The Impact of the Presence of Natural Gas Pipeline on House Prices: Evidence from 5 Northern States in the US

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ABSTRACT

In this study, we focused on explaining the relationship between house pricing and natural gas pipeline. Using a quarterly frequency dataset, we focus our analysis on the selected 5 northern states in the US over the time span of 1991-2015 and also included some other control variables like Natural gas consumption by residential sector, population, Heating and Cooling degree days. Since house pricing is not normally distributed, we employed quantile regression, concentrating on fixed effect quantile estimate. Our empirical analyses reveal that natural gas pipeline has no significant impact in determining the variability in house pricing and the results further explain that the fixed effect statistic of the natural gas pipeline inflow is insignificant across quantiles. Furthermore, this study reveals that Population is highly significant across all quantiles, having a positive impact on house pricing. The significance and impact of the rest of the control variable are further discussed in the study. Finally, our result presents that natural gas pipeline does not have any significant impact on housing value, and this result can be adopted and used across all other regions and countries.

Keywords: House pricing, Natural gas pipeline, Quantile regression, Fixed effect quantile estimate.

ÖZ

Bu çalışma üç aylık bir veri kümesi kullanarak konut fiyatları ve doğal gaz boru hatta arasındaki ilişkiyi incelemektedir. Analiz 1991-2015 yılları arasındaki zaman diliminde ABD'de seçilen 5 kuzey eyaletine odaklanmakta ve diğer kontrol değişkenlerini de modele dahil etmektedir. Kontrol değişkenleri arasında emlak sektörüne göre doğal gaz tüketimi, nüfus, ısınma ve soğutma derecesindeki gün sayısını yer almaktadır. Konut fiyatları normal olarak dağılmadığından, sabit etkiler panel yapısı altında kantil regresyon modeli kullanılmıştır. Ampirik analizler, doğal gaz boru hattının konut fiyatlamasındaki değişkenliği belirlemede önemli bir etkisi olmadığını ortaya koymaktadır ve sonuçlar, doğal gaz boru hattı uzunluklarının sabit etkiler modeli tahminlerinin önemsiz olduğunu göstermektedir. Ayrıca, bu çalışma nüfusun tüm kantillerde oldukça önemli olduğunu ve ev fiyatlandırması üzerinde olumlu bir etkisi olduğunu ortaya koymaktadır. Kontrol değişkeninin geri kalanının önemi ve etkisi de çalışmada ele alınmıştır. Bu çalışmanın sonucu, doğal gaz boru hattının konut değeri üzerinde önemli bir etkiye sahip olmadığını ve bu sonucun diğer tüm bölgeler ve ülkelerde de geçerli olabileceğini göstermektedir.

Anahtar kelimeler: Konut fiyatlandırması, Doğal gaz boru hattı, Kantil regresyon, Sabit etkiler tahmini.

DEDICATION

To My Parent

Thank you for believing in me, thank you for supporting my dreams. And most importantly, Dad I want to specially thank you for teaching me that no one is above mistake.

Ayodeji Samson Fatigun

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LIST OF ABBREVIATIONS

CDD	Cooling Degree Days
DD	Degree Days
HDD	Heating Degree Days
HP	House price
INNG	Inflow of Natural Gas
NG	Natural Gas
NGCRB	Natural Gas Consumption by Residential Sector
POP	Population

Chapter 1

INTRODUCTION

1.1 Background of the Study

Natural gas is tipped to be the solution to the long problem of energy dependency faced by the United States. Due to technological advancement, the extraction of shale gas that was considered uneconomical ten years ago is now contributing immensely to the US economy (Munasib, Abdul, and Rickman, 2015). Relative to another energy source like petroleum derivatives and coal etc., natural gas is considered as the cheapest alternative energy source, it has a smaller impact on carbon footprint and also emits reduced pollutants. As a result, many have argued that natural gas is the bridge to the dream future and that this could also be the potential solution to US high carbon emission problem paving a way to meet up with the Kyoto target of reduced greenhouse emissions (Meinshausen, Malte, Nicolai, Hare and Allen, 2009).

The contribution of the oil and gas to US economic growth over the years cannot be overemphasized, in order to quantify the impact of the oil and gas sector on the economy, the American Petroleum Institute, employed PricewaterhouseCoopers (PWC) to measure the contribution or economic impact of oil and gas in the terms of labor income, value added and employment. The annual report reveals that oil and natural gas has a huge economic contribution or impact throughout all the sectors of the economy including all the 50 states and the District of Columbia. The report further shows that the oil and gas industry created 10.3 million jobs in 2015 which include

both per time and full-time jobs, in order words accounting for about 5.6% of the total US employment level in 2015.

Joskow and Paul (2013) in his analysis on natural gas from shortage to abundance in the US, explain that natural gas importation into the United States has fallen due to the extraction of shale gas, and as a result more jobs have been created, because investment has increased and which automatically cause unemployment to decrease in the country.

Kilian, Lutz and Cheolbeom Par (2009) explained that the US economy does not totally depend on oil and gas compared to other giant oil-producing countries. They also claim in their report that volatility of oil price does affect US economy for instance anytime the oil price increases, there is a negative impact on businesses for example the cost of producing and the cost of transportation goes up. These are all market reaction in the short run due to oil shocks, things will become more expensive as the market is not in equilibrium but the market will surely adjust back to equilibrium in the long run. This supports the findings of Ikenberry, David and Lakonishok (1995). Similarly, if the price of oil drops, it will have a negative impact on unconventional oil activity, but local consumers and businesses benefit from the decline in oil price. Despite the tremendous contribution of oil and gas to the US economy, it is safe to say that the US economy does not depend on oil to thrive because the economy is incredibly diverse.

1.2 Research Problem Statement

Considering the immense contribution of oil and gas to US economy, Munasib, Abdul, and Dan Rickman (2015) argued that the breakthrough in the sector has also led to the construction of new gas pipelines that cut across the country. The US oil and gas

pipeline structure is very huge and it stand out as one of the largest in the world. The U.S Energy Information Administration's 2017 annual report shows more than 305,000 miles of both intrastate and interstate gas transmission pipelines and also an additional 190,000 (miles) of crude oil and refined petroleum product pipelines which are quite enormous. Furthermore, the reports also show that natural gas has been proven to be the most dominant and most influential energy source. Their analysis shows that 31.7% of electricity generated in 2017 comes from natural gas, which exceeds all other fossil fuel contribution to electricity generation and this shows the dominance and how important natural gas is to US economy.

However, evaluating the impact of the US enormous oil & gas pipeline structure has attracted the interest of little and only very few studies has actually tried to evaluate the impact of this huge oil and gas pipeline structure on the residential property value since it passes through residential areas, farms and land of many Americans (Boxall, Peter, Chan and McMillan, 2005).

This study seeks to investigate whether natural gas pipeline proximity to residential buildings has any significance on the residential value. In order words, our aim is to examine whether the residential property value is affected by the presence of a natural gas pipeline. In order to achieve research objectives, we panel five (5) Northern region of the United States to examine whether the gas pipeline affects housing price or not.

