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M.A. THESIS

EMPIRICAL ANALYSIS OF THE REGIONAL HOUSE PRICE CONVERGENCE IN THE KINGDOM OF SAUDI ARABIA

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Asst. Prof. PINAR DENIZ

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ÖZ

2015Q1'den 2020Q4'e kadar bu çalışma, Suudi Arabistan Krallığı'ndaki bölgesel konut fiyatlarını incelemektedir. Panel birim kök testi, birinci nesil LLC, IPS ve Hadri kullanılan yöntemlerden bazılarıdır. Doğrusal olmayan ve zamanla değişen faktör modeli ikincisidir. Phillips ve Sul bu modeli 2007'de geliştirdi. Sonuçlar, panel birim kök testinin ilk nesli arasında bazı çelişkiler olduğunu gösteriyor. Ancak bu karışıklık, Phillips ve Sul testinin sonucu ile bulundu. Sonuçlar, Suudi konut piyasasında ülke düzeyinde bir yakınsama olmadığını, bunun yerine kulüp düzeyinde yakınsamanın olduğunu göstermektedir. Bazı bölgeler yakınsama yolunda bir kulüp olarak birlikte hareket ediyorlardı, ayrıca test Suudi pazarı için aynı şekilde hareket eden üç kulübü ortaya çıkardı. Birinci nesil, veri setini değerlendirmek için tipik bir yaklaşım olarak kullanılırken, Phillips ve Sul testi, fiyatlandırma modelini gruplamalar halinde test etmek için saltanatları kulüplere bölerek birinci nesil ve sofistike sonucu vurgulamak için kullanıldı. Birinci nesil, tüm ülkenin sonucundan sorumludur. İkinci yöntem ise tüm ülke için sonuçlar üretmekte, alt kulüpler halinde kümelenmekte ve konut fiyatları sektöründe farklı yakınsama ve ayrışma yönleri sergilemektedir. Bulgular, alıcılar ve satıcılar gibi konut amaçlı gayrimenkullere ilgi duyan kişilere ve bu genişleyen sektördeki gayrimenkul geliştiricilerine fayda sağlayacaktır.

Anahtar Kelimeler: Konut fiyatı, yakınsama, bölgesel ekonomik, emlak piyasası, Suudi Arabistan Krallığı.

ABSTRACT

From 2015Q1 through 2020Q4, this study examines the regional housing price in the Kingdom of Saudi Arabia. Panel unit-root test, first-generation LLC, IPS, and Hadri are some of the methods used. The non-linear and time-varying factor model is the second. Phillips and Sul developed this model in 2007. The results show some contradictions between the first generation of the panel unit root test. However, this confusion was found by the result of the Phillips and Sul test. The results show that there is no convergence in the Saudi housing market on a country level, rather the convergence was on a club level. Some regions were moving together as a club toward convergence way, also the test revealed three clubs for the Saudi market moving the same way. The first generation was used as a typical approach to evaluate the dataset, while the Phillips and Sul test was used to emphasize the first-generation and sophisticated result by splitting reigns into clubs to test the pricing pattern as groupings. The first generation is responsible for the entire country's outcome. The second method, on the other hand, produces results for the entire country, clustering reigns into sub-clubs and displaying the different directions of convergence and divergence in the residential housing price sector. The findings will benefit people with an interest in residential real estate, such as purchasers and sellers, as well as real estate developers in this expanding sector.

Keywords: House price, convergence, regional economic, real estate market, Kingdom of Saudi Arabia

DEDICATION

This work is dedicated to my wonderful parents, Maher and Frhan, as well as my siblings, for their unwavering support throughout my life.

I'd also like to thank Turkey, my second home, for hosting me during my graduate and undergraduate studies, and to Marmara University where I did my graduate studies. Also, I dedicate this to Istanbul Şehir University, where I completed my undergraduate studies and where my academic journey began.

It took me years to get to this academic level from where I first began pursuing my interest; throughout that period, I encountered numerous events and individuals who are still alive in my heart, including university professors and friends. Throughout my studies, I had numerous different experiences and meetings at Şehir. At the university, I used to be surrounded by excellent people. I'll never forget those happy days; I'm a member of the community who cherishes all his wonderful recollections. Every semester, I met new people and gained a great deal of knowledge. At university halls where I spent the happiest days of my life. Many persons who touched my heart during my studies are the people I will never forget and who will live in the depths of my heart till I die.

After finishing the Witr prayer, I'm penning this devotion. I remembered all people who came into my life during my university studies, including professors, teachers, and friends, during my prayer. My tears streamed down on those unforgettable moments, which were both delicious and bitter. I write this down in my graduation thesis to preserve some of these great memories for as long as I am alive and even after I die.

I thank Almighty Allah for guiding me on my journey and stopping me at various points along the way so that I might meet all these wonderful people, Mohammed, peace be upon him stated that "He who does not thank the people is not thankful to Allah," (Dawud, 1984).

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey–Fuller
CPI	Consumer Price Index
DF	Dickey–Fuller
EGLS	Estimated Generalized Least Squares
GAS	General authority of statistics
GLS	Generalized Least Squares
GNI	Gross national income
HPI	House Price Index
IPS	Im, Pesaran, and Shin
KSA	Kingdom of Saudi Arabia
LLC	Levin, Chien-Fu Linb
LM	Lagrange multipliers
MBS	Mohammad Bin Salman
MOI	Ministry of interior
MSRM	Markov Switching Regression Model
SADF	Supremum Augmented Dickey–Fuller
SAIBOR	Saudi Arabian Interbank Offered Rate
SAMA	Saudi Arabia Monetary Agency
SBG	Saudi Binladin Group
SURADF	Seemingly Unrelated Regressions Augmented Dickey-Fuller
VAR	Vector autoregression
VECM	Vector Error Correction Model

1 INTRODUCTION

The real estate market is the most important market at all, and it has an impact on the value of all sectors, including investment, government, and social. So, we find that every investment is affected by its real estate, such as restaurants whose prices differ due to the difference in their properties, so if the real estate market is correct and revived, the society will flourish with it and if it is inflated, then there is pressure on society, and if the real estate market collapses, it will be a disaster for the country. To clarify more, and before delving into details, we simply explain that the property is every stable, fixed asset that cannot be moved from its place to another place of the property, such as land and buildings. Considering this, the real estate market is the market in which the real estate sale, purchase, investment, and rent operations take place. Growing works of literature regarding house price convergence developed to analyze their market or other markets for comprehensive understanding which will lead to the dynamics of decision marking.

Many call the real estate the title of "the righteous son" because it provides stability and is one of the types of fruitful investment in general, because prices are constantly rising, which made it a feasible option, but to get the best results, the investor must study the market and the area in which he wants to invest to know the needs of individuals in the long term. The investor can obtain the study through specialists in real estate investment. What distinguishes the Kingdom of Saudi Arabia from others is that more than the half of its population does not exceed the age of 35 years old, according to new research (Saudi Youth in Numbers, 2020), which made many companies and real estate developers tend to buy land and provide real estate units for future generations, in 2025 the Saudi housing market is in need to add more than 3 million units (Jameel, 2019).

The Kingdom of Saudi Arabia supports the real estate market through a huge set of administrative and investment facilities, including foreign investment, where investment licenses are given for long periods exceeding five years and facilitated through the General Investment Authority, in addition to flexibility in visas for foreign investors and granting them investment advantages. The size of the real estate market in the Kingdom of Saudi Arabia provides various opportunities to invest in a very large group of residential properties, which include residential units, villas, apartments, or commercial properties

such as shops, malls, and commercial buildings, in addition to land that many individuals and companies seek to acquire. Real estate investment requires patience and intelligence in choosing, as real estate investment requires experience, planning, and analysis in addition to a strong knowledge of investment rules and principles. Many people tend to invest in real estate in the Riyadh region, as it is the capital of the Kingdom of Saudi Arabia and one of the huge economic markets in the Kingdom, but this does not mean weakness when investing in the rest of the Kingdom, as the real estate market and real estate indicators remain on the rise in the Kingdom of Saudi Arabia.

The purpose of the making of this research is to determine an accurate house price in the Saudi market in the long run. Also, to see the movement of the prices from one province to another, whether going in the same direction or in different pathway. It is natural and necessary for governments, institutions, and commercial companies, including industrial, educational and others, to plan their future to achieve private and public goals, provide all services, reach a state of justice and stability for society, and work to make decisions to predict events before it happens in all aspects of community activity. About the future in the facts of yesterday and today. Among the most important time series are those related to economic indicators and annual sales of companies in all aspects of their activities, education, population size, etcetera. Furthermore, most crucially, the Saudi Arabian housing price indicator.

The question itself is a familiar one for many other countries such as the US, and UK for the developed economy. In different case, India, and China for the emerging economy but not for the Kingdom of Saudi Arabia. So, that as an emerging economy we need to have such a study to contribute to the real estate market for the country. That will create a tremendous door to enter this kind of study for the Saudi economy. Yet, the government of Saudi Arabia plans to make a real estate hub in the region, so we need to put an eye on this sector. The market of house prices in Saudi Arabia would be considered a newborn market for the country because the new polices reformation for foreigners besides the country opened its door widely for investors and tourists. That what would crystallize the originality of our research in this case. Moreover, a couple of research have been published for the Saudi house market, but all of them concentrate on the cured oil price, which is the

main commodity of the country in our case. Several events occurred between 2015Q1 and 2020Q4, the impact of new tariffs and the announcement of a new project, which could be key factors for HPI and influence on prices and even the future prices. On the other hand, if these events don't live up to our expectations, they will tell us that there are certain factors to focus on, to test the housing market in better way.

2 LITERATURE SURVEY

2.1 Convergence in housing price

Several studies were carried out to ascertain the behavior of housing prices in various states. It is expected that real estate prices in different regions within the same country will move differently from each other and independently because supply and demand are key factors in this regard to determine the price level (Meen, 2001). There is also the possibility of what is called a "ripple effect" and this occurs in many separate places, but it moves from one place to another due to the migration of people and the movement of funds (Meen, 1999). Meen argues that real estate markets have their prices converging over time because they are interdependent within the same country.

Many different studies based on econometric techniques have tested the existence of a ripple effect. By using some procedures to test the roots of units, already there has been written several academic papers and discuss the relative stability of house prices in a specific region within one country. Much literature has been written about the convergence of house prices in various regions and countries around the world, especially in developed economies, and we can look at some examples of this literature such as; (Ashworth & Parker, 1997; Cook, 2003, 2005; Drake, 1995; Meen, 1999), this is for the UK, and throughout these, there were varieties of statistical techniques to determine the housing market in the Kingdom. A wide dataset in the UK has been used in testing the market. The results were moving toward equilibrium end in the long-run, for more than 30 years (Holmes, 2007). With stationary prices in the UK being the key ingredient in this regard, driven stochastically in the City of London. On the other hand, it appears that areas outside London have prices moving in the same pattern, but with slight differences (Holmes & Grimes, 2008). Furthermore, looking at the United States of America, many pieces of literature also elaborated the market at quietly similar to the UK period, such as; (Gupta & Miller, 2012; MacDonald & Taylor, 1993; Pollakowski & Ray, 1997; Tirtiroğlu, 1992). These studies focused on whether the real state price convergence in the long run. But MacDonald & Taylor used cointegration analysis and found that long-term prices in the houses were stable, on the other hand, there was no strong evidence of support for the ripple effect in their study. In the early 1990s, prices in some major areas seemed to move in similar patterns with the rise in house prices, but before this time they were moving

differently from each other. The regional factor was a cause of convergence, and this may give clear evidence that the major regions have an impact on convergence and divergence (Clark & Coggin, 2009). To give more accurate information in determining the movement of price changes And also, some studies related to the same field and using data in developed countries such as Spain, found some evidence that some areas converge and diverge based on some physical and economic characteristics, and this may give convergence to some regions and the divergence of some areas (Larraz-Iribas & Alfaro-Navarro, 2008). Moreover, a study shows that in Spain as well house prices are not moving in a pattern of converging on steady trend, that gives evidence of house price in Spain is segmented (Blanco et al., 2016). This study applied a novel regression-based and convergence test by (Phillips & Sul, 2007). Besides, advanced economies also have made their study and testes. France has examined the house prices in Paris among different districts. This research employed a method that rarely been researched before. "Spatial diffusion", and figured out how the speculative pattern assumed the role in the economy (Roehner, 1999). An unusual study was tested on the second-hand house market. Concentrate on analyzing the trend of the house prices, with date-set from 1981 to 1997 on a monthly base. That study consented to three major cities in Sweden. Interest rates and long and short-run play a huge role in determining the prices of the second-hand house (Berg, 2002). Moreover, Stevenson re-examines the heteroscedasticity in house price and found evidence of his hypothesis by implementing the Generalized Least Squares model (GLS). Not only that but also used Estimated Generalized Least Squares Model (EGLS), and hedonic models at a certain level. The evidence consisted of two main factors, ages, and locations, these models provided more efficacy in setting the house prices (Stevenson, 2004). According to cointegration test and error correction model, Australian example shows up to spot a light on the ripple effect in metropolitan cities. This model became an ideal method for researchers in this field in recent time. Constricting an innovative approach to examine the diffusion in quantitatively path. The study explored the diffusion of eight cities in Australia empirically, that gives a tracking way see how house prices market is changing (Luo et al., 2007). One more detailed study for the Australian case examined the capital cities of each state in Australia. The main implication was to apply non-liner model to examine the heterogeneity and transitional dynamics in their case over

the different capital states in Australia. The result was according to the finding there was one sub-group moving in non-convergence on the other side there were two other sub-group is converging after the period of 2014 (Churchill et al., 2018). Besides, the Finnish example of examining the house prices with "time series econometrics", showed two interactions between mortgage and house prices. The study used Vector Error Correction Model (VECM) and that suggests only one linear is stationary vector among four different variables (Oikarinen, 2009). Poland has its own case as well; a study was conducted to see whether the house prices are going in same direction or not. The study focused on the log t-regression, they figured out that there is no evidence of common prices over the Polish cities, in other word the prices are moving in different direction from one to other (Tomal, 2019).

