Vital Economic Determinants and Real GDP in GCC Countries: Panel Cointegration Analysis

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Abstract

This article uses Pedroni's procedure to study the long run equilibrium between the real GDP in GCC countries[2] and six determinant variables such as the human development index, labour force, foreign direct investment, exports and imports as ratios of GDP and gross capital formation (% of GDP). The Augmented Dickey Fuller (ADF) and PP statistics proposed by Pedroni are in favour of rejection of the null no co-integration. Two different regressions are runed, so the group mean panel "Fully Modified Ordinary Least Squares" (FMOLS) and group mean panel "Dynamic Ordinary Least Squares" (DOLS) estimators to estimate the long-run equilibrium individually and aggregately. Finally a comparison of forecasts is made using the APE criterion.

Keywords: Economic determinants, GCC countries, panel unit roots, cointegration, forecasts.

1. Introduction

The "Gulf Cooperation Council" (GCC) states differ significantly from the other Arab countriesby the abundant natural resources of oil and gas and their derivatives. These resources formed the cornerstone of the local output which contributed greatly to the availability of liquidity and investment at home and abroad. The oil boom has had an impact to make larger the (GCC) role, attracting foreign investment and contributing to the expansion of the

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[2] The GCC countries are: Kingdom of Saudi Arabia (KSA), United Arab Emirates (UAE), Sultanate of Oman (SuO), State of Kuwait (SK), State of Qatar (SQ) and the Kingdom of Bahrain (KB).

country's infrastructure (Mourad, 2015). While the world was resorting to impose taxes and fees to meet the increasing expenses, the GCC countries did not turn those options because of the superiority of revenues on national expenditure components represented by the “household final consumption expenditure”, the “government final consumption expenditure” and the “gross capital formation”. In a recent study, Mourad (2017 b)elucidates the direct impact of changing oil prices on both of GDP, domestic saving and national spending in all GCC countries. Since the nominal GDP measured on current prices, the comparisons between different time periods are made only on Real Gross Domestic Product “RGDP” which is considered as an indicator of the overall health of the economy. In our case, the RGDP is obtained by adjusting the nominal GDP using the consumer price index (CPI) since it is available to all Gulf countries in the same period[3]. For this, we calculated the real GDP dividing the nominal GDP[4] of a given year by the consumer price index (CPI) choosing 2006 prices as a base year$\left(\mathrm{RGDP}_t = 100 \times \frac{\mathrm{GDP}_t}{\mathrm{CPI}_t}\right)$. For more clarity, the real GDP measured in $ billion is affected by multiple economic determinants which are limited in our study to six variables: Human Development Index (HDI) [5], labour force (Labour) measured in million people, “Foreign Direct Investment (FDI) net inflows”, trade flows[6] based on exports (REXP), imports (RIMP) and “Gross Capital Formation” (GCF) . The variables FDI, REXP, RIMP and GCF are calculated as a percentage of GDP. For this study, panel data analysis are conducted for six countries involving measurements over the period 2000-2015. The passage from univariate time series to panel series requires appropriate techniques to detect the presence of the Panel Unit Root

[3]The CPI data are obtained from the GCC-STAT website: https://gccstat.org/en/ - common base year = 2006.

[4] For the variables GDP,Labor, FDI and GCF, the data source is: https://data.worldbank.org/indicator

[5] United Nations Development Programme-Human Development Reports: http://hdr.undp.org/en/data

[6] World Trade Organization: http://stat.wto.org/StatisticalProgram/WSDBStatProgramHome.asp

"PUR" for cross-sectional data. In fact, the analysis of the "PUR" allows to take in consideration of the dependence between the individual series and consequently to resort to the tests adapted with this situation. The second goal is to perform panel co-integration tests to examine the co-integrating relationship of the seven variables. At this stage, this research will use the Pedroni's procedure (1995, 1996, 1997, 1999, 2001, 2004 and 2007) signalling other procedures can be used like the procedure proposed by Kao (1999) or Groen and Kleibergen (2003). Afterward, the expected long-run relation among the variables in a panel framework with two methods is estimated, so "FMOLS" and "DOLS" are proposed in this paper because each of them is more reliable estimator in the co-integrated panel regression (Kao & Chiang 2000).

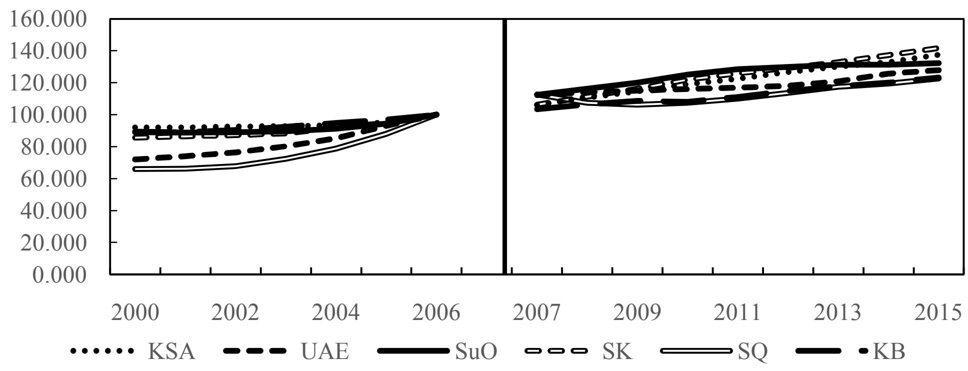
This paper is divided into 7 sections. The introduction is exhibited in the first section. In the second section, a panoramic view of all variables is presented. Review of literature is devoted to section three and the main methods of the "PUR" tests are dealt with in the fourth section. In the fifth and sixth sections, a panel co-integration analysis using Pedroni's procedure is performed and the long-run equilibrium relationship using "FMOLS" and "DOLS" estimators. The effects of each determinant on the RGDP variable are also estimated and the forecast performance for the year 2015 for the two estimated models using the "Mean Absolute Percentage Error" MAPE criterion is measured. Finally, in the seventh section, conclusion and discussion are proposed.

