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Trade and GDP in World's Top Economies: Panel Co-integration Analysis

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Abstract

This study investigated the impact of exports and imports per capita (EXPPCA and IMPPCA) on the nominal GDP per capita (GDPPCA) taken in natural logarithm in the top ten economies in the world (the list of countries: United States, China, Japan, Germany, United Kingdom, India, France, Brazil, Italy, Canada. This list is based on estimates for 2017 by IMF's World Economic Outlook Database, April 2017). We performed a rich analysis of the panel unit root tests (PURT) using, firstly, the most six tests of the first generation assuming the independence of individual time series in panel and, secondly, dealing with cross-sectional dependence using the Sectionally Augmented Dickey-Fuller (CADF) test of the second generation. The findings revealed that all variables are integrated at order one. The test statistics for co-integration ended to reject the null hypothesis of no co-integration. Finally, two regressions were executed, so the group mean panel Fully Modified OLS (FMOLS) and group mean panel Dynamic OLS (DOLS) estimators. The estimation results associated with the long-run equilibrium are realized individually and aggregately according to the two methods FMOLS and DOLS. For the countries China, Japan, United Kingdom, Brazil, Italy, a positive impact of EXPPCA on GDPPCA is observed but EXPPCA do not have an impact on GDPPCA in the other countries, i.e., United States, Germany, India, France and Canada. The variable IMPPCA has a positive impact on GDPPCA for all countries (except China, Canada and Japan), but it has a negative impact both in China and Canada, and it hasn't a significant effect on the Japanese GDPPCA. About forecasts for the year 2016, it seems that the FMOLS estimator (respectively DOLS estimator) shows an excellent forecast performance for the United States, China, France, Brazil and Canada (respectively for Japan, Germany, United Kingdom, India and Italy).

Keywords: Merchandise trade; GDP; Top economies; Co-integration analysis

Introduction

In 1960, the number of independent countries in the world reached sixty countries, but now it has reached 193 countries (members in the United Nations) and the future bodes for the emergence of new countries. As telecommunication technology has made the world a small village, competition among countries, particularly developed ones, has increased both the production of goods and the markets. The competition for the production of goods and services has become an essential feature of this era. The diversification of the wealth and production of countries necessitates the need for trade exchange between them. The industrialized countries were the most in need to sell their products to the developing countries, but they need the oil that is the lifeblood of many industrialized countries in the world. The 10 countries involved in our study are distinguished by abundant industries that constitute the basis of the outputs which have contributed greatly to the availability of liquidity and investment at home and abroad. Their strong industrial power based on good oriented planning has had an impact on their expansion in the world and, consequently, their share in international trade has increased substantially, which has raised the GDP per capita in each of these countries. For more each of ten countries, consider the three variables:

GDP per capita: GDPPCA=Y_{it}

Exports per capita: EXPPCA=$X_{(1,it)}$

Imports per capita: IMPPCA=$X_{(2,it)}$

Where, i=1,…,10; t=1970, 2016

Despite the nominal value of the variable GDP per capita, it reflects a very important more information according to Mourad [1] (in fact, Mourad has built a simple linear regression model between the indicator $I_{(80/20)}$ (dependent variable Y_i, where i=1,…,78) which is the ratio of income share held by highest 20% on lowest 20% in a country and the GDP per capita independent variable (X_i). We mention that in 2010, the minimum per capita GDP was about 342 dollars in Ethiopia, while the maximum was about 102863 dollars in Luxembourg. For the $I_{(80/20)}$ indicator, we see a minimum of 3.444 in Ukraine and a maximum of 20.5 in Lesotho. Since the countries have heterogeneous values, we have scaled the data to become a vector standard for each variable:

$$X_i \to \frac{X_i}{\sqrt{\sum_{i=1}^{n} X_i^2}}, \quad Y_i \to \frac{Y_i}{\sqrt{\sum_{i=1}^{n} Y_i^2}}$$

After taking into account the heteroscedasticity of residues detected by several tests as Spearman's rank correlation coefficient by Breusch-pagan [2], White [3]. We have used the Weighted Generalized Least Squares (WGLS) to estimate the model [4] for the use of this method) and we have obtained:

$$\hat{Y}_i = 0.102 - 0.1136X_i$$

$$t_{stat} \to (15.17)\ (-4.49)$$

Thus, we have become aware that the GDP per capita is negatively related to $I_{(80/20)}$ indicator. In fact an improvement in the GDP per capita will reduce the gap between the richest and poorest in a country. Some studies have suggested that income inequality has risen more than inequality in consumption [5-7]).

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So, we have a panel data for ten countries involving measurements over 47 years. Our balanced panel data contain observations of each of the variables obtained over multiple time periods for the same individuals. The passage from univariate time series to panel series requires appropriate techniques for the panel unit root tests for cross-sectional data. Our first goal is to decide the order of the integrations of our series. During this stage, the literature of the analyses of the panel data allows us to take account of the dependence between the individual series and, consequently, we will resort to the tests adapted to this situation. Our second goal is to perform panel co-integration tests to examine the co-integrating relationship of the three variables taking Y_{it} as the output variable. At this stage, we will limit ourselves to the procedure proposed by Pedroni [8-13] knowing that other procedures can be used like the procedure proposed by Kao [14] or Groen and Kleibergen [15]. Afterward, we proceed to estimate the expected long-run relation between the variables in a panel framework with two methods, so Fully Modified OLS (FMOLS) and Dynamic OLS (DOLS) are proposed in this paper because the FMOLS or DOLS estimator is more reliable in the co-integrated panel regression [16]. Our article is divided into 7 sections, the first of which is the introduction. In the second section, we present a panoramic view of the all variables. Review of literature is devoted to section three and the panel unit root tests are dealt with in the fourth section. In the fifth and sixth sections, we performed a panel analysis co-integration tests proposed by Pedroni and the long-run equilibrium relationship is estimated using FMOLS and DOLS estimators. Finally, in the seventh section, the effects of each explanatory variable on the dependent variable are analyzed and the forecast performance for the year 2016 is measured using the MAPE criterion.