1.3 Research Objectives and Significance

According to the data provided by the international monetary fund in 2017, the United States is currently the world largest economy increasing from around $19.4 trillion in 2017 to $20.4 trillion in 2018. With the world becoming more globalized, this study

can be adopted by other researchers that seeks to know whether gas the presence of gas pipeline has any significance on house pricing or whether the presence of gas pipeline can attract any environmental development in their region or country.

1.4 Research Methodology

This study used the conventional panel based econometric technique to examine the correlation or the relationship between the gas pipeline (NGINFLOW) and the housing price (HP). We incorporate natural gas consumption per residential sector (NGRCB), population (POP), heating degree days (HDD), and cooling degree days (CDD) as an additional variable for ceteris paribus effect for our selected states and a panel data set for the states over the time period of 1991-2015 was used for our analysis. For empirical analysis, the following estimations were used in our study: we tested for stationarity of the variables using a conventional unit root approach. Furthermore, we used OLS, random and fixed effect panel estimates to examine the long run relationship between our variable of interest. Based on our analysis the relationship between our variables are non-normal so using either OLS or random and fixed effect panel estimates to make decisions might not be effective. Rather in order to avoid this pitfall, we adopted the fixed effect quantile estimates to test the impact of the gas pipeline on house pricing, since it allows for the coefficient of each variable to be tested across different quantile in the distribution.

1.5 Research Structure

Chapter one of this research contains the introductory section, which includes background study, problem statement, research objectives and significance, research methodology and research structure. Chapter two covers relevant conceptual and literature based review on what the previous studies had done. In chapter three, we discuss the research methodology employed. Chapter four focuses on the results and

discussion of empirical findings. While in chapter five, we conclude and present our policy recommendations.

Chapter 2

LITERATURE REVIEW

According to the U.S Energy Information Administration's 2017 annual report, natural gas stands out to be a dominant and most influential energy source in the United States. The report provided shows that in 2017 about 4,015 billion kilowatt-hours or (4.01 trillion kWh) of electricity was generated in the United States at utility scale facilities and of which 31.7% or (1,273 billion khw) of the electricity generation comes from natural gas, which serves as the highest means of electricity production source in the United States. Furthermore, natural gas is proven to be a reliable source of cleaner energy relative to other fossil fuel.

Table 1: United States Electricity generation in 2017 (U.S Energy Information Administration's 2017 annual report)

Energy source	**Billion- Kilowatts per hour**	**Percentage share in total**
Total energy generated of all source	4,015	
Total of all (Fossil Fuel)	2,516	62.7%
Examples of fossil fuel used by united states for electricity generation are;		
Natural gas	1,273	31.7%
Coal	1,208	30.1%

Petroleum (total) Examples are:	21	0.5%
Petroleum liquids	13	0.3%
Petroleum coke	9	0.2%
Other gases	14	0.4%
Nuclear	805	20.0%
Renewables	687	17.1%
Hydropower plants	300	7.5%
Wood	43	1.1%
Solar	53	1.3%
Wind	254	6.3%
Biomass (total)	64	1.6%
Landfill gas	11	0.3%
Geothermal	16	0.4%
Municipal solid waste(biogenic)	7	0.2%
Hydropower storage pump	-6	0.2%
Biomass waste other	3	0.1%
Other Sources	13	0.3%

Table 1, shows the United State electricity energy source for the year 2017 and the largest and the most important energy source for the United States electricity production is natural gas.

Solomon, Plattner, Knutti, and Friedlingstein (2009) discussed the United States high carbon emission problem, while Zhang, Myhrvold, Hausfather and Caldeira (2016), explain that natural gas emits fewer pollutants relative to other fossils. Also Center for Climate and Energy Solution reported that the use of natural gas has helped to reduce the greenhouse gas emission to 1990 mid-levels in the US, and this might be paving the way to meet up with Kyoto target of greenhouse gas emission reduction Protocol, Kyoto (1997). For example: US Energy information administration annual's report in

2017 shows that about 1,208 billion kilowatt-hours or 30.1% of total electricity production in 2017 come from coal, and based on Zhang, Myhrvold, Hausfather and Caldeira (2016), argument that natural gas emits far fewer pollutants than coal, it is safe to say that increase in the use of natural gas as an energy source and reduction in the use of coal which is actually the second largest energy source in the United States will help to reduce the greenhouse gas emission.

It is earlier discussed in this study how huge and enormous the US pipeline structure is. Furthermore, Vidic, Radisav, Vandenbossche and Abad (2013) argued about how this gigantic pipeline passes through residential areas, farms, and the land of many Americans. There is currently an ongoing debate over whether there is a causal relationship between gas pipelines and property values. On January 2 2016, Lebanon daily news reported that realtors argue that gas pipeline can reduce property value by 5% to 40% and as a result, the valuable property becomes less attractive to potential buyers. The report provided by the news house also claims that the realtors expressed their dissatisfaction and said natural gas pipeline has a negative impact on the environment, private property rights and that it also affects owner's wallet in case of sale of the property.

According to James Sherer (2016) a realtor who works with Lancer country-based Kingsway realty, based on his experience, he claims that "people often wince, whenever they see oil and gas pipeline" and this which shows people's dissatisfaction about oil and gas pipeline and can affect property value drastically. This also supports the findings of Boxall, Peter, Chan and McMillan (2005) argue that the presence of a natural gas pipeline has a negative impact on nearby properties. But contrary to this, Fruits, and Eric (2008) in their analysis on the natural gas pipeline and residential

property values explains that there is no significant relationship between the presence of gas pipeline and residential property value.

2.1 Overview OF Natural Gas Impact on House Pricing

Diskin, Barry and Friedman (2011) in their study on the effect of natural gas pipeline on residential value explain that they could not find any systematic relationship between the residential property value and proximity to the gas pipeline. Their findings support the results from the studies of Fruits and Eric (2008) and Tsur, Somerville and Jake Wetzel (2014). In their study explains that without rupture of gas pipeline, pipeline on their own has no effect on house prices. While Boxall, Peter, Chan and McMillan (2005) among a few other kinds of literature argues that the proximity of gas pipeline to residential property has an impact on the property value.

The presence of gas pipeline on properties comes with certain restrictions, for example, permanent structures cannot be built directly over them neither can trees be planted and as a result, many believe that the presence of gas pipeline as well as the restriction placed on them would cause a decline in the house price. But contrary to this ideology William's spokesman Christopher Stockton (2016) said that pipeline easement does not cause a decline in property value. and also in his speech he made reference to the proposed constitution pipeline in New York, whereby the Federal Energy Regulatory Commission (FERC) came to the conclusion that there was no concrete evidence or testament that natural gas pipeline would cause a decline in house price, as reported by Lebanon daily news in 2016.