2. A panoramic view of the proposed variables of this research

A question imposes itself on every econometric researcher: What is the benefit of these desired economic variables? The Consumer Price Index (CPI) is the first one. It is pointed out using the base year (2006) and leads to the RGDP. Figure 1 shows the difference in CPI level among GCC countries. Before the base year (the left-hand side), it seems that SQ followed by UAE has held the lowest level and then after (the right-hand side) an excessive surge in 2007, it returns to the CPI level of 122.7 to the year 2015 (a rise of 22.7 %) followed by (KB) (a rise of 23.33%). Finally, in 2015, SK and KSA reached the highest CPI levels (41.7% and 37.55% respectively). These interesting findings explain the relatively low values in

RGDP of these two countries as they reached 80.48 USD billion and USD 469.65 billion while the nominal GDP values were respectively 114.04 USD billion and 646.002 USD billion.

Figure 1: Consumer Price Index in GCC countries



Concerning the Human Development Index (HDI)[7], what is its importance and why has it been chosen as an explanatory variable for the RGDP. In fact, the Human Development Index (HDI) occurred as an indicator that gives greater weight to the quality of human life. To rank the GCC countries according to their HDI, we present in table (1) the six countries with the highest (very lowest) HDI as well as GCC countries. This means that the Gulf countries need to make more efforts to catch up in the first countries in the world, knowing that their potential financial possibilities and their wealth of oil and gas allow access to this goal if there is a good political behaviour and the countries went through the pace of reform in all fields of the life. Table (1) reflects the divergence between the highest and lowest advanced countries and the place of the GCC countries

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[7]According to United Nations Development Programme (UNDP), there are four categories of countries

a- Very high HDI ($HDI \geq 0.800$)

b- High HDI($0.710 \leq HDI < 0.800$)

c- Medium HDI ($0.535 \leq HDI < 0.710$)

d- Low HDI($HDI < 0.535$)

for them. Qatar's rank (33) in the world is the highest among the GCC countries while Oman's rank (52) is the lowest. Through the above, it seems clear why this variable is chosen as one of the explanatory variables to measure its long-run impact on the RGDP.

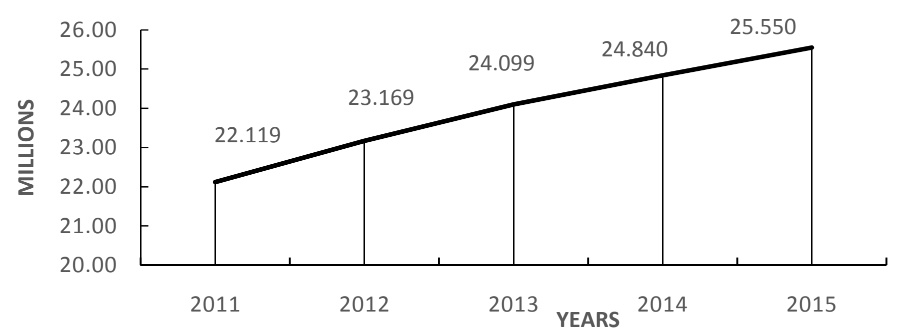
Table 1: Rank of GCC countries according to their HDI at 2014

The highest HDI		**HDI of GCC countries**		**The lowest HDI**	
Country	**Rank(HDI)**	**Country**	**Rank(HDI)**	**Country**	**Rank(HDI)**
Norway	1 (0.949)	KSA	39 (0.837)	Burkina Faso	183 (0.402)
Australia	2 (0.935)	UAE	41 (0.835)	Burundi	184 (0.40)
Switzerland	3 (0.930)	SuO	52 (0.793)	Chad	185 (0.392)
Denmark	4 (0.923)	SK	48 (0.816)	Eritrea	186 (0.391)
Netherlands	5 (0.922)	SQ	32 (0.850)	Central African Republic	187 (0.350)
Germany	6 (0.925)	KB	45 (0.824)	Niger	188 (0.348)

Source: The author according to the UN Human Development Report 2015

Economically speaking, it is well known that the GDP growth increases with the employment rate. To make comparisons between several countries, it would be useful to distinguish between the growths of GDP per hour worked and that due per person employed (Ahmad, Lequiller, Marianna, Pilat, Schreyer, & Wölf, 2005). Moreover according to Okun's law, the economists generally consider that the GDP growth and the change in unemployment are negatively correlated (Mourad 2017a, 344-349). To give an idea of the reality of the labour force in the GCC countries, the chart for the last five available years is presented i.e. during the period 2011-2015. Through figure 2, the rate of change of total number of employed in the GCC countries between 2011 and 2015 reached (15.5 %) with about an annual rate of (3.67 %), while the average annual rate of unemployment of the total labor force during the same period mounted to (5.62) in KSA, (0.32) in SQ and (3.21) in SK signaling a large difference in unemployment rates between citizens and non-citizens reaching respectively (11.9, 2.0, 6.1) and (0.3, 0.2, 2.5). For the rest of the GCC countries, there are no statistics concerning the unemployment rates related to citizens and non-citizens, but they are available for the total labor force in each country and therefore according to the World Bank, they were (3.95) in UAE, (1.22) in KB and 17.54 in SuO. For more information about the forecasts of the labour force, unemployment rates and GDP for GCC countries refer to Mourad (2015).

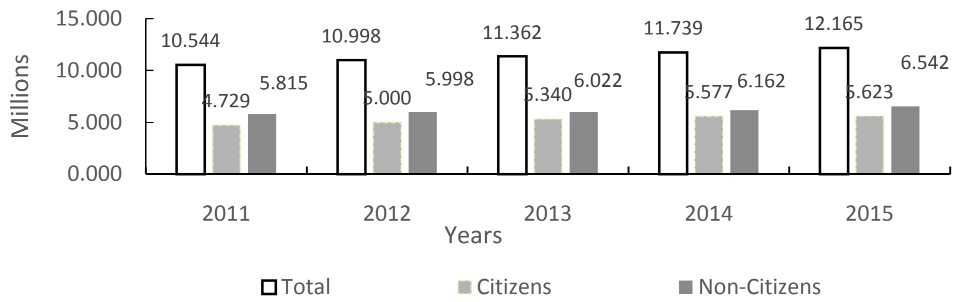
Figure 2: Labour force (15 year and above) in GCC Countries



Source: The author according to the World *Bank*

Due to the importance of KSA in the GCC countries, presented in Figure 3, the distribution statistics of labor force between citizens and non- citizens.

Figure 3: Labor force (15 year and above) in KSA



Source: The author (2015)

It seems that the labor force in KSA represents about 47.5 % of the total labor force in GCC. Economically speaking, any increase in the labor force and with a reduction in the unemployment rate leads implicitly to a decrease in inflation and consequently to an increase in the RGDP.