Additionally, emerging economies have conducted many studies and research in the field of real estate price convergence. Precisely after the global financial crisis that occurred in 2008. Many studies have been conducted in China on the convergence of real estate prices in various regions in the country (Zhang et al., 2017) in these studies investigated throughout the country. This shows whether the real estate in China is in a converging approach or moving oppositely. Not only that technique but also an insight into how the "ripple effect" changed the house prices over time. The "ripple effect" was evidence for three main cities in China "Shanghai, Guangzhou, and Beijing" among 35 other cities that have been tested. But there was not enough evidence to rely on in determining house prices throughout the country (Zhang & Morley, 2014). Another study on China case has studied the convergence and divergence of house prices depending on data-panel of 70 cities, large and medium-size over five years. The result finds that the policy in the sector of real estate is not at the priority at that time which leads the prices to diverge. This paper used "Pairwise Testing" or so-called "All-pairs testing" to come up with the formula of decomposition of the prices (Mao, 2016). One more study found that the house prices are in converge path by posting it with "spatial dependence" and "endogenous growth model". These implications were implemented in 34 different cities in China. The model figured out that if house price appreciated on regular bases will end up to price convergence (Chow et al., 2016). Besides, in South Africa, the "ripple effect" was tested on the three main sizes of houses. According to the available dataset based on

quarterly from the first quarter of 1966 till 2010. The study used the nonlinear unit root test and Bayesian method alongside “standard linear tests” of the stationarity test. They found out that plenty of evidence supporting the stationarity of ripples effects in the five big cities in the country (Balcilar et al., 2013). The second most populous country in the world India examined the behavior of house prices with a panel of data from 2007 to 2011 to observe whether the market is converging or diverging, using the test of [“unit roots in heterogeneous panels” (Im et al., 2003)]. The study explored that many populated cities in India are not in a convergence way, therefore, the Indian house market is moving independently in every city (Aye et al., 2013). Seemingly Unrelated Regressions Augmented Dickey-Fuller (SURADF) test is method key applied to investigate the market in Taiwan. This test was developed by "Im, Pesaran, and Shin, and by Sarno and Taylor” in 2001 (Breuer et al., 2001), it can let the researchers discern both stationary and unit-root processes. The Taiwan example focused more on stationary and non-stationary processes. The outcomes were differing, the stationary one, all house prices changes were upon the building structure and location (Lee & Chien, 2011). Another example from Taiwan occurred in the same year of the previous one using a different methodology to examine the housing market. First, the researchers applied an old school technique, johansen cointegration test (Johansen, 1988). Which has the ability of estimation on unit-root series. This example aimed to find the dynamic relations and linkages of the data-set from 1998 to 2008 quarterly (Chen et al., 2011). A Southeast Asia country, Malaysia, have had tested the “ripple effect” by Lagrange multipliers (LM) and univariate. This method was applied to examine the house price over five indices ‘aggregate housing, detached housing, semi-detached housing, terrace housing and high-rise housing’ (Lean & Smyth, 2013). The study tested 14 different locations and the relationship over the long run on the average of the country. Likewise, Turkey has introduced its study on the house price by the Central Bank of Turkey, focused more on the regional evidence, with using 26 regions data-set across the country (Ganioğlu & Seven, 2019). The Turkish paper shows that one of the benefits of the work is to help the buyers and sellers on one level, and on the other level the outcomes will also support the regulators and policymakers to make the decision.

2.2 Housing price in KSA

Our case moved to spot the light on the Kingdom of Saudi Arabia (KSA) on the House Price Index (HPI). Several studies examined and analyzed the Saudi house prices. The researchers rely on a variety of methods, tests, and statistical techniques. One of the factors that determine house prices in Saudi Arabia is the construction cost. A survey was conducted on 5 real estate agents and consultants and contractors, 14, 16. They found out, there are thirty-four different components affecting the operation of construction in the Kingdom (Assaf et al., 2010). A study used the Vector autoregression (VAR) analysis to see the influence of the monetary policy and The Saudi Arabian Interbank Offered Rate (SAIBOR) on the house prices. Alongside with figuring out that the SAIBOR has much more impact on the house price. Precisely, the granger causality test, impulse variance decompositions on the housing market. Not only that but also, the SAIBOR case Granger cause unlike the monetary policy has nothing to show with Granger cause (Obaid et al., 2020). Oil price was a strong element of determining house prices in KSA. The study investigated the housing market in the kingdom applying Supremum Augmented Dickey-Fuller (SADF), and Markov Switching Regression Model (MSRM). To see whether the market is encountering price bobbles. A shred of evidence found that the housing prices were affected due to the crude oil price (Alola, 2020). An empirical study used time-series examination to figure out the main factor of house prices changing. The study developed an econometrics model using various variables such as income, population, house price, and Consumer Price Index (CPI). The result shows that the demand in the housing market was inelastically comparing the variables that have been used to determine the prices (Al Obaid, Hussain Mohammed A, 2020).

3 METHODOLOGY

In our methodology section we use non-stationary penal method based on Dickey–Fuller test (DF) and augmented Dickey–Fuller test (ADF). This will make an estimation in the unit-root of our dataset. Most of the tests that focus on the penal unit-root are based on ADF, specifically, they are an extension of the main test. The procedures of the penal unit-root test are more complex than the time-series test. In particular, the estimation factor in panel unit-test tend to the degree of heterogeneity.

We use the panel unit-root test instead of time series test because of the originality of the panel unit-root, as it goes more informative if we increase the number of the cross-section.

For our dataset, we have the HPI of 13 provinces of the kingdom of Saudi Arabia starting from 2015Q1 to 2020Q4. Our time series is containing 24 quarters with their HPI for 13 regions. We apple the analysis of panel unit-root test for our example to determine the path of each region. Our tests are null hypothesis is the term for a hypothesis that may be false, or that it affects nothing at all. Often during an examination on a dataset, besides, we will study another section of the idea, which is the section that might work and is known as the alternative hypothesis.

3.1 Panel unit-root tests

3.1.1 Levin, Lin, and Chu (2002) test

We start with the first test of the panel unit-root abbreviated as LL or LLC. This test forces on the opposite of the null hypothesis of the homogeneous stationary hypothesis. If the result rejects the null hypothesis that means it is nonstationary. Simply our panel would not consider as a valid hypothesis (Convergence in HPI). Some panels of the null hypothesis contain unit root, on the other side in alternative hypothesis if we fail to reject the null hypothesis, means that, the panels are stationary.

The main model is written as the following:

$$\Delta y_{it} = \rho y_{it-1} + \sum_{L=1}^{Pi} \theta_{iL} \Delta y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \quad \text{m=1,2,3} \qquad (1)$$

The null hypothesis goes as the following:

$$H_0: P = 0 \quad (2)$$
$$H_0: P < 0$$

Like any other tests of unit-root test, LL test assumes that all the individuals are independent as cross-sectional. For that the rejection of the null hypothesis goes with the standard normal distribution.

3.1.2 Im, Pesaran and shin (2003) test

IPS test is a quite alike the previous test LL, but it has an obstacle, which is a restricted ρ to make all i homogeneous. So, for that reason IPS extended the test LL by proposing basic procedure, the coefficient will allow the heterogeneity in the variable $Y_{i,t-1}$. Besides the procedure relies on the average of the individual unit-root. The equation as the following:

$$\Delta y_{it} = \rho_i y_{it-1} + \sum_{L=1}^{Pi} \theta_{iL} \Delta y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \quad (3)$$

And the null hypothesis and the alternative hypothesis formulated as the following:

$$H_0: \rho_i = 0 \text{ for all } i \quad (4)$$
$$H_0: \rho < 0 \text{ for at least one } i \quad (5)$$

The null hypothesis mean that all series are nonstationary and contain unit root, and the alternative hypothesis assumes that some panels have stationarity.

3.1.3 Hadri (2000) test

Hadri test is originally based on the Lagrange multiplier test (LM). Conducting such a test means that its focus is stationary in the rejection of the null hypothesis. The alternative hypothesis assumes that there is a unit root in some of the panels.

This test has two main models.

$$y_{it} = r_{it} + \epsilon_{it} \tag{6}$$

And

$$y_{it} = r_{it} + \beta_i t + \epsilon_{it} \tag{7}$$

Where r_{it} is random.

And y_{it}, t = 1, T and i = 1, and N is the dataset observed for all i to test the stationarity. But the ϵ_{it} and u_{it} are independent.

Where the second substitution model goes:

$$y_{it} = r_i 0 + \beta_i t + \sum_{t=1}^{t} u_{it} + \epsilon_{it} \tag{8}$$

$$= r_i 0 + \beta_i t + e_{it} \tag{9}$$

And $e_{it} = \sum_{t=1}^{t} u_{it} + \epsilon_{it}$ deduced the:

$$E\left[e_{it}e_{js}\right] = \min(t,s)\sigma_u^2 + \sigma_\epsilon^2 \quad i = j, \qquad t = s, \tag{10}$$

$$= \min(t,s)\sigma_u^2 \quad i = j, \ \ t \neq s, \tag{11}$$

$$= O \quad i \neq j, t = s, \tag{12}$$

$$= O \quad i \neq j, t \neq s, \tag{13}$$

So, the matrix become this way for the second model.

$$y_i = X_i\beta_i + e_i, \qquad i = 1, \dots, N, \tag{14}$$

Where

$$y_i' = \left(y_{i^1,\dots,} y_{iT}\right), \tag{15}$$
$$e_i' = \left(e_{i^1,\dots,} e_{iT}\right),$$

And

$$X_i = (l_T, a_T), \tag{16}$$

Where $\beta_i = (rio, \beta_i)'$ is 2×1 is the parameter's vector, X_i is $T \times 2$ vector.

Where lT is a $T \times 1$ vector for everyone and a_T is a $T \times 1$.

3.2 Phillips and Sul test (2007)

The method of Phillips and Sul analyze the individual heterogeneity and can also include the development of the heterogeneous behavior. If there is need to collect such behavior the method is capable to capture this in empirical model. Originally this econometric test was developed as convergence test for the time varying.

Log t-regression test for convergence hypothesis was developed by Phillips and Sul in 2007 based on non-liner time-varying factor model.

