM_t$	-0.31(2.25)**	-0.12(0.22)	0.16(0.29)	-0.06(0.14)
$POSO_t$	-0.04(0.93)	0.58(1.52)	-0.18(1.02)	0.07(0.75)
$NEGO_t$	0(0.02)	-0.1(0.4)	0.08(0.31)	-0.08(0.57)
Panel C:Diagnostic				
F	5.53**	4.94**	1.98	3.67
ECM_{t-1}	-0.13(3.05)	-0.02(1.71)	-0.02(2.73)	-0.04(3.67)*
LM	0.7	2.08	0.05	0.01
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.8	0.6	0.76	0.7
Wald Test:				
Wald-Short	3.24*	1.82	5.83**	0.51
Wald-Long	12.03**	0.81	17.79**	0.11

(***Continued…***)

(Table 2 Continued)

Nonlinear ARDL	Maine	Michigan	Minnesota	Missouri
Panel A: Short-Run				
$\Delta POSI_t$	0.55(1.53)	-0.09(1.12)	0(0.02)	-0.12(1.76)*
$\Delta POSI_{t-1}$	0.48(1.33)			
$\Delta NEGI_t$	1.09(1.94)*	0.29(1.38)	0.07(0.38)	0.23(1.1)
$\Delta NEGI_{t-1}$	1.5(2.22)**	-0.22(0.89)	-0.43(2.34)**	-0.62(2.26)**
$\Delta NEGI_{t-2}$	-1.59(3.11)**	-0.53(2.19)**		-0.14(0.52)
$\Delta NEGI_{t-3}$		0.44(1.82)*		-0.03(0.11)
$\Delta NEGI_{t-4}$		0.05(0.2)		-0.03(0.14)
$\Delta NEGI_{t-5}$		0.14(0.59)		0.46(1.88)*
$\Delta NEGI_{t-6}$		-0.12(0.52)		0.27(1.11)
$\Delta NEGI_{t-7}$		-0.32(1.65)		-0.52(2.88)**
$\Delta POSM_t$	-0.13(1.39)	0.04(0.81)	0.03(1.35)	0.05(2.88)**
$\Delta POSM_{t-1}$		0.1(2.28)**		
$\Delta NEGM_t$	-0.18(1.94)*	-0.11(4.36)**	-0.17(4.56)**	-0.11(3)**
$\Delta NEGM_{t-1}$	0.15(1.21)			
$\Delta NEGM_{t-2}$	-0.15(1.21)			
$\Delta NEGM_{t-3}$	0.06(0.5)			
$\Delta NEGM_{t-4}$	-0.03(0.25)			
$\Delta NEGM_{t-5}$	-0.14(1.17)			
$\Delta NEGM_{t-6}$	0.27(2.23)**			
$\Delta NEGM_{t-7}$	-0.22(2.84)**			
$\Delta POSO_t$	-0.01(1.18)	-0.04(2.24)**	-0.02(1.35)	-0.03(2.13)**
$\Delta POSO_{t-1}$		0(0.15)	-0.03(2.17)**	0.01(0.34)
$\Delta POSO_{t-2}$		-0.04(1.8)*		-0.06(2.39)**
$\Delta POSO_{t-3}$				0.04(1.43)
$\Delta POSO_{t-4}$				-0.01(0.49)
$\Delta POSO_{t-5}$				0.02(0.68)
$\Delta POSO_{t-6}$				0.06(2.15)**
$\Delta POSO_{t-7}$				-0.06(4)**
$\Delta NEGO_t$	0.01(0.95)	-0.02(2.04)**	-0.01(0.98)	0(0.14)
$\Delta NEGO_{t-1}$				-0.01(0.74)
$\Delta NEGO_{t-2}$				0.01(0.69)
$\Delta NEGO_{t-3}$				-0.03(2.14)**
Panel B: Long-Run				
Constant	4.42(11.98)**	4.96(44.67)**	4.35(14.97)**	4.73(36.66)**
$POSI_t$	-0.02(0.01)	-0.59(1.11)	0.03(0.02)	-1.58(1.52)
$NEGI_t$	7.44(1.5)	5.88(9.73)**	3.25(1.3)	3.9(4.15)**
$POSM_t$	0.62(0.97)	0.35(2.46)**	0.63(1.36)	0.62(2.18)**
$NEGM_t$	-1.01(1.11)	-0.72(3.78)**	0.24(0.53)	-0.31(1.22)
$POSO_t$	-0.17(0.87)	-0.09(1.62)	-0.01(0.06)	0.04(0.57)
$NEGO_t$	0.18(1.07)	-0.11(2.14)**	-0.12(0.86)	0.05(0.67)
Panel C:Diagnostic				
F	2.34	6.50**	2.87	2.9
ECM_{t-1}	-0.08(2.21)	-0.16(5.15)**	-0.04(2.78)	-0.08(2.77)
LM	6.45**	0.52	0.92	2.07
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.56	0.56	0.57	0.65
Wald Test:				
Wald-Short	0.5	5.41**	4.71**	0.92
Wald-Long	7.54**	69.70**	6.20**	1.65

(***Continued…***)

(Table 2 Continued)