Let's take a look at the FDI in the GCC countries. Figure 4 reveals that since 2005, the (GCC) countries have witnessed a significant increase in its volume (Hussein, 2009) and World Investment Report of UNCTAD (2008). Despite the importance of FDI inflows in GCC countries, they fell from 29.384 billion in 2011 to 17.912 billion in 2015 (1.85% to 0.83% of FDI in World respectively).

Figure 4: Foreign direct investment in GCC

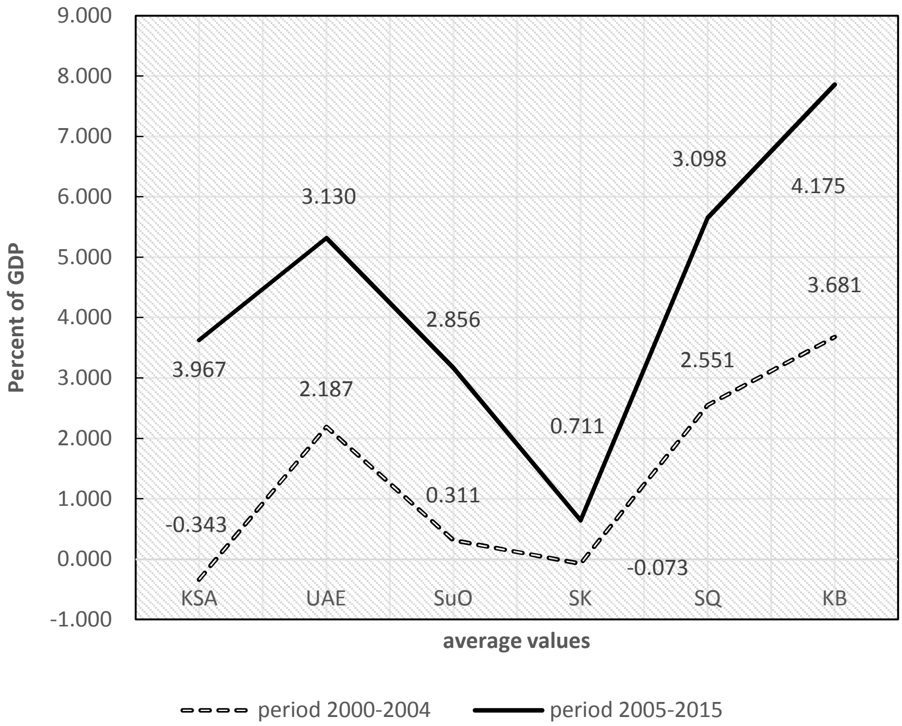
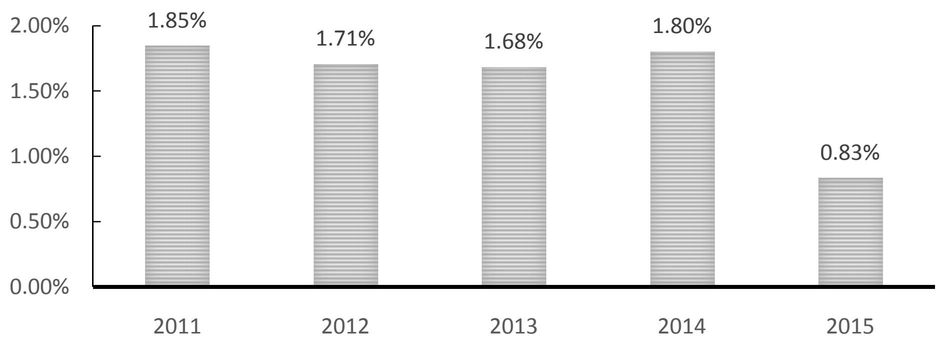


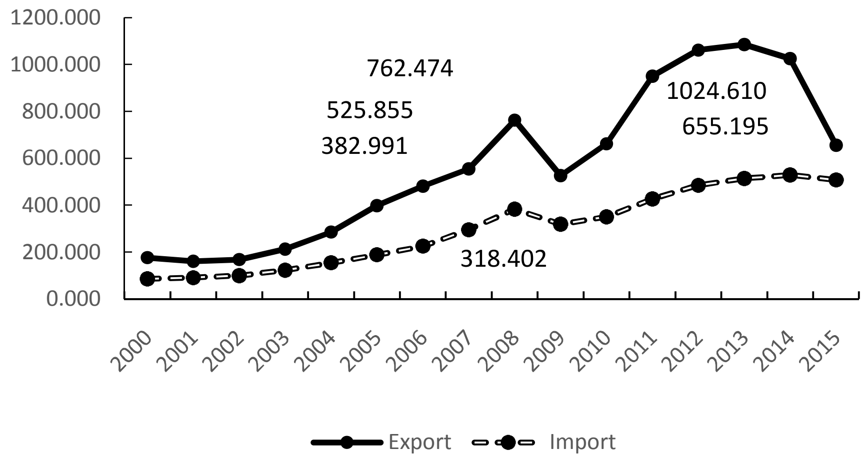
Figure 5 reveals the evolution of FDI in GCC as a percentage from FDI in World. Hussein (2009) tests empirically the impact of FDI on RGDP in GCC countries using pooled regression analysis. But it was necessary to study firstly the presence of (PUR) and then to investigate the possibility of the co-integration between the two considered variables.

Figure 5: FDI inflows in GCC as share of FDI in world



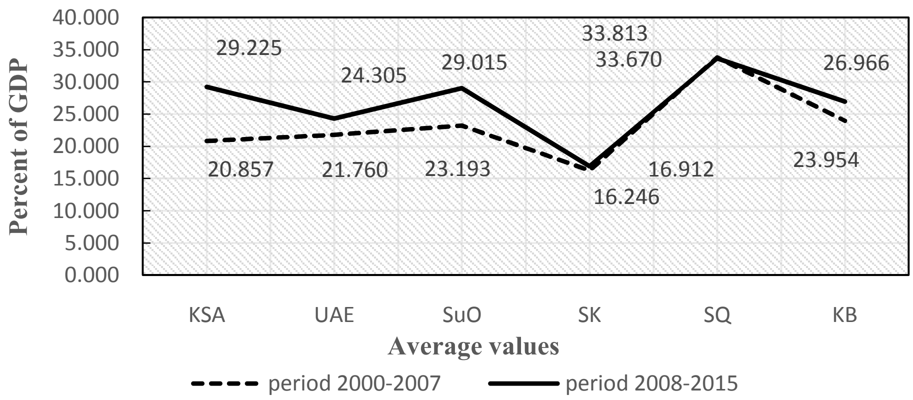
In economy, the foreign trade generally contributes to the increase in national income, especially in the case of high proportion of exports and low proportion of imports. Consequently there is a relationship between the imports and exports of goods and the GDP. In fact, an increase in exports reflects an increase in the GDP while the imports affect usually negatively the GDP. Let us look at the evolution of these two time series during the period 2000-2015. Figure 6 shows the negative impact of the "global financial crisis" of 2008 on the decline of exports and imports by 31.03 % and 16.86 % respectively.