First, the model needs the panel data X_{it} decomposed and time is $(t = 1, \dots, T)$ and region is $(i = 1, \dots, N)$ as the following:

$$X_{it} = g_{it} + a_{it} \tag{17}$$

g_{it} is permanent component and a_{it} is transitory component. However, these components will change the equation (1) to:

$$X_{it} = \left[\frac{g_{it} + a_{it}}{\mu_t}\right]\mu_t = \delta_{it}\mu_t \tag{18}$$

The μ_t is the single component for all regions and the time-varying is represented as δ_{it}. Also, we need to estimate the δ_{it}, so the μ_t will be removed, and it became as the following:

$$h_{it} = \frac{X_{it}}{\left(\frac{1}{N}\right)\sum_{i=1}^{N}\delta_{it}} = \frac{\delta_{it}}{\left(\frac{1}{N}\right)\sum_{i=1}^{N}\delta_{it}} \tag{19}$$

The developers of this test are Phillips and Sul ensure the convergence test if $\alpha \geq 0$ and the null hypothesis is:

$$H_0: \delta_i = \delta \text{ and } a \geq 0 \tag{20}$$

And for null hypothesis t-test of the convergence, can be tested as the following equation:

$$\text{Log}\left(\frac{H_1}{H_t}\right) - 2\log\left(\text{Log (t)}\right) = c + blog(t) + \varepsilon_t for\ t = [rT], [rT+1], \dots, T\ with\ r > 0 \tag{21}$$

4 DATA AND EMPIRICAL RESULTS

4.1 Data

The focus of this study is on residential housing prices in Saudi Arabia on a quarterly basis. The data was obtained from General Authority of Statistics of Saudi Arabia (GAS). Unlike other developed countries, the GAS began extracting data for each province in the kingdom in 2015 Q1. They also extracted data for each city and, in certain circumstances, for each neighborhood. In the instance of Saudi Arabia, the GAS only made it to Riyadh, the capital. As a result, we concentrated on regional house prices. We also collect additional data to apply a regression model to the HPI and examine further. First, unlike HPI, we obtained a dataset of power subscribers from the Saudi Arabia Monetary Agency (SAMA) on a main regional basis. Second, we use World Bank Open Data to get population and GNI data. Unlike the HPI quarter base, all three variables are based on a yearly basis. Furthermore, we enter the annual dataset repeatedly for each quarter when using the variable with HPI in a regression model. To illustrate, the HPI has four different values from Q1 to Q4 in year 1, while the three variables only have one, thus we utilize the same annual number from Q1 to Q4. Moreover, the electricity subscribers, population, and GNI dataset are in millions, so for this reason we take the natural logarithm of them to facilitate the usage. Not to be forgotten, Saudi Arabia has two regional classifications. The first is the basic regional classification, which consists of four main regions: Central, Western, Eastern, and Southern. There are 13 sub-regions in the second classification. There are sub-regions inside each of the primary regions. The population and GNI per capita was obtained only for the correlation relationship test.

Table 1 Descriptive Statistics[1]

	N	Minimum	Maximum	Mean	Std. Deviation
Ar Riyad (SA 1)	24	80.59	102.4	91.43	7.04
Makkah (SA 2)	24	79.98	100.8	86.87	6.54
Madinh (SA 3)	24	91.09	103.7	95.03	4.1
Eastern (SA 4)	24	76.04	97.9	86.03	6.94
Al Qaseem (SA 5)	24	76.05	98.1	84.05	5.82
Aseer (SA 6)	24	83.24	97.7	86.01	3.8

[1] The classification in the descriptive statistics table and so on in the research (SA) is made by the author. It is not an official classification.

Tabouk (SA 7)	24	75.81	100.3	83.75	6.99
Hail (SA 8)	24	83.9	98.7	90.46	4.78
Jazan (SA 9)	24	79.2	106.4	91.16	7.89
Al Baha (SA 10)	24	75.59	96.5	83.99	7.28
Al Jouf (SA 11)	24	76.92	95.2	82.93	4.14
Najran (SA 12)	24	75.06	97.6	85.1	6.35
Northern (SA 13)	24	78.11	100	86.65	6.03

4.2 Empirical Results

4.2.1 LLC, IPS and Hadri test results

The results of the 3 method we apply LLC, IPS and Hadri are shown below in Table 2-4. With very low probability in house price index which indicate that the rejection of the null hypothesis at less than 5%.[2]

Table 2 LLC Test result

LLC		
	Statistic	Prob.
Constant	-8.8973	0.000***
Constant and trend	-2.8006	0.0026***

The LLC test has a probability of rejecting the null hypothesis at a significant level of less than 5%. This means that, in our instance, in the Saudi regional housing market is not moving in a convergence route in both directions, the constant, and constant and trend. The null hypothesis of house price convergence in the Saudi housing market is rejected by LLC.

Table 3 IPS Test result

IPS		
	Statistic	Prob.
Constant	-5.56858	0.000***
Constant and trend	0.78589	0.784

[2] (*) denotes rejecting null hypothesis at 0.1 significance level and (**) rejecting the null hypothesis at 0.05 lastly (***) rejecting the null hypothesis at 0.01 significance level.

However, the IPS test revealed a significant difference in terms of constant and trend probabilities, which is greater than 10%. As a result, we fail to reject the null hypothesis. On the other hand, the constant, with a probability of less and 1% of significance will surely reject the null hypothesis. Only by using the IPS test can this uncertainty be resolved by rejecting the hypothesis in constant and failing to reject in constant and trend, where there is some missing information. Furthermore, we will be able to analyze this paradox and figure out what happened in our prospective outcomes.

Table 4 Hadri Test result

	Hadri test			
	Hadri Z-stat		Heteroscedastic Consistent Z-stat	
	Statistic	Prob.	Statistic	Prob.
Constant	7.67286	0***	7.955	0.000***
Constant and trend	8.23731	0***	8.06	0.000***

In the Hadri test, the results are basic; it indicates that the null hypothesis is rejected on a less than 5% significant level in both constant and constant and trend. In this way, the Saudi market has stationary.

4.2.2 Phillips and Sul result

Table 5 Log(t) test results [3]

Variable	Coefficient	Standard Error	T-Statistic
log(t)	-1.7209	0.1347	-12.7716***

The log(t) of the convergence test over 13 Saudi Arabian regions is shown in Table 5 for the Phillip and Sul test. The results suggest that the entire panel of our house pricing case was rejected. Because the T-statistic is -12.7716, which is less than the critical value which is -1.65. As a result, the test indicates that there is no convergence in the full sample for the Saudi instance from 2015Q1 to 2020Q4. As a result of shown in table 5, the null hypothesis is rejected. We will now employ sub-group analysis to look for a probable

[3] Log *t*-test with critical value -1.65

convergent club among the 13 provinces. For this purpose we apply the clustering method by (Phillips & Sul, 2007).

After receiving these results, they validate the null hypothesis across all 13 provinces in table 6. Phillips and Sul devised the clustering technique, which we use to go forward. This method divided the data into three groups. The following is a summary of the club: SA3 Madinh, SA8 Hail, SA9 Jazan, and SA10 Al-Baha are part of Club 1. Club 2 is made up of three provinces: SA1 Ar-Riyad, SA5 Al-Qaseem, and SA13 Northern. Finally, SA2 Makkah, SA4 Eastern, SA6 Aseer, SA7 Tabouk, SA11 Al-Jouf, and SA12 Najran make up Club 3.

Table 6 Initial convergence club classification[4]

	Region	Coefficient	Standard Error	T-Statistic
Club 1	SA3, SA8, SA9, SA10	0.1201	1.0474	0.1146
Club 2	SA1, SA5, SA13	0.0435	0.8495	0.0512
Club 3	SA2, SA4, SA6, SA7, SA11, SA12	-0.5228	0.4167	-1.2547

Club 1 has a T-statistic of 0.1146, club 2 has a T-statistic of 0.0512, and club 3 has a T-statistic of 0.0512. All these numbers are smaller than the critical value of -1.65, indicating that the test in club classification fails to reject the null hypothesis. In this regards we can say that all regions in one club are converging. So, we do have converging in HPI in the form of clubs, according to the results in table 6.

After applying the clustering club technique we need to investigate more in these 3 clubs by merging them to larger converging club using (Phillips & Sul, 2007) method.

Table 7 Club merging classification test

Clubs	Coefficients	Standard error	T-Statistics
1+2	-1.1694	0.1039	-11.2556*
2+3	-0.751	0.1021	-7.3566*

The calculated coefficients and t-statistics from the merging club analysis are provided in Table 7. We have three clubs, each of which is heading in its own way, based on the initial

[4] Ar Riyad (SA 1) Makkah (SA 2) Madinh (SA 3) Eastern (SA 4) Al Qaseem (SA 5) Aseer (SA 6) Tabouk (SA 7) Hail (SA 8) Jazan (SA 9) Al Baha (SA 10) Al Jouf (SA 11) Najran (SA 12) Northern (SA 13),

results of the converging club categorization and club merging. These clubs are depicted in the map of the Kingdom of Saudi Arabia below (Figure 1). For more precise information, we take the average of each club from 2015Q1 to 2020Q4 and index it in (Figure 2). We can observe that the housing price in Saudi Arabia is not moving in the same way as the rest of the country. There are numerous provinces inside each club, each with a different economic level and population density. In other words, these clubs provide compelling evidence of geographical disparities in the Saudi house market. Economic factors such as income, population, employment, and so on can explain this. Furthermore, there was a targeted destination in each sub-grub of the house price, and we wish to investigate the prospective driver of the clubs.

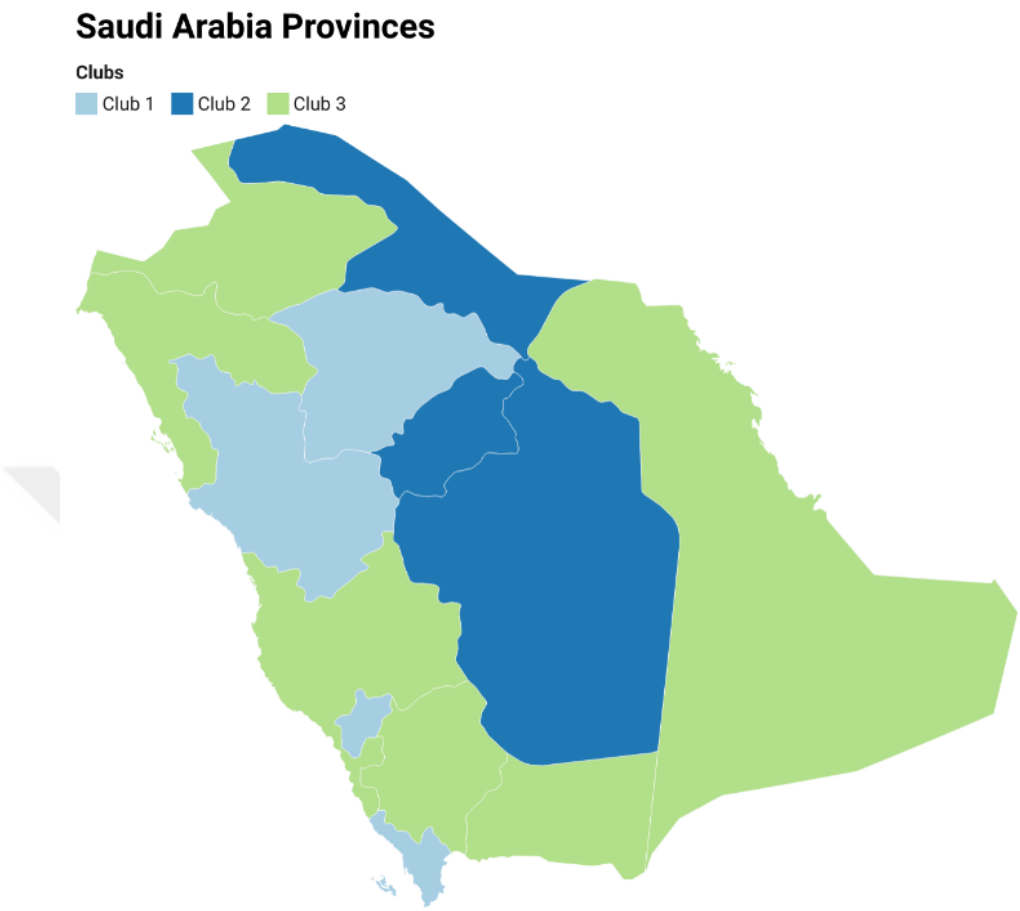

Figure 1 Saudi Arabia provinces [5][6]

[5] This map shows each convergence club, for more detail see Table 3. Figure 1, convergence club for 13 provinces of the kingdom of Saudi Arabia.