Economic evolution of the top ten economies in the world

To appreciate the economy of each of these countries, it would be useful to take a look, on the one hand, on the FDI inflows and FDI outflows and on the other hand on the evolution of GDP per capita during the period 1990-2016. Indeed, the average of the FDI inflows as a percentage of gross fixed capital formation (respectively the FDI outflows) reached 6.2% (7.2%) in United States, 7.8% (1.6%) in China, 0.4% (5.0%) in Japan, 5.9% (9.9%) in Germany, 17.3% (19.0%) in United Kingdom, 4.1% (1.3%) in India, 6.0% (13.1%) in France, 12.6% (1.6%) in Brazil , 4.2% (5.9%) in Italy and 12.3% (14.3%) in Canada. If we compare these statistics to the world average evaluated at 7.9% (7.8%), we can divide the top ten economies in terms of GDP into two groups: The first group is China, India and Brazil each of which has an average of FDI inflows greater than the average of FDI outflows. It seems that each of these three countries favors the FDI inflows more than the FDI outflows. The second group consists of the other countries, each of which seeks to invest more in the rest of the world to stimulate its economic strength and encourage its international trade. If we investigate the GDP per capita (current US$) for each country (Figure 1) then we appreciate its rapid rise from the year 1970 to the year 2016. More precisely, we find around 11 times for United States, 71 times for China, 19 times for Japan, 15 times for Germany, 17 times for United Kingdom, 15 times for India, 13 times for France, 19 times for Brazil, 15 times for Italy and 10 times for Canada. China has managed to raise GDP per capita by more than 71 times from $113 per capita in 1970 to around $8123 in 2016 with an average annual growth rate at 10.15%. While EXPPCA has increased from $2.72 in 1970 to around $1522 in 2016 (around 540 times). Regarding the size of the population of these ten countries (Figure 2), it dropped from 55.3% in 1970 to 49.35% in 2016. the German economy benefits from a highly skilled labour force and a thriving industry (27.41% of GDP in 2016), which made it a leading exporter of chemicals, motor vehicles, iron and steel products, manufactured goods, electrical products and household equipment, while the imports focus on food, petroleum products, manufactured goods, electrical products, motor vehicles. The industry in Japan economy (28.63% of GDP in 2015) where robotics is one of the most promising areas for future economic growth, with Japanese technology outperforms the rest of the world. The commercial companies such as Toyota, Sony, Toshiba and Panasonic have an international reputation. Toyota especially benefited from increased sales in North America.

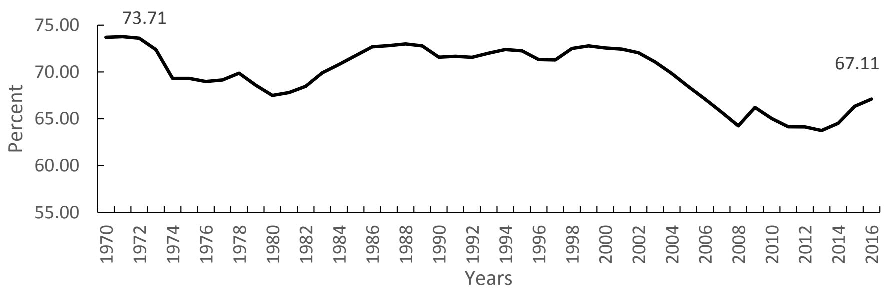

Figure 1: GDP of top ten economies in the world as share of world GDP.

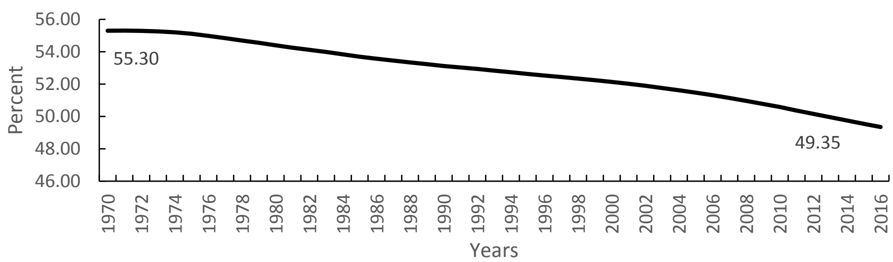

Figure 2: POP of top ten economies in the world as share of world POP.

Manufacturing is one of the pillars of Japanese economic power, but Japan has few natural resources. Therefore, one of the methods followed by Japanese companies is to import raw materials and convert them to products sold locally or exported.