Nonlinear ARDL	Mississippi	North Carolina	North Dakota	Nebraska
Panel A: Short-Run				
$\Delta POSI_t$	0.06(0.45)	0.02(0.23)	0.06(0.33)	-0.15(1.74)*
$\Delta POSI_{t-1}$		-0.27(2)**	-0.28(1.15)	-0.22(1.74)*
$\Delta POSI_{t-2}$		-0.15(1.12)	0.23(1.04)	0.24(1.95)*
$\Delta POSI_{t-3}$		0.2(2.13)**	-0.75(3.31)**	-0.21(2.34)**
$\Delta POSI_{t-4}$			1.03(4.39)**	
$\Delta POSI_{t-5}$			-0.01(0.04)	
$\Delta POSI_{t-6}$			-0.71(4.02)**	
$\Delta POSI_{t-7}$			0.25(1.95)*	
$\Delta NEGI_t$	0.89(2.44)**	0.22(4.89)**	0.37(1.69)*	0.1(0.66)
$\Delta NEGI_{t-1}$	-0.29(0.58)		-0.67(2.15)**	0.17(0.9)
$\Delta NEGI_{t-2}$	-0.43(0.84)		0.3(1.11)	-0.38(2.37)**
$\Delta NEGI_{t-3}$	0.82(1.61)		0.85(3.05)**	0.07(0.49)
$\Delta NEGI_{t-4}$	0.24(0.48)		-0.57(1.83)*	-0.01(0.1)
$\Delta NEGI_{t-5}$	-1.64(3.3)**		-0.44(2.01)**	-0.27(1.98)**
$\Delta NEGI_{t-6}$	-0.11(0.21)			0.7(4.85)**
$\Delta NEGI_{t-7}$	1.15(3.04)**			-0.41(3.81)**
$\Delta POSM_t$	0.04(1.16)	0(0.38)	0.11(1.09)	0.03(1.6)
$\Delta POSM_{t-1}$			0.3(2.24)**	
$\Delta POSM_{t-2}$			0.01(0.1)	
$\Delta POSM_{t-3}$			-0.03(0.24)	
$\Delta POSM_{t-4}$			-0.2(1.48)	
$\Delta POSM_{t-5}$			0.22(1.55)	
$\Delta POSM_{t-6}$			0.02(0.12)	
$\Delta POSM_{t-7}$			-0.19(1.96)**	
$\Delta NEGM_t$	-0.11(1.47)	-0.12(4.79)**	-0.06(1.28)	-0.05(1.81)*
$\Delta NEGM_{t-1}$	-0.18(2.42)**	-0.04(1.08)		
$\Delta NEGM_{t-2}$		0.07(2.66)**		
$\Delta POSO_t$	-0.03(1.09)	0(0.12)	0.02(0.42)	-0.02(1.34)
$\Delta POSO_{t-1}$	-0.04(0.79)	-0.02(1.36)	-0.11(2.61)**	-0.01(0.39)
$\Delta POSO_{t-2}$	0.02(0.43)	0.01(0.36)		-0.02(1.12)
$\Delta POSO_{t-3}$	-0.06(2.01)**	-0.02(0.97)		0(0.21)
$\Delta POSO_{t-4}$		-0.02(1.36)		-0.01(0.42)
$\Delta POSO_{t-5}$		0.03(2.13)**		0.02(1.28)
$\Delta POSO_{t-6}$				-0.01(0.29)
$\Delta POSO_{t-7}$				-0.02(1.99)**
$\Delta NEGO_t$	0(0.15)	-0.02(2.33)**	-0.05(1.48)	-0.03(3.23)**
$\Delta NEGO_{t-1}$		-0.01(0.47)		0.01(1.32)
$\Delta NEGO_{t-2}$		-0.01(1.33)		
Panel B: Long-Run				
Constant	4.44(14.42)**	4.9(65.13)**	5.11(28.89)**	5.37(16.07)**
$POSI_t$	0.71(0.45)	-0.56(1.54)	0.03(0.15)	0.21(0.2)
$NEGI_t$	2.25(1.11)	2.19(5.55)**	1.34(6.29)**	4.69(3.82)**
$POSM_t$	0.46(1.02)	-0.04(0.38)	0.55(2.78)**	0.54(1.76)*
$NEGM_t$	0.57(1.09)	-0.3(1.97)**	-0.19(1.21)	0.23(0.69)
$POSO_t$	0.12(1.03)	0.11(3.64)**	-0.02(0.44)	-0.17(1.91)*
$NEGO_t$	-0.02(0.15)	0.04(1.01)	0.04(0.82)	-0.37(2.15)**
Panel C:Diagnostic				
F	2.8	4.93**	4.28*	4.92**
ECM_{t-1}	-0.08(2.02)	-0.1(4.3)**	-0.33(3.99)**	-0.05(2.16)
LM	3.78	0.008	0.41	1.89
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.57	0.66	0.61	0.59
Wald Test:				
Wald-Short	18.05**	0.38	0.9	20.10**
Wald-Long	0.09	4.51**	0.71	3.75**

(***Continued…***)

(Table 2 Continued)