Figure 6: Foreign trade of GCC countries



The second point deserving to be explored is the negative response of the foreign trade due to the fall of the oil prices per barrel. Indeed, the stunning fall in oil prices, from $ 93.17 in 2014 to $48.66 in 2015, has been an important negative repercussion on foreign trade of GCC countries. As a consequence, the values of exports and imports have declined 36.05 % and 3.98% respectively. The last variable chosen in panoramic view is the "Gross Capital Formation" (GCF). Examination of the data related to this variable closely, on the first hand, shows that there is a distinction among the countries, and on the other, a distinction between two phases: the first phase includes the period 2000-2007, i.e. before the "global financial crisis" and the second phase covers the period 2008-2015 i.e. during the emergence and after the "global financial crisis" (Figure 7).

Figure 7: Gross capital formation in GCC



Focussing on the countries, the most distinguished in the second phase are in KSA, UAE, SuO and KB while in SK and SQ no distinguish between the two phases. The ratio of GCF to GDP in SQ is almost double that is observed in SK.

3. Review of Literature

If we inspect the literature related to the panel unit root and Pedroni's procedure for panel co-integration, we find it very abundant. Ahmed et al. (2017) considered the heterogeneity across the panel of eight economies in the Asian region to establish a Pedroni's panel co-integration analysis. Jaunky & Lundmark (2017) studied the PUR for paper production for seventeen Organisation for Economic Co-Operation and Development (OECD) members. Saleh. Assaf, Ihalanayake and Lung (2015) examined the influence of tourism industry on the GDP of three countries Bahrain, Jordan and Saudi Arabia. Aboubacar, Xu and Ousseini (2015) investigated the importance of the foreign aid on the economic growth in WAEMU's (West African Economic and Monetary Union) countries[8] using the "group-mean panel" (FMOLS) and (DOLS) estimators. Oskooe and Akbari (2015)

[8]Benin, Niger, Burkina Faso, Senegal, Côte d'Ivoire , Togo, Mali, Guinea-Bissa

studied the stationarity of per capita GDP in OPEC countries. Adeleye, Adeteye and Adewuyi (2015) examined the interaction between the foreign trade and the economic growth in Nigeria. Firat (2012) dealt with the unit root hypothesis related to the real GDP for thirty-five advanced economies. Sun and Heshmati (2010) informed us that the international trade inspected in thirty-one provinces in China affects significantly the economic growth. In the PUR context, Ozturk and Kalyoncu (2007) analysed the stationarity of RGDP per capita in 27 OECD countries. Ramirez (2006) utilized the Pedroni's (FMOLS) procedure to estimate the panel co-integration between production and labor productivity. Lee (2005) used the panel co-integration technical proposed by Pedroni to study three annual time series, RGDP, energy use (EU) and real gross capital formation (GCF) for eighteen developing countries. Keller (2001) discussed international trade and particularly the role of the importing intermediate goods in the revivification of the technology.

4. Detection of panel unit root

Chronologically, there are three generations of (PUR) tests. In the first generation, the researchers assumed that the individual time series in the panel were independently distributed. The most used tests in practice, such as Levin and Lin (1992-1993), Levin, Lin and Chu (LLC) (2002), Harris and Tzavalis (HT) (1999), Breitung (quoted λ) (2000), Im, Pesaran and Shin (IPS) (2003), Maddala and Wu (MW) (1999), Hadri (LM) (2000). The null hypothesis of this tests is that all panels contain a unit root (exception Hadri's test in which the null is stationarity). The alternative designates that all panels are stationary for (LLC), (HT), (λ), but it designates that at least one panel is stationary for (IPS) and (MW). For Hadri's test, the alternative designates that some panels contain unit roots. For (LLC), (λ), (IPS), the calculated values are compared to the "1%, 5%, and 10% significance levels" with the one-tailed (negative) of a standard normal with $(-2.326), (-1.645)$ and (-1.282) as critical values correspondingly, however, for Hadri's test, the critical values with the one-tailed (positive) of a standard normal are $(2.326), (1.645)$ and (1.282) respectively. For (HT) test, and in the panel data of the sample, the critical values (Intercept only) are $(-3.28), (-2.25)$ and (-1.71) at 1%, 5%, and 10% significance levels respectively. For (MW) test (non-parametric Fisher-type test), it is distributed as χ^2 with (2N=12) degrees of freedom and the associated critical value is (21.026) to 5% significance level. In the second generation, these tests are based on the idea of abandoning the independence between panels and dealt with the cross section dependence suggesting the advantage of the common individual movement of time series to obtain new test statistics for the PUR. After that, the most used tests in practice are quoted. Bai and Ng (2004) useda method entitled "Panel Analysis of Non stationarity in the Idiosyncratic and Common components" (PANIC). Chang (2002, 2004) adopted a nonlinear instrumental variable (IV) method to provide constant PUR test statistics that are not affected by the cross section dependence. Choi (2001) modelled the cross dependence imposing the same pair-wise error covariances across the different cross section units. Phillips and Sul (2003) tested directly the panel unit root in the time series and not in its components. Pesaran (2007) proposed the "Cross Sectionally Augmented Dickey-Fuller" (CADF). Moon & Perron (2004) suggested a procedure according to which the common factors of the different cross sections have differential effects, Bai & Ng (2010) used (PANIC) residuals estimating the pooled autoregressive coefficient. Among the tests of the third generation, Chang & Song (2009) developed a PUR test that is valid for very general panels.