Literature Review

There is a rich literature in econometrics dealing with the panel unit root and estimating the long-run equilibrium relationships among the relevant variables using Pedroni's panel co-integration approach. Mourad [17] has estimated a long-run equilibrium relationship between the real GDP in GCC countries [18] and six determinant variables such as the human development index, labor force, foreign direct investment, exports and imports as ratios of GDP and gross capital formation (% of GDP). Ahmed et al. [19] have considered the heterogeneity across the panel of eight economies in the ASEAN region to establish a long-run relationship between output, energy, trade, and emissions over a period of three decades. The log-linear Equation is used to investigate the relationship between the economic growth, CO_2 emissions, total energy consumption in transportation of goods from air, rail and road, trade openness measured as (exports and imports scaled by GDP). Panel unit root tests are used and Pedroni's panel co-integration test has been proposed for co-integration in panel data and the long-run elasticity (individual country and full panel) are estimated using the Fully Modified Ordinary Least Squares estimator (FMOLS) taking into account the heterogeneous co-integrated panel data. Jaunky and Lundmark [20] have employed a variety of univariate and panel data unit root tests to test the non-stationary process for paper production for seventeen Organisations for Economic Co-Operation and Development (OECD) members over the period 1980-2012. Three generations of panel unit root tests are considered and cross-sectional dependence is detected. Saleh et al. [21] examine the contribution of tourism industry to the GDP of three countries: Bahrain, Jordan and Saudi Arabia. Their analysis is based on a comprehensive set of panel data (transformed to natural logarithms) of tourism receipts, education investment, foreign direct investment and fixed capital formation. The results show a long-run relationship between tourism growth and GDP. Using the DOLS panel co-integration estimation technique for long-run equilibrium analysis model, the estimated coefficient (elasticity) of gross fixed capital formation (GFCF) is positively related to GDP and highly significant but with the negative and positive FDI coefficients, the relationship between FDI and GDP is concave upwards in all proposed models. Aboubacar et al. [22] investigate whether foreign aid (AID) has a significant influence on economic growth in WAEMU's (West African Economic and Monetary Union) countries (Benin, Niger, Burkina Faso, Senegal, Côte d'Ivoire, Togo, Mali, Guinea-Bissa). Using the group-mean panel FMOLS and DOLS estimators developed by Pedroni, their estimated models reveal that in the long-run, the effect of AID on economic growth is heterogeneous across sectors. Indeed, there exists a positive long-run impact of the aid in agriculture, aid in trade policies and regulations and aid in education on the economic growth. Oskooe and Akbari [23] have studied the stationarity per capita GDP of a panel of OPEC countries. The empirical results indicate that real GDP per capita series among OPEC countries are non-stationary. This means that oil price shocks would possibly permanently affect the real output levels of OPEC countries. Adeleye et al. [24] examine the impact of international trade on economic growth in Nigeria. In The Long-Run Model Equation, there is a negative impact of the total import on the economic growth, while the total export will affect the economic growth positively. Firat [25] has dealt with the unit root hypothesis related to the real GDP for thirty-five advanced economies. The results obtained from the unit root tests in applied singular and panel structures suggest that the null hypothesis must not be rejected. In order to evaluate the effects of international trade on China's economic growth, Sun and Heshmati [26] inform us that the iinternational trade inspected in China's thirty-one provinces for a period of six years, has made an increasingly significant contribution to economic growth. In the panel unit root context, Ozturk and Kalyoncu [27] have analysed the stationarity of real GDP per capita for 27 OECD countries using panel unit root tests. The results overwhelmingly indicate that real GDP per capita series among OECD countries are non-stationary. Ramirez [28] has utilized the FMOLS procedure developed by Pedroni to generate consistent estimates of panel co-integration for production and labor productivity function considering the stock of private capital and the public capital stock. The results suggest that, in the long-run, changes in the stocks of public and private capital and the economically active population have a positive and economically significant effect on Real GDP and labor productivity. Lee [29] has studied three annual time series (in natural logarithms), RGDP, energy use (EU) and real gross capital formation (GCF), for the eighteen developing countries. The used panel unit root tests confirm that three series have a panel unit root. Based on the tests for co-integration suggested by Pedroni, Lee concludes that the variables GDP, EC, and K move together in the long run. The FMOLS estimates of the elasticities of energy consumption and capital stock with respect to GDP are positive in most countries, that is, an increase in capital stock or energy consumption tends to promote RGDP. Keller [30] discussed that international trade which involves importing intermediate goods of a high quality contributed to the diffusion of technology.

Methodology

Panel unit root tests (PURT)

In terms of time, we have three generations of panel unit root tests (PURT). In the first generation, the literature assumed that the individual time series in the panel were cross-sectionally independently distributed. We quote the most used tests in practice, such as Levin and Lin [31,32], Levin, et al. (LLC) [33], Harris and Tzavalis (HT) [34] Breitung (λ) [35], Im, Pesaran and Shin (IPS) [36], Maddala and Wu (MW) [37], Hadri (LM) [38] . The null hypothesis of these tests is that all panels contain a unit root (except Hadri 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 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 the critical values of (-2.326), (-1.645), and (-1.282) correspondingly, however, for Hadri 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 for a panel data with N=10 and T=50, the critical values (trend included) are (-2.82), (-1.97) and (-1.54) at 1%, 5%, and 10% significance levels respectively. For (MW) test (non-parametric Fisher-type test), it is distributed as χ^2 with (2N=24) degrees of freedom and the associated critical value is (36.41) to 5% significance level. In the second generation, these tests were based on the idea of abandoning the independence between panels and dealt with the problem of cross section dependence suggesting the advantage of the common individual movement of time series to obtain new test statistics for the panel unit root. We quote the most used tests in practice. Bai and Ng [39,40] used a method entitled "Panel Analysis of Non stationarity in the Idiosyncratic and Common components" (PANIC), Chang [41,42] adopted a nonlinear instrumental variable (IV) method to provide constant panel unit root test statistics that are not affected by the cross section dependence, Choi [43] modelled the cross dependence using a two-way error-component model which imposes the same pair-wise error covariances across the different cross section units, Phillips and Sul [44], unlike the PANIC technique proposed by Bai and Ng to test the unit root separately in the common and individual components of the time series, they test directly the panel unit root in the time series and not in its components, Pesaran [45] proposed a simple alternative where the standard ADF regressions are augmented with the cross section averages of lagged levels and first-differences of the individual series , he named his test "Cross Sectionally Augmented Dickey-Fuller (CADF)", Moon and Perron [46] suggested a procedure according to which the common factors have differential effects on different cross section units, Bai and Ng [47] used (PANIC) residuals to form two new tests estimating the pooled autoregressive coefficient, and using simply a sample moment. Among the tests of the third generation we mention Chang Q and Song [48] which developed a panel unit root test that is valid for very general panels. Below we will use the first-generation tests and the CADF test of the second generation and this is what we have been able to apply using the RATS software (version 9.2). For all used tests, we have the following: The average lags chosen from p_{max} such that, following Schwert [49], Newey and West [50], Ng and Perron [51], the maximum lag is computed considering a bandwidth according to the rule.