Clackamas and Washington (2008) study on the natural gas pipeline on residential value was carried out to check whether there are any possible or potential impacts of

the proposed Oregon pipeline's projects on property values on both nearby and adjacent property to the pipeline, using a similar intrastate pipeline ''south mist pipeline extension''. Hedonic housing pricing model was used with available information of more than 10,000 property transactions to examine the extent to which closeness to the SMPE would affect the sale value of a single-family house. Clackamas and Washington concluded based on their result that the value of residential property close by and adjacent to the SMPE are not affected nor is there any statistically significant or economically significant relationship with residential property values and SMPE. Furthermore, the studies discover that the proposed pipeline project by Oregon would have no effect on residential property that is both close by and also those that are adjacent to the pipeline.

In addition, the Interstate Natural Gas Association of America Foundation (1996) conducted research to examine whether natural gas pipelines have any impact on nearby residential property value. The research was conducted looking at specific four separate geographically diverse areas and this area includes suburban traversed multiple natural gas and product pipelines, the commercial area traversed by one natural gas pipeline, the suburban area traversed by one natural gas pipelines and rural area traversed by one natural gas pipeline. Using the paired sale, linear regression and descriptive statistics analysis, the study examined the possible price and non-price impact coming from a location along the route of the natural gas. Based on the cumulative result of the four cases, the study reveals that there is no effect or significant impact on the value of properties located along the route of natural gas pipelines. Furthermore, the Interstate Natural Gas Association of America Foundation (INGAA) also claims that the size of the pipeline and the product carried by the pipeline does not have any significant impact on the property value situated along the

natural gas route. In addition to this the study emphatically claims that in the researched or studied areas, the existence of pipeline did not hinder or impede the development of the surrounding properties, neither does it aid development decisions of the environment which the pipeline is located. The study finally concluded that it is very likely that conclusion and result from this study can be applied to other regions of the country involving the natural gas pipeline.

Diskin et al (2011) conducted research to test whether proximity to natural gas pipelines has any effect on real estate sale price; the study gathered approximately about 1,000 data after studying numerous subdivisions. Using a matched pair's analysis, the study result shows that there is no systematic relationship between residential sale value and proximity to the natural gas pipeline and also claims that previous studies encountered also corroborate with their findings.

Most prior studies on the natural gas pipeline and residential value claim that there is no significant impact of proximity to the gas pipeline and residential sale price. We could conclude that house prices are not affected by proximity to gas pipeline based on the prior studies, but it is simply early to reach conclusion as additional research will be necessary to reach a substantial conclusion about the topic.

2.2 Relationship or Impact of Natural Gas Pipeline on House Price

The Lititz-based realtor Dennis Beck (2016), said based on his experiences "the impact of the pipeline on house prices is certainly not going to be not going to be positive in fact he said that the impact could be a very large negative one and could make some properties really difficult to sell". This statement by Dennis Beck actually contradicts several claims, results and conclusion of several academic kinds of literature that gas

pipeline does not have any impact of the house sale price or value. And moreover, Dennis Beck is not only the person that claims that gas pipeline affects house price or value. For example, The Lebanon daily news (2016), reported that local realtor often People often acts irrationally when they discover that pipelines are on the property, and as a result, some may cut down the price. The news article also reported that the realtors have experienced a situation whereby the presence of gas pipeline on a residential property influence the deal with the potential buyers (whereby some potential buyers will reduce the price they are willing to pay for the house drastically because of the presence of the pipeline) and this act express their dissatisfaction in seeing gas pipeline on their property or close to their resident, some even call off the deal totally because of their children thinking about possible hazard that may occur because of the pipeline. Local realtors said that properties are unique and the impact of pipelines on properties values depends on the propinquity of the pipeline to the property, whether it's an agricultural area or residential area and the pressure level of the gas travelling in the pipeline. Houses with gas pipeline are often stigmatized and the presence of gas pipeline on properties often comes with restrictions according to Lebanese local realtors, they also claim that permanent structures can't be constructed on them neither can trees be planted directly over them.

Tsur Somerville and Jake Wetzel (2014) examines the effect of gas pipeline on property values and the result shows that pipelines on their own do not have any effect on house or property value, but the case of explosion or spillage with fatalities and Visible environmental effects, the property nearby the affected pipeline even if they are far away from the affected pipeline normally experience fall in the sale value for a period of time and the magnitude of the effect declines with time. The result of this research is quite interesting and unique because very few prior studies consider the

effect of ruptures on house prices in which realistically would affect the value of the house located at the incident site. This is very important and should always be considered when examining the impact of the gas pipeline on property value.

2.3 Summary of the Review

Conclusively, going by the studies discussed above it is clear that there is no concrete evidence that the presence of gas pipeline has any impact of the house or residential property value except cases of rupture or explosion of the pipeline which causes a decline in nearby property value for a period of time.

Chapter 3

DATA AND RESEARCH METHODOLOGY

3.1 Data and Description of Variables

In this study, we attempt to examine the relationship between house pricing and natural gas pipeline using a using quarterly frequency from a cross-section of states and regions in the United States, over the time span of 1991-2015. According to past studies done on house pricing, we can deduce that many other factors affect house pricing and because of that adopt a multivariate method in our study to reduce an omitted variable bias. Aside from natural gas pipeline, the study also incorporates some other control variables, for example, population, natural gas consumption, cooling and heating degree days and degree days of each selected state. For the selected states, we obtained the data on house pricing and population from the Federal Reserve Bank OF ST. Louis, while data on natural gas inflow per state & natural gas consumption are obtained from U.S Energy Information Administration, and finally we obtain data on heating and cooling degree days from National Oceanic and Atmospheric Administration. The northern State in the US is known for a high level of energy demand, and this study decided to select a sample of 5 states in the northern region with a high level of energy demand. The states include Massachusetts, Washington Dc, South Dakota, North Dakota and Michigan.

The variables of interest used for the empirical analysis in this study are discussed below:

- House price (Hp): This includes the price at which houses are offered for sale.in our study we consider the price of a house on a quarterly basis for all the selected states.
- Population (POP): We also consider the total number of people or the inhabitant in each selected States on a quarterly basis as one of the key variables that might affect house price.
- Cooling degree days (CDD): CDD measures how hot the temperature was on a particular day or over a period of days and quantifies the energy required for cooling the building. A day with an average temperature of 80°F has 15 CDD, while if the next day has an average temperature of 83°F, it has 18 CDD and the aggregate CDD for the two days will be 33CDD.
- Heating degree days (HDD): HDD measures how cold the temperature was on a particular day or over a period of days, and quantifies the energy required for heating the building. A day with an average temperature of 40°F has 25 HDD, if the second-day temperature is the same with the first day having 40°F then it has 25 HDD and the aggregate of the HDD for the two days is 50HDD.
- Degree days (DD): DD measures the heating and cooling days. DD comprises the addition of HDD and CDD (HDD + cdd).
- Natural gas inflow (nginflow): The amount of natural gas coming in or imported into a particular state.
- Natural gas consumption (ngrcb): This refers to the amount of natural gas consumed by each residential building.

It should be noted that in our analysis we use natural logarithms and the first difference of the natural logarithms for all our variables. For natural logarithms, “ln” precedes

the variable name, and the first differences of the natural logarithms "dln" precede the variable name. For example, lnhp = natural log of house price and dlnhp = ln(hp_t)- = ln(hp_{t-1}) = first difference natural logarithms of house price. Table 2 shows the summary statistics of the variable employed for the empirical analysis in level and natural logarithm forms.