[6] Club 1 SA3 Madinh, SA8 Hail, SA9 Jazan and SA10 Al-Baha. Club 2 SA1 Ar-Riyad, SA5 Al-Qaseem and SA13 Northern. Club 3 SA2 Makkah, SA4 Eastern, SA6 Aseer, SA7 Tabouk, SA11 Al-Jouf and SA12 Najran.

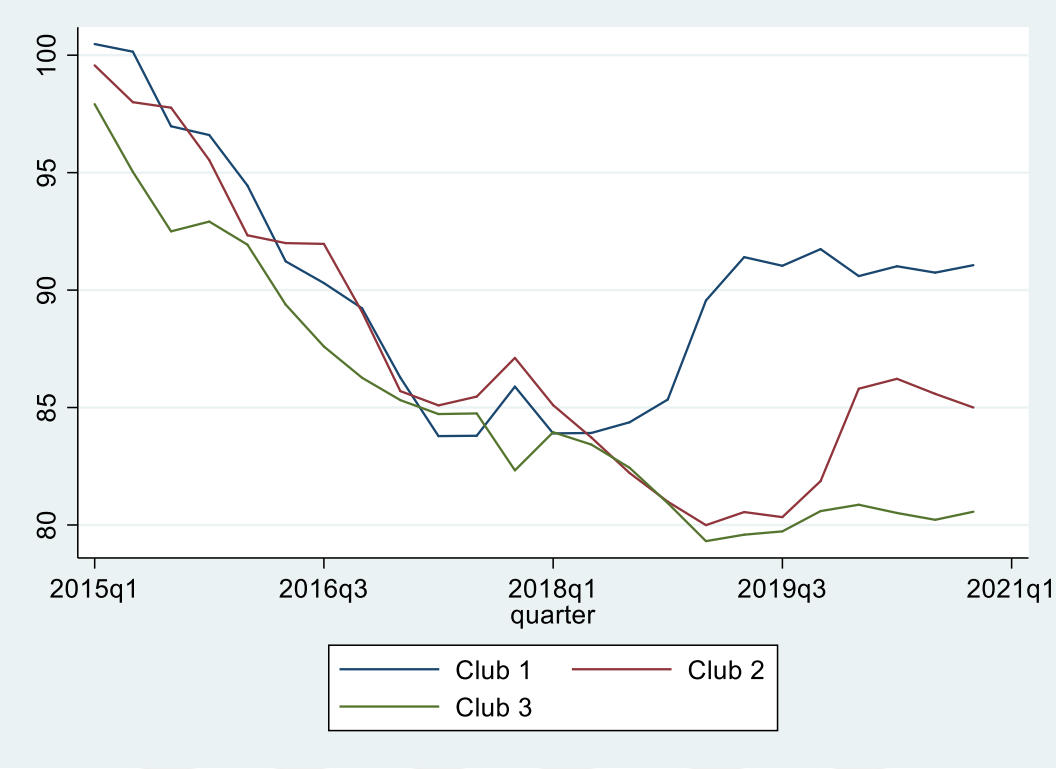

Figure 2 The mean of each club[7]

4.3 Finding

In this section we collect different of variables that will help our research for comprehensive understanding on the housing market of Saudi Arabia. We use the electricity subscribers of the residential sector for four main regions. We analyze the correlation between the residential electricity subscribers and HPI of the Saudi provinces, and after that we apply the regarrison analysis. In this regard, the 13 provinces of the Kingdom of Saudi Arabia are group into four main regions. The first region is the Central region which include Ar Riyad, Al Qaseem, and Hail. The second region is the Western region include Makkah, Madinh, and Tabouk. The third region is the Eastern region which has Eastern, Al Jouf, and Northern. Lasty, the fourth region is the Southern region include Aseer, Jazan, Al Baha, and Najran. Figure 3 will illustrate these main regions below.

The hypothesis assumes whether the electricity subscribers effect the HPI in negative or positive direction or there is no affection. Moreover, the other two variables; GNI and

[7] This figure shows the mean of each club combined, clubs are according to Phillips and Sul club classification.

population, we use them as an aggregate dataset unlike the electricity subscribers. We use GNI and Population only to see the correlation relationship between them and the HPI. We also, used electricity subscribers as proxy to determine the units available in the market.

Our HPI dataset is based on quarterly level, but the other variables are based on annual level. Thus, we apply the correlation and regression models as the HPI is the dependent variable and electricity subscribers, GNI, and population as independent variables. For each quarter of HPI we use the same annual data of the independent variables, only for population and GNI. Further, we take the natural algorithm of population and GNI and the HPI as well and apply the correlation relationship test only.

The Saudi market has a dominant player in the construction sector. In 1931 Mohammed Binladin founded his construction company in the Kingdom of Saudi Arabia. During the time of the King Abdul Aziz in 1950, the King ordered to expand the Grand Mosque in Medina. Saudi Binladin Group (SBG) was honored to take this project and develop it (SBG, 2021). Since that time the founder of SBG build an unprecedented relationship with the royal family in the Kingdom. The main customer for SBG was the government, but on 11 September 2015 things are changed after the collapse of Crane in Masjid al-Haram in Makkah. According to a report by Al Arabiya News ("More than 100 people were killed by the crane collapse") (Al Arabiya News, 2015). The operator of the crane was SBG. This incidence was the beginning of the affection over the house price. On 11th December 2015 the Bureau of Experts at the Council of Ministers issue the law of idle land. Saudi had many empty lands in the big cities which was a reason of pushing the prices upward. So, the Saudi government imposes tax over unconstructed land within the city limit by 2.5% of the land value (Saudi Laws, 2015). This law has three stages. First, the first phase includes lands with an area of 10,000 square meters as a minimum, provided that this land is undeveloped and falls within the scope determined by the Ministry. The second phase, the lands owned by one owner, and in one plan, if they are developed and with an area of 10,000 square meters or more within the scope determined by the Ministry. third level, it is imposed on lands with an area of 5,000 square meters or more, if they are developed lands and belong to one owner and are in one approved scheme. On 24th October 2017 Mohammed bin Salman (MBS) the crown prince announced NEOM project. The

project is in the far northwest of the Kingdom of Saudi Arabia in the Emirate of Tabouk Province. according to MBS the project of NEOM needs around $500 billion to establish such futuristic city, and NEOM is targeting the visionary individual not the conventional mentality. The Kingdom move on to reform its economy by imposing value added tax (VAT) on 1st January 2018, on most of the commodity and services at 5% rate. However, on 1st of July 2020 the rate of VAT was increased to 15% due to COVID-19 pandemic (Zakat, Tax and Customs Authority, 2020). These five variables will be out dummy dataset to test the uncertainty of the HPI in the Saudi market.

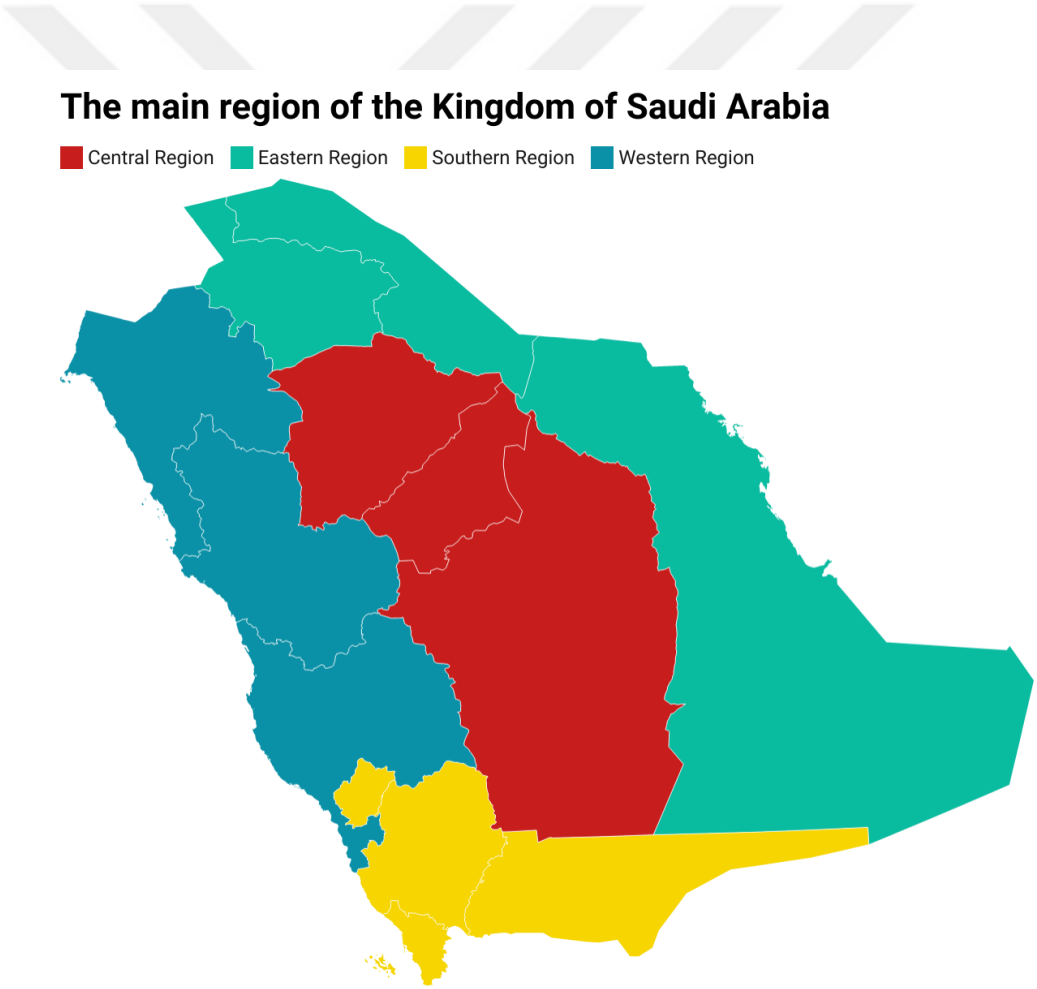

Figure 3 The main region of the kingdom of Saudi Arabia[8]

[8] Central region: Ar Riyad, Al Qaseem, and Hail. Western region: Makkah, Madinh, and Tabouk. Eastern region: Eastern, Al Jouf, and Northern. Southern: Aseer, Jazan, Al Baha, and Najran.

Figure 3 shows the four main regions of the Kingdom of Saudi Arabia, we mention this to illustrate better view for the Electricity subscribers, because SAMA published this dataset according to this classification. We apply this dataset for each main region with its sub-regions, only in the variable of electricity subscribers. The implementation of our dataset has a limit due to the lack of publications. For this reason, we take the dataset of HPI from 2015 to 2019 and we left 2020 because there was no data for the electricity subscribers for 2020. Since the dataset of HPI is quarterly based we use the aggregate of the electricity subscribers repeatedly for each quarter for the same year. First, we start with the correlation between the independent variables represented by the electricity subscribers; based on main regional level and dependent variable represented by the HPI, and then apply a regression model on both variables. Secondly, we use the aggregate dataset which are the population and Gross national income (GNI) and apply correlation relationship model.

The correlation below will have four variables, their names are: Central, Western, Eastern, and Southern. These are the representation of the electricity subscribers for each main region over sub-region.

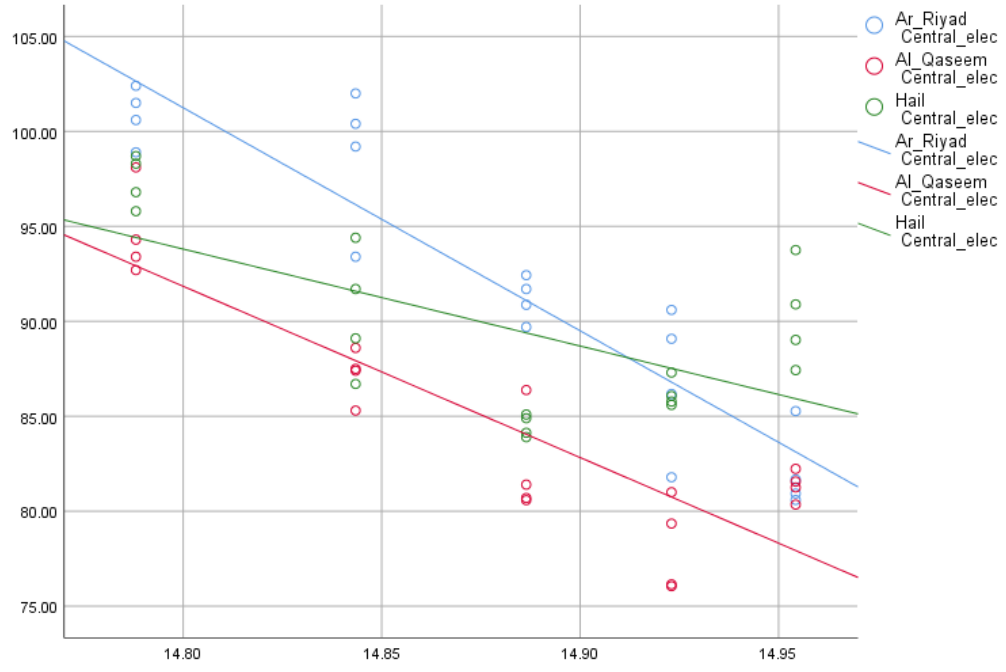

Figure 4 Scatterplot of Central vs Ar Riyad, Al Qaseem, Hail

Figure 4 shows negative relationship. In this case the (central) represent the electricity subscribers and the sub-regions name represent the HPI.