$$pmax = int\left(4\left(\frac{T}{100}\right)^{1/4}\right) \approx 3$$

All the variables are taken in natural logarithm. In fact, for purposes of economics analysis, the great advantage of the natural logarithm is that small changes in the natural log of a variable are directly interpretable as percentage changes, to a very close approximation. Below we will use the first-generation tests and the CADF test of the second generation and this is what we have been able to apply using the RATS software. For the variables in order RGDPCA, EXPPCA and IMPPCA, the average lags (data in level) are respectively [(1.3), (2.1), (2.2)] while for the data in first difference, the average lags are [(0.5), (0.7), (0.6)] respectively. In Table 1 reported the results of PUR tests.

It seems that it is convenient to consider the variables in the first difference to reach stationarity. Before deciding whether or not panels are stationary, the degree of cross section dependence is tested estimating individual ADF (p=0,1,2,3) regressions included intercept but without cross section augmentations and computing pair-wise cross section correlation coefficients of the residuals from these regressions (namely $\hat{\rho}_{ij}$ The simple average of these correlation coefficients across all the ((10 × 9)/2=45 pairs, together with the associated cross section dependence (CD) test statistics proposed in Pesaran [52] are given by:

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

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

Under the null hypothesis of zero, cross section dependence CD is asymptotically distributed as N(0,1). The results of (CD) test statistics are in the Table 2:

Inspecting results in Table 3, it seems that we reject strongly the null of zero cross section dependence for the all variables and by consequence the CD statistics leave little room for doubting that the errors associated of each from these variables are highly correlated across countries. As we have seen previously, the IPS technique proposes unit root tests for dynamic heterogeneous panels based on the mean of individual unit root statistics. Under the unit root hypothesis and no cross section dependence IPS is asymptotically distributed as N(0,1). Pesaran proposes a cross-sectionally augmented version of the IPS (CIPS) that allows for cross section dependence. In fact the CIPS statistic is none other than $\overline{\text{CADF}}$ statistic based on the Augmented Dickey-Fuller statistics averaged across the group. In Table 3, all variables are I(1) for all values of (p). For this, there is a strong tendency to accept the null hypothesis (all panels contain unit roots). Finally, observing globally all the results offered by the panel unit root tests, we decide to consider all the variables as stationary in first differences thus I(1).

Pedroni's methodology and panel co-integration test

The use of co-integration techniques to test for the presence of

Tests	LLC		IPS $Z_{\bar{t}-bar}$		Breitung (λ)			
Variables	X	Δ X	X	Δ X	X		Δ X	
GDPCAP	0.07	-4.61[a]	0.88	-7.42[a]	0.02		-10.69[a]	
EXPPCA	-0.20	-3.88[a]	-1.09	-7.22[a]	-5.27[a]		-10.54[a]	
IMPPCA	0.07	-4.55[a]	-2.03[b]	-7.66[a]	-5.86[a]		-11.69[a]	
Tests	**MW**		**Hadri (LM)**		**HT**			
Variables	X	Δ X	X	Δ X	X		Δ X	
					$\hat{\rho}$	Z	$\hat{\rho}$	Z
GDPCAP	61.29[a]	89.28[a]	281.61	146.33	0.90	1.85	0.14	-21.88[a]
EXPPCA	66.01[a]	78.28[a]	228.22	149.24	0.86	0.45	0.10	-23.13[a]
IMPPCA	82.01[a]	74.54[a]	174.05	116.02	0.83	-0.48	0.15	-21.5[a]

[a]Rejection of the null hypothesis at the 1%, 5% and 10% significance levels respectively.

Table 1: Panel unit root test (trend included).

p	0	1	2	3	0	1	2	3
Variables			$\bar{\hat{\rho}}$				CD	
GDPCAP	0.429	0.268	0.251	0.258	19.73[a]	12.32[a]	11.52[a]	11.86[a]
EXPPCA	0.418	0.650	0.658	0.665	19.22[a]	29.91[a]	30.28[a]	30.60[a]
IMPPCA	0.477	0.646	0.641	0.642	21.93[a]	29.70[a]	29.48[a]	29.54[a]

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

Table 2: Cross section correlations of the errors in the ADF (p) regressions of variables (trend included).