All the variables (exception FDI variable) are taken in natural logarithm. Below, the first-generation tests and the CADF test of the second generation are used and this is what are applied using the RATS software (version 9.2) are. For all used tests, the following is considered:

- Number of panels = 6, number of periods = 16
- Individual Specific Component: Constant
- The average lags chosen from p_{max} respect the suggestions of Schwert (1989), Newey & West (1994), Ng & Perron (2001):$pmax = int\left(4\left(\frac{T}{100}\right)^{1/4}\right) \approx 3$

For the variables in order rgdp, hdi, labor, FDI, rexp, rimp andgcf, the average lags (data in level) are (0.17), (0.83), (2.33), (0.67), (1.67), (0.67) and (1.17) respectively, while for the data in first difference, the average lags are (0.00), (0.67), (2.17) (0.50) (1.00), (0.67) and (1.5) respectively is rejected. The results of the PUR tests are in table (2). Considering the results of LLC test, for the variables rgdp and labour, the null hypothesis of non-stationarity at 5 % and 1 % significance level respectively is rejected. For other variables, they are integrated at order one i.e.I(1), whereas on the basis of the IPS tests statistics, it would be concluded that the unit root hypothesis is rejected for all variables (exception rexp and gcf) and by consequence all the variables are I(1). Using the Breitung's test statistics, it seems that the null hypothesis that all series are stationary in first difference is strongly rejected and similar results are obtained by the HT test. The outputs of Z_μ test statistics proposed by Hadri reveal that we strongly reject the null hypothesis that all series are stationary in favour of the alternative that at least one of them contains a unit root. All the variables are at leastI(1). Finally, for the MW test statistics, all variables (exception Labour) are stationary in first difference.

Table 2: Panel unit root test (constant included)

Tests	**LLC**		**IPS**		**Breitung (λ)**	
Variables	X	ΔX	X	ΔX	X	ΔX
rgdp	**-2.17[b]**	**-4.52[a]**	-0.04	**-4.41[a]**	1.76	**-4.67[a]**
hdi	**-1.39[c]**	-0.99	0.33	**-2.30[b]**	0.45	**-2.78[a]**
labour	**-2.86[a]**	**-1.4[c]**	-0.04	**-3.13[a]**	-0.21	**-3.84[a]**
FDI	0.08	**-4.55[a]**	-0.98	**-4.77[a]**	**-2.99[a]**	**-4.91[a]**
rexp	-0.75	2.35	**-3.40[a]**	**-2.21[b]**	**-2.46[a]**	**-3.57[a]**
rimp	**-1.32[c]**	**-3.32[a]**	-0.11	**-4.54[a]**	0.46	**-3.97[a]**
gcf	-0.51	**-3.95[a]**	**-1.74[b]**	**-4.89[a]**	-0.46	**-3.15[a]**

Tests	MW		Hadri (LM)		HT			
Variables	X	ΔX	X	ΔX	X		ΔX	
					$\hat{\rho}$	Z	$\hat{\rho}$	Z
rgdp	**27.09**[a]	**60.71**[a]	15.34	8.02	0.88	0.81	-0.01	**-10.49**[a]
hdi	16.54	**44.98**[a]	16.54	5.62	0.93	1.42	0.23	**-7.46**[a]
labour	**45.13**[a]	14.37	16.27	6.77	0.96	1.86	0.68	**-1.72**[c]
FDI	**22.96**[a]	**63.34**[a]	5.23	6.68	0.64	**-2.46**[b]	-0.12	**-11.87**[a]
rexp	**31.89**[a]	**36.55**[a]	9.21	7.18	0.72	-1.42	0.11	**-8.98**[a]
rimp	19.90	**65.26**[a]	12.83	7.98	0.72	-1.42	-0.15	**-12.20**[a]
gcf	**31.42**[a]	**57.85**[a]	8.30	4.81	0.58	**-3.23**[b]	-0.10	**-11.57**[a]

a, b, and c denote rejection of the null hypothesis at the "1%, 5% and 10% significance levels" respectively.

Before deciding whether or not panels are stationary, the cross section dependence among the residuals resulting from the individual ADF(p = 0,1,2,3) regressions (included intercept only) and computing (6 × 5) /2 = 15 correlation coefficients (namely $\hat{\rho}_{ij}$) for each variable is tested. The simple averages of these correlation coefficients are calculated with the associated "cross section dependence" (**CD**) test statistics proposed by Pesaran (2004):

$$\bar{\hat{\rho}} = \frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \quad (1)$$

$$CD = \left(\frac{TN(N-1)}{2}\right)^{1/2} \bar{\hat{\rho}} \quad (2)$$

Under the null hypothesis of zero cross section dependence CD is asymptotically distributed as N(0,1) . The results of (CD) test statistics are presented in the table (3).

Table 3: Cross Section Correlations of the Errors in the ADF(p) Regressions of variables (N = 6)

p	0	1	2	3	0	1	2	3
Variables	$\bar{\hat{\rho}}$				CD			
rgdp	0.706	0.897	0.888	0.870	**10.93**[a]	**13.90**[a]	**13.76**[a]	**13.47**[a]
hdi	0.091	-0.019	0.060	0.073	1.41	-0.30	0.93	1.12
Labour	0.626	0.416	0.228	0.201	**9.69**[a]	**6.45**[a]	**3.54**[a]	**3.12**[a]
FDI	0.112	0.082	0.077	0.133	1.73	1.28	1.19	2.05
rexp	0.735	0.807	0.771	0.741	**11.38**[a]	**12.50**[a]	**11.95**[a]	**11.48**[a]
rimp	0.062	0.038	0.014	-0.009	0.95	0.59	0.22	-0.14
gcf	0.362	0.328	0.340	0.293	**5.61**[a]	**5.08**[a]	**5.27**[a]	**4.54**[a]

[a] Rejection of the null hypothesis at the 1%, significance level.

Inspecting results in table (3), it seems that the null of cross section independence for the variables rgdp, labor, rexp and gcf is strongly rejected and by consequence the CD statistics inform clearly that the ADF residuals associated of each from these variables are highly correlated across countries. For other variables, cross section independence is considered. As previously seen, the IPS technique proposes PUR tests for dynamic heterogeneous panels based on the mean of individual unit root statistics. Under the null hypothesis and no cross section dependence, the IPS is asymptotically distributed as $N(0,1)$. Pesaran (2007) proposes a CADF version of the IPS entitled (CIPS) that allows for cross section dependence. In fact, the CIPS statistic is none other than $\overline{CADF}$ statistic based on the Augmented Dickey–Fuller (ADF) statistics averaged across the group. In table 4, all variables (except labor) are $I(1)$ with (p=0) and let us return to the IPS results, the variable rexp is I(0) in level with ($\bar{p} = 1.67$) but it is I(1) according to the CIPS test with (p = 0,1,2). For this, there is a strong tendency to accept it as a first difference. Finally, observing all the results offered by the PUR tests globally, we decide to consider all the variables as stationary in first differences thus I (1).