Nonlinear ARDL	Montana	New Hampshire	New Jersey	New Mexico
Panel A: Short-Run				
$\Delta POSI_t$	0.27(1.74)*	0.09(1.91)*	0.4(2.41)**	-0.01(0.06)
$\Delta POSI_{t-1}$	-0.68(3.54)**		-0.61(2.53)**	
$\Delta POSI_{t-2}$	-0.32(1.71)*		0.3(1.86)*	
$\Delta POSI_{t-3}$	0.35(1.87)*			
$\Delta POSI_{t-4}$	-0.44(2.29)**			
$\Delta POSI_{t-5}$	0.94(5.74)**			
$\Delta NEGI_t$	0.42(1.71)*	0.52(1.92)*	0.09(0.37)	0.73(2.84)**
$\Delta NEGI_{t-1}$	0.41(1.5)		0.61(1.93)*	0.75(2.1)**
$\Delta NEGI_{t-2}$	-0.01(0.05)		-0.52(2.25)**	-0.58(2.28)**
$\Delta NEGI_{t-3}$	-0.53(1.84)*			
$\Delta NEGI_{t-4}$	1.04(3.49)**			
$\Delta NEGI_{t-5}$	-1.33(4.66)**			
$\Delta NEGI_{t-6}$	0(0.01)			
$\Delta NEGI_{t-7}$	0.52(2.47)**			
$\Delta POSM_t$	-0.04(0.62)	0.02(0.68)	-0.09(2.45)**	0(0.01)
$\Delta POSM_{t-1}$	0.01(0.09)			
$\Delta POSM_{t-2}$	-0.01(0.1)			
$\Delta POSM_{t-3}$	-0.09(1.03)			
$\Delta POSM_{t-4}$	-0.16(1.8)*			
$\Delta POSM_{t-5}$	0.08(0.95)			
$\Delta POSM_{t-6}$	0.09(1.36)			
$\Delta NEGM_t$	-0.11(1.39)	-0.17(3.35)**	-0.02(1.03)	0.03(0.6)
$\Delta NEGM_{t-1}$	-0.08(0.77)	-0.06(0.81)		-0.29(4.64)**
$\Delta NEGM_{t-2}$	0.05(0.51)	-0.01(0.07)		0.2(4.55)**
$\Delta NEGM_{t-3}$	0.25(2.39)**	-0.04(0.48)		
$\Delta NEGM_{t-4}$	0.04(0.35)	0.15(2.08)**		
$\Delta NEGM_{t-5}$	-0.11(1.07)	-0.14(2.91)**		
$\Delta NEGM_{t-6}$	-0.13(1.84)*			
$\Delta POSO_t$	0.01(0.61)	-0.02(0.94)	0(0.01)	-0.02(1.01)
$\Delta POSO_{t-1}$		-0.07(3.09)**		0(0.12)
$\Delta POSO_{t-2}$				-0.05(2.42)**
$\Delta NEGO_t$	-0.01(0.59)	0.01(0.66)	-0.02(2.04)**	-0.05(3.49)**
$\Delta NEGO_{t-1}$	-0.02(0.52)			
$\Delta NEGO_{t-2}$	-0.01(0.48)			
$\Delta NEGO_{t-3}$	-0.04(1.35)			
$\Delta NEGO_{t-4}$	0.01(0.33)			
$\Delta NEGO_{t-5}$	0.04(1.91)*			
Panel B: Long-Run				
Constant	3.62(3.83)**	3.96(11.94)**	4.9(19.77)**	4.87(18.51)**
$POSI_t$	-3.91(0.74)	1.82(2.14)**	1.55(0.77)	-0.08(0.06)
$NEGI_t$	-1.87(0.45)	0.16(0.05)	0.76(0.15)	3.41(1.79)*
$POSM_t$	1.27(1.26)	0.32(0.65)	-0.54(0.99)	0(0.01)
$NEGM_t$	-0.21(0.3)	0.57(1.09)	-0.53(1.02)	0.06(0.19)
$POSO_t$	0.12(0.47)	0.04(0.34)	0(0.01)	0.22(1.97)**
$NEGO_t$	-0.03(0.17)	0.12(0.68)	0.22(1.22)	0.07(0.78)
Panel C:Diagnostic				
F	5.68**	2.67	2.32	2.77
ECM_{t-1}	-0.06(1.34)	-0.05(3.64)*	-0.03(3.63)*	-0.07(2.53)
LM	2.62	0.12	0.001	0.3
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.8	0.59	0.7	0.52
Wald Test:				
Wald-Short	1.64	4.75**	0.1	2.51
Wald-Long	2.82*	0.02	2.71*	3.08*

(***Continued…***)

(Table 2 Continued)