The correlation coefficients are -0.927 for Ar Riyad, -0.878 for Al Qaseem, and for Hail -0.623. which makes all of them a strong negative.

Scatterplot of Western vs Makkah, Madinh, Tabouk

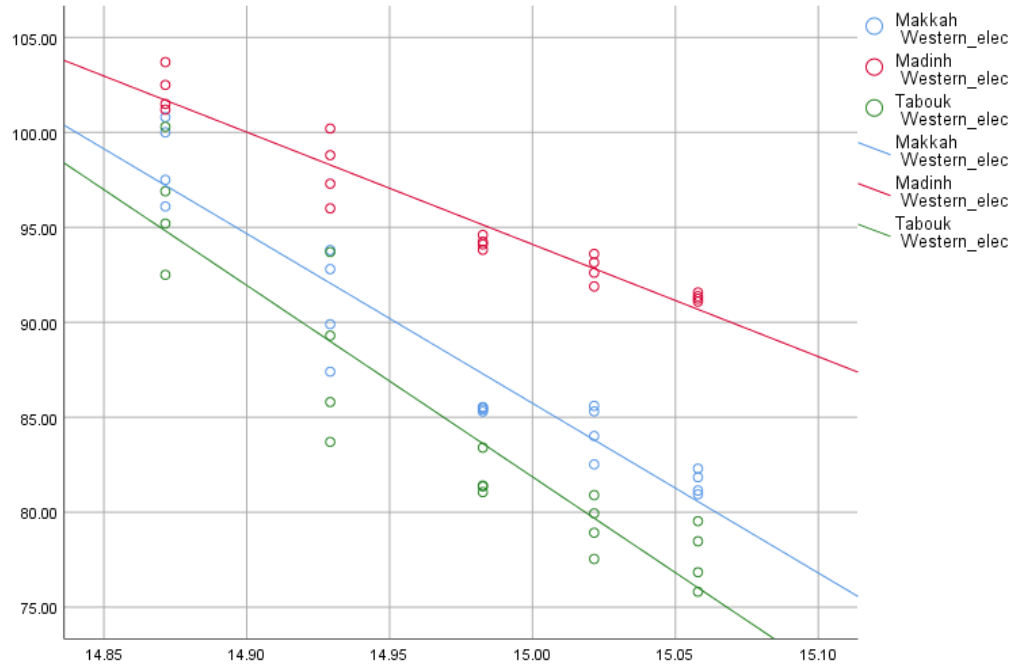

Figure 5 Scatterplot of Western vs Makkah, Madinh, Tabouk

Here we have the relationship for the Western region. It goes in the same direction of the Central region. It is a negative relationship. We want to figure out the relationship between the correlation and scatterplot. We use the same dataset that we use in the relationship. We receive the correlation of Western vs Makkah, Madinh, and Tabouk.

The correlation coefficient between western region and Makkah is -0.948 which make it a strong negative. Also, between western region and Madinh is -0.965 it is a strong negative. lastly, the correlation coefficient between the western region and Tabouk is -0.928 and it goes the same as the previous a strong negative.

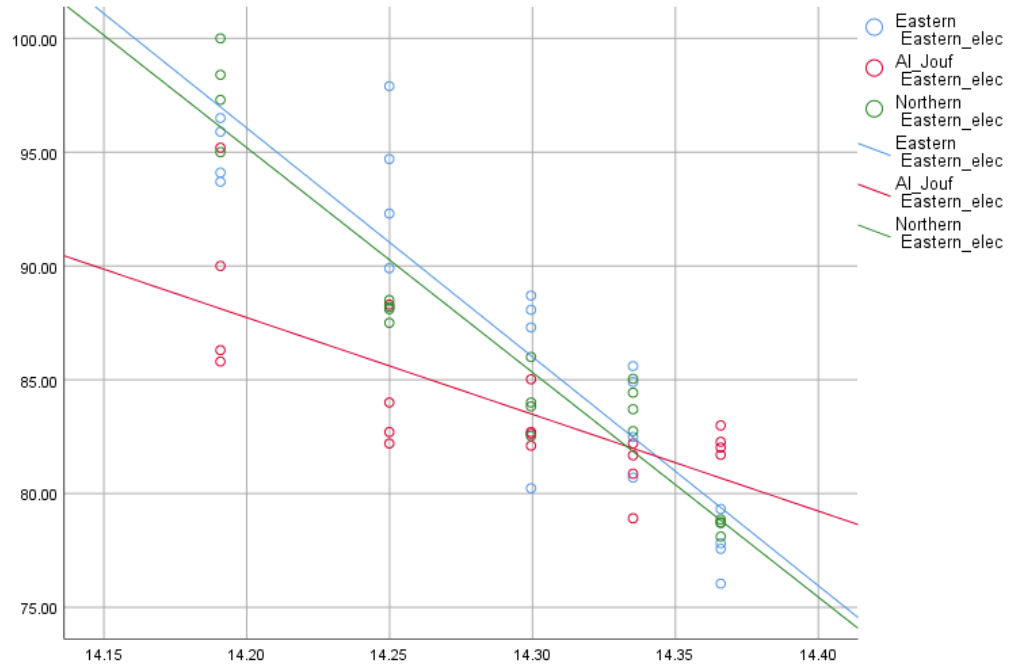

Figure 6 Scatterplot of Elec_Eastern vs Eastern, Al Jouf, Northern

For the third main region of the kingdom of Saudi Arabia the Eastern regain, that include the following sub-region: Eastern, Al Jouf, and Northern. The Elec_Eastern represent the electricity subscribers of the residential sector for that main region. The relationship between the HPI and electricity subscribers as shown in figures 6.

The relationship between the HPI and the electricity subscribers in these sub-regions is negative relationship. As the HPI is decreasing and the subscribers are in raise. In terms of the correlation coefficient between the electricity subscribers and the HPI for the Eastern as main region, the Eastern province is -0.908, -0.734 for Al Jouf, and -0.952 for Northern. With the results are shown similarly as the previous two main regions the Central region and the Western region a strong negative.

The fourth main region of the Kingdom of Saudi Arabia which is the southern region. Within this region we have the following sub-region Aseer, Jazan, Al Baha, and Najran. The relationship between the sub-region in HPI and electricity subscribers is a negative relationship.

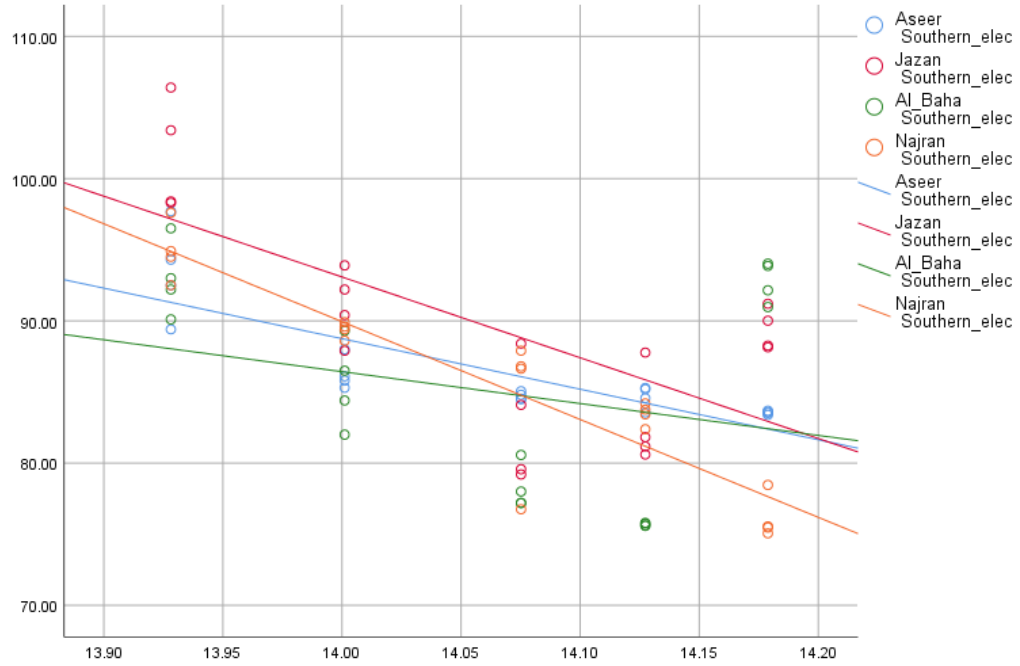

Figure 7 Scatterplot of southern vs Aseer, Jazan, Al Baha, and Najran

The correlation coefficient for the fourth main region: Aseer is -0.82, for Jazan -0.677, for Al Baha -0.271, and lastly for Najran -0.92. The table below show the entire correlation coefficient for every sub-region of the electricity subscribers.

Table 8 Sub-Region Correction coifficent of Electricity subscribers

Main Region	Sub-Region	correlation coefficient
Central	Ar Riyad	-0.927
	Al Qaseem	-0.878
	Hail	-0.623
Western	Makkah	-0.948
	Madinh	-0.965
	Tabouk	-0.928
Eastern	Eastern	-0.908
	Al Jouf	-0.734
	Northern	-0.952
Southern	Aseer	-0.82
	Jazan	-0.677
	Al Baha	-0.271
	Najran	-0.92

All the relationship between the electricity subscribers and HPI is a negative relationship. Further, the correlation coefficients between the main region and sub-region are strong negative but Al Baha in Southern which has -0.271 correlation coefficient which is the only one has weak negative correlation coefficients. The 12 sub-regions are in the range between more than -0.5 and less than -1.

The reason behind using the fixed effect model is that the limitation pushes us this pathway due to lack of regional dataset. We only had the electricity subscribers in hand. The outcomes will be generalized for our case because there are no other variables on regional level available and out main interest is to focus on the electricity subscribers. The table below shows the results of the apply model.

Table 9 fixed effect model[9]

VARIABLES	Central HPI	Eastern HPI	Western HPI	Southern HPI
Central Elec	-0.959***			
	(0.0912)			
Eastern Elec		-0.924***		
		(0.0729)		
Wester Elec			-0.924***	
			(0.0536)	
Southern Elec				-0.522***
				(0.0758)
Constant	18.75***	17.66***	18.33***	11.80***
	(1.357)	(1.042)	(0.802)	(1.066)
Observations	60	60	60	80
R-squared	0.664	0.741	0.842	0.394
Number of Pid	3	3	3	4

The number of Pid is represent the regions that included in each region. We have very high probability level for the four regions Central, Eastern, Western, and Southern. -0.959, -0.924, -0.924, and -0.522 respectively.

After we find out the correlation between the electricity subscribers and HPI we move forward to figure out the regression for every main region. Table 9 illustrates the results of

[9] Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

every main region. We sort up the sub-regions on main region bases and then we take the average of each region. After that we take the natural logarithm of each main regions and the natural logarithm of electricity subscribers as well to apply the regression.

The table below show the regression of the electricity subscribers within the four main regions; Central: Ar Riyad, Al Qaseem, and Hail. Western: Makkah, Madinh, and Tabouk. Eastern: Eastern, Al Jouf, and Northern. Southern: Aseer, Jazan, Al Baha, and Najran.