Table 4 : CIPS test statistics for GCC panel data

	Level				First difference			
Variables	P=0	P=1	P=2	P=3	P=0	P=1	P=2	P=3
rgdp	-1.38	-2.02	-1.55	-1.44	**-2.35**[c]	-1.58	-1.71	-1.05
hdi	-1.48	-2.00	-1.95	**-3.77**[a]	**-2.30**[c]	-2.00	-1.46	**-16.27**[a]
labour	**-2.91**[a]	**-4.47**[a]	**-2.97**[a]	**-2.59**[b]	-1.42	-1.91	-2.25[c]	-0.68
FDI	**-2.85**[a]	**-2.96**[a]	**-2.87**[a]	**-9.23**[a]	**-4.12**[a]	**-2.84**[a]	**-2.41**[b]	**-7.12**[a]
rexp	-1.76	-1.89	-2.04	**-2.67**[a]	**-2.93**[a]	-2.19	**-2.61**[b]	**-2.82**[a]
rimp	-1.07	-0.56	-0.24	0.34	**-3.52**[a]	-2.18	-1.21	-0.73
gcf	-1.82	-1.03	-0.96	-1.45	**-3.73**[a]	-2.13	-1.10	**-2.92**[a]

a, b, and c denote rejection of the null hypothesis at the 1%, 5% and 10% significance levels respectively. The critical values at the 1%, 5% and 10% significance levels are around -2.66, -2.37 and -2.22 respectively (Intercept only)

5. Pedroni's methodology and panel co-integration test

The research of long run relationship among integrated variables enjoyed very important popularity in the empirical literature. McCoskey & Kao (1998), Kao (1999), Baltagi & Kao (2000), Pedroni (1995, 1996, 1997, 1999, 2001, 2004, 2007) proposes residual-based, while Groen & Kleibergen (2003), Larsson & Lyhagen (1999) and Larsson, Lyhagen, & Lythgren (2001) propose maximum-likelihood-based panel co-integration test statistics, Westerlund (2007) proposes new error correction-based co-integration tests for panel data with small size distortions. In this case study, the long-run relationship between the dependent real GDP (rgdp=Y) variable and the explanatory variables$(\text{hdi} = X_1)$, $(\text{labour} = X_2)$, $(\text{FDI} = X_3)$, $(\text{rexp} = X_4)$, $(\text{rimp} = X_5)$ and $(\text{gcf} = X_6)$ is tested, examining a panel spanning the years 2000 to 2015 across 6 (GCC) countries, in terms of logarithms (exception FDI). No one series will diverge from all the remaining series and that co-integrating relationships exist. Therefore, the objective of this article is to construct a panel co-integration study using the Pedroni procedure. In fact, Pedroni adopted respectfully the two-step approach proposed by Engle and Granger (1987) destinated to test the unit root in the case of univariate time series and to extend this procedure for the residual-based panel co-integration tests for the regression model. He proposes several residual-based null of no co-integration panel test statistics. Using Pedroni's procedure, the goal consists to test the hypothesized long-run regression between the dependent variable rgdp and six other independent variables (N=6) as the following:

$$Y_{it} = \alpha_i + \beta_{1i} X_{1i,t} + \beta_{2i} X_{2i,t} + \beta_3 X_{3i,t} + \beta_{4i} X_{4i,t} + \beta_{5i} X_{5i,t} + \beta_{6i} X_{6i,t} + e_{it}$$

$$i \epsilon [1,6], t \epsilon [1, T] (3)$$

Pedroni takes into consideration the heterogeneity of the parameters that may differ among individuals. Such heterogeneity can be located both at the long-run regression i.e. the co-integration relations, and at the short-run dynamics. Thus, under the alternative hypothesis, there exists a co-integration relation which is specific for each individual. Pedroni proposes seven statistics, four of which are based on the "within-dimension" and three on the "between-dimension". The first type of four statistics based on "within-dimension" (panel co-integration statistics) is:

- Non-parametric test referred to the "panel-$\boldsymbol{\nu}$ statistic".
- Non-parametric test referred to the "panel ρ-statistic" of Phillips-Perron.
- Non-parametric test referred to the "panel t-statistic" of Phillips-Perron or "panel pp-statistic".
- Parametric test referred to the "panel t-statistic" of ADF " panel ADF-statistic".

The second type of three statistics based on "between-dimension" (group mean panel co-integration statistics) is:

- Non-parametric test referred to the "group ρ-statistic" of Phillips-Perron.
- Non-parametric test referred to the "group t-statistic" of Phillips-Perron or "group pp-statistic".
- Parametric test referred to the "group t-statistic" of ADF or "group ADF-statistic".

These three statistics allow autoregressive parameter to vary over the cross section, based on estimators that simply average the individually estimated coefficients for each member. Using an appropriate normalizations based on Brownian motion functions, Pedroni has shown that each of the 7 statistics follows a standard normal distribution for T and N sufficiently large:

$$\frac{\mathfrak{X}_{N,T}-\mu\sqrt{N}}{\sqrt{v}} \sim N(0,1)(4)$$

Where $\mathfrak{X}_{N,T}$ refers to one of the seven standardized statistics, μ and v are the moments tabulated by Pedroni (1999). Under the alternative hypothesis, “panel-$\boldsymbol{v}$ statistic” is a right tailed test (an upper test) i.e. the null of no co-integration for the large positive values is rejected. The remaining statistics are left tailed tests (lower tests) and by consequence the null of no co-integration for the large negative values is rejected. In terms of power, for shorter panels, with$(T \leq 20)$, simulations made by Pedroni reveal that the group ADF generally doing best, followed by the panel ADF and the panel rho. Statistically speaking, for all tests, the null hypothesis of no co-integration is:

$$H_0: \gamma_i = 1\ \forall i = 1, \dots, N$$

Where the parameter γ_i is estimated in the model:

$$\hat{e}_{it} = \gamma_i \hat{e}_{it-1} + u_{it}(5)$$

With $\hat{e}_{it}$ is the estimate residue for the equation (3). The alternative hypothesis changes according to the within (intra) or between (inter) dimension vision. In the “within-dimension”:

$$H_a: \gamma_i = \gamma < 1\ \forall i = 1, \dots, N$$

Where γ is a common value? The alternate to no co-integration must be that if the individuals are co-integrated, then they will exhibit the samelong run co-integrating relationships. In the “between-dimension”:

$$H_a: \gamma_i < 1\ \forall i = 1, \dots, N$$

Where a common value $\gamma$is not required. Under this alternative hypothesis, the individual cross sections contain co-integrating relationships that are free to take on different values for different members of the panel, in other words, the presence of heterogeneity among individuals is allowed.