Variables	Level intercept and trend				First difference intercept			
	P=0	P=1	P=2	P=3	P=0	P=1	P=2	P=3
GDPCAP	-1.55	-1.71	-1.77	-1.75	-5.39[a]	-3.92[a]	-3.27[a]	-2.63[a]
EXPPCA	-1.76	-1.95	-1.68	-1.78	-5.75[a]	-4.67[a]	-3.35[a]	-2.67[a]
IMPPCA	-1.75	-2.04	-1.71	-1.75	-5.82[a]	-4.64[a]	-3.51[a]	-2.79[a]
The critical values at the 1%, 5% and 10% significance levels are around -3.06, -2.84 and -2.73 respectively.					The critical values at the 1%, 5% and 10% significance levels are around -2.55, -2.33 and -2.21 respectively.			

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

Table 3: CIPS test statistics for the panel data (trend included).

long run relationships among integrated variables has enjoyed growing popularity in the empirical literature. McCoskey and Kao [53], Kao [16], Baltagi and Kao [54], Pedroni [8-13,55] proposes residual-based, while Groen and Kleibergen [15], Larsson and Lyhagen [56] and Larsson et al. [57] propose maximum-likelihood-based panel co-integration test statistics, Westerlund [58] proposes new error correction-based co-integration tests for panel data having good small-sample properties with small size distortions. In our case, we tested the long-run relationship between the (GDPPCA=Y) and the two variables (EXPPCA=X_1) and (IMPPCA=X_2) examining a panel spanning the years 1970 to 2016. The data are expressed in natural logarithms. It was expected that no series will diverge from all the remaining series and that co-integrating relationships exist. Therefore, the objective of this research is to construct a panel co-integration study using the Pedroni procedure which allows varying the degree of heterogeneity allowed among the members of the panel. Based on the co-integration tests and the unit root tests proposed by Engle and Granger [59] in the case of univariate time series [18], one might be tempted to think that the statistics of the panel unit root could be directly applicable to the tests of null of no co-integration, with perhaps some changes in critical values to reflect the use of estimated residues. Pedroni extends the procedure of residual-based panel co-integration tests for the models, where there is more than one independent variable. He proposes several residual-based null of no co-integration panel co-integration test statistics. Pedroni proposes seven statistics, four of which are based on the within-dimension and three on the between-dimension. For the steps to follow in this method [17] we considered the hypothesized long-run regression between the dependent variable GDPPCA and two other explanatory variables (M=2) as the following:

$$y_{1it}=\alpha_i+g_i t+\beta_{1i} x_{1it}+\beta_{2i} x_{2it}+e_{it} \quad (1)$$

$i\epsilon[1,10]$, $t\epsilon[1,T]$

Where y_{1it} represents $\ln(y_{1it})$ over time periods (t=1,….., T) and countries (i=1,….., N). Likewise x_{1it} and x_{2it} represent $\ln(x_{1it})$ and $\ln(x_{2it})$ respectively. The α_i represents the country-specific fixed effects, and g_i represents potentially heterogeneous country-specific deterministic trends. We used the estimate residuals $\hat{e}_{it}$ in (1) to estimate the model:

$$\hat{e}_{it} = \gamma_i \hat{e}_{it-1} + u_{it} \quad (2)$$

Statistically speaking, the null hypothesis of no co-integration is:

H_0: $\gamma=1$ ∀ i=1,………,N.

Whereas, the alternative hypothesis changes according to the within (intra) or between (inter) dimension vision. In the within-dimension:

H_a: $\gamma_i=\gamma<1$ ∀ i=1,………,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 same long run co-integrating relationships.

In the between-dimension:

H_a: $\gamma_i<1$ ∀ i=1,………,N.

Where, a common value γ 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, we allow the presence of heterogeneity between individuals. Since in practice, it is rare to find identical co-integration vectors for all individuals, we therefore assume that the heterogeneity through parameters will differ among individuals. Fixed effects and heterogeneous trends have been included for all tests. Using the software RATS (version 9.2), Table 4 reports both the within and between dimension panel co-integration test. We report results for the raw data as well as for data that have been demeaned with respect to the cross-sectional dimension for each time period, which serves to extract common time effects from the data. The test is done with raw data using the options (Det=trend, Lags=6) and relative to mean to remove the time effects using the options (Det=trend, Lags=6, TDUM: to subtract out common time effects). For the demeaned data, four among seven test statistics, Panel and group ADF-statistics (1% significance level), panel PP and Panel-ν statistics (10% significance level successively) reject the null hypothesis of no co-integration.

Estimation of the long-run equilibrium relationship between 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 between the different variables can be further estimated by several methods proposed in the, e.g., the Fully-Modified Ordinary Least Squares (FMOLS) that it is semi-parametric procedure suggested by Phillips and Hansen [60], Phillips [61], Pedroni [8] and the dynamic OLS (DOLS) estimator proposed by Stock and Watson [62], Kao and Chiang [16] and Mark and Sul [63]. In both cases, the FMOLS and DOLS procedures estimate both individual-specific co-integrating vectors and an aggregated estimator. The DOLS procedure includes lags and leads of the regressors to eliminate feedback effects and endogeneity. The DOLS can very quickly and exhaust the degrees of freedom in a data set. If we choose truncation at lag p, there are 2p+1 added regressors in the differences for each right side endogenous variable, plus we lose 2p+1 data points allowing for lags and leads and differences. So with 46 observations per individual, two right-side endogenous variables, (p=2) leaves us with 41 usable observations, and 12 regressors. For this, we estimated the model:

$$\tilde{y}_{it} = \beta_{1i}\tilde{x}_{1it} + \beta_{2i}\tilde{x}_{2it} + \sum_{s=-2}^{2} c_{is}^{1}\Delta\tilde{x}_{1i,t+s} + \sum_{s=-2}^{2} c_{is}^{2}\Delta\tilde{x}_{2i,t+s} \quad (3)$$

$i\epsilon[1,10]$, $t\epsilon[p+1,T-p-1]$.