Nonlinear ARDL	Nevada	New York	Ohio	Oregon
Panel A: Short-Run				
$\Delta POSI_t$	0.01(0.04)	0.07(0.7)	0.13(1.01)	0.13(0.51)
$\Delta POSI_{t-1}$	-0.16(0.48)		-0.19(1.52)	
$\Delta POSI_{t-2}$	-0.01(0.02)			
$\Delta POSI_{t-3}$	0.38(1.71)*			
$\Delta NEGI_t$	0.77(2.24)**	0.4(1.8)*	0.11(1)	1.1(3.18)**
$\Delta NEGI_{t-1}$	0.1(0.2)			-0.52(1.09)
$\Delta NEGI_{t-2}$	0.37(0.79)			-0.77(2.2)**
$\Delta NEGI_{t-3}$	-0.19(0.42)			
$\Delta NEGI_{t-4}$	-0.63(1.92)*			
$\Delta POSM_t$	0.03(1.1)	-0.09(1.41)	0.01(1.25)	0.05(0.85)
$\Delta POSM_{t-1}$				0.07(0.98)
$\Delta POSM_{t-2}$				0.02(0.31)
$\Delta POSM_{t-3}$				-0.05(0.73)
$\Delta POSM_{t-4}$				-0.18(2.78)**
$\Delta POSM_{t-5}$				0.12(2.54)**
$\Delta NEGM_t$	-0.17(2.82)**	-0.13(2.12)**	-0.15(6.08)**	-0.14(2.58)**
$\Delta NEGM_{t-1}$		0.06(0.7)		-0.12(1.55)
$\Delta NEGM_{t-2}$		-0.07(0.83)		-0.08(1.04)
$\Delta NEGM_{t-3}$		0.19(2.42)**		0.25(3.26)**
$\Delta NEGM_{t-4}$		-0.16(2.02)**		-0.04(0.52)
$\Delta NEGM_{t-5}$		0.15(1.88)*		0.1(1.4)
$\Delta NEGM_{t-6}$		-0.15(2.72)**		-0.21(3.06)**
$\Delta NEGM_{t-7}$				0.08(1.68)*
$\Delta POSO_t$	0.03(0.98)	0(0.65)	-0.02(4.07)**	-0.03(1.28)
$\Delta POSO_{t-1}$	-0.01(0.34)			0.01(0.32)
$\Delta POSO_{t-2}$	-0.04(1.37)			-0.07(2.01)**
$\Delta POSO_{t-3}$				-0.01(0.19)
$\Delta POSO_{t-4}$				0.05(1.39)
$\Delta POSO_{t-5}$				-0.01(0.31)
$\Delta POSO_{t-6}$				0.02(0.7)
$\Delta POSO_{t-7}$				-0.06(2.57)**
$\Delta NEGO_t$	-0.04(1.95)*	-0.03(1.69)*	-0.03(3.17)**	-0.02(1.9)*
Panel B: Long-Run				
Constant	4.66(23.87)**	4.87(19.37)**	4.71(12.03)**	5.02(20.31)**
$POSI_t$	-1.73(2.48)**	1.23(0.72)	-4.11(1.05)	-2.26(1.64)
$NEGI_t$	7.26(3.95)**	1.24(0.6)	4.39(1.98)**	8.84(4.67)**
$POSM_t$	0.34(1.15)	0(0.01)	0.53(1.01)	0.83(2.5)**
$NEGM_t$	0.02(0.07)	0.33(0.55)	-1.76(1.09)	-0.12(0.37)
$POSO_t$	0.51(3.81)**	0.08(0.68)	-0.74(1.01)	0.25(3.89)**
$NEGO_t$	-0.09(0.72)	-0.04(0.26)	-0.4(1.36)	-0.17(1.66)*
Panel C:Diagnostic				
F	4.56**	2.83	5.69**	5.27**
ECM_{t-1}	-0.08(4.94)**	-0.05(3.85)**	-0.02(1.23)	-0.1(3.99)**
LM	0.12	1.9	0.11	1.01
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.67	0.51	0.64	0.71
Wald Test:				
Wald-Short	0.47	0.22	0.36	18.91**
Wald-Long	1.04	0.01	80.95**	5.92**

(***Continued…)***

(Table 2 Continued)

Nonlinear ARDL	Oklahoma	Pennsylvania	Rhode Island	South Carolina
Panel A: Short-Run				
$\Delta POSI_t$	0.16(1.42)	-0.03(0.43)	0.47(1.88)*	-0.03(0.61)
$\Delta POSI_{t-1}$	-0.11(0.73)		-0.74(1.91)*	
$\Delta POSI_{t-2}$	-0.22(1.47)		0.21(0.57)	
$\Delta POSI_{t-3}$	0.11(0.76)		0.76(2.18)**	
$\Delta POSI_{t-4}$	-0.03(0.23)		-0.47(1.96)*	
$\Delta POSI_{t-5}$	-0.2(1.46)			
$\Delta POSI_{t-6}$	0.09(0.7)			
$\Delta POSI_{t-7}$	0.31(3.44)**			
$\Delta NEGI_t$	0.58(3.35)**	0.48(2.73)**	0.08(0.22)	0.79(3.68)**
$\Delta NEGI_{t-1}$	-0.31(1.18)		0.96(1.96)**	-0.51(1.68)*
$\Delta NEGI_{t-2}$	0.27(1.05)		-0.76(2.09)**	-0.18(0.6)
$\Delta NEGI_{t-3}$	0.42(1.57)			0.39(1.33)
$\Delta NEGI_{t-4}$	0.17(0.71)			-0.18(0.61)
$\Delta NEGI_{t-5}$	-0.31(1.91)*			-0.36(1.63)
$\Delta POSM_t$	0.08(2.28)**	0.01(0.48)	-0.12(2.09)**	0.01(0.37)
$\Delta NEGM_t$	-0.19(5.23)**	-0.15(4.51)**	-0.13(2.3)**	-0.15(4.35)**
$\Delta NEGM_{t-1}$	-0.13(2.56)**	0.04(0.72)		
$\Delta NEGM_{t-2}$	0.07(1.89)*	-0.07(2.06)**		
$\Delta POSO_t$	-0.01(0.98)	-0.02(1.28)	0(0.44)	0(0.07)
$\Delta POSO_{t-1}$		-0.02(0.72)		0.03(1.27)
$\Delta POSO_{t-2}$		0.01(0.26)		-0.06(3.94)**
$\Delta POSO_{t-3}$		-0.05(2.1)**		
$\Delta POSO_{t-4}$		0.04(2.95)**		
$\Delta NEGO_t$	-0.04(3.78)**	-0.01(1.2)	0(0.37)	-0.02(2.03)**
$\Delta NEGO_{t-1}$	-0.03(2.06)**	-0.02(1.7)*		-0.02(2.03)**
$\Delta NEGO_{t-2}$	0.02(1.36)			
$\Delta NEGO_{t-3}$	0(0.06)			
$\Delta NEGO_{t-4}$	-0.03(2.43)**			
Panel B: Long-Run				
Constant	4.24(8.78)**	4.61(19.8)**	4.93(16.06)**	4.87(102.93)**
$POSI_t$	-2.43(0.79)	-0.67(0.38)	0.36(0.18)	-0.15(0.6)
$NEGI_t$	2.8(1.78)*	0.7(0.53)	7.97(1.79)*	4.16(8.62)**
$POSM_t$	0.57(0.77)	0.17(0.44)	-0.08(0.19)	0.03(0.38)
$NEGM_t$	0.14(0.23)	-0.46(0.71)	-0.5(0.8)	-0.02(0.31)
$POSO_t$	0.25(1.06)	-0.12(0.7)	0.05(0.44)	0.12(6.01)**
$NEGO_t$	-0.11(0.4)	0.01(0.05)	-0.07(0.35)	-0.01(0.44)
Panel C:Diagnostic				
F	5.33**	2.49	2.06	4.40**
ECM_{t-1}	-0.03(1.52)	-0.04(2.22)	-0.05(3.1)	-0.18(4.94)**
LM	0.01	0.16	0.91	0.68
QS (QS^2)	S(S)	S(S)	S(S)	U(S)
Adjusted R^2	0.69	0.63	0.65	0.6
Wald Test:				
Wald-Short	24.65**	1.83	0.01	1.33
Wald-Long	6.35**	1.82	1.11	69.39**