Since in practice, it is rare to find identical co-integration vectors for all individuals, heterogeneity through parameters that may differ between individuals is considered. Using the software RATS, table 5 indicates the results of co-integration tests. The ADF and PP statistics are certainly in favour of rejection of the null. The results are similar for the raw and demeaned data.

Table 5: Pedroni Panel Co-integration Tests

Alternative hypothesis : Common AR coefficients "within-dimension"		
Tests	Statistics	
	Raw	Relative to mean
Panel-***v*** statistic (non-parametric)	-1.44	-1.36
Panel ρ-statistic(non-parametric)	2.28	2.04
Panel pp-statistic (non-parametric)	-3.27**	-4.96**
Panel ADF-statistic (parametric)	-3.30**	-5.21**
Alternative hypothesis : Individual AR coefficients "between-dimension"		
Tests	Statistics	
	Raw	Relative to mean
Group ρ-statistic (non-parametric)	3.25	2.83
Group pp-statistic (non-parametric)	-4.19**	-6.30**
Group ADF-statistic(parametric)	-4.00**	-5.91**
(**) indicate the rejection of the null hypothesis of no co-integration on the "1 % significance level "		

The variance ratio test is right-sided, while the other Pedroni tests are left-sided. All reported values are distributed $N(0,1)$ under the null of unit root or no co-integration. For the left-sided tests, the rejection of the null will take place in the left tail. The critical values are $-1.28, -1.64$ and -2.33 at $10\ \%, 5\%$ and 1% significance levels respectively. Inspecting table 5, the ADF and PP statistics are certainly in favour of rejection of the null, while the rho statistics aren't. The results are similar for the raw and demeaned data. Finally, noting when the original time series Y_{it} is transformed into deviations from time means, then a new time series given by $\widetilde{Y}_{it} = Y_{it} - \overline{Y}_t;\ \overline{Y}_t = \frac{1}{N}\sum_{i=1}^{N} Y_{it}$ is constructed. These are the demeaned time series. It is also interest to note that the variable on the right hand side (RHS) of the model may be endogenous. This endogeneity means that the explanatory variable is correlated with the error term. The correlation of a RHS variable with the error term means that OLS is neither unbiased nor consistent.

6. Estimation of the long-run relationship among the variables

When the residues of the co-integration relationship are correlated with the innovations of regressors, the "ordinary least squares" estimators "OLS" of the co-integration vector parameters are biased. This bias entitled as long-term endogeneity or a bias of the second order implies non-standard distributions of the main usual tests statistics. Given the evidence of panel co-integration, the long-run relationships among the different variables can be further estimated by several methods proposed in the literature, *e.g. the* "FMOLS" that it is semi-parametric procedure suggested by Phillips and Hansen (1990) , Phillips (1995), Pedroni (1995) and the "DOLS" estimator proposed by Stock and Watson (1993) , Kao and Chiang (2000) and Mark and Sul (2003). In both cases, the "FMOLS" and "DOLS" procedures estimate both individual-specific co-integrating vectors and an aggregated estimator. Pedroni constructs the panel "OLS" estimator for the co-integration vector parameters and shows that both the panel "FMOLS" t-statistic and "Panel FMOLS GroupMean" t-statisticof this estimator is distributed as a standard normal. When the individual dimension is sufficiently large and even for the short time series, the "FMOLS" estimator and the "FMOLS GroupMean" estimator are consistent and they have a relatively well performance controlling the likely endogeneity of the regressors and serial correlation. About the "DOLS" procedure, it consists of including lags and leads of the regressors in the equation (3) to eliminate feedback effects and endogeneity. This has the consequence of eliminating the correlations between the explanatory variables and residues. Thus the equation (3) becomes:

$$Y_{it} = \alpha_{1i} + X'_{it}\mathfrak{B}_i + \sum_{s=-p}^{p} c_{is}^{1}\,\Delta X_{1i,t+s} + \ldots + \sum_{s=-p}^{p} c_{is}^{6}\,\Delta X_{6i,t+s} + e_{it} \quad (6)$$

Where a truncation at lag p is chosen, the "DOLS" can very quickly exhaust the degrees of freedom in a data set. In fact, there will be 2p + 1 added regressors in the differences for each right side endogenous variable, plus 2p + 1 data points are lost allowing for lags and leads and differences. So with 16 observations per individual, six right side endogenous variables, $(p = 1)$ leaves us with 13 usable observations, and 25 regressors. The estimates from such an over-parameterized model will likely be unusable. For this $(p = 0)$ is choosed and the model becomes:

$$Y_{it} = \alpha_{1i} + X'_{it}\mathfrak{B}_i + c^1_{i0}\Delta X_{1i,t} + \ \ldots + c^6_{i0}\Delta X_{6i,t} + e_{it} (7)$$

This model is with 13 regressors and 15 usable observations. In the tables (6) and (7), the estimation results associated with the long-run equilibrium individually and aggregately according to the two methods "FMOLS" and "DOLS" considering the period 2000-2014 are presented:

Table 6: Group mean panel FMOLS estimation in heterogeneous panels (rgdp LHS Variable)

Country	hdi	labor	FDI	rexp	rimp	gcf	Intercept
KSA	4.177 (2.19)	0.847 (1.63)	0.009 (1.33)	0.701 (9.22)	-0.195 (-1.82)	0.087 (0.59)	-16.646 (-2.27)
UAE	7.759 (5.96)	0.435 (6.78)	-0.009 (-2.49)	0.436 (3.81)	-0.496 (-3.20)	-0.281 (-3.90)	-28.394 (-4.96)
SuO	2.440 (5.98)	0.491 (11.39)	-0.003 (-0.71)	1.367 (10.73)	-0.900 (-8.09)	0.746 (10.17)	-11.840 (-7.22)
SK	7.853 (3.03)	0.432 (5.12)	-0.059 (-3.16)	0.677 (4.01)	-1.995 (-14.15)	1.023 (13.93)	-29.625 (-2.62)
SQ	5.903 (7.91)	0.992 (59.72)	0.005 (1.22)	1.322 (13.73)	0.129 (1.52)	0.414 (3.68)	-28.821 (-8.61)
KB	10.667 (9.8)	0.865 (25.01)	0.000 (0.06)	0.270 (4.51)	0.248 (3.57)	0.007 (0.17)	-45.505 (-9.26)
Group	**5.458** **(14.23)**	**0.774** **(44.76)**	**-0.003** **(-1.53)**	**0.733** **(18.80)**	**-0.382** **(-9.05)**	**0.300** **(10.06)**	**-23.116** **(-14.26)**