Alternative hypothesis: Common AR coefficients (within-dimension)		
Tests	Statistics	
	Raw data	Demeaned data
Panel-v statistic (non-parametric)	2.30**	1.36*
Panel ρ-statistic (non-parametric)	-1.02	-0.93
Panel pp-statistic (non-parametric)	-1.28*	-1.57*
Panel ADF-statistic (parametric)	-1.07	-2.62***
Alternative hypothesis : Individual AR coefficients (between-dimension)		
Tests	Statistics	
	Raw	Demeaned data
Group ρ-statistic (non-parametric)	-0.08	0.19
Group pp-statistic (non-parametric)	-0.93	-0.99
Group ADF-statistic (parametric)	-0.71	-2.73***

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.
Conclusion: The estimation proceeds on the basis that the demeaned series are co-integrated.
Note 1: The data have been demeaned with respect to common time effects to accommodate some forms of cross-sectional dependency, so that in place of y_{it}, x_{1it} and x_{2it} we use:

$$\tilde{y}_{it} = Y_{it} - \overline{Y}_t ; \overline{Y}_t = \frac{1}{N}\sum_{i=1}^{N} y_{it}$$

$$\tilde{x}_{jit} = x_{jit} - \overline{x}_{jt} \; ; \overline{x}_{jt} = \frac{1}{N}\sum_{i=1}^{N} x_{jit} \; ; j = 1,2$$

Note 2: A variable on the right hand side (RHS) of your model may be endogenous. This endogeneity means that the explanatory variable is correlated with the model's error term. The correlation of a RHS variable with the error term means that OLS is neither unbiased nor consistent.
Note 3: Kernel width=6

*, **, *** indicates the rejection of the null hypothesis of no co-integration on the 10%, 5% and 1 % significance levels respectively.

Table 4: Pedroni panel co-integration tests results.

In Table 5, we present the estimation results associated with the long-run equilibrium individually and aggregately according to the two methods FMOLS and DOLS (between parentheses figure the t-statistics). For all of the group mean FMOLS estimates and standard errors in Table 5, we have considered the case in which the data have been demeaned over the cross-sectional dimension in order to account for some of the likely cross-sectional dependence through common time effects. The FMOLS group mean estimators for the panel as a whole provide credible estimates for the parameters.

The RATS option (AVERAGE=simple) is an equally weighted average. For the full sample, the group mean estimates associated with $\tilde{x}_{1it}$ and $\tilde{x}_{2it}$ are both positive.

LHS Variable: demeaned variable $\tilde{y}_{it}$				
	FMOL		DOLS	
Country (i)	$\tilde{x}_{1it}$	$\tilde{x}_{2it}$	$\tilde{x}_{1it}$	$\tilde{x}_{2it}$
United States	0.4689 (4.83)	0.5239 (4.11)	0.4730 (4.84)	0.3883 (2.77)
China	2.1777 (4.29)	-1.6606 (-3.0)	2.4712 (5.63)	-1.9774 (-3.99)
Japan	1.8536 (6.50)	-1.1357 (-2.79)	1.8261 (5.74)	-0.8442 (-1.62)
Germany	-0.0462 (-0.17)	1.1757 (6.46)	0.0789 (0.12)	1.3510 (5.15)
United Kingdom	-0.7427 (-1.72)	1.0560 (1.95)	-0.5828 (-1.67)	0.9074 (2.02)
India	0.2112 (0.57)	0.2450 (0.73)	0.0371 (0.11)	0.6167 (2.06)
France	0.2135 (0.90)	0.4461 (1.77)	-0.2725 (-0.92)	0.9673 (3.03)
Brazil	0.1770 (0.80)	0.2946 (2.36)	0.3472 (1.72)	0.2485 (1.88)
Italy	1.3815 (3.17)	-0.1656 (-0.54)	1.3996 (2.50)	-0.2270 (-0.46)
Canada	0.7125 (1.55)	-0.1781 (-0.38)	1.0573 (1.79)	-0.5285 (-0.88)
Group	0.6407 (6.55)	0.0601 (3.38)	0.6835 (6.28)	0.0902 (3.15)

Table 5: Group mean panel FMOLS and DOLS estimators in heterogeneous panels.

Conclusion and Discussion of the Results

If we closely investigate the long-term equilibrium relationship for each country, we find different results for both FMOLS and DOLS techniques. For the countries USA, China, Japan, Italy, and Canada (significant at around 12%), using FMOLS, we find a positive impact of EXPPCA on GDPPCA , so an increase of 1% in the variable EXPPCA leads to a large increase in GDPPCA of 0.47%, 2.18%, 1.85%, 1.38% and 0.71% respectively but using DOLS estimator, effects will be successively 0.47%, 2.47%, 1.83% , 1.40% and 1.06%, and for Brazil, we observe a rate of 0.35% . For the rest of the countries, we did not see a significant effect of EXPPCA on GDPPCA. We also note that China has distinguished itself from other countries. China has managed to raise GDP per capita by more than 71 times from $113 per capita in 1970 to around $8123 in 2016 with an average annual growth rate at 10.15%. While EXPPCA (IMPPCA) has increased from $2.72 ($2.78) in 1970 to around $1522 ($1151) in 2016 i.e., around 540 (414) times. China's share of exports and imports in (GDP) has rapidly increased until 2008, mounted respectively from about 2.5% in 1970 to 35.21% as the highest percentage in 2006 and from 2.46% to 28.78% in 2005 and then declined after the global financial crisis that has spread rapidly since the fall of 2008, and by 2016, the shares of exports and imports reach 18.73% and 14.17% respectively. According the FMOLS and DOLS estimators, it is remarkable that EXPPCA do not have an impact on GDPPCA in the other countries. For the United States, Germany, United Kingdom, France, Brazil, using FMOLS estimator, we find a positive impact of IMPPCA on GDPPCA, so an increase of 1% in the variable IMPPCA leads to an increase in GDPPCA of 0.52%, 1.18%, 1.06%, 0.45%, 0.30% respectively. Positive effects have also been found with the DOLS procedure: 0.39%, 1.35%, 0.91%, 0.97% and 0.25% respectively. With regard to China and Japan, we see their differentiation from the rest of the countries as a 1% increase in IMPPCA leads successively to a decline at 1.66% and 1.14% according to FMOLS, 1.98% and 0.84% according to DOLS. Based on these results, it is necessary to choose between the two methods for each country calculating the forecasts for the last year 2016 noting that the period data 1970-2015 have been