Table 2: Summary Statistics of the Variables

Variable	Observations	Mean	sd	min	Max
Hp	500	181.3635	60.16006	95.76	367.06
Nginflow	500	4645.832	2846.021	1523.88	11071.81
Pop	500	4750.725	3567.232	633.012	10056.61
Ngrcb	500	114606.2	128539.1	9995.406	414287
Cdd	500	467.968	205.3502	88.94	1068.781
Hdd	500	7098.77	1351.010	4772.84	10908.88
Dd	500	7566.74	1403.27	5102.19	11318.84
Lnhp	500	5.146	.333	4.562	5.905
Lnnginflow	500	8.275	.571	7.329	9.312
Lnpop	500	7.96	1.152	6.450	9.216
Lnngrcb	500	10.887	1.33	9.210	12.934
Lncdd	500	6.024	.542	4.488	6.97
Lnhdd	500	8.850	.184	8.471	9.297
Lndd	500	8.915	.184	8.537	9.334
Dlnhp	495	.00965	.0197	-.088	.069
Dlnnginflow	495	.00605	.0243	-.138	.265
Dlnpop	495	.001892	.00214	-.0049	.016
Dlnngrcb	495	.00108	.0328	-.148	.176
Dlncdd	495	.0003	.1322	-.542	.676
Dlnhdd	495	-.000995	.0316	-.146	.162
Dlndd	495	-.00102	.0271	-.106	.125
dlnhp4	480	.0383	.0562	-.217	.170
dlnnginflow4	480	.0225	.0705	-.076	.527
dlnpop4	480	.0075	.0075	-.0092	.032
dlnngrcb4	480	.0061	.093	-.213	.303
dlncdd4	480	.0051	.373	-1.202	.928
dlnhdd4	480	-.0013	.089	-.252	.261
dlndd4	480	-.0012	.075	-.1916	.201

Table 3: Pearson Correlation Coefficient Year to Year Growth

Correlation Year-on-Year Growth Rate							
	dlnhp4	dlnngi~4	dlnpop4	dlnngr~4	dlncdd4	dlnhdd4	dlndd4
dlnhp4	1						
dlnnginflow4	0.029	1					
dlnpop4	0.245*	-0.045	1				
dlnngrcb4	0.010	-0.039	0.149*	1			
dlncdd4	0.048	-0.047	-0.073	-0.306*	1		
dlnhdd4	-0.006	0.0278	0.1080*	0.881*	-0.446*	1	
dlndd4	0.0021	0.0244	0.094*	0.873*	-0.225*	0.966*	1

The Pearson correlation coefficient estimates result is reported in Table 3. It should be noted that our analyses in this study are based on year to year growth rate and although the estimated correlation above does account for the possible relationship between our variables of interest, however, the estimated correlation coefficient may be useful in identifying the potential signs of a relationship that might exist among our variable of interest. Using the year to year Pearson correlation coefficient estimates of the population on house pricing is 0.245 and we can deduce that the only population has a significant relationship with house pricing the rest of the variables have no significant relationship with house price. Furthermore, examining the relationships between our control variables, natural gas consumed by residential sector and the population has a significant positive relationship with the estimated correlation coefficient of 0.149; cooling degree days have a negative relationship with natural gas consumption with an estimated correlation coefficient of -0.306. Furthermore, heating degree days have a positive significant relationship with population, gas consumption by the residential sector and negative relationship with cooling degree days. The estimated correlation coefficient between heating degree and other population, gas consumption and cooling degree days are 0.1080, 0.881 and -0.446. Finally, the degree days has a positive significant relationship population, gas consumption, negative relationship with

cooling degree days and positive significant relationship with heating degree days. The estimated correlation coefficient between degree days and these variables are 0.094, 0.873, -0.225, and 0.966 respectively. These variables are significant at ($p < 0.1$) significance level. Based on the sign that each coefficient has, an increase in one variable will either lead to an increase or decrease in another. To sum it up, this study used a panel based method to examine the impact of the gas pipeline and all other control variables on house pricing.

3.2 Unit Root Testing Approach (Panel)

Numerous macroeconomics variables are featured by random properties that could lead an analyst to invalid or spurious conclusions. Panel series will be stationary if the autocovariance of that particular variable is not a function of time, in order words, a variable will be stationary if it does not change with time. Studies reveal that macroeconomic variable(s) either in panel data or time series that are not stable contain unit roots. Recent studies suggested that panel-based unit root testing is more powerful or has higher power when comparing it to time series unit root testing approach (Baltagi, 2005**).** Despite the general use of both panel-data methodology and quantile-regression methodology, only a few studies have discussed the intersection between the two methodologies and also explaining the difficulty in extending the different method to quantile. In this study, we use quantile-regression methodology and panel unit root testing approach but we focus on fixed effects Panel quantile regression. The panel unit root approach testing in our study as advanced by Maddala and Wu (Fisher-ADF and Fisher-PP type, 1999), is Levin, Lin and Chu (LLC, 2002) and Im, Pesaran and Shin (IPS, 2003) and the result is discussed in chapter 4 of this study.

In order to be as brief as possible, we decided to discuss only LLC approach here (the Levin, Lin and Chu (2002) panel unit root testing approach taking into consideration ADF identify in Eq. (1) since these panel unit root approaches are conventional.

$$\Delta s_{it} = \alpha_i s_{i.t-1} + \sum_{r-1}^{\alpha} \chi_{ir} \Delta s_{i.t-r} + u_{it} \quad (1)$$

LLC (2002) unit root testing suggests that the persistence parameters $\propto_i$ interconnected cross-sections, for example ($\alpha_i = \alpha$ for all i). LLC evaluates null hypothesis: $\alpha_i = 0$ for all I against its alternative $\alpha_i \angle 0$ for all i. Our result in this study shows that the variables of interest are all non-stationary at their level forms so as a result, we use first differences of the natural logged variables. Furthermore, we estimated Ordinary Least Square (OLS), but the OLS regression Models assumes that regression coefficient is constant across all the samples, and heterogeneity of house pricing across all state is not taken into account as we can't use the OLS because the relationship between our variables is non-normal. Also based analysis and our result in Table 7 it is evident that none of none of the control variables has any significant impact on house pricing. In order words, all the control variable are insignificant under the random and fixed effect panel estimates, which shows that the relationship between our variable of interest is not normal. In an attempt to examine the relationship between our variable of interest, we decided to adopt a fixed effect quantile panel estimates. In addition, fixed quantile provides a complete characterization and more flexible when there is a focus on the impacts of natural gas pipeline on house pricing at both lower and at higher levels.