(***Continued…***)

(Table 2 Continued)

Nonlinear ARDL	South Dakota	Tennessee	Utah	Virginia
Panel A: Short-Run				
$\Delta POSI_t$	0.43(1.92)*	-0.16(0.84)	0.23(1.21)	0.26(1.57)
$\Delta POSI_{t-1}$		0.29(0.91)	-0.13(0.55)	0.02(0.08)
$\Delta POSI_{t-2}$		-0.73(2.25)**	-0.06(0.27)	-0.56(2.1)**
$\Delta POSI_{t-3}$		0.05(0.15)	0.05(0.22)	0.54(3.07)**
$\Delta POSI_{t-4}$		0.29(1.42)	0.36(1.92)*	
$\Delta NEGI_t$	-0.28(1.18)	1.09(3.92)**	0.95(3.35)**	-0.22(0.96)
$\Delta NEGI_{t-1}$	0.09(0.28)	-0.86(1.93)*	0.08(0.18)	-0.39(1.17)
$\Delta NEGI_{t-2}$	-0.56(1.79)*	0.13(0.3)	-0.62(1.43)	-0.09(0.25)
$\Delta NEGI_{t-3}$	0.3(0.98)	0.68(1.78)*	0.51(1.25)	0.52(1.64)
$\Delta NEGI_{t-4}$	0.4(1.38)	0.05(0.13)	0.01(0.02)	-0.35(1.17)
$\Delta NEGI_{t-5}$	-0.87(3.04)**	-0.47(1.9)*	-0.36(0.94)	0.31(1.1)
$\Delta NEGI_{t-6}$	-1.58(5.38)**		-0.53(1.36)	-0.5(2.39)**
$\Delta NEGI_{t-7}$	2.36(11.2)**		0.61(2.21)**	
$\Delta POSM_t$	0(0.07)	0.05(1.88)*	-0.02(0.94)	0.01(0.14)
$\Delta POSM_{t-1}$				0.14(2.64)**
$\Delta POSM_{t-2}$				-0.07(2.07)**
$\Delta NEGM_t$	0.1(2.01)**	-0.09(2.18)**	-0.18(4.08)**	-0.26(6.81)**
$\Delta NEGM_{t-1}$		-0.21(3.6)**	-0.16(2.5)**	
$\Delta NEGM_{t-2}$		0.13(3.15)**	0.17(3.82)**	
$\Delta POSO_t$	0.03(0.79)	-0.02(1.2)	-0.03(1.62)	-0.01(0.98)
$\Delta POSO_{t-1}$	-0.08(1.12)	0.02(0.59)	-0.04(1.96)*	-0.08(3.5)**
$\Delta POSO_{t-2}$	0(0.01)	-0.04(2.36)**		0.05(2.96)**
$\Delta POSO_{t-3}$	0.03(0.46)			
$\Delta POSO_{t-4}$	-0.07(0.93)			
$\Delta POSO_{t-5}$	0.06(0.85)			
$\Delta POSO_{t-6}$	0.01(0.16)			
$\Delta POSO_{t-7}$	-0.09(1.89)*			
$\Delta NEGO_t$	-0.03(2.5)**	-0.03(2.28)**	-0.03(2.07)**	-0.01(1.05)
$\Delta NEGO_{t-1}$		-0.02(0.85)		
$\Delta NEGO_{t-2}$		-0.01(0.44)		
$\Delta NEGO_{t-3}$		0(0.17)		
$\Delta NEGO_{t-4}$		0.02(0.95)		
$\Delta NEGO_{t-5}$		-0.01(0.73)		
$\Delta NEGO_{t-6}$		-0.02(1.43)		
Panel B: Long-Run				
Constant	5.58(1.55)	4.92(59.66)**	5.45(2.06)**	4.59(12.52)**
$POSI_t$	-4.79(0.22)	-0.51(1.17)	-7.49(0.31)	-1.18(0.42)
$NEGI_t$	-5.69(0.21)	5.01(5.24)**	14.59(0.45)	2.67(0.77)
$POSM_t$	-0.21(0.06)	0.28(2.04)**	-1.73(0.46)	-0.66(0.87)
$NEGM_t$	4.58(0.28)	-0.24(2.09)**	-2.58(0.35)	-0.94(0.81)
$POSO_t$	1.52(0.27)	0.08(2.62)**	0.67(0.4)	-0.16(0.6)
$NEGO_t$	-1.64(0.27)	0.08(1.5)	-0.5(0.34)	-0.24(0.75)
Panel C:Diagnostic				
F	2.39	3.32	2.7	2.89
ECM_{t-1}	-0.02(0.28)	-0.19(4.55)**	-0.01(0.44)	-0.02(1.52)
LM	19.91*	0.003	2.6	1.58
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.75	0.57	0.64	0.67
Wald Test:				
Wald-Short	14.60**	4.98**	1.12	0.29
Wald-Long	0.54	3.95**	1.58	0.14