Comparison of forecasts for 2016 between FMOLS and DOLS estimators: MAPE (%)											
Country	**United States**	**China**	**Japan**	**Germany**	**United Kingdom**	**India**	**France**	**Brazil**	**Italy**	**Canada**	**Group**
FMOLS	5.09	11.76	2.19	6.54	0.25	17.14	0.16	1.81	5.66	0.89	1.90
DOLS	5.84	13.12	1.63	10.31	0.75	10.77	0.54	0.04	5.45	1.02	0.86

Table 6: Forecast performance for the year 2016.

used to estimate the two predictive models. In Table 6, for each country and for the group of 10 countries we have measured the forecast performance for the year 2016 using the Mean Absolute Percentage Error (MAPE). It seems clear that both FMOLS and DOLS estimators shows good forecast performance for the year 2016 for all countries except for China and India. In fact, this finding may be understandable if we know that the GDP per capita in these two countries is the lowest in this group. The forecasts for the entire group seem to be excellent under both methods FMOLS and DOLS.

References

1. Mourad M (2016) Indicators of sustainable development in Jordan: Measuring and looking forward. The 15th International Annual Conference: Sustainability and Competitiveness in Business. Al-Zaytoonah University of Jordan, Faculty of Economics and Administrative Sciences.
2. Breusch TS, Pagan AR (1979) A simple test for heteroscedasticity and random coefficient variation. Econometrica, pp: 1287-1294.
3. White H (1980) A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. Econometrica 48: 817-838.
4. Mourad M (2017) Econometrics from Theory to Practice, Tome 1, Edition 1, 2017, Publications of the Lebanese University, Beirut, Lebanon.
5. Fisher JD, Johnson DS, Smeeding TM (2013) Measuring the trends in inequality of individuals and families: Income and consumption. Am Econ Rev 103: 184-188.
6. Fisher J, Johnson DS, Smeeding TM (2015) Inequality of income and consumption in the US: Measuring the trends in inequality from 1984 to 2011 for the same individuals. Rev Income Wealth 61: 630-650.
7. Henry LM (2014) Income inequality and income-class consumption patterns. Economic Commentary 18: 1-4.
8. Pedroni P (1995) Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Working Papers in Economics No. 95-013, Indiana University.
9. Pedroni P (1996) Fully modified OLS for heterogeneous cointegrated panels and the case of purchasing power parity. Working paper, Indiana University.
10. Pedroni P (1999) Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxf Bull Econ Stat 61: 653-670.
11. Pedroni P (2001) Purchasing power parity tests in cointegrated panels. Rev Econ Stat 83: 727-731.
12. Pedroni P (2004) Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Econometric Theory 20: 597-625.
13. Pedroni P (2007) Social capital, barriers to production and capital shares: Implications for the importance of parameter heterogeneity from a non-stationary panel approach. J Appl Econom 22: 429-451.
14. Kao C (1999) Spurious regression and residual-based tests for cointegration in panel data. J Econom 90: 1-44.
15. Groen JJ, Kleibergen F (2003) Likelihood-based cointegration analysis in panels of vector error-correction models. J Bus Econ Stat 21: 295-318.
16. Kao C, Chiang MH (2001) On the estimation and inference of a cointegrated regression in panel data. InNonstationary panels, panel cointegration, and dynamic panels. Emerald Group Publishing Limited, pp: 179-222.
17. Mourad M (2018) Vital economic determinants and real GDP in GCC countries: Panel cointegration analysis. 1st International Educational Conference-IACEB 2018: Study of contemporary economic, financial, and administrative conditions in the age of globalization, organized by the Faculty of Economics and Business Administration, Lebanese University on 3-4 May, 2018.
18. Mourad M (2015) Population growth and development prerequisites in the GCC States. Arab Center for Research and Policy Studies, Edition 1, 2015, Beirut, Lebanon.
19. Ahmed K, Bhattacharya M, Shaikh Z, Ramzan M, Ozturk I (2017) Emission intensive growth and trade in the era of the Association of Southeast Asian Nations (ASEAN) integration: An empirical investigation from ASEAN-8. Journal of Cleaner Production 154: 530-540.
20. Jaunky VC, Lundmark R (2017) Dynamics of wood pulp production: Evidence from OECD countries. forests 8: 107.
21. Saleh AS, Assaf AG, Ihalanayake R, Lung S (2015) A panel cointegration analysis of the impact of tourism on economic growth: Evidence from the Middle East region. Int J Tour Res 17: 209-220.
22. Aboubacar B, Xu D, Ousseini AM (2015) Foreign aid's effect on economic growth, new results from WAEMU's countries. Theoretical Economics Letters 5: 425.
23. Oskooe SAP, Akbari LT (2015) Is per capita real GDP stationary? Evidence from OPEC Countries. International Journal of Humanities and Social Science 5: 166-168.
24. Adeleye JO, Adeteye OS, Adewuyi MO (2015) Impact of international trade on economic growth in Nigeria (1988-2012). International Journal of Financial Research 6: 163.
25. Firat H (2016) Is real GDP stationary? Evidence from some unit root tests for the advanced economies. Journal of Social and Economic Statistics 5: 60-80.
26. Sun P, Heshmati A (2010) International trade and its effects on economic growth in China.
27. Ozturk I, Kalyoncu H (2007) Is per capita real GDP stationary in the OECD countries? Evidence from a panel unit root test.
28. Ramirez MD (2007) A panel unit root and panel cointegration test of the complementarity hypothesis in the Mexican case: 1960-2001. Atlantic Economic Journal 35: 343-356.
29. Lee CC (2005) Energy consumption and GDP in developing countries: A cointegrated panel analysis. Energy Econ 27: 415-427.
30. Keller W (2001) Knowledge spillovers at the world's technology frontier.
31. Levin A, Lin CF (1992) Unit root tests in panel data: Asymptotic and finite-sample properties. University of California. San Diego, mimeographed.
32. Levin A, Lin CF (1993) Unit root tests in panel data: New results. University of California at San Diego, Economics Working Paper Series.
33. Levin A, Lin CF, Chu CS (2002) Unit root tests in panel data: Asymptotic and finite-sample properties. J Econom 108: 1-24.
34. Harris RD, Tzavalis E (1999) Inference for unit roots in dynamic panels where the time dimension is fixed. J Econom 91: 201-226.
35. Breitung J (2001) The local power of some unit root tests for panel data. InNonstationary panels, panel cointegration, and dynamic panels. Emerald Group Publishing Limited, pp: 161-177
36. Im KS, Pesaran MH, Shin Y (2003) Testing for unit roots in heterogeneous panels. J Econom 115: 53-74.
37. Maddala GS, Wu S (1999) A comparative study of unit root tests with panel data and a new simple test. Oxf Bull Econ Stat 61: 631-652.
38. Hadri K (2000) Testing for unit roots in heterogeneous panel data. Econometrics Journal 3: 148-161.
39. Bai J, Ng S (2002) Determining the number of factors in approximate factor models. Econometrica 70: 191-221.
40. Bai J, Ng S (2004) A PANIC attack on unit roots and cointegration. Econometrica 72: 1127-1177.
41. Chang Y (2002) Nonlinear IV unit root tests in panels with cross-sectional dependency. J Econom 110: 261-292.