Table 10 Regreission model of electricity subscribers[10]

Main Regions	Electricity Subscribers	Constant
Central Region	-0.869***	18.775***
	(0.091)	(0.410)
Eastern Region	-1.013***	18.800***
	(0.061)	(0.275)
Western Region	-0.984***	19.393***
	(0.073)	(0.327)
Southern Region	-1.192***	19.379***
	(0.219)	(0.976)

The results show that the electricity subscribers have an influence over the HPI in the Saudi market with very high percentage at 1% significance. according to this result we can say that if the electricity subscribers increased the HPI will decrease.

We move forward to analyze the population and GNI. Starting with the relationship between the population and the 13 provinces and the GNI between the 13 provinces. Afterward, find out the correlation coefficient then applying the regression model.

The scatterplot in figure 8 depicts the association between population and HPI for each province. As shown on the graph, the relationship is trending downward, indicating that there is a negative relationship between the population and the HPI. The GNI, on the other hand, indicates total differences; figure 9 demonstrates that the movement direction is upward, indicating that the GNI and HPI have a positive relationship.

[10] The significant level *** 0.01, ** 0.05, and * 0.1

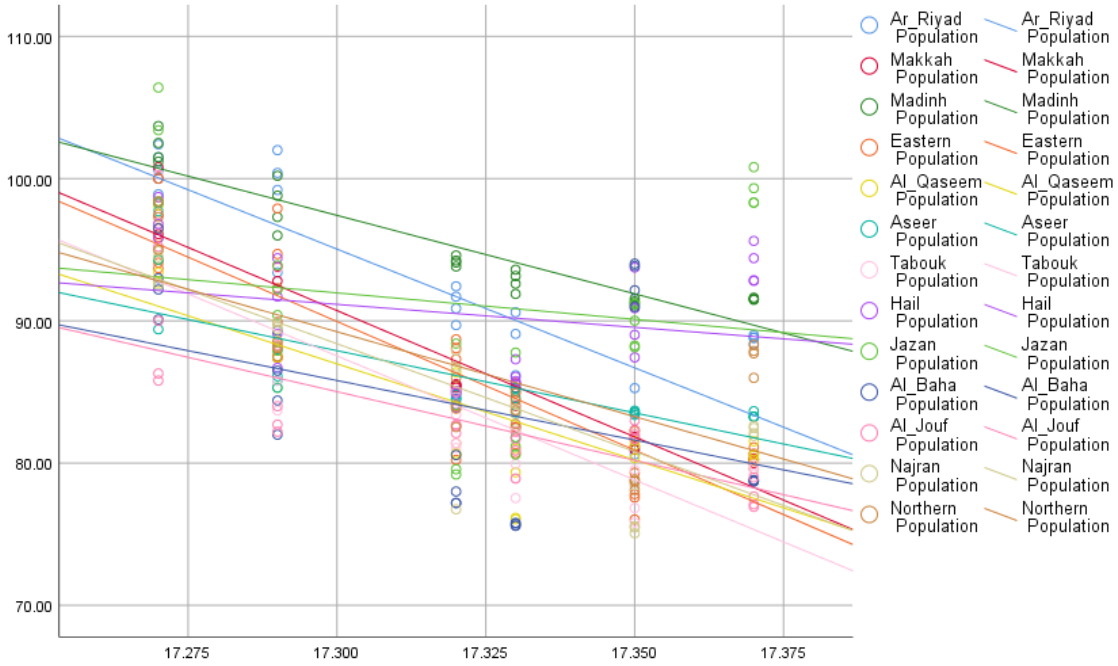

Figure 8 Scatterplot of Population vs HPI

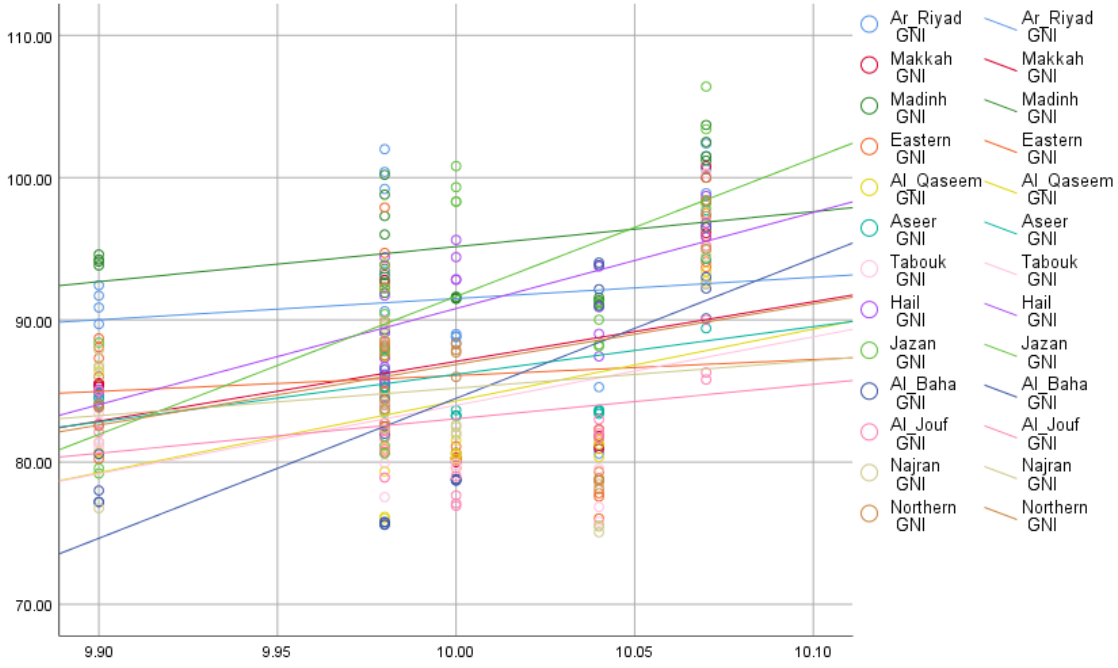

Figure 9 Scatterplot of GNI vs HPI

Table 11 correlation coefficien of Population and GNI[11]

Region	Population Correlation Coefficient	GNI Correlation Coefficient
Ar Riyad	-0.821*	0.116 (**)
Makkah	-0.940*	0.351 (**)
Madinh	-0.931*	0.328 (**)
Eastern	-0.902*	0.088 (**)
Al Qaseem	-0.802*	0.474 (**)
Aseer	-0.796*	0.481 (**)
Tabouk	-0.863*	0.376 (**)
Hail	-0.234**	0.773 (*)
Jazan	-0.163**	0.672 (*)
Al Baha	-0.398**	0.738 (*)
Al Jouf	-0.807*	0.319 (**)
Najran	-0.827*	0.166 (**)
Northern	-0.684*	0.386 (**)

In terms of the population 10 out of 13 provinces have a strong negative correlation, and 3 out of 13 have weak negative correlation, as the table number 10 shows. Moreover, the GNI has different point of view, 10 out of 13 provinces have weak positive correlation, while only 3 have strong positive correlation.

Table 12 Regression model of selected dummy variables and population and GNI[12]

Variables	Club1	Club 2	Club 3
Population	0.940***	-0.522*	-1.230***
	(0.261)	(0.474)	(0.327)
GNI	1.056***	0.310*	0.112*
	(0.100)	(0.181)	(0.125)
Crane Incidence	-0.034*	-0.010*	-0.042*
	(0.020)	(0.036)	(0.025)
Fees on idle land	0.007*	-0.039*	-0.008*
	(0.020)	(0.036)	(0.025)
VAT 5%	-0.107***	-0.071**	-0.023*
	(0.017)	(0.031)	(0.021)

[11] The symbol * refer to between -0.5 and -1, the symbol ** refer to less than 0 to -0.49, the symbol (**) refer from 0 to 0.49, and (*) refer to 0.5 to 1.

[12] The significant level *** 0.01, ** 0.05, and * 0.1

VAT 10%	0.016*	0.046*	0.021*
	(0.014)	(0.025)	(0.017)
Constant	-22.259***	10.480***	24.689***
	(5.097)	(9.263)	(6.388)

According to Table 12, the variation in the incidence of cranes was significant at 0.1 threshold for the three clubs. In addition, when the government of the Kingdom of Saudi Arabia imposed a tax on wasteland, the effect showed a result greater than the percentage of cranes, it also represented a significant level of 0.05 for club 2 but in clubs 1 and 3 the significance level is at 0.1. In addition, on January 1, the government imposed a 5% VAT. This shows a significance level of 10% on club1 but on club2 and 3 the significance level is at 0.01, unlike the other variables. Finally, in the third quarter of 2020 due to the Covid19 pandemic, the Ministry of Finance increased VAT from 5% to 15%. However, the significant level in clubs 1, 2 and 3 is at 0.1. The values in parentheses are the standard error. However, the population in club 1 and 3 has 0.01 significant level on the HPI, wherein club 3 shows only 0.1 significance level. Lastly, the GNI has the highest impact on club 1 with 0.01 significance level and club 2 and 3 with only 0.1 significance level.

Table 13 NEOM as dummy variable for Tabouk region

Variable	Tabouk
NEOM	-4.866***
	(0.864)
Constant	22.070***
	(3.825)

We use the NEOM project as a dummy variable for the Tabouk region because the megaproject under construction is in the north-west of the Kingdom, where the Tabouk region is located. Thus, the results show that the project has a significance level of 0.01, the significance level is too high to say that from 2015Q1 to 2020Q4, NEOM makes some changes to HPI in Tabouk region.

5 CONCLUSIONS AND LIMITATIONS

5.1 Conclusion

The Saudi house market is a crucial one due to its geographical location and economic feature. Also, the kingdom of Saudi Arabia is the largest country in the middle east. Besides the housing market in the country is a newborn one for non-locals to grab eyes on it. The methods that we apply to test the convergence of the housing market show rejection almost in every implication. The LLC rejected the null hypothesis to say there is no stationarity in the housing market. But IPS has different point of view, it only rejected the hypothesis in constant but in constant and trend the test fails to reject the hypothesis. The results of Hadri test shows there is stationary in the Saudi market. That what motivate us to move further to investigate more and see whether this first generation of panel unit-root show good results or not. Moreover, these tests are quite old comparing to Phillips and Sul method. For this reason, this might by a limitation of the first generation. Hence, we apply Phillips and Sul test. The result shows that there is a rejection of the null hypothesis of the regional house price which means there is no convergence in the housing market of the kingdom of Saudi Arabia. But Phillips and Sul test not only testify on one level of analysis, but it also goes beyond that and divides the provinces into sub-group and testing them one by one. Meanwhile, the test came up with 3 sub-group and shows that the 3 groups are moving in a convergence, each include 4, 3, and 6 provinces, respectively. The result of Phillips and Sul test confirms that the uncertainty of the IPS one rejection and the other fail to reject the null hypothesis and the problematic in Hadri test. According to the result we come up with from Phillips and Sul, the market is divided into 3 groups and each one of them is moving in its way. Consequently, that explain to us the reason of behind the contradictory results of the first-generation panel unit root test. Moreover, we want to investigate more on the HPI by conducting regression model, electricity subscribers, and the results show how this variable influence the HPI in strong way. The four main regions show there is an influence on HPI by the electricity subscribers.

5.2 Limitations

For the housing market of the Kingdom of Saudi Arabia we do have a crucial issue in terms of the availability of the data. The General authority of statistics of Saudi Arabia (GAS) start the process of extracting the data for the house price in 2015, on regional level.

If we look on other emerging market such as China, India, and Turkey we can see there is more interest of collecting dataset on regional level and cities level. At the other side in developed markets the interest in this regard move to neighborhood house price in one city. One another limit we have is the social indices on regional level such as income, education, house ownership. These data are not available in the time of making this research because the GAS was re-established in October 2015 by the royal decree no: 64283 (Council of Ministers, 2015). Also, in the finding section that we use the variable of electricity subscriber variable to run a regression model which also has the limit of lacking dataset. We could only have data until 2019 from 2007 but not for 2020 as we have the HPI from 2015 to 2020. So, we use from 2015 to 2019. However, we were a bit luck in variables such as population and GNI, we have the data from 2015 to 2020, but not on regional level, they are based on aggregate dataset.