(***Continued…***)

(Table 2 Continued)

Nonlinear ARDL	Texas	Vermont	Washington	Wisconsin
Panel A: Short-Run				
$\Delta POSI_t$	0.04(0.37)	1.05(1.63)	0.05(1.07)	0.29(1.21)
$\Delta POSI_{t-1}$	-0.24(2.08)**			-0.23(0.62)
$\Delta POSI_{t-2}$				0.52(1.41)
$\Delta POSI_{t-3}$				-0.44(1.2)
$\Delta POSI_{t-4}$				0.39(1.09)
$\Delta POSI_{t-5}$				0.09(0.25)
$\Delta POSI_{t-6}$				-0.56(2.16)**
$\Delta NEGI_t$	0.03(0.56)	1.22(2.08)**	0.1(0.68)	0.26(0.82)
$\Delta NEGI_{t-1}$			-0.29(2.04)**	-0.37(0.8)
$\Delta NEGI_{t-2}$				-0.69(1.48)
$\Delta NEGI_{t-3}$				1.07(2.35)**
$\Delta NEGI_{t-4}$				-0.01(0.02)
$\Delta NEGI_{t-5}$				-1.6(3.87)**
$\Delta NEGI_{t-6}$				0.82(2.85)**
$\Delta POSM_t$	0(0.08)	-0.03(0.39)	0(0.25)	0.07(1.24)
$\Delta POSM_{t-1}$				0.16(2.23)**
$\Delta POSM_{t-2}$				-0.04(0.51)
$\Delta POSM_{t-3}$				-0.09(1.69)*
$\Delta NEGM_t$	-0.01(0.28)	-0.32(1.89)*	-0.18(4.54)**	-0.21(3.94)**
$\Delta NEGM_{t-1}$	-0.13(2.93)**	-0.14(0.58)	0.11(2.59)**	0.08(1.12)
$\Delta NEGM_{t-2}$	0.17(3.84)**	-0.14(0.55)		-0.17(2.33)**
$\Delta NEGM_{t-3}$	-0.1(2.13)**	0.08(0.31)		0.18(2.47)**
$\Delta NEGM_{t-4}$	0.08(1.7)*	-0.47(1.92)*		-0.17(2.44)**
$\Delta NEGM_{t-5}$	0(0.03)	0.81(3.4)**		0.14(3.07)**
$\Delta NEGM_{t-6}$	-0.09(1.96)**	-0.35(2.21)**		
$\Delta NEGM_{t-7}$	0.08(2.46)**			
$\Delta POSO_t$	-0.02(1.59)	0.01(0.51)	-0.04(2.79)**	0(0)
$\Delta POSO_{t-1}$	-0.01(0.55)			-0.03(0.81)
$\Delta POSO_{t-2}$	0.01(0.43)			-0.01(0.27)
$\Delta POSO_{t-3}$	-0.02(1.74)*			-0.02(0.55)
$\Delta POSO_{t-4}$				0.05(1.5)
$\Delta POSO_{t-5}$				-0.03(0.93)
$\Delta POSO_{t-6}$				0.03(1.05)
$\Delta POSO_{t-7}$				-0.05(2.49)**
$\Delta NEGO_t$	-0.04(3.47)**	0.01(0.49)	0(0.58)	-0.01(0.61)
Panel B: Long-Run				
Constant	4.67(16.6)**	5.48(3.75)**	4.42(21.81)**	4.84(31.09)**
$POSI_t$	0.86(0.81)	-1.33(0.25)	1.27(1.36)	-0.87(0.62)
$NEGI_t$	0.83(0.52)	19.35(0.65)	0.79(0.64)	5.03(3.08)**
$POSM_t$	0.03(0.08)	-0.47(0.46)	-0.09(0.25)	0.41(1.64)
$NEGM_t$	0.58(1.22)	-2.45(0.65)	-0.23(0.46)	-0.24(0.97)
$POSO_t$	0.21(1.45)	0.15(0.48)	-0.11(0.64)	0.06(0.49)
$NEGO_t$	0.03(0.18)	0.23(0.52)	0.08(0.55)	-0.04(0.6)
Panel C:Diagnostic				
F	2.61	2.03	2.6	4.28*
ECM_{t-1}	-0.03(2.06)	-0.06(0.83)	-0.04(2.45)	-0.12(2.59)
LM	0.27	0.85	2.44	0.41
QS (QS^2)	S(S)	S(S)	S(S)	S(S)
Adjusted R^2	0.59	0.47	0.59	0.64
Wald Test:				
Wald-Short	2.15	0.06	2.79*	15.95**
Wald-Long	4.51**	3.72*	1.58	17.52**