42. Chang Y (2004) Bootstrap unit root tests in panels with cross-sectional dependency. J Econom 120: 263-293.

43. Choi I (2001) Unit root tests for panel data. J Int Money Finance 20: 249-272.

44. Phillips PC, Sul D (2003) Dynamic panel estimation and homogeneity testing under cross section dependence. Econom J 6: 217-259.

45. Pesaran MH (2007) A simple panel unit root test in the presence of cross-section dependence. J Appl Econom 22: 265-312.

46. Moon HR, Perron B (2004) Testing for a unit root in panels with dynamic factors. J Econom 122: 81-126.

47. Bai J, Ng S (2010) Panel unit root tests with cross-section dependence: A further investigation. Econometric Theory 26: 1088-1114.

48. Chang Y, Song W (2009) Testing for unit roots in small panels with short-run and long-run cross-sectional dependencies. Rev Econ Stud 76: 903-935.

49. Schwert GW (1989) Tests for unit roots: A Monte Carlo investigation. J Bus Econ Stat 7: 147-160.

50. Newey WK, West KD (1994) Automatic lag selection in covariance matrix estimation. Rev Econ Stud 61: 631-653.

51. Ng S, Perron P (2001) Lag length selection and the construction of unit root tests with good size and power. Econometrica 69: 1519-1554.

52. Pesaran MH (2004) General diagnostic tests for cross section dependence in panels.

53. McCoskey S, Kao C (1998) A residual-based test of the null of cointegration in panel data. Econometric Reviews 17: 57-84.

54. Baltagi BH, Kao C (2000) Nonstationary panels, cointegration in panels and dynamic panels.

55. Pedroni P (1997) Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Working paper, Indiana University.

56. Larsson R, Lyhagen J (1999) Likelihood-based inference in multivariate panel cointegration models. Stockholm School of Economics Working Paper Series in Economics and Finance, pp: 331.

57. Larsson R, Lyhagen J, Löthgren M (2001) Likelihood-based cointegration tests in heterogeneous panels. Econom J 4: 109-142.

58. Westerlund J (2007) Testing for error correction in panel data. Oxf Bull Econ Stat 69: 709-748.

59. Engle RF, Granger CW (1987) Co-integration and error correction: representation, estimation, and testing. Econometrica, pp: 251-276.

60. Phillips PC, Hansen BE (1990) Statistical inference in instrumental variables regression with I (1) processes. Rev Econ Stud 57: 99-125.

61. Phillips PC (1995) Fully modified least squares and vector autoregression. Econometrica, pp: 1023-1078.

62. Stock JH, Watson MW (1993) A simple MLE of cointegrating vectors in higher order integrated systems.

63. Mark NC, Sul D (2003) Cointegration vector estimation by panel DOLS and long-run money demand. Oxf Bull Econ Stat 65: 655-680.