3.3 Quantile Regression

Past studies often estimate a conditional mean model with fixed effect, to examine the impact of the independent variable on the dependent, and in this study, our aim is to examine the impact of the natural gas pipeline on house pricing.

$$E(S_{it} \left| K_{it}^{T}, \theta_i \right.) = K_{it}^{T}\alpha + \theta_i \qquad (2)$$

S_{it} denotes the logarithms of population number for the state I at year t, while θ_i denotes the unobserved county effects which serve as controls for the time-invariant source of unobserved heterogeneity. For example foreign exchange, income level or minimum wage, the interest rate on a mortgage loan, etc. are unobserved variables classified under the constant variable in which some has a significant effect on house pricing. The distribution of our dependent variable which is house pricing is not normal, so using the assumption of normal distribution in this study will definitely lead to error. In addition, when the residual series is non-normal, the results are robust to outliers and the distribution is heavy-tailed. Using a quantile regression approach will be more efficient than using the OLS approach because quantile regression is robust to outliers and does not make any distributional assumptions.

Also when focusing on the impact of the natural gas pipeline on house pricing at both lower and higher levels quantile regression allows for more flexible and complete characterization. Eq3 below:

$$C_{s_{it}}(\tau/k_{it,}\theta_i) = \alpha_{1_\tau} NGINFLOW_{it} + \alpha_{2_\tau} pop_{it} + \alpha_{3_\tau} CDD_{it} + \alpha_{4_\tau} HDD_{it} + \alpha_{5_\tau} DD_{it} + \alpha_{6_\tau} NGRCB_{it} + \theta_i \quad (3)$$

We estimated the fixed-effects version of the conditional quantile regression model in eq3 above and we first examine the conventional linear form. Since the relationship between natural gas pipeline and house pricing is nonlinear we extended the above equation in eq4 below to be a nonlinear equation.

$$C_{s_{it}}(\tau/k_{it,}\theta_i) = \phi_{1_\tau} NGINFLOW + \phi_{2_\tau} NGINFLOW_{it}^{2} + \phi_{3_\tau} POP_{it} + \phi_{4_\tau} CDD + \phi_{5_\tau} HDD + \phi_{6_\tau} DD + \phi_{7_\tau} NGRCB + \theta_i \quad (4)$$

In the above equation 2.2 above, all our variables are similar to the 2nd equation except $NGINFLOW_{it}^{2}$. We should also note that evidence will support the inverted U-shaped

relationship at τ quantile if $\phi_{1_T} \rangle 0$ and $\phi_{2_T} \langle 0$, the turning point of the natural gas pipeline is calculated as follows:

$$NGINFLOW_T^* = \frac{\phi_{1_\tau}}{2\phi_{2\tau}}, \quad (5)$$

ϕ_{1_T} and ϕ_{2T} denotes the coefficient of linear and quadratic terms of a natural gas pipeline at τ quantile.

Koenker and Bassett (1978) introduced quantile regression in a seminar article as an extension of the classical least-squares estimation of the conditional mean to a collection of models for different conditional quantile functions, (Zhike & Ting, 2017). The τth regression quantile estimate $\hat{\alpha}(\tau)$ stands as the solution to the following minimization difficulty.

$$\hat{\alpha}(\tau) = \underset{\alpha \in \lambda^p}{\arg\min} \left[\sum_{i \in \{i: s_i \geq k_i \alpha\}} \tau \left| s_i - k_i \alpha \right| + \sum_{i \in \{i: s_i \langle k_i \alpha\}} (1-\tau) \left| S_i - k_i \alpha \right| \right] \quad (6)$$

where τ is a parameter $(0 \langle \tau \langle 1)$ that represents the size of the quantile? Saltagolu and Bao (2006) argued that the main advantage of the quantile regression over the traditional OLS is its ability to analyze the whole distribution, while the conventional OLS enable researchers to approximate the conditional median and the conditional mean situated at the centre of the distribution, which gives incomplete description of a conditional distribution (Tukey & Mosteller, 2006).

3.4 Fixed Effects Quantile Regression

Assuming that the conditional quantile functions of the response of ith individual S_{ij} of jth observation have this form:

$$A_{sij}(T/C_{ij}) = \theta_i + C_{ij}^{\ T} \psi(T) \qquad \text{j=1,}\ldots\ldots k_i \qquad \text{i= 1…,Z} \quad (7)$$

This formula shows that has a pure location shift effect on the conditional quantile function response. C_{ij} covariates effects are allowed to depend on upon the quantile, τ, of interest, but the ψ 's do not.

In order to estimate a model that comprises several quantiles simultaneously, we propose:

$$\underset{(\theta,\psi)}{Min}\sum_{r=1}^{q}\sum_{j=1}^{z}\sum_{i=1}^{m_i}G_r V_{tr}(s_{ij}-\theta-c_{ij}{}^{T}\psi(T_r)) \quad (8)$$

When z is large relative to m_i shrinkage may become advantageous in controlling the variation that might occur as a result of the introduction of a larger number of estimated θ parameters. We will then consider estimator solving through penalized version,

$$\underset{(\theta,\psi)}{Min}\sum_{r=1}^{q}\sum_{j=1}^{z}\sum_{i=1}^{m_i}G_r V_{tr}(s_{ij}-\theta-c_{ij}{}^{T}\psi(T_r))+\phi\sum_{i=1}^{z}|\theta_i| \quad (9)$$

For $\phi \to 0$, the fixed effects estimator that was described above was obtained, where $\phi \to \infty$ and the $\hat{\theta} \to 0$ for all I 1,2 …….., Z also a purged of the fixed effects was obtain.

Chapter 4

RESULTS AND EMPIRICAL DISCUSSION

4.1 Panel Unit Root Tests Result

In this section, our focus or emphasis is to analyze the panel based estimation result carried out in this study. The results of panel unit roots testing were reported in Table 4 and Table 5, this was implemented by various panel unit roots testing approach, using the least squares method. The results indicate that all variables in Table 4 and Table 5 are stationary at first difference. Furthermore, having tested the stationarity properties of each variable, to determine the coefficient of the parameters, we decided to examine the conventional OLS estimate, random and fixed effect panel estimates. Our results show that the relationship between our variable is non-normal and using a normal distribution to explain the relationships between our variable of interest will lead to a misleading result and as a result, we decided to adopt fixed effect quantile estimates.