(***Continued…***)

(Table 2 Continued)

Nonlinear ARDL	West Virginia	Wyoming	District of Columbia
Panel A: Short-Run			
$\Delta POSI_t$	0.13(0.31)	-0.31(1.66)*	0.07(0.6)
$\Delta POSI_{t-1}$	0.12(0.2)		
$\Delta POSI_{t-2}$	-1.18(2.12)**		
$\Delta POSI_{t-3}$	1.73(3.6)**		
$\Delta POSI_{t-4}$	-0.12(0.27)		
$\Delta POSI_{t-5}$	-0.8(2.74)**		
$\Delta NEGI_t$	0.97(2.36)**	0.43(5.01)**	0.55(1.48)
$\Delta NEGI_{t-1}$	0.06(0.09)		0.8(1.61)
$\Delta NEGI_{t-2}$	0.61(0.97)		-0.26(0.54)
$\Delta NEGI_{t-3}$	-1.21(2.72)**		-0.56(1.21)
$\Delta NEGI_{t-4}$			1.66(3.65)**
$\Delta NEGI_{t-5}$			-1.61(3.48)**
$\Delta NEGI_{t-6}$			0.66(2.01)**
$\Delta POSM_t$	-0.1(2.33)**	-0.07(1.04)	0.05(0.6)
$\Delta POSM_{t-1}$		0.09(1.04)	-0.01(0.09)
$\Delta POSM_{t-2}$		0.04(0.48)	-0.03(0.3)
$\Delta POSM_{t-3}$		0.04(0.49)	-0.11(1.17)
$\Delta POSM_{t-4}$		-0.19(2.36)**	0.19(2.83)**
$\Delta POSM_{t-5}$		0(0.01)	
$\Delta POSM_{t-6}$		0.13(2.38)**	
$\Delta NEGM_t$	0.21(2.14)**	-0.13(1.83)*	-0.11(1.49)
$\Delta NEGM_{t-1}$	-0.35(2.48)**	0.02(0.2)	-0.09(0.88)
$\Delta NEGM_{t-2}$	0.02(0.17)	-0.12(1.21)	0.25(2.36)**
$\Delta NEGM_{t-3}$	0.22(2.43)**	0.17(2.48)**	-0.26(3.31)**
$\Delta POSO_t$	-0.03(2.48)**	0.01(0.31)	0(0.17)
$\Delta POSO_{t-1}$		-0.01(0.26)	
$\Delta POSO_{t-2}$		0.02(0.5)	
$\Delta POSO_{t-3}$		-0.06(2.1)**	
$\Delta NEGO_t$	-0.05(1.71)*	-0.02(1.63)	-0.06(2.44)**
Panel B: Long-Run			
Constant	5.26(10.08)**	4.78(32.84)**	3.78(5.28)**
$POSI_t$	2.7(1.12)	0.04(0.11)	1.58(0.66)
$NEGI_t$	4.64(2.45)**	2.68(9.14)**	-5.29(1.15)
$POSM_t$	-0.84(1.11)	-0.26(1.7)*	-1.63(1.32)
$NEGM_t$	-0.88(1.12)	-0.15(0.82)	0.64(0.79)
$POSO_t$	-0.27(1.18)	0.14(1.81)*	0.05(0.17)
$NEGO_t$	-0.04(0.3)	-0.1(1.61)	-0.42(1.19)
Panel C:Diagnostic			
F	5.41**	7.30**	1.78
ECM_{t-1}	-0.12(1.62)	-0.16(5.22)**	-0.04(2.31)
LM	0.8	0.54	0.05
QS (QS^2)	S(S)	S(S)	S(S)
Adjusted R^2	0.63	0.49	0.65
Wald Test:			
Wald-Short	0.86	4.46**	2.54
Wald-Long	1.99	9.42**	0.15

***Notes*:**

a. Numbers in parentheses are absolute values of the *t*-ratios and * (**) indicates significance at the 10% (5%) confidence level.
b. At the 10% (5%) significance level when there are three exogenous variables

(k=3), the upper bound critical value of the *F* test is 3.77 (4.35). This comes from Pesaran et al. (2001, Case III in Table CI, page 300).

c. At the 10% (5%) significance level when there are six exogenous variables in the nonlinear model (k=6), the upper bound critical value of the *t*-test for significance of ECM_{t-1} is -4.04 (-4.38). This comes from Pesaran et al. (2001, Case III in Table CI, page 303).
d. LM denotes Lagrange multiplier test of residual serial correlation. It is distributed as $\chi 2$ with one degree of freedom since we are testing for 1st order serial correlation. Its critical value at the 10% (5%) level is 2.71 (3.84).
e. All Wald tests are distributed as $\chi 2$ with one degree of freedom and its critical value at the 10% (5%) level is 2.71 (3.84).

house prices in the long run only in Alabama, Georgia, and Hawaii, which is a clear sign of long-run asymmetric effects. Indeed, oil price changes do have long-run asymmetric effects in 26 states. These are the states in which the Wald test (reported as Wald-Long) is significant, thus rejecting equality of the normalized long-run coefficient attached to the POSO and NEGO variables.