6 Discussion

Because of the uniqueness of the study, which is the first of its kind for the Saudi housing market, the statistics department in the Kingdom of Saudi Arabia would be enthused to add such scientific research. Together with setting up an example for everybody who wants to study the market. Not only will the government inspire, but academic scholars will examine the housing industry from a variety of perspectives. People in Saudi Arabia usually monitor the ministry of municipality, rural affairs, and housing, as well as its current programs and news. However, among these individuals, there are undoubtedly many scholars who are concerned about the housing market. They would also like to learn about a range of measuring methods for predicting prices in their fields of interest or enterprises. In this section, we present our findings as literature for future studies and research. The limitations we meet throughout the implementation of this research are indicated in the limitation section. These limitations may drive competent authorities to work harder in the future to transform them from limitations to strengths by putting in more effort. Although we have such limitations, but GAS still have the time to fulfill the gap to create a solid base for further research.

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6.1 APPENDIX

Interview questionnaires

An interview was held with an ex-engineer of SBG

Mustafa Ziad Kalfa is civil engineer, joined SBG in 2012. Division of Interior and exterior finishing of buildings. Kalfa left SBG in 2021 after 9 years of working.

Q1: What is the size of the Saudi Binladin Group in the Saudi market? What are the company's capabilities before the collapse of the Grand Mosque crane in September 2015?

A1: The Saudi Binladin Group was the owner of the largest share of the sovereign projects offered by the state due to the good relationship that brought together King Fahd and Abdullah with Sheikh Bakr - what distinguished the company that was (the experienced administrative staff - and the trained technical staff).

The company has completed many internal and external projects as well (Senegal, Malaysia, Morocco, Syria, Jordan)

The number of the company's affiliates exceeded the barrier of 300,000 employees in the urban sector only.

Q2: How did the company change after the crane collapsed?

A2: When a protest note was submitted to the Public Prosecution Office against the group - the company's classification was dropped, and thus it was unable to enter any sovereign project and some pending projects were withdrawn from it - work on the King Abdelaziz Airport project was resumed later.

Q3: How did competitors take an advantage over the Saudi Binladin Group in the Saudi real estate market?

A3: After the announcement of the bankruptcy of Saudi Oger (the second largest construction company) and the construction disaster - so to speak, many companies in the market rose and many companies were established later. We can say that the disaster that occurred in the Great Mosque of Mecca contributed to raising competition in the private sector between companies to become the owner of the share The largest of the sovereign projects of the state.

Q4: How was the influence of Saudi Binladin Group on the Saudi real estate market, positive or negative? How would you describe that?

A4: The group did not contribute to the development of the private real estate sector, but it had some factories that contributed to the development of business completion. These factories (precast concrete factory) are one of the largest companies specialized in this item.

Q5: Does the company still have the capabilities and influence that it had before the crane accident?

A5: The company has lost a lot of its employees, administrators, and technicians in the recent period. Some left the Kingdom and others joined competing companies, and the company is still under the stage of reorganization.

Q6: Was there a government proposal to stimulate the real estate field after the crane accident? What was the form of this stimulus proposal?

A6: In the past years, the Saudi government contributed to supporting projects of the Ministry of Housing and supporting the private investment sector in the field of housing and construction, but the group only participated in precast concrete factories because of the capabilities and quality.

The end of the interview.

The provinces of the Kingdom of Saudi Arabia also known as Region or Emirate. The provinces named according to Ministry of interior (MOI) in the Kingdom of Saudi Arabia.

Emirates	Capital city	Governorates	Approx. area (km2)
Emirate Of Eastern Province	Dammam City	Dammam	540,000 km²
		Al Ahsa	
		Hafar Al-Batin	
		Jubail	
		Qatif	
		Khobar	
		Khafji	
		Ras Tanura	
		Abqaiq	
		Al Nairyah	
		Qaryat al-Ulya	
Emirate Of Riyadh Province	Riyadh City	Riyadh	380,000 km²
		Diriyah	
		Al-Kharj	
		Dawadmi	
		Al Majma'ah	
		Al-Quway'iyah	
		Wadi ad-Dawasir	
		Al Aflaj	
		Al Zulfi	
		Shaqraa	
		Hotat Bani Tamim	
		Afif	
		As Sulayyil	
		Dhurma	
		Al-Muzahmiyya	
		Rumah	
		Thadig	
		Huraymila	
		Al Hariq	
		Al-Ghat	
Emirate Of Madinah Province	Madinah City	Medina	150,000 km²
		Yanbu	
		Al-'Ula	

		Mahd adh Dhahab	
		Badr	
		Khaybar	
		Al Hinakiyah	
Emirate Of Makkah Province	Makkah City	Mecca Jeddah Ta'if Al Qunfudhah Al Lith Rabigh Al Jumum Khulays Al Kamil Al Khurmah Ranyah Turubah	137,000 km²
Emirate Of Tabouk Province	Tabouk City	Tabuk Al Wajh Duba Tayma Umluj Haql	136,000 km²
Emirate Of Najran Province	Najran City	Najran Sharurah Hubuna Badr Al Janub Yadamah Thar Khubash Al Kharkhir	130,000 km²
Emirate Of Hail Province	Hail City	Ha'il Baqaa Al Khazaiah Al Shinan	120,000 km²
Emirate Of Northern Borders Province	Ar'ar City	Arar Rafha Turaif	104,000 km²
Emirate Of Al-Jowf Province	Sakakah City	Sakakah Qurayyat Dumat al-Jandal	85,000 km²

Emirate Of Aseer Province	Abha City	Abha Khamis Mushait Bisha Al-Namas Muhayil Sarat Abidah Tathlith Rojal Ahad Rafidah Dhahran Al Janub Balqarn Al Majaridah	80,000 km²
Emirate Of Al-Qasim Province	Buraidah City	Buraidah Unaizah Ar Rass Al Mithnab Al Bukayriyah Al Badayea Asyah Al Nabhaniyah Uyun AlJiwa Riyadh Al Khabra Al Shimasiyah	73,000 km²
Emirate Of Jazan Province	Jazan City	Jizan Sabya Abu `Arish Samtah Al Harth Damad Al Reeth Baish Farasan Al Dayer Ahad al Masarihah Al Edabi Al Aridhah Al Darb	13,000 km²
Emirate Of Al Baha Province	Al Baha City	Al Bahah Baljurashi Al Mandaq	12,000 km²

Al Makhwah
Al Aqiq
Qilwah
Al Qara

First generation test

LLC test

Null Hypothesis: Unit root (common unit root process)
Series: RESID
Date: 05/22/21 Time: 14:28
Sample: 2015Q1 2020Q4
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel
Total number of observations: 296
Cross-sections included: 13

Method	Statistic	Prob.**
Levin, Lin & Chu t*	-8.89729	0.0000

** Probabilities are computed assuming asympotic normality

Intermediate results on RESID

Cross section	2nd Stage Coefficient	Variance of Reg	HAC of Dep.	Lag	Max Lag	Band-width	Obs
1	-0.13498	4.6945	7.8342	1	4	1.0	22
2	-0.09531	0.5756	2.0159	0	4	3.0	23
3	-0.05204	0.0920	0.7759	1	4	3.0	22
4	-0.09899	5.9006	4.1892	0	4	3.0	23
5	-0.22864	5.0916	5.9292	0	4	2.0	23
6	-0.24453	0.1943	2.6160	0	4	3.0	23
7	-0.15692	2.2081	3.3959	0	4	0.0	23
8	-0.13509	2.1234	6.1774	1	4	3.0	22
9	-0.20028	17.118	17.128	0	4	3.0	23
10	-0.29022	19.827	24.995	0	4	1.0	23
11	-0.31739	2.9150	3.5531	0	4	3.0	23
12	-0.22827	9.4461	8.2001	0	4	1.0	23
13	-0.24643	7.6522	9.9017	0	4	1.0	23
	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.14058	-10.891	1.074	-0.554	0.919		296

IPS test

Null Hypothesis: Unit root (individual unit root process)
Series: RESID
Date: 05/22/21 Time: 14:29
Sample: 2015Q1 2020Q4
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Total number of observations: 296
Cross-sections included: 13

Method	Statistic	Prob.**
Im, Pesaran and Shin W-stat	-5.56858	0.0000

** Probabilities are computed assuming asympotic normality

Intermediate ADF test results

Cross section	t-Stat	Prob.	E(t)	E(Var)	Lag	Max Lag	Obs
1	-1.8643	0.3417	-1.515	0.893	1	4	22
2	-3.6771	0.0118	-1.521	0.826	0	4	23
3	-2.1034	0.2452	-1.515	0.893	1	4	22
4	-1.2756	0.6228	-1.521	0.826	0	4	23
5	-2.6820	0.0923	-1.521	0.826	0	4	23
6	-9.5504	0.0000	-1.521	0.826	0	4	23
7	-3.3609	0.0236	-1.521	0.826	0	4	23
8	-1.7827	0.3786	-1.515	0.893	1	4	22
9	-1.7170	0.4099	-1.521	0.826	0	4	23
10	-2.1496	0.2286	-1.521	0.826	0	4	23
11	-3.3967	0.0218	-1.521	0.826	0	4	23
12	-2.1486	0.2290	-1.521	0.826	0	4	23
13	-2.4623	0.1371	-1.521	0.826	0	4	23
Average	-2.9362		-1.520	0.841			

Hadri test

Null Hypothesis: Stationarity
Series: RESID
Date: 05/22/21 Time: 14:30
Sample: 2015Q1 2020Q4
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett kernel
Total (balanced) observations: 312
Cross-sections included: 13

Method	Statistic	Prob.**
Hadri Z-stat	7.67286	0.0000
Heteroscedastic Consistent Z-stat	7.95453	0.0000

* Note: High autocorrelation leads to severe size distortion in Hadri test, leading to over-rejection of the null.
** Probabilities are computed assuming asympotic normality

Intermediate results on RESID

Cross section	LM	Variance HAC	Bandwidth	Obs
1	0.5507	159.6679	3.0	24
2	0.6489	133.6882	3.0	24
3	0.6383	53.88268	3.0	24
4	0.6325	157.0088	3.0	24
5	0.5497	94.87656	3.0	24
6	0.5544	38.56280	3.0	24
7	0.5896	150.3440	3.0	24
8	0.1956	69.58792	3.0	24
9	0.1931	170.8943	3.0	24
10	0.1992	125.4151	3.0	24
11	0.6436	40.50607	3.0	24
12	0.5931	117.0173	3.0	24
13	0.4534	98.85768	3.0	24

Phillips and Sul test

log t test:

Variable	Coeff	SE	T-stat
log(t)	-1.7209	0.1347	-12.7716

The number of individuals is 13.
The number of time periods is 24.
The first 7 periods are discarded before regression.

```
xxxxxxxxxxxxxxxxxxxxxxxxxxx Club classifications xxxxxxxxxxxx
> xxxxxxxxxxxxxxxxxxx
------------------------------- Club 1 :(4)-------------------
> ------------
 | 3 | 8 | 9 | 10 |
-----------------------------------------------------------------
> ------------

log t test:
```

Variable	Coeff	SE	T-stat
log(t)	0.1201	1.0474	0.1146

```
The number of individuals is 4.
The number of time periods is 24.
The first 7 periods are discarded before regression.
------------------------------- Club 2 :(3)-------------------
> ------------
 | 1 | 5 | 13 |
-----------------------------------------------------------------
> ------------

log t test:
```

Variable	Coeff	SE	T-stat
log(t)	0.0435	0.8495	0.0512

```
The number of individuals is 3.
The number of time periods is 24.
The first 7 periods are discarded before regression.
------------------------------- Club 3 :(6)-------------------
> ------------
 | 2 | 4 | 6 | 7 | 11 | 12 |
-----------------------------------------------------------------
> ------------

log t test:
```

Variable	Coeff	SE	T-stat
log(t)	-0.5228	0.4167	-1.2547

```
The number of individuals is 6.
The number of time periods is 24.
The first 7 periods are discarded before regression.
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
> xxxxxxxxxxxxxxxxxx
```

The log t test for Club 1+2

log t test:

Variable	Coeff	SE	T-stat
log(t)	-1.1694	0.1039	-11.2556

The number of individuals is 7.
The number of time periods is 24.
The first 7 periods are discarded before regression.

The log t test for Club 2+3

log t test:

Variable	Coeff	SE	T-stat
log(t)	-0.7510	0.1021	-7.3566

The number of individuals is 9.
The number of time periods is 24.
The first 7 periods are discarded before regression.