Table 7: Group mean panel DOLS estimation in heterogeneous panels (rgdp LHS Variable)

Country	hdi	labor	FDI	rexp	rimp	gcf	Intercept
KSA	-2.949 (-3.92)	2.538 (12.94)	-0.020 (-7.83)	0.697 (17.79)	-0.866 (-18.96)	0.751 (12.97)	10.698 (3.68)
UAE	15.951 (22.88)	0.124 (4.29)	0.020 (8.19)	1.337 (25.70)	-1.572 (-24.43)	0.902 (14.69)	-67.486 (-21.22)
SuO	12.672 (17.84)	-0.081 (-1.60)	-0.055 (-12.84)	4.103 (23.20)	-0.561 (10.60)	0.509 (17.82)	-67.666 (-17.79)
SK	-6.458 (-4.05)	0.572 (13.71)	0.080 (6.29)	0.106 (1.40)	-2.878 (-33.07)	1.786 (36.19)	35.556 (5.07)
SQ	-1.543 (-1.98)	1.039 (125.5)	-0.062 (-15.6)	0.761 (6.0)	-0.592 (-7.08)	0.391 (6.98)	8.862 (2.68)
KB	10.707 (13.79)	0.868 (32.97)	0.007 (2.78)	0.181 (2.84)	0.297 (4.27)	-0.045 (-1.57)	-45.358 (-12.66)
Group	4.730 (18.19)	0.843 (76.67)	-0.005 (-7.76)	1.198 (31.40)	-1.029 (-36.69)	0.716 (35.55)	-20.899 (-16.43)

The results of individual estimates resulting from “FMOLS” and “DOLS” procedures are used to calculate the forecasts for the year 2015 and the performance of forecasts is compared. All results are presented in the table (8).

Table 8: Forecast performance for the year 2015 for the rgdp variable

Country	Observed data	Forecasted data		MAPE (%) Data in Log		MAPE (%) Raw data	
		FMOLS (1)	DOLS(2)	(1)	(2)	(1)	(2)
KSA	6.1520	6.1213	6.1794	**0.50**	**0.45**	**3.021**	**2.78**
UAE	5.6691	5.6826	5.6155	**0.24**	**0.95**	**1.36**	**5.22**
SuO	3.9659	3.9556	3.7087	**0.26**	**6.49**	**1.021**	**22.68**
SK	4.3880	4.3945	4.3289	**0.15**	**1.35**	**0.654**	**5.740**
SQ	4.8992	4.8967	5.0300	**0.05**	**2.67**	**0.246**	**13.98**
KB	3.2283	3.2176	3.1686	**0.33**	**1.85**	**1.066**	**5.80**

It seems clear that the “FMOLS” estimator shows an excellent forecast performance for the year 2015 compared with the “DOLS” estimator. The latter led to very bad forecasts for 2015, especially for Sultanate of Oman and State of Qatar. Using the FMOLS method, the lowest value of the APE is in Qatar (0.05 %) and the greatest value is in Saudi Arabia (0.5%). In raw date, the APE values vary between a minimum of 0.25% in Qatar and a maximum about 3 % in Saudi Arabia. All results are in line to adopt the FMOLS technique to estimate the long-term equilibrium relationship between our variables. Before ending this discussion, it is useful to mention that the signs of the parameters of the two estimated long-run equilibrium aggregate model according to both methods “FMOLS” and “DOLS” are the same.

7. Conclusion and discussion

The investigation of the long-term equilibrium relationship for each country leads to different results for both “FMOLS” and “DOLS” techniques. For the all countries and by using FMOLS, a positive impact on rgdp for both of variables hdi, labor andrexp is found. An increase of 1% in the variable hdi leads to a fairly large increase in rgdp: 4.18% in KSA, 7.76% in UAE, 2.44% in SuO (minimum impact), 7.853 in SK, 5.9% in SQ and 10.67% maximum impact) in KB. An increase 1% in the labour force have a positive impact on the rgdp countries according the previous sequence with rises 0.85 %, 0.44%, 0.49 %, 0.43% (minimum), 0.99% (maximum) and 0.87 % respectively. There is a positive impact of the rexp variable, so that a 1% increase in share of exports of GDP will have an impact on rgdp with 0.7 %, 0.44 %, 1.37 % (maximum), and 0.68 %, 1.32 % and 0.27 % respectively. Regarding the FDI variable, its negative impact is only on UAE and SK, as an increase of unit in the variable FDI leads to a decline of rgdp about 0.9% in UAE and 5.9 % in SK, noting that the average of the FDI variable was 0.466 (% of GDP) in SK during the period 2000-2015.The impact of foreign direct investment on the economic growth of the host country is very complex and it's not confirmed by saying that FDI helps to achieve high economic growth rate. It is true that, for example, the FDI may help to improve the host country's trade balance through an increase in the size and values of its export, but, in turn, that may lead to an exit some local enterprises of the market and by consequence, the private national investment rate tends to a decline. In fact, the comparison should be between the decline in private national investment and the higher growth due to FDI inflows. If the impact of FDI on growth is less than the growth lost by the decline of the national investment then the impact of the foreign direct investment on economic growth will be negative (Simionescu 2016). For this, a future proposal studying the relationship betweenthe economic growth, the foreign direct investment and the private national investment for the GCC countries is suggested. Furthermore, the effect of the rimp variable on the rgdp variable varies among the GCC countries: it is negative in KSA, UAE, SuO, and SK and positive in both SQ and KB. An increase at 1 % in imports (share of GDP) will have a decline of rgdp with 0.195 %, 0.496 %, 0.9 % and 2.0 % in KSA, UAE, SuO, and SK respectively, whereas there will be an increase of 0.13 % and 0.25 % in SQ and KB successively. Finally, there is a negative effect only on the gcf on the rgdp in UAE, so an increase at 1 % in gcf will lead to a decay of rgdp at 0.28 %, while it will lead a rise of 0.75 %, 1.02% and 0.41 % in SuO, SK and SQ respectively.

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