Other diagnostic statistics are similar to those of the linear models in that the LM statistic is insignificant in almost all of the models, which supports autocorrelation free residuals. The outcome of the CUSUM and CUSUMSQ tests also supports the stability of the estimated coefficients in almost all of the models. Finally, the size of the adjusted R^2 reveals that nonlinear models have a much better fit than the linear models in all of the states, and this alone favors the use of nonlinear models.

4. Summary and Conclusion

The major oil price shock to most oil importing countries dates back to 1973, when OPEC raised the price of oil fourfold. Another shock that doubled oil prices was the Iranian revolution in 1979. Both events brought stagflation to oil importing countries by raising fuel prices and production costs. Thus, early studies have attempted to validate the stagflationary effects of oil prices by assessing their impacts on inflation and production. Subsequent studies then argue and show that rising oil prices could also affect other sectors of an economy such as consumption, investment, stock market, etc.

Our study considers the link between oil and house prices in the U.S. Using an aggregate measure of house and oil prices, we conclude that the co-movement between these two variables in the U.S. is generally negative. We argue that this could be either due to aggregation bias or avoidance to consider the asymmetries. To support our argument, we disaggregate the aggregate house price index of the U.S. by 50 states and D.C., and consider the asymmetric effects of oil price changes on house prices in each state. Since an asymmetry analysis necessitates the use of nonlinear models, we compare the results to those of a linear model.

Our findings are summarized as follows: after allowing for the effects of household income and mortgage rates, we find that oil prices have short-run effects on house prices in 40 states when we apply the linear ARDL approach in Pesaran et al. (2001) to our reduced form model of house price determination. However, short-run effects last into the long run only in Alaska and Michigan. While in Alaska the long-run effects of rising oil prices are positive, they are negative in Michigan. When increase in oil prices is separated from the declines and the nonlinear ARDL approach in Shin et al. (2014) is applied to the same model, the outcome is quite different. Short-run effects are found in almost all of the states in an asymmetric manner. However, short-run cumulative or impact asymmetric effects are found in only 15 states,[7] which include Alabama, Arizona, Florida, Georgia, Hawaii, Idaho, Indiana, Michigan, North Carolina, Nebraska, Nevada, Oregon, South Carolina, Tennessee, and Wyoming. While we find significant long-run asymmetric effects in 26 states, increases in oil prices increase house prices in the long run in the 11 states of Alabama, Arizona, Florida, Georgia, Idaho, North Carolina, Nevada, Oregon, South Carolina, Tennessee, and Wyoming. However, a decrease in oil prices reduces house prices in the long run only in Alabama, Georgia, and Hawaii. All in all, our analysis shows that house prices in most states are not affected by oil prices in the long run and in the few states that are affected, the impact of rising oil prices is in line with their inflationary effects. While all states should be prepared to deal with rising oil prices in the short run, only a few states that we have identified in this study must deal with rising oil prices in the long run. Of course, monetary authorities such as the US Federal Reserve which target inflation should also be prepared to offset the inflationary effects of oil prices via interest rate policies in order to stabilize the housing market.[8]

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[7] These relatively more significant outcomes from the nonlinear model compared to the linear model signify the importance of the nonlinear adjustment of oil prices and use of nonlinear models in the real estate markets. Data permitting, the analysis should be extended to other countries.

[8] Note that none of the five largest oil producing states seems to be affected in the long run, thus implying that house prices do not respond asymmetrically to oil price changes in large oil producing states in the long run but do in the short run. These five states are Texas which contributed to 40.5% of the total oil production in 2018; North Dakota which contributed 11.5%, New Mexico which contributed 6.3%, Oklahoma which contributed 5%, and Alaska which contributed 4.5%. These are reported by the U.S. Energy Information Administration.

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Appendix

Sources of Data and Definition of Variables

Quarterly data over the period 1976Q1-2016Q3 are used to carry out the estimation.[9]

Variables and Sources of Data:

P: House Price Index: "a broad measure of the movement of single-family house prices. It is a weighted, repeat-sales index, meaning that it measures average price changes in repeat sales or refinancings on the same properties. This information is obtained by reviewing repeat mortgage transactions on single-family properties whose mortgages have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975" (Federal Housing Finance Agency, 2020). The data are obtained from the US Federal Housing Finance Agency.

I: Household Income: Total Personal Income published by the U.S. Bureau of Economic Analysis. "Personal Income is the income received by all persons from all sources. It is the sum of net earnings by place of residence, property income, and personal current transfer receipts (Figueroa and Aten, 2019). The Consumer Price Index program has been used to make the series real.

M: Mortgage Rate: 30-Year conventional mortgage rate from Board of Governors of the Federal Reserve System (US), which is "contract interest rates on commitments for fixed-rate first mortgages" (Board of Governors of the Federal Reserve System, 2009). Source is the Primary Mortgage Market Survey data provided by Freddie Mac. Retrieved from Federal Reserve Bank of St. Louis (FRED).

O: Oil Prices: spot crude oil price is dollars per barrel (real, seasonally adjusted) defined as West Texas Intermediate (WTI) and retrieved from FRED.

[9] Mortgage rates and oil price data are available at monthly frequency but not state level house prices. They are only available at annual, semi-annual, and quarterly frequencies. Therefore, the frequency that gives us the largest number of observations is quarterly frequency.