Table 4: The Panel Unit Root Results (Level)

Levels	LNHP	LNNINFLOW	LNPOP	LNNGRCB	LNCDD	LNHDD	LNDD
LLC	-4.228	-0.0839	-2.145	0.681	1.449	1.308	2.739
	(.000)	(0.4644)	(.016)	(0.7528)	(0.926)	(.904)	(.997)
IPS	-3.028	-0.6158	0.2649	-1.3561	-2.674	-2.477	-2.44
	(.001)	(0.2690)	(.604)	(0.0875)	(0.0037)	(.006)	(.007)
Breitung	1.533	-3.2788	0.7760	2.7586	-5.9967	0.0554	-.211
	(0.94)	(0.0005)	(.781)	(0.0029)	(0.000)	(.522)	(.416)
Hadri	76.68	45.995	94.413	42.6826	13.3541	16.371	14.13
	(.000)	(.000)	(.000)	(.000)	(0.000)	(.000)	(.000)
ADF Fisher	0.119	7.6297	-1.344	3.5753	15.2345	6.877	6.93
	(.452)	(0.000)	(.911)	(0.0002)	(0.000)	(0.000)	(.000)

Table 5: The panel Unit Root Results (First Difference)

Δ	LNHP	LNNINFLOW	LNPOP	LNNGRCB	LNCDD	LNHDD	LNDDD
LLC	0.858 (.804)	-0.8133 (0.2080)	-0.708 (.2394)	-1.821 (0.034)	-4.32 (0.000)	-0.898 (0.184)	0.873 (0.809)
IPS	-1.49 (.067)	-7.811 (0.000)	-1.934 (.0265)	-8.5812 (0.000)	-11.79 (0.000)	-8.011 (0.000)	-6.861 (0.000)
Breitug	-4.09 (.000)	-5.315 (0.000)	-1.999 (.0228)	-2.9833 (0.0014)	-5.556 (0.000)	-3.112 0.001	-3.700 (0.0001)
Hadri	10.03 (.000)	1.3097 (0.0952)	50.226 (0.000)	0.1216 (0.4516)	-1.433 (0.924)	-0.396 (0.654)	-0.530 (0.702)
ADF	9.152 (.000)	25.793 (0.000)	10.049 (0.000)	27.846 (0.0000)	30.973 (0.000)	27.11 (0.00)	27.469 (0.000)

4.2 OLS Estimates

In order to examine the relationship between the dependent variable and the independent variables, we use the conventional OLS estimation which is done on a year to year growth rate. The result of our OLS estimation in Table 6 below shows that the only population has a significant impact on house pricing. Using OLS may lead to misleading results since the relationship between the explanatory variable is not normal (Ejeb & Arfaoui, 2016). This result pushes us to do a fixed and random panel quantile estimates regression, to examine whether this approach will explain the relationships between our variables of interest.

Table 6: Linear Regression

Variables	Coef.	t-stat	P-value
dlnnginflow4	0.035	1.43	0.154
dlnngrcb4	-0.002	-0.04	0.970
dlnpop4	1.872***	4.86	0.000
dlncdd4	0.010	1.38	0.169
dlnhdd4	-0.001	-0.01	0.990
_Cons	0.023***	5.00	0.000

*** represent a rejection of the null hypothesis at 5% significance level

4.3 Fixed Effects Panel Estimates and Random Effects Panel Estimates

Furthermore, since our OLS estimated result is not reliable, we shifted our attention to fixed and random effects panel estimate to see if we can examine the relationship between our control variables and the dependent house pricing. Considering the results of the estimate in Table 6 below, we can deduce that none of the control variables has any significant impact in determining the variability in house pricing. Natural gas inflow per state, natural gas consumption in the residential sector, population, cooling and heating degree days are all insignificant. Also using quantile regression to explain the relationship between the variable will be more efficient because it allows for flexible and complete characterization at both lower and higher levels of the distributions.

Table 7: Fixed and Random Effects Results

	Fixed Effects panel Estimates			Random Effects panel Estimates		
Variables	Coef.	t-stats	p-value	Coef.	Z-static	p-value
dlnnginflow4	0.0168	0.36	0.735	0.0352	0.88	0.376
dlnngrcb4	0.009	0.05	0.961	-0.00205	-0.01	0.990
dlnpop4	2.10	1.52	0.202	1.872	1.69	0.091
dlncdd4	0.0102	1.19	0.30	0.0102	1.23	0.218
dlnhdd4	-0.014	-0.07	0.944	-0.00077	-0.00	0.996
Cons	0.022	1.87	0.131	0.0233	1.91	0.056

4.4 Fixed Effects Quantile Panel Estimates

Furthermore, as we have discussed earlier that OLS or fixed and random effect panel estimates lack the potency to in explaining our variable of interest because it is non-normal and as we cannot see any significant relationship between the dependent house pricing and the individual control variables using this model. Rather than discarding

the variables and claiming that variability in house pricing is not determined by these variables, we decided to further our analysis using a fixed effect quantile estimator.

Since this approach explains a non-normal distribution, adopting it in our study to explain the impact of independent variables on our dependent housing price will be more appropriate and may provide more reliable and accurate results. Since quantile estimator allows the estimate of the coefficient to be tested across all quantiles. We hereby concentrate on the fixed effect quantile panel estimates and Table 7 below shows the result of our analysis.

Table 8: Fixed Effect Quantile Results

Variables	Coef 0.05	Coef 0.25	Coef 0.50	Coef 0.75	Coef 0.95
dlnnginflow4	0.155	0.039	-0.0069	-0.011	-0.041
	(1.20)	(0.72)	(-0.25)	(-0.33)	(-0.74)
dlnngrcb4	-0.101	0.032	0.004	-0.032	-0.341***
	(-0.48)	(0.36)	(0.09)	(-0.60)	(-3.72)
dlnpop4	4.065***	1.461***	0.98***	1.156***	1.362***
	(3,38)	(2.85)	(3.75)	(3.80)	(2.62)
dlncdd4	0.029	-0.00155	0.009	0.017**	0.043***
	(1.07)	(-0.13)	(1.58)	(2.47)	(3.60)
dlnhdd4	-0.155***	-0.0364	0.0002	0.088	0.466***
	(-0.66)	(-0.36)	(0.00)	(1.48)	(4.58)
Cons	-0.102***	0.011*	0.039***	0.060***	0.105***
	(-7.78)	(1.94)	(13.74)	(17.92)	(18.38)

*** represent the rejection of the null hypothesis at 5% significance level.

Using fixed effect quantile panel approach, we examine the impacts or in order words importance of parameter heterogeneity, and our investigation in Table 7 was carried out on year to year growth rate. The constant variable in the Table 7 measures the conditional quantile of the dependent house pricing, at 0.05^{th} quantile the conditional quantile of house price was negative but became positive at the 0.25^{th} quantile and across the rest of the quantile distribution. This means that the percentage change in

house price is heavily skewed to the right. More also the results show that the constant coefficient is increasing together with the quantile, at 0.25^{th}, 0.50^{th}, 0.75^{th} and 0.95^{th} quantile the coefficient was 0.011^{*}, 0.039^{***}, 0.060^{***} and 0.105^{***} respectively. Figure 1 illustrates the relationship between the fixed effect intercept estimates and the quantiles. The fixed estimates are shown on the vertical axis with the quantiles on the horizontal axis. The graphical plot shows that; the constant term became significant at 0.05 quantile at 5% significance level. The upward thin line represents the 5% significance level.