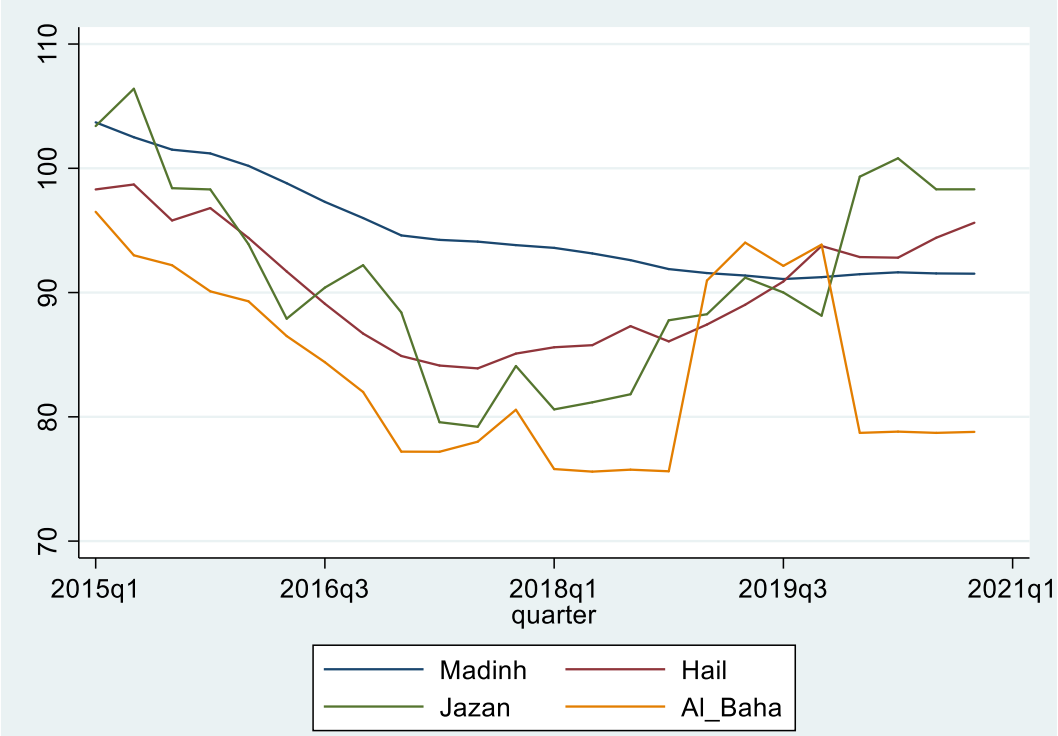

Figure 10 HPI for Club 1

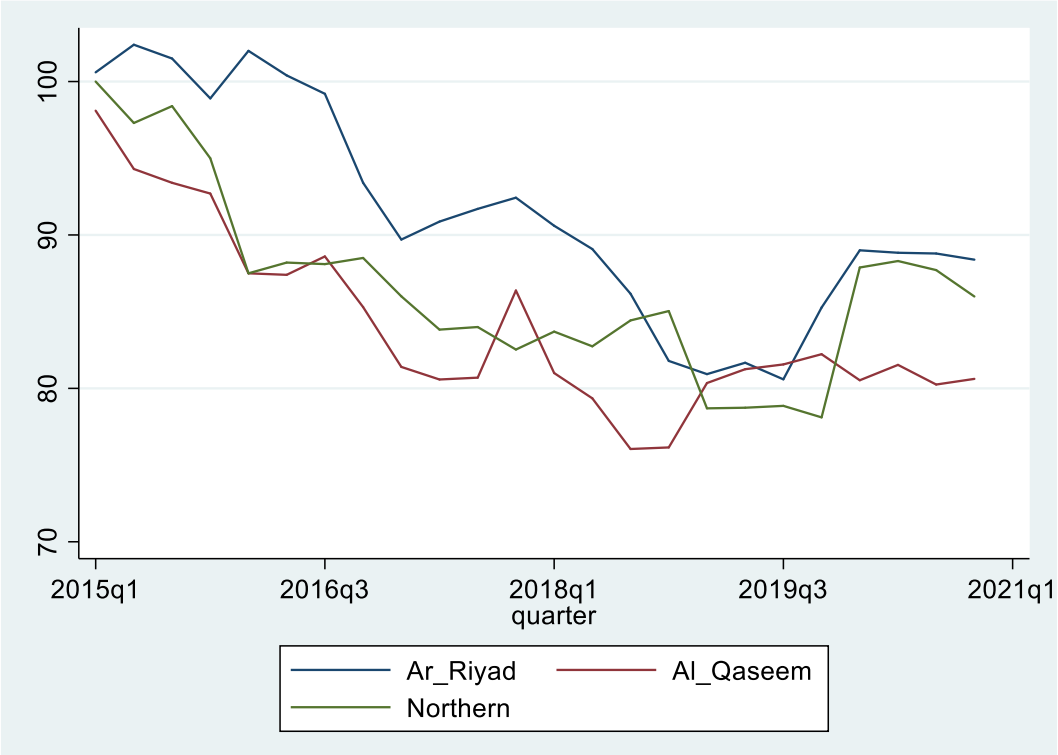

Figure 11 HPI for Club 2

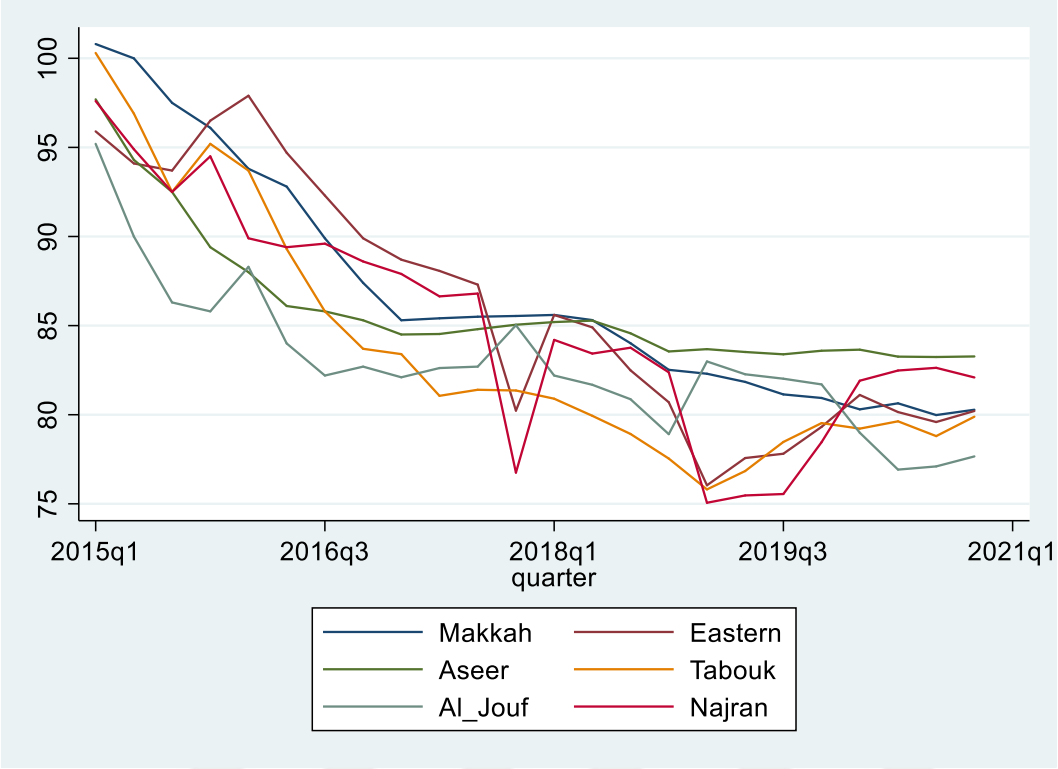

Figure 12 HPI for Club 3

6.2 Raw Dataset

6.2.1 House price index of the Kingdom of Saudi Arabia

Quarter	Ar Riyad	Makkah	Madinh	Eastern	Al Qaseem	Aseer	Tabouk	Hail	Jazan	Al Baha	Al Jouf	Najran	Northern
2015 Q1	100.60	100.80	103.70	95.90	98.10	97.70	100.30	98.30	103.40	96.50	95.20	97.60	100.00
2015 Q2	102.40	100.00	102.50	94.10	94.30	94.30	96.90	98.70	106.40	93.00	90.00	94.90	97.30
2015 Q3	101.50	97.50	101.50	93.70	93.40	92.50	92.50	95.80	98.40	92.20	86.30	92.50	98.40
2015 Q4	98.90	96.10	101.20	96.50	92.70	89.40	95.20	96.80	98.30	90.10	85.80	94.50	95.00
2016 Q1	102.00	93.80	100.20	97.90	87.50	88.00	93.70	94.40	93.90	89.30	88.30	89.90	87.50
2016 Q2	100.40	92.80	98.80	94.70	87.40	86.10	89.30	91.70	87.90	86.50	84.00	89.40	88.20
2016 Q3	99.20	89.90	97.30	92.30	88.60	85.80	85.80	89.10	90.40	84.40	82.20	89.60	88.10
2016 Q4	93.40	87.40	96.00	89.90	85.30	85.30	83.70	86.70	92.20	82.00	82.70	88.60	88.50
2017 Q1	89.70	85.30	94.60	88.70	81.40	84.50	83.40	84.90	88.40	77.20	82.10	87.90	86.00
2017 Q2	90.87	85.41	94.24	88.07	80.58	84.53	81.06	84.13	79.57	77.19	82.62	86.64	83.83
2017 Q3	91.70	85.50	94.10	87.30	80.70	84.80	81.40	83.90	79.20	78.00	82.70	86.80	84.00
2017 Q4	92.43	85.54	93.82	80.23	86.38	85.05	81.36	85.09	84.09	80.57	85.02	76.75	82.53
2018 Q1	90.60	85.60	93.60	85.60	81.00	85.20	80.90	85.60	80.60	75.80	82.20	84.20	83.70
2018 Q2	89.08	85.31	93.15	84.90	79.35	85.28	79.94	85.77	81.17	75.59	81.68	83.43	82.74
2018 Q3	86.17	84.01	92.61	82.49	76.05	84.57	78.92	87.30	81.82	75.75	80.87	83.76	84.43
2018 Q4	81.79	82.52	91.89	80.70	76.15	83.55	77.54	86.07	87.77	75.62	78.91	82.38	85.04
2019 Q1	80.93	82.30	91.57	76.04	80.35	83.68	75.81	87.43	88.26	90.97	82.99	75.06	78.70
2019 Q2	81.67	81.84	91.37	77.57	81.25	83.52	76.84	89.02	91.20	94.02	82.27	75.47	78.74
2019 Q3	80.59	81.14	91.09	77.81	81.56	83.39	78.47	90.89	90.01	92.15	82.02	75.55	78.86
2019 Q4	85.27	80.94	91.24	79.32	82.23	83.59	79.53	93.75	88.14	93.86	81.70	78.46	78.11
2020 Q1	89.00	80.30	91.48	81.11	80.53	83.65	79.22	92.86	99.33	78.71	78.99	81.91	87.88
2020 Q2	88.84	80.64	91.63	80.15	81.53	83.26	79.63	92.81	100.81	78.81	76.92	82.48	88.30
2020 Q3	88.79	79.98	91.54	79.59	80.25	83.24	78.80	94.41	98.31	78.71	77.10	82.63	87.71
2020 Q4	88.39	80.28	91.52	80.21	80.62	83.27	79.89	95.62	98.31	78.79	77.66	82.09	85.99

6.2.2 Electricity subscribers in the Kingdom of Saudi Arabia in the four main regions

Year	Central	Eastern	Western	Southern
2015	2,644,736.00	1,455,418.00	2,874,875.00	1,119,219.00
2016	2,795,226.00	1,543,995.00	3,045,577.00	1,203,944.00
2017	2,918,041.00	1,622,515.00	3,212,644.00	1,296,512.00
2018	3,026,781.00	1,681,458.00	3,340,310.00	1,365,938.00
2019	3,122,954.00	1,733,854.00	3,463,863.00	1,438,077.00

6.2.3 Population and GNI dataset of the Kingdom of Saudi Arabia

Year	Population	GNI per capita
2015	31,717,667	$ 23,710.00
2016	32,442,572	$ 21,610.00
2017	33,099,147	$ 19,990.00
2018	33,699,947	$ 21,610.00
2019	34,268,528	$ 22,840.00
2020	34,813,867	$ 21,930.00