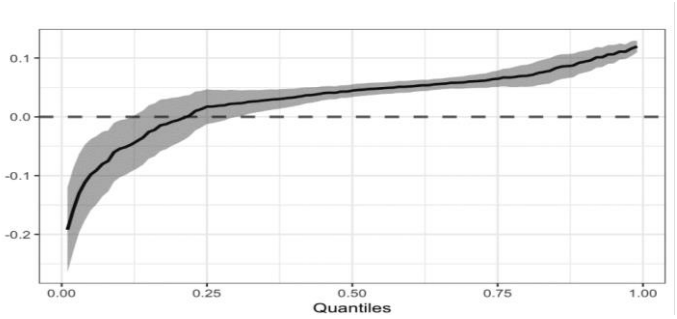

Figure 1: Panel quantile regression estimates of intercept

Furthermore, the natural gas pipeline inflow per states denoted as dlnnginflow has no significant relationship in determining house pricing across all quantile. In order words, our result shows that natural gas pipeline has no significant impact in determining the variability in house pricing. Hence, these results support the findings of Fruits (2008). Fruits, Eric argued that natural gas pipeline has no statistical significance or does it has any economical significant on the residential sale price. Table 7 confirms that the coefficient of nginflow is insignificant across all the distribution. This result is depicted in Figure 2 as the fixed effect statistic of the natural gas pipeline inflow is insignificant across quantiles. As the horizontal thin line that identifies 5% significance level is somehow parallel to the fixed effect statistic line.

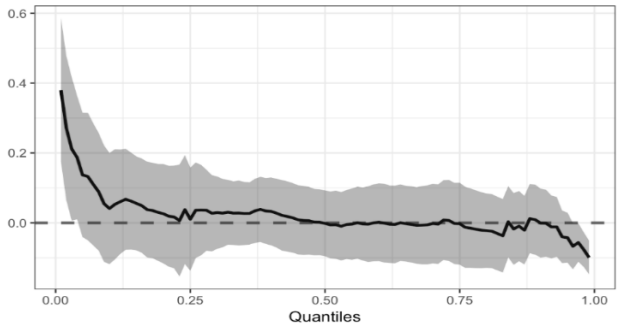

Figure 2: Panel quantile regression estimates of NGINFLOW

We further our analysis by examining the natural gas consumption by residential sectors' impact on the dependent house pricing, and our analysis results reveal that although the ngrcb is insignificant in the OLS and the random and fixed panel estimates, in fixed effect quantile panel estimates, it is negatively significance at the upper or at 95% quantile. Table 7 reveals that ngrcb enters the regression having a coefficient that is insignificant at (5%, 25% 50% 75%) quantile but at 95% quantile, the coefficient of was negatively significant. Meaning that 1 percentage point change in natural gas consumption, at the upper quantile house pricing will change by -0.34 percentage point. This result is also depicted in Figure 3. The fixed effect estimate of the natural gas consumption is only significant at the upper quantiles which correspond to those high jump values of natural gas consumption. The natural gas consumption only becomes significant at extreme quantiles.

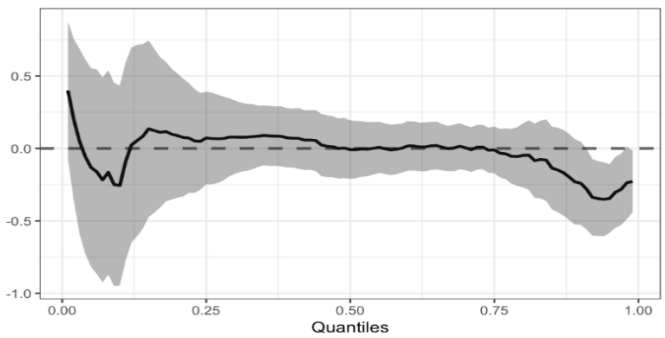

Figure 3: Panel quantile regression estimates of NGRCB

The next notable result is the impact of the population (dlnpop) on house pricing. The coefficient of the variable population is insignificant under the random and fixed panel estimates regression, but in quantile regression, population proves to be highly economically and also statistically significant above 0.75th quantile with a positive sign. This result shows that the increase in population will increase house pricing, this support the conventional theory of demand and supply. If the population of people living in a region increases automatically more housing will be needed and this will increase housing investment. More also the coefficient of the population is very high at the lowest quantile (4.065***) indicating that the effect of the population at the lowest quantile will be more relative to the rest of the quantiles but they are all positive and highly significant. This result is also depicted in Figure 4. The fixed effect statistic of the population appears to be significant in all quantiles, as the horizontal thin line that identifies 5% significance level of quantiles is above the fixed effect statistic.

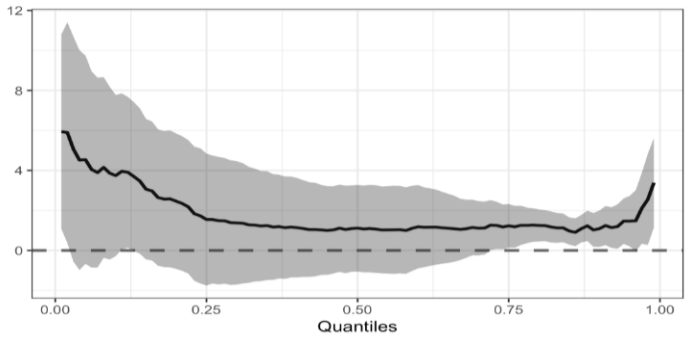

Figure 4: Panel quantile regression estimates of POP

The next in line is the cooling degree days (dlncdd) and house pricing nexus. Our result in Table 7 reveals that the coefficient of cooling degree days is only significant at the upper quantile (75^{th} and 95^{th}). This means that states in the higher quantile in our distribution need residential buildings with constant power in order to maintain a cool temperature in the building, and this demand is unique which will obviously lead to

increase in investment, will cause the house pricing to go up. The impact is more at the 95th quantile relative to the 75th quantile, and at the lower quantile, cooling degree days has no significant impact on house pricing. This result is also depicted in Figure 5. The fixed effect statistic of the cooling degree days only become significant at the extreme upper quantiles which correspond to those high jump value of cooling degree days. Thus, cooling degree days only become significant at extreme quantiles.

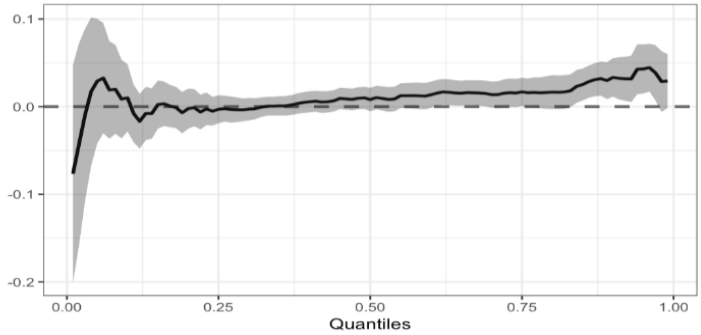

Figure 5: Panel quantile regression estimates of CDD

Finally, the next notable result is the heating degree days and house pricing nexus, which is our last control variable. Based on our result in Table 7 we can deduce HDD has a negative significant impact on house pricing at the lowest quantile (5th) and a positive significant impact in determining the variability in house pricing at the highest quantile (95th). The result of the HDD is quite unique, it enters the regression with negative significance on house pricing, and after the lowest quantile, it became insignificant and then became positively significant at the highest quantile. This means that for the state in the lowest quantile, 1 percentage point change in HDD will cause house pricing to change by -0.155 percentage point and for states at the 95th quantile 1 percentage point change in HDD will cause house price to change by 0.466 percentage

point. This result is also depicted in Figure 6. The fixed effect estimates of the heating degree days exhibit a different pattern across quantiles. The variable becomes significant at the lower and extreme quantiles which correspond to those low and high jump value of heating degree days. Thus, cooling degree days only become significant at lower extreme and higher lower quantiles.

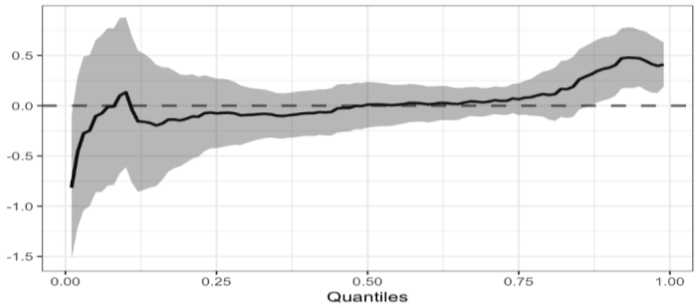

Figure 6: Panel quantile regression estimates of HDD

Chapter 5

CONCLUSION

5.1 Conclusion

The aim of this study is to examine the impact of the natural gas pipeline on house pricing for the selected northern states in the US. In order to achieve this, the fixed effect quantile regression estimation technique was employed in our study. The reason is that the distribution of our dependent variable which is house pricing is not normal, so using the assumption of normal distribution in this study will definitely lead to error.

Also, quantile regression allows for more flexible and complete characterization when focusing on the impact of the natural gas pipeline on house pricing at both lower and higher levels of the quantiles. For this reason, in this study, we estimated the fixed-effects version of the conditional quantile regression model and we first examine the conventional linear form.

Since the relationship between natural gas pipeline and house pricing is nonlinear. Using quarterly data from 5 northern states, over the period of 1991-2015, our result reveals that natural gas pipeline (lnnginflow) has no significant impact on house pricing across all the distribution. Furthermore, an interesting by-product of our studies reveals that there is a strong significant positive relationship between population and house pricing at all point of the distribution with a stronger association at the lower quantile. This study also revealed to us that the population has a great economic

impact. Our results show that an increase in population will definitely lead to an increase in house pricing and this will contribute to the United States investment rate.

Finally, this study reveals that natural gas consumption by the residential sector enters the regression insignificance but became negatively significant at the highest quantile (95^{th}). This caught our attention; this might possibly mean that states at the highest quantile prefer to use an alternative energy source other than natural gas. We cannot emphatically explain why this is the case but housing policymakers must review the impact of gas consumption especially for states at the highest quantile before making any decisions.

Another contribution of this study is to highlight that the existing level of the natural gas pipeline is not as important as other determinant house pricing. Although natural gas has a significant impact on the US economy according to Joskow, Paul (2013), but according to our study, we do not find any significant impact of the gas pipeline on house pricing.

In summary, our results reveal that having a uniform housing policy across all the 5 states might be ineffective due to the differential impact of each control variables on housing price across different quantile. And also the use of fixed effect quantile regression approach in this study provides a more accurate picture of factors affecting house pricing and consequently our results can be used by researchers for their future empirical studies.

Over a decade ago shale gas was considered uneconomical but due to technological advancement, the extraction of shale gas that was considered uneconomical ten years

ago is now contributing immensely to the US economy (Munasib, Abdul, & Rickman, 2015). Natural gas' pipeline impact on residential value has caused controversies whereby many argue that the pipeline does and does not affect residential property value. The result of this study shows that natural gas pipeline does not have any significant impact on housing value.

REFERENCES

Abrevaya, Jason, and Christian M. Dahl. "The effects of birth inputs on birthweight: evidence from quantile estimation on panel data." *Journal of Business & Economic Statistics* 26, no. 4 (2008): 379-397.

Baltagi, B. (2008): *Econometric analysis of panel data*. John Wiley & Sons.

Boxall, Peter C., Wing H. Chan, and Melville L. McMillan. "The impact of oil and natural gas facilities on rural residential property values: a spatial hedonic analysis." *Resource and energy economics* 27.3 (2005): 248-269.

Diskin, B. A., Friedman, J. P., Peppas, S. C., & Peppas, S. R. (2011). The Effect of Natural Gas Pipelines on Residential Value. *Right of Way*, 24-27.

Fruits, Eric. "Natural Gas Pipelines and Residential Property Values: Evidence from Clackamas and Washington Counties." *Online at: http://www. academia. edu/195355/Natural_Gas_Pipelines_and_Residential_Property_Values_Evidence_from_Clackamas_and_Washington_Counties* (2008).

Ikenberry, David, Josef Lakonishok, and Theo Vermaelen. "Market underreaction to open market share repurchases." *Journal of financial economics* 39.2-3 (1995): 181-208.

Joskow, Paul L. "Natural gas: from shortages to abundance in the United States." *American Economic Review* 103.3 (2013): 338-43.

Kilian, L. (2008). The economic effects of energy price shocks. *Journal of Economic Literature*, *46*(4), 871-909.

Koenker, R., 2004. Quantile regression for longitudinal data. *Journal of Multivariate Analysis*, *91*(1), pp.74-89.

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics*, *108*(1), 1-24.

Lv, Zhike, and Ting Xu. "A panel data quantile regression analysis of the impact of corruption on tourism." *Current Issues in Tourism* 20, no. 6 (2017): 603-616.

Meinshausen, M., Meinshausen, N., Hare, W., Raper, S. C., Frieler, K., Knutti, R., ... & Allen, M. R. (2009). Greenhouse-gas emission targets for limiting global warming to 2 C. *Nature*, *458*(7242), 1158.

Muehlenbachs, Lucija, Elisheba Spiller, and Christopher Timmins. "The housing market impacts of shale gas development." *American Economic Review* 105.12 (2015): 3633-59.

Munasib, Abdul, and Dan S. Rickman. "Regional economic impacts of the shale gas and tight oil boom: A synthetic control analysis." *Regional Science and Urban Economics* 50 (2015): 1-17.

Powell, David. "Quantile regression with nonadditive fixed effects." *Quantile Treatment Effects* (2016).

Protocol, K. (1997). United Nations framework convention on climate change. *Kyoto Protocol, Kyoto, 19*.

Solomon, S., Plattner, G. K., Knutti, R., & Friedlingstein, P. (2009). Irreversible climate change due to carbon dioxide emissions. *Proceedings of the national academy of sciences*, *106*(6), 1704-1709.

Vidic, R. D., Brantley, S. L., Vandenbossche, J. M., Yoxtheimer, D., & Abad, J. D. (2013). Impact of shale gas development on regional water quality. *science*, *340*(6134), 1235009.

Zhang, X., Myhrvold, N. P., Hausfather, Z., & Caldeira, K. (2016). Climate benefits of natural gas as a bridge fuel and potential delay of near-zero energy systems. *Applied energy*, *167*, 